Building automation – impact on energy efficiency

Application per EN 15232
eu.bac product certification

Answers for infrastructure.

SIEMENS

Contents

1 Introduction

Target groups

This user's guide by Siemens Building Technologies (Siemens BT) is targetted at all participants in the planning phases for buidlings and, in particular, building automation and control.

1.1 Use, targets, benefits

The user's guide was written for building automation and control engineering and sales activities for both new and existing buildings. European standard EN15232: 2007 on "Energy Efficiency in buildings – Influence of Building Automation and Control and Building Management" and eu.bac (European Building Automation Controls Association) provides the basis for this work.

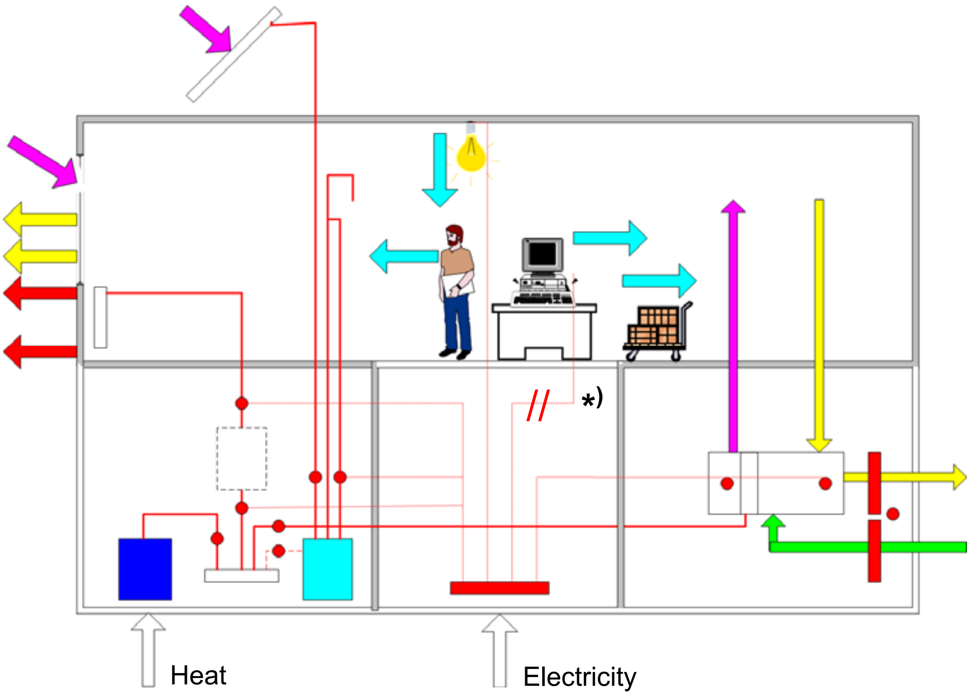
Building automation and control functions should be selected based on their impact on a building's efficiency. The purpose of the user's guide is to provide understanding on using building automation and control functions to promote higher energy efficiency in buildings as well as the methods involved. It further explains which building automation and control system functions by Siemens meet requirements per EN 15232.

The use of energy-efficient building automation and control functions saves building operating costs, existing energy resources and lowers CO_2 emissions.

1.2 What constitutes energy efficiency?

Actual consumption or calculated or estimated amounts of energy required to cover the various requirements relating to the standardized use of a building serves as the measure of energy efficiency. Per EU Directive “Energy Performance of Building Directive” (EPBD), the following thermal and electrical forms of energy are considered when determining the energy efficiency of a building:

- Heating
- DHW (domestic hot water)
- Cooling
- Ventilation
- Lighting
- Auxiliary energy



Source image: Prof. Dr. Ing. Rainer Hirschberg, FH Aachen; Germany
Example: Building without cooling

***) Note**

Equipment from building users, such as PCs, printers, machines (excluding building elevators), etc., are not part of the electrical energy needs of a building for our purposes. The heat gain does, however, influence a building’s thermal energy needs.

Building energy efficiency

Thermal and electrical energy (in the example: ⇧heat and ⇧electricity) should be kept to a minimum to achieve a high degree of energy efficiency.

The energy efficiency value for an individual building is determined by comparing it to reference values. It could, for example, be documented in an energy pass for the building.

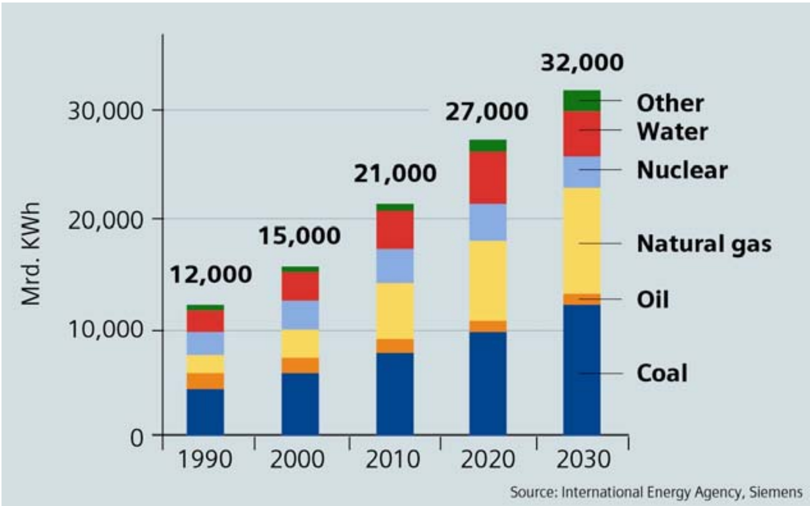
Executing regulations are assigned to the individual countries per EN standard to determine the size of the reference values or how to calculate them.

2 Global situation: energy and climate

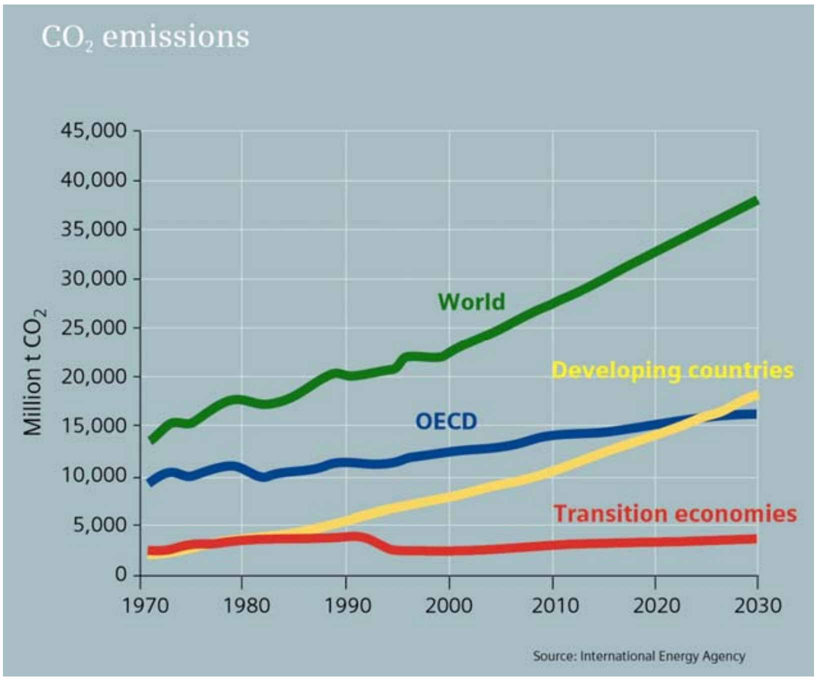
In this section, we discuss the global energy and climate situation as well as future perspectives on improving the situation.

2.1 CO_2 emissions and global climate

The global demand for energy has increased dramatically over the past decade and is likely to continue according to forecasts. Within the percentage of fossil fuels, oil is likely to stagnate or even decline in the future, while natural gas and coal are projected to increase significantly.



Global CO_2 emissions are developing in sync with the increased consumption of fossil fuels. They have strongly increased since 1970 and will continue to do so.



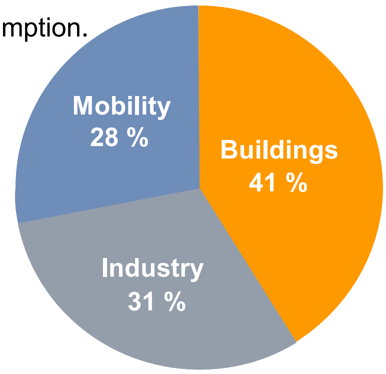
The impact of CO_2 emissions are already unmistakable: The average air temperature is continuously increasing over the long term; weather dynamics are increasing dramatically.

The consequences include an increase in storm winds and storms, damage to crops and forests, an increase in the seal level as well as mudslides, droughts and erosions – so for example, hurricane Katarina (New Orleans):

The Climate Change Report 2007 by the United Nations is calling for global action.

2.2 Primary energy consumption in Europe

Buildings account for 41 % of primary energy consumption. Of which 85 % is used for room heating and room cooling as well as 15 % for electrical energy (in particular, for lighting).



Overall, buildings account for 35 percent of primary energy use to achieve comfortable temperatures and 6 percent for electrical energy. That amounts to a significant portion.

2.3 Turning the tide – a long-term process

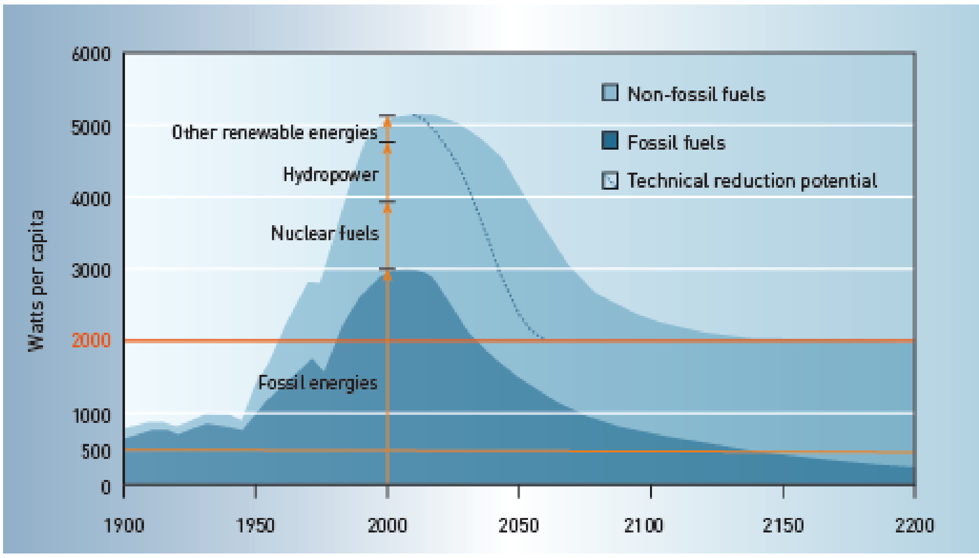
Europe has developed visions for a low-energy future and is intensely searching for ways to implement the visions:

Vision for the future

We want to find ways to continue enjoying our lives in reasonable comfort, but using less energy, and with fewer CO_2 and greenhouse emissions than today.

The scenario ”Paths toward a 2’000 watt society” as part of Swiss energy policies pursues goals that are similar to current efforts at the EU-level.

Statistics and vision "CO_2 in CH: The 2’000 watt society“ published by “Novatlantis” illustrates that the path to a low-energy society is a long-term one.



Source: Novatlantis - Sustainability within the ETH

On the one hand, the chart illustrates the dramatic rise in energy use since the end of WWII (1945 through 2000). The short collapse in the increase is probably due to the oil crises (1973) and recession (1975). Nonetheless, the oil crises evidently did not change behavior.

Greenhouse gases roughly keep pace with the increase in fossil fuels – and as is well known, these have significantly increased too.

On the other hand, the right side of the chart outlines the vision for the future: The goal is a dramatic reduction in the consumption of fossil energy carriers as well as cutting overall energy use to 2’000 watts per person.

2.4 Reduce energy use in buildings

Well-developed building construction standards are now available for low-energy houses that have proven themselves. The technology is ready to use – yet it is still going to take a number of decades before the technology is deployed throughout Europe.

New buildings

New buildings should only be built with future-oriented low-energy standards and equipped with energy-saving building automation and control functions of BAC efficiency class A.

Current situation

Europe is developed – its building inventory cannot be transitioned to state-of-the-art energy-saving construction technology either in the short or medium-term. It is only possible over the long term with available construction capacity. And the required costs will certainly be enormous.

Some existing buildings cannot even be transitioned over the long term to state-of-the-art construction technology for cultural as well as historical reasons.

With regard to energy efficiency, we will still have to deal with a less-than-optimum building environment and do the best we can – for example, with the help of building automation and control.

Update existing buildings

Various short-term measures can significantly improve the energy efficiency of existing building. Examples:

- Update using energy-saving building automation and control
- Position heating setpoint and cooling set at the far end of comfort levels
- Update mechanical ventilation with heat recovery
- Replace older boilers (often oversized, not very efficient)
- Lower the heat transmission losses on the buildings exterior
  - Replace existing windows
  - Improve insulation of the rest of the exterior shell (walls, roof)
- Update older buildings to the Minergie standard for renovations
- etc.

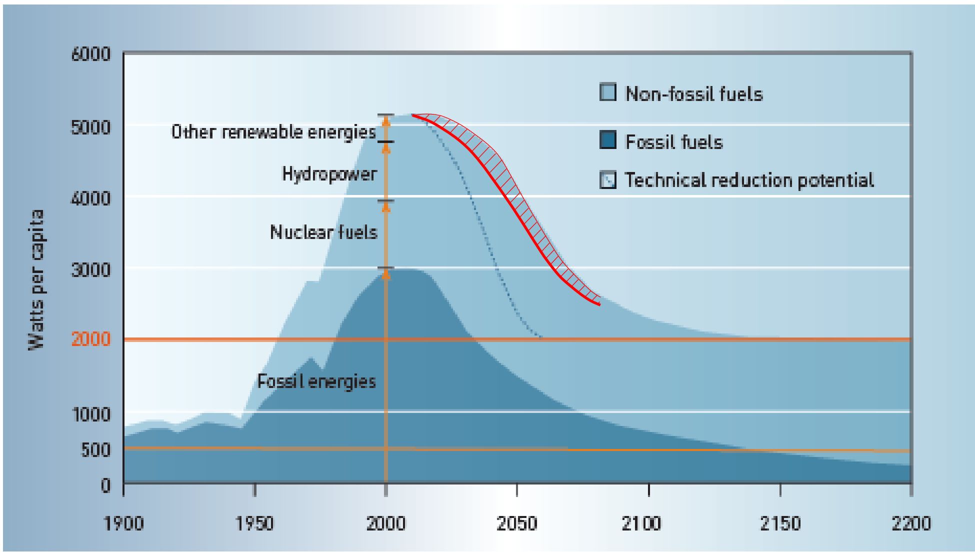
Short-term executable measures

You can achieve significant reductions in energy use and CO_2 emissions by further updating building automation and control functions in older and less energy-efficient buildings.

Goal of these measures

Existing buildings can be operated at significantly lower energy use after updating building automation and system functions that are optimally set and activated:

- Cost savings from operational energy
- Conserve the environment and existing energy resources
- Guarantee reasonable comfort during occupancy



Source: Novatlantis - Sustainability within the ETH

Overall energy use should be decreased by reducing the primary energy use for the building within the red intersecting region.

Energy saving potential with building automation and control

Building automation and control systems are the building's brain. They integrate the information for all the building's technology. It controls the heating and cooling systems, ventilation and air conditioning plants, lighting, blinds as well as fire protection and security systems.
The building's brain is thus the key for an effective check of energy use and all ongoing operating costs.

Quote by Prof. Dr. Ing. Rainer Hirschberg, FH Aachen; Germany
Primary energy use for heat in buildings amounts to some 920 TWh (Terawatt hours) in Germany. Of which more than half (ca 60 %) comes from non-residential buildings where it makes sense to use building automation and control. A cautious estimate in business management (based on EN 15232) indicates that 20 % can be saved by building automation and control, corresponding roughly to 110 TWh

and a primary savings, extrapolated to overall consumption, of 12 %. Thus largely achieving the German government's stated target by 2020.

This finding certainly applies to a similar extend for other countries. So that the intelligent use of building automation and control can make a significant contribution to EU savings targets of 20 % in 2020.

2.5 Siemens contribution to energy savings

We are taking the initiative

Siemens feels an obligation to assist its customers in improving the energy efficiency of their buildings. As a consequence, Siemens is a member of a number of global initiatives.

A important part of the history of Siemens

Global achievements

- More than 100 years experience with energy management systems and corresponding services
- Years of experience as an energy innovator - Siemens holds more than 6'000 energy-related patents
- Implemented more than 1'900 global energy projects since 1994
- Overall savings of ca. EUR 1.5 billion over a period of ten years
- CO_2 savings from all energy projects: Ca. 2.45 mio. tons of CO_2 annually
- 700'000 tons corresponds to 805'000 cars each driving 20'000 kilometers a year

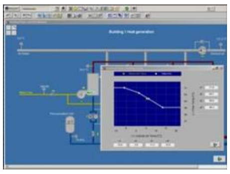
eu.bac (European Building Automation & Controls Association) was established as the European platform representing the interest of home and building automation and control in the area of quality assurance. Siemens took the initiative and the members include renowned international manufacturers of products and systems in the home and building automation and control sector. These companies came together to document the control quality of their products through standardization, testing and certification. Products and systems with the eu.bac certification display an guaranteed state and quality assurance.

Siemens is a partner of the GreenBuilding initiative by the European Commission, with a goal of implementing cost-effective, energy efficiency potential in buildings. As a signatory to this initiative, Siemens BT must ensure that its customers can achieve a mimimum energy efficiency of at least 25 % in their building infrastructures.

For the past five years, Siemens has also been a member of LEED (Leadership in Energy and Environmental Design) – a US initiative that is similar to GreenBuildings. LEED continues as a recognized and respected certification, where independent third-parties certify that the building project in question is environmentally friendly and profitable and represents a healthy location for work and living.

Headed by former US president Bill Clinton, the initiative cooperates with larger municipal governments and international companies to develop and implement various activities to reduce greenhouse gases. Specifically, the initiative informs large cities on measures available to optimize energy efficiency in buildings without sacrificing comfort for the residents and users. Here again, Siemens has taken the lead in conducting energy audits, building renovation and guaranteed savings from such projects.

German industry can make a number of contributions to climate protection and is therefore a problem solver. To underscore the German economy's commitment to climate protection, a number of leading business people came together under the auspices of the Association of German Industry on the initiative “Business for climate change”. The initiative represents, with more than 40 companies, the entire spectrum and abilities of the productive economy in Germany.



But Siemens is above all concerned about making a contribution by providing various services to the customer so that we can solve the global problems of energy and climate. To this end, Siemens BT has prepared **comprehensive BAC and TBM functions** – **for new buildings** as well as **to update existing buildings**. What’s more, Siemens BT even provides performance contracting.

3 Building automation and control system standards

This section discusses EU measures and goals with regard to energy and the environment, as well as the process and new standards intended to grasp and disarm the energy situation.

3.1 EU measures

Energy is a central concern of the European Community

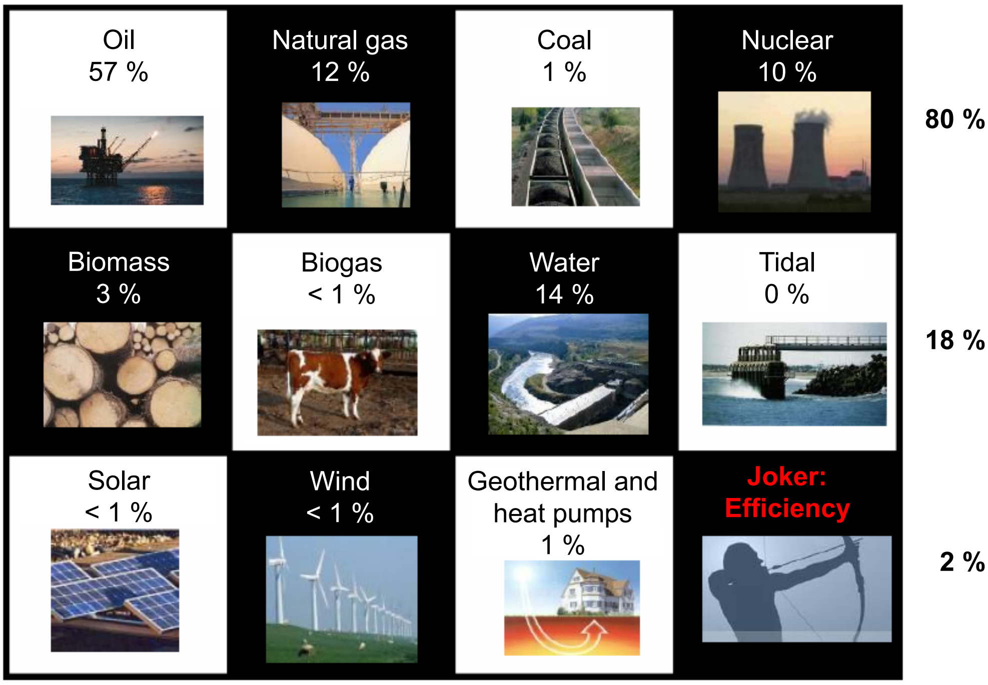
Dependency
Without actions, dependency on foreign energy will climb to 70 % by 2020 / 2030.

Environment
Energy generation and consumption cause some 94 % of CO_2 emissions.

Supply
Influence on energy supply is limited.

Price
Significant increase within a few short years.

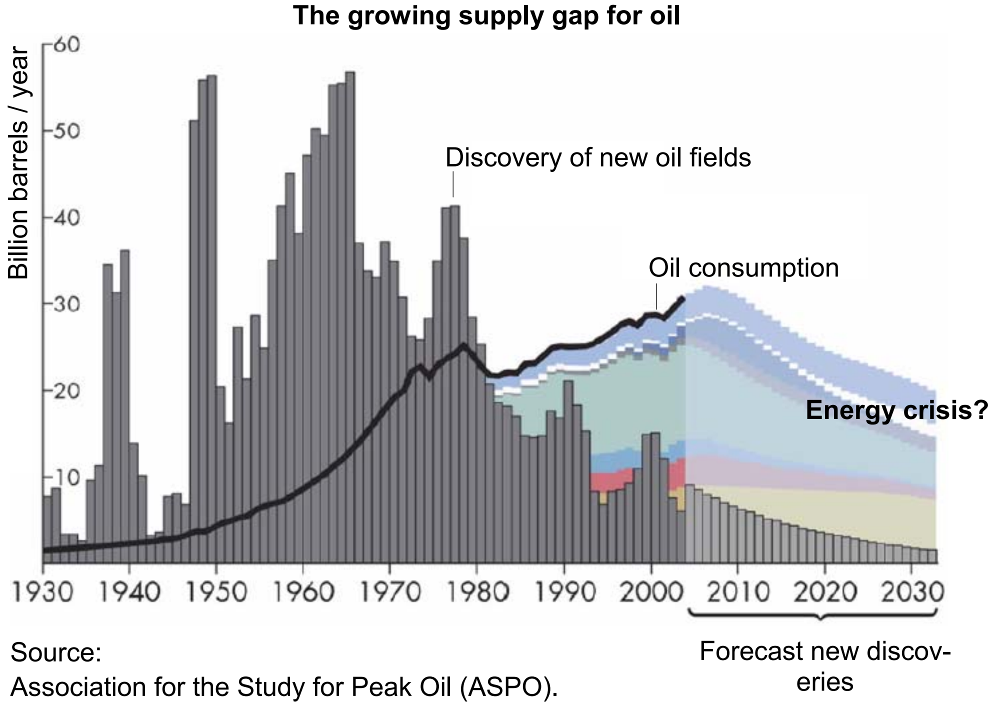
Example: Dependency



End energy consumption, Switzerland.
- Figures: BFE Overall energy statistics for 2006
- Chart: Zwölferspiel by Dr. Daniele Ganser, University of Basle.
  www.histsem.unibas.ch/peak-oil

The percentages of renewable and non-renewable energy differs in other European countries, but the problem of dependency hardly varies at all.

Example: Supply and prices



Source:
Association for the Study for Peak Oil (ASPO).
www.peakoil.ch

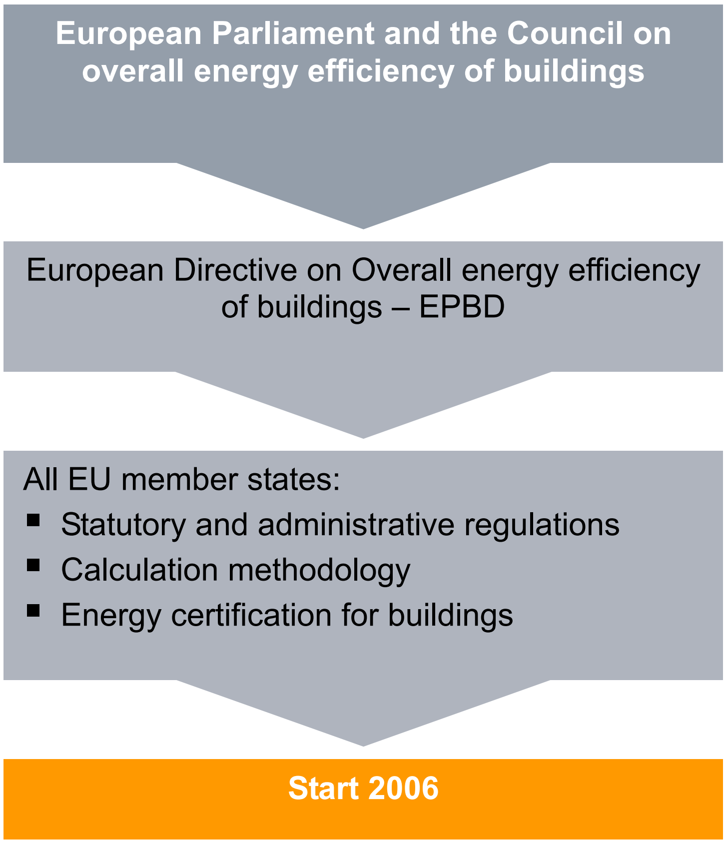
Supply is not secure, yet the price increase is ...

Goal 2020: "20 20 20“

By 2020, the European Community (Commission energy and climate policy) wants to

- Use 20 % less energy versus the reference year of 1990
- Emit 20 % less greenhouse gases versus the reference year of 1990
- Achieve 20 % of overall energy consumption from renewable energies

EU and domestic legislation



EPBD
Energy **P**erformance of **B**uilding **D**irective

Motivation and content:
Concerning increased energy efficiency constitutes an important part of the package of policies and measures needed to comply with the Kyoto Protocol and should appear in any policy package to meet further commitments, the European Union issued a **Directive on Energy Performance of Buildings (EPBD)** in Dec 2002. Member States shall bring into force the laws, regulations and administrative provisions necessary to comply with this Directive at the latest on 4 January 2006.

"The objective of this Directive is to promote the improvement of the energy performance of buildings within the Community, taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness.

This directive lays down requirements as regards:
(a) The general framework for a methodology of calculation of the integrated energy performance of buildings
(b) The application of minimum requirements on the energy performance of new buildings
(c) The application of minimum requirements on the energy performance of large existing buildings (>1000 m^2) that are subject to major renovation
(d) Energy certification of buildings
(e) Regular inspection of boilers and of air-conditioning systems in buildings and in addition an assessment of the heating installation in which the boilers are more than 15 years old (Article 1 of EPBD)

Consequences of the EPBD:
To meet the requirement for “methods to calculate the integrated overall energy efficiency of buildings” arising from the EPBD, the European Community tasked the **CEN (C**omité **E**uropéen de **N**ormalisation **–** Europaen committee for standardization) to draft European Directives on the overall energy efficiency of buildings.

The **TC**s **(T**echnical **C**ommitée**)** at CEN developed various calculations and integrated them into an impressive number of European standards (**EN**)**.** The general relationship are described in the document prCEN / TR 15615 **(“**Declaration on the general relationship among various European standards and the EPBD **-** Umbrella document“).This means that the impact of windows, building shell, technical building systems, and building automation functions can now be calculated.

The energy performance of a building means the amount of energy estimated or actually consumed to meet the different needs associated with a standardized use of the building, which may include:

• Heating	EN 15316-1 and EN 15316-4
• Cooling	EN 15243
• Domestic hot water	EN 15316-3
• Ventilation	EN 15241
• Lighting	EN 15193
• Auxiliary energy	

Initiative of the building automation industry

With regard to article 3 "Adoption of a methodology" the EPBD does not require any explicit methodology for building automation (refer to the Annex of the EPBD). For this reason, the building automation industry – with the specific support of Siemens experts applied to the appropriate EU and CEN committees to have building automation functions included in the calculation methodologies. In response, a standard for calculating the impact of building automation functions was drawn up by the CEN / TC247 (standardization of building automation and building management in residential and non-residential buildings) to supplement the standards for the building shell and the individual disciplines:

- **Building automation** **EN 15232**
  Title:
  Energy performance of buildings -
  Impact of Building Automation, Controls and Building Management

CEN / TC 247

CEN / TC247 develops European and international standards for building automation, controls and building management (BACS), for instance:

- Product standards for electronic control equipment in the field of HVAC applications (e.g. EN 15500)
  → Basis for product certification related to EPBD
- Standardization of BACS[1] functions (EN ISO 16484-3)
  → Basis for the impact of BACS on energy efficiency
- Open data communication protocols for BACS (e.g. EN ISO 16484-5)
  → Prerequisite for integrated functions with BACS impact on energy efficiency
- Specification requirements for integrated systems (EN ISO 16484-7)
  → Prerequisite for integrated functions with impact on energy efficiency
- Energy performance of BAC functions (EN 15232)
  Title: Energy performance of buildings - Impact of Building Automation, Controls and Building Management
  → Basis for the impact of BACS on the energy efficiency of buildings

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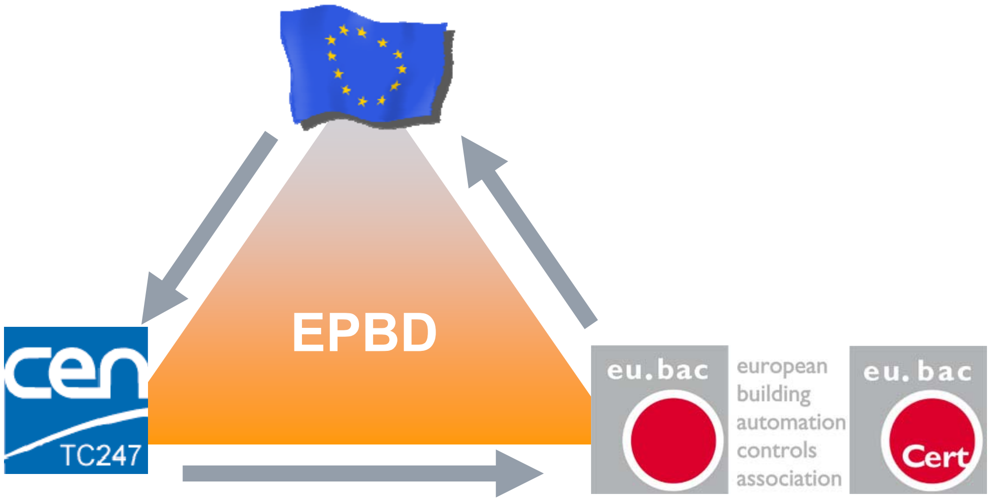
[1] BACS = Building Automation and Controls System

Procedure

The EU mandated European CEN to standardize calculation methods to improve energy savings.



CEN TC247 prepared and approved

- **EN 15232** Impact of BACS functions on energy efficiency
- Product standards with energy performance criteria (e.g. EN 15500)

eu.bac prepared the certification procedure and test method and proposed this certification to the European Community

CEN	European Committee for Standardization
EPBD	Energy Performance of Building Directive
eu.bac	european building automation and controls association
EN	European Norm
EU	European Union

3.2 The standard EN 15232

What is EN 15232?

A new European standard EN15232: *"Energy performance of buildings - Impact of Building Automation, Control and Building Management"* is one of a set of CEN (Comité Européen de Normalisation, European Committee for Standardization) standards, which are developed within a standardization project sponsored by European Community. The aim of this project is to support Directive of Energy Performance of Building (EPBD) to enhance energy performance of buildings in the member states of EU. Standard EN15232 specifies methods to assess the impact of Building Automation and Control System (BACS) and Technical Building Management (TBM) functions on the energy performance of buildings, and a method to define minimum requirements of these functions to be implemented in buildings of different complexities. Siemens Building Technology got involved very much in the elaboration of this standard.

Building Automation and Control System (BACS) and Technical Building Management (TBM) have impact on building energy performance from many aspects. BACS provides effective automation and control of heating ventilating cooling, hot water and lighting appliances etc., that leads to increase operational and energy efficiencies. Complex and integrated energy saving functions and routines can be configured on the actual use of a building depending on the real user needs to avoid unnecessary energy use and CO_2 emissions. Building Management (BM) especially TBM provides information for operation, maintenance and management of buildings especially for energy management - Trending and alarming capabilities and detection of unnecessary energy use.

Content of EN 15232

The standard EN15232: *"Energy performance of buildings - Impact of Building Automation, Control and Building Management"* provides guidance for taking BACS and TBM functions as far as possible into account in the relevant standards.This standard specifies:

- a structured list of control, building automation and technical building management functions which have an impact on the energy performance of buildings
- a method to define minimum requirements regarding the control, building automation and technical building management functions to be implemented in buildings of different complexities
- detailed methods to assess the impact of these functions on the energy performance of a given building. These methods enable to introduce the impact of these functions in the calculations of energy performance ratings and indicators calculated by the relevant standards
- a simplified method to get a first estimation of the impact of these functions on the energy performance of typical buildings

3.3 eu.bac - certification

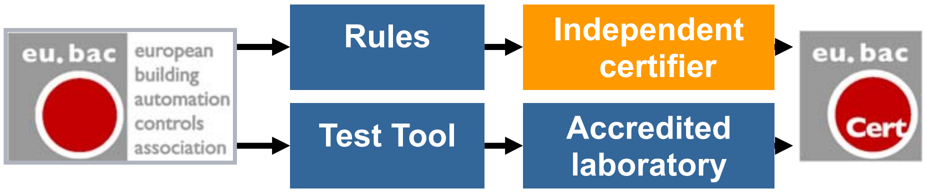
eu.bac Cert is a joint venture of eu.bac and various European certification bodies and test laboratories in conformity with the relevant provisions of the EN 45000 set of standards.

EU mandate for CEN to standardize calculation methods to improve energy efficiency

TC247: EN 15232 "Energy performance of buildings – Impact of Building Automation"

and

Product Standards
- Terminology
- Product data incl. energy performance criteria
- Test procedure



eu.bac Cert guarantees users a high level of
- energy efficiency, and
- product and system quality

as defined in the corresponding EN / ISO standards and European Directives.

Some public organizations approve only eu.bac-certified products.

3.4 Standardization benefits

Calculation standard

The EN 15232 standard clearly shows for the first time the huge potential energy savings that can be made in the operation of technical building systems. Consequently, all planners should apply the EN 15232 standard. Planners are generally familiar with energy requirements and are therefore able to provide construction owners with information on the benefits of building automation. Manufacturers of building automation facilities should also use the EN 15232 standard for assessment purposes when carrying out modernization work.

Product standards and certification

Product standards such as EN 15500 "Building automation for HVAC applications – electronic individual zone control equipment" define energy efficiency criteria that are verified and certified by eu.bac. Product users can therefore be sure that the promised characteristics and quality are actually delivered.

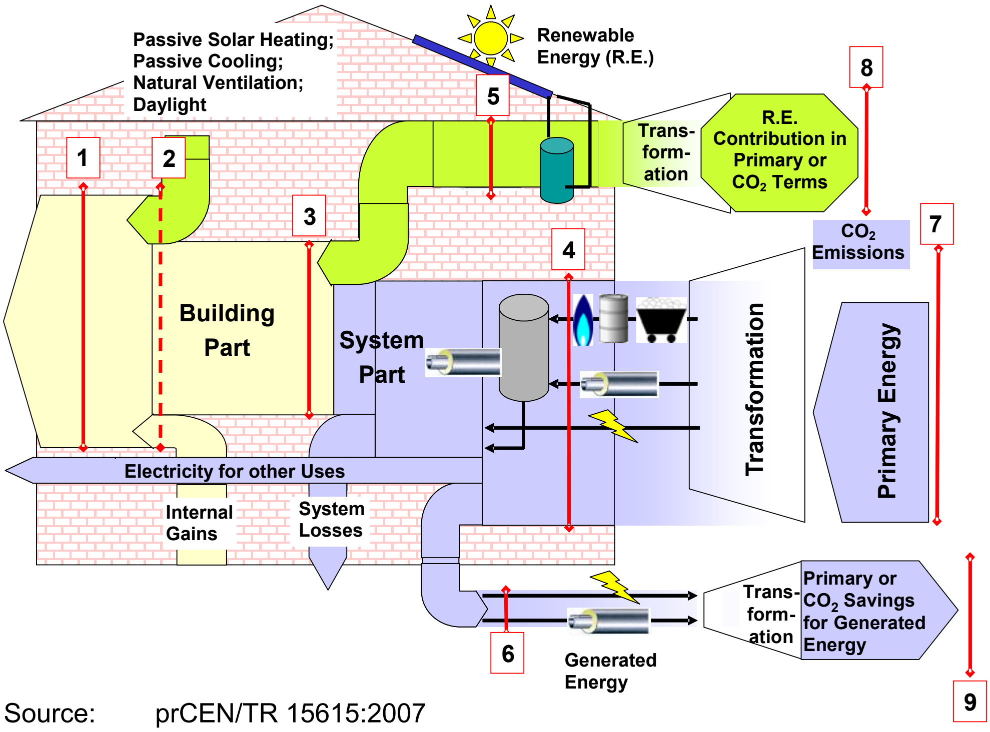
4 The EN 15232 standard in detail

EN 15232 makes it possible to qualify and quantify the benefits of building automation and control systems. The entire standard is based on building simulations using pre-defined building automation and control functions.

Parts of the standard can be used directly as a tool to qualify the energy efficiency of building automation and control projects. Further planned, is to assign projects to one of the standard energy efficiency classes A, B, C or D.

Energy flow model

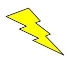
The energy needs of various building models with differing BAC and TBM functions are calculated with the help of simulations. Various energy flow models for the basis, e.g. **Energy flow model for thermal conditioning of a building**:



Source: prCEN/TR 15615:2007

itle: Declaration on the general relationship between various European standards and the EPBD (“Umbrella document”)

Symbols:

 Electricity

 Natural gas, oil, coal, biomass, etc.

 Heat, refrigeration

Key:

[1] is the energy needed to fulfill the user's requirements for heating, lighting, cooling etc, according to levels that are specified for the purposes of the calculation.

[2] is the "natural" energy gains – passive solar, ventilation cooling, daylighting, etc. together with internal gains (occupants, lighting, electrical equipment, etc)

[3] is the building's net energy use, obtained from [1] and [2] along with the characteristics of the building itself.

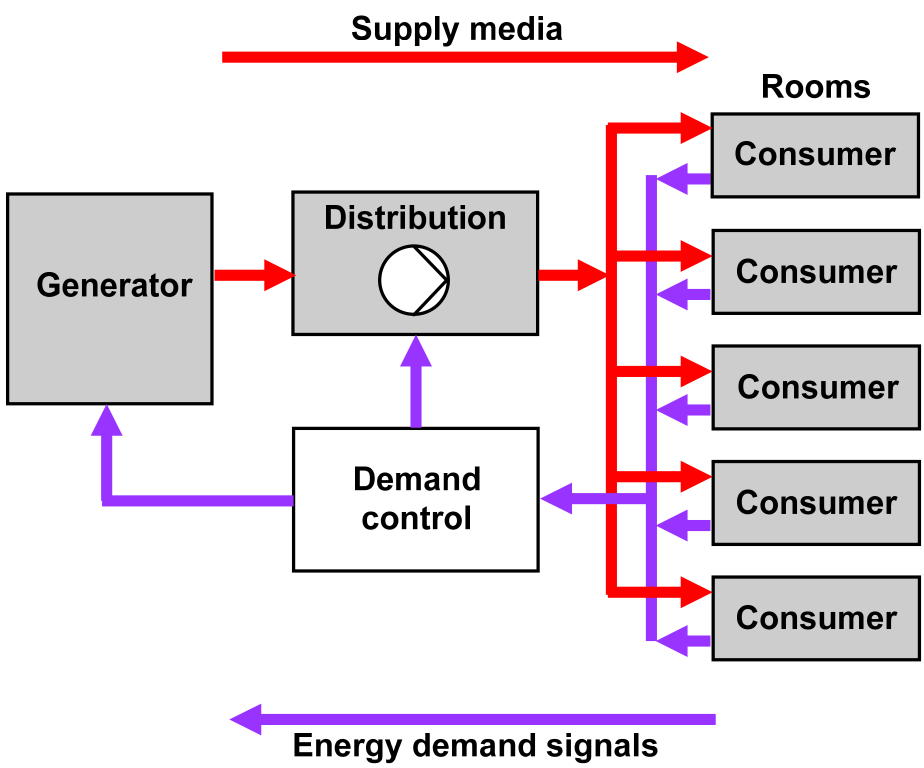
[4] is the delivered energy, represented separately for each energy carrier, inclusive of auxiliary energy, used by heating, cooling, ventilation, hot water and lighting systems, taking into account renewable energy sources and co-generation. This may be expressed in energy units or in units of the energyware (kg, m³, kWh, etc).
[5] is renewable energy produced on the building premises.
[6] is generated energy, produced on the premises and exported to the market; this can include part of [5].
[7] represents the primary energy usage or the CO_2 emissions associated with the building.
[8] represents the primary energy or emissions associated with on-site generation that is used on-site and so is not subtracted from [7].
[9] represents the primary energy or CO_2 saving associated with exported energy, which is subtracted from [7].

The overall calculation process involves following the energy flows from the left to the right of the model above.

The model above is a schematic illustration and is not intended to cover all possibilities. For example, a ground-source heat pump uses both electricity and renewable energy from the ground. And electricity generated on site by photovoltaics could be used within the building, it could be exported, or a combination of these. Renewable energywares like biomass are included in [7], but are distinguished from non-renewable energywares by low CO_2 emissions. In the case of cooling, the direction of energy flow is from the building to the system.

Energy demand and supply model

The BAC functions per EN 15232 are based on the energy demand and supply model for a building listing below.



Rooms represent the source of energy demand. Suitable HVAC plants should ensure comfortable conditions in the rooms with regard to temperature, humidity, air quality and light as needed.
Supply media is supplied to the consumer per energy demand allowing you to keep losses in distribution and generation to an absolute minimum.

The building automation and control functions described in Sections 4.1 and 4.2 are aligned in accordance with the energy demand and supply model. The relevant energy-efficiency functions are handled starting with the room via distribution up through generation.

4.1 List of relevant building automation and control functions

Energy efficiency-relevant functions and possible **processing functions** for building automation and control systems are the focus of EN 15232. They are listed in the left part of a multi-page table grouped by the different areas of use.

This list includes
- All functions and processing functions per EN 15232
- Justifications for energy savings by functions and processing functions per EN 15232
- Recommendations for efficient application in the various building types

The function list below has 12 columns:

Column 1 through 3 correspond to the content of EN 15232
- Column 1 Establish the field of use
- Column 2 Establishes the building automation and control functions to be evaluated as well as the corresponding numbers for possible processing functions
- Column 3 Establishes processing functions to be assessed

Columns 4 through 13 are supplements by Siemens BT
- Column 4 Refers to interpretations by Siemens Building Technologies for the functions and processing functions EN 15232.
  (BT = Remarks of Siemens BT)
- Column 5 Declares how the corresponding function saves energy
- Columns 6-13 Illustrates the building types where the functions can be used efficiently

1	2		4	5	6							
1	2	3	4	5	6	7	8	9	10	11	12	13

On the following pages are
- Right side: Tables from EN 15232
- Left side: Extracts from detailed commentaries on EN 15232
  Remarks of Siemens BT

☞ Continued on the next double-page

Extract from EN 15232 section 7.4

7.4.1. Emission control

One shall differentiate at least the following types of room temperature control:

0) no automatic control of the room temperature;
1) central automatic control: There is only central automatic control acting either on the distribution or on the generation. This can be achieved for example by an outside temperature controller conforming to EN 12098-1 or EN 12098-3;
2) individual room control shall be performed by thermostatic valves either conforming or not conforming to EN 215;
3) individual room control shall be performed by an electronic controller either conforming or not conforming to prEN 15500.

Note:

Set points for heating and cooling should be configured so that there is always a minimum dead band between heating and cooling.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

1. Plants required for "emission control" of thermal energy (e.g. radiators, chilled ceilings, VAV systems) may have different supply media (e.g. water, air, electricity). As a result, different BAC solutions may be possible for a processing function

2. The Siemens interpretation stands by the processing function in the function list from EN 15232: It includes thermostatic valves and electronic control equipment.
   - Non-communicating electronic control equipment may include a local scheduler. But experience suggests that they are often not properly set
   - Thermostatic valves are not used for “cooling control”

3. Communication between a superposed centralized unit and electronic individual room controllers allow for centralized schedulers, monitoring of individual room controllers as well as centralized operation and monitoring

4. Demand control (by use) = Demand control based on occupancy information from a presence detector or a presence button with automatic reset after a set period. Control switches from Pre-Comfort to Comfort or the other way around using this occupancy information (see EN 15500). Notes:
   - Air quality control is considered in "Ventilation and air conditioning control"
   - Occupancy information can influence “heating control”, “cooling control” and “ventilation and air conditioning control”

HEATING CONTROL		BT	Reason for energy saving	Efficiently used in: Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Emission control		1									
	The control system is installed at the emitter or room level, for case 1 one system can control several rooms										
0	No automatic control		The highest supply output is continuously supplied to the heat exchangers. Results in the emission of unnecessary heat energy at partial load.								
1	Central automatic control		Supply output is controlled e.g. by the outdoor temperature (corresponding to the probable demand of the consumers). Energy losses at partial load are reduced, but heat source gains in the rooms cannot be considered individually.								
2	Individual room automatic control by thermostatic valves or electronic controller	2	Supply output based on room temperature (= controlled variable). It considers heat sources in the room as well (heat from the sun, people, animals, technical devices). The room can be held comfortable with less energy. Comment: Electronic control equipments result in higher energy efficiency than thermostatic valves (higher control accuracy, coordinated manipulated variable impacts all the valves in the room).	•							
3	Individual room control with communication between controllers and to BACS	3	The aforementioned justification. With the addition of: Centralized ... • Schedulers make it possible to reduce output during non-occupancy • Operating and monitoring functions further optimize operation		•			•		•	•
4	Integrated individual room control including demand control (by occupancy, air quality, etc.)	4	The aforementioned justification. In addition: • Effective occupancy control results in additional energy savings in the room at partial load • Demand-controlled energy provision (energy generation) results in a minimum of loss in provision and distribution			•	•		•		

Extract from EN 15232 section 7.4

7.4.2. Control of distribution network water temperature

One shall differentiate at least the following types of supply temperature control:

0) no automatic control;
1) outside temperature compensated control;
2) indoor temperature control.

7.4.3. Control of distribution pumps

One shall differentiate at least the following types of pump control:

0) no control;
1) on/off control;
2) variable speed pump control with constant Δp;
3) variable speed pump control with variable Δp.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

5. Processing function 2 also includes processing function 1 (ON/OFF control); otherwise processing function 2 would generally be less efficient than 1

6. Pump solutions with an external power control input (e.g. based of the effective load by the consumer), are more expensive overall. They do, however, allow for more precise pump control than pumps with integrated pressure control equipment. Furthermore, the risk of under-provisioning for individual consumers is reduced

HEATING CONTROL		BT	Reason for energy saving	Efficiently used in: Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Control of distribution network hot water temperature (supply or return)											
	Similar function can be applied to the control of direct electric heating networks										
0	No automatic control		The highest design temperature of all consumers is continuously provided in distribution. Results in significant energy losses at partial load								
1	Outside temperature compensated control		Distribution temperature is controlled by the outdoor temperature (corresponding to the probable temperature demand of the consumers). Reduces energy loss at partial load	•							
2	Indoor temperature control		Distribution temperature based on room temperature (= controlled variable). It considers heat sources in the room as well (heat from the sun, people, animals, technical devices). Keeps energy losses at partial load at an optimum (low)		•	•	•	•	•	•	•
Control of distribution pumps											
	The controlled pumps can be installed at different levels in the network										
0	No control		No savings, since electrical power for the pump is drawn continuously.								
1	On off control		Electrical power for the pump is drawn only as required – e.g. during occupancy, protective mode (frost hazard).	•							
2	Variable speed pump control with constant Δp	5	Pressure difference does not increase at decreasing load when maintaining a constant pressure difference at the pump. The pump speed is reduced at partial load which lowers the electrical power.								
3	Variable speed pump control with proportional Δp	6	Pressure difference decreases at the pump as the load is decreased. This provides additional reductions in speed and electrical power at partial load versus 2.		•	•	•	•	•	•	•

Extract from EN 15232 section 7.4

7.4.4. Intermittent control of emission and/or distribution

One shall differentiate at least the following types of intermittent control of emission and/or distribution:

0) no automatic control;
1) automatic intermittent control without optimum start in conformity with EN 12098-1 or EN 12098-3 or EN 12098-5 or EN ISO 16484-3;
2) automatic intermittent control with optimum starts in conformity with EN 12098-2 or EN 12098-4.

7.4.6. Generation control

The generation control depends on the generator type. Nevertheless the goal consists generally in minimising the generator operating temperature. This enables limiting the thermal losses. For thermodynamic generators this also enables increasing the thermodynamic efficiency.

Three main types of temperature control can be differentiated:

0) constant temperature control;
1) variable temperature depending on the outdoor temperature;
2) variable temperature depending on the load (this includes control according to room temperature).

7.4.7 Sequencing of generators

If different generators are available one can differentiate at least the following types of sequence control:

0) without priorities;
1) priorities based on loads and generator capacities;
2) priorities based on generator efficiencies.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

7. This Siemens interpretation stands by the processing function in the function list from EN 15232: Switching on generators with the same nominal output is accomplished based solely on load (no additional prioritization)

HEATING CONTROL		BT	Reason for energy saving	Efficiently used in: Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Intermittent control of emission and/or distribution											
	One controller can control different rooms/zone having same occupancy patterns										
0	No automatic control		No savings, since emission and/or distribution permanently in operation.								
1	Automatic control with fixed time program		Savings in emission and/or distribution outside the nominal operating hours	•				•			
2	Automatic control with optimum start/stop		Additional savings in emission and/or distribution by continuously optimizing the plant operating hours to the occupancy times.		•	•	•		•	•	•
Generator control											
0	Constant temperature		The generator continuously provides the highest design temperature of all consumers. Results in significant energy losses at partial load.								
1	Variable temperature depending on outdoor temperature		Generation temperature is controlled by the outdoor temperature (corresponding to the probable temperature demand of the consumers). Strongly reduces energy losses.	•							
2	Variable temperature depending on the load		Generation temperature is controlled by the effective temperature demand of the consumers. Keeps energy losses at generator to an optimum (low)		•	•	•	•	•	•	•
Sequencing of different generators			Priority control adapts momentary generation output (with priority to renewable energies) to current load in an energy efficient manner								
0	Priorities only based on loads	7	Only the generators required per current load are switched on								
1	Priorities based on loads and generator capacities		At increasing output stages for all generators (e.g. 1 : 2 : 4, etc.) • the momentary generator output can be adapted more precisely to load • the large generators work at a more efficient partial load range		•	•	•	•	•	•	•
2	Priorities based on generator efficiency (check other standard)		The generator operational control is set individually to available generators so that they operate with an overall high degree of efficiency or using the cheapest energy form (e.g. solar, geothermic heat, cogeneration plant, fossil fuels)								

Extract from EN 15232 section 7.4

7.4.1. Emission control

One shall differentiate at least the following types of room temperature control:

0) no automatic control of the room temperature;
1) central automatic control: There is only central automatic control acting either on the distribution or on the generation. This can be achieved for example by an outside temperature controller conforming to EN 12098-1 or EN 12098-3;
2) individual room control shall be performed by thermostatic valves either conforming or not conforming to EN 215;
3) individual room control shall be performed by an electronic controller either conforming or not conforming to prEN 15500.

Note:
Set points for heating and cooling should be configured so that there is always a minimum dead band between heating and cooling.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

1. Plants required for "emission control" of thermal energy (e.g. radiators, chilled ceilings, VAV systems) may have different supply media (e.g. water, air, electricity). As a result, different BAC solutions may be possible for a processing function

2. The Siemens interpretation stands by the processing function in the function list from EN 15232: It includes thermostatic valves and electronic control equipment.
   - Non-communicating electronic control equipment may include a local scheduler. But experience suggests that they are often not properly set
   - Thermostatic valves are not used for “cooling control”

3. Communication between a superposed centralized unit and electronic individual room controllers allow for centralized schedulers, monitoring of individual room controllers as well as centralized operation and monitoring

4. Demand control (by use) = Demand control based on occupancy information from a presence detector or a presence button with automatic reset after a set period. Control switches from Pre-Comfort to Comfort or the other way around using this occupancy information (see EN 15500). Notes:
   - Air quality control is considered in "Ventilation and air conditioning control"
   - Occupancy information can influence “heating control”, “cooling control” and “ventilation and air conditioning control”

COOLING CONTROL		BT	Reason for energy saving	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Emission control		1									
	The control system is installed at the emitter or room level, for case 1 one system can control several rooms										
0	No automatic control		The highest supply output is continuously supplied to the heat exchangers. Results in the emission of unnecessary heat energy at partial load.								
1	Central automatic control		Supply output is controlled e.g. by the outdoor temperature (corresponding to the probable demand of the consumers). Energy losses at partial load are reduced, but heat sources in the rooms cannot be considered individually.								
2	Individual room automatic control by thermostatic valves or electronic controller	2	Supply output based on room temperature (= controlled variable). It considers heat sources in the room as well (heat from the sun, people, animals, technical devices). The room can be held individually comfortable.								
3	Individual room control with communication between controllers and to BACS	3	The aforementioned justification. With the addition of: Centralized ... • Schedulers make it possible to reduce output during non-occupancy • Operating and monitoring functions further optimize operation								
4	Integrated individual room control including demand control (by occupancy, air quality, etc.)	4	The aforementioned justification. In addition: • Effective occupancy control results in additional energy savings in the room at partial load • Demand-control energy provisioning (energy generation) results in a minimum of loss from provision and distribution		•	•	•	•	•	•	•

Extract from EN 15232 section 7.4

7.4.2. Control of distribution network water temperature

One shall differentiate at least the following types of supply temperature control:

0) no automatic control;
1) outside temperature compensated control;
2) indoor temperature control.

7.4.3. Control of distribution pumps

One shall differentiate at least the following types of pump control:

0) no control;
1) on/off control;
2) variable speed pump control with constant Δp;
3) variable speed pump control with variable Δp.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

5. Processing function 2 also includes processing function 1 (ON/OFF control); otherwise processing function 2 would generally be less efficient than 1

6. Pump solutions with an external power control input (e.g. based of the effective load by the consumer), are more expensive overall. They do, however, allow for more precise pump control than pumps with integrated pressure control equipment. Furthermore, the risk of under-provisioning for individual consumers is reduced

8. Comparable functions can be used for controlling networks for electrical direct cooling (e.g. compact cooling units or split units for individual rooms)

COOLING CONTROL		BT	Reason for energy saving	Efficiently used in							
				Residential	**Offices**	**Lecture halls**	**Schools**	**Hospitals**	**Hotels**	**Restaurants**	**Wholesale**
Control of distribution network cold water temperature (supply or return)											
	Similar function can be applied to the control of direct electric heating networks	8									
0	No automatic control		The lowest design temperature of all consumers is continuously provided in distribution. Results in significant energy losses at partial load								
1	Outside temperature compensated control		Distribution temperature is controlled by the outdoor temperature (corresponding to the probable temperature demand of the consumers). Strongly reduces energy losses.								
2	Indoor temperature control		Distribution temperature based on room temperature (= controlled variable). It considers heat sources in the room as well (heat from the sun, people, animals, technical devices). Keeps energy losses at partial load to an optimum (low)		•	•	•	•	•	•	•
Control of distribution pumps											
	The controlled pumps can be installed at different levels in the network										
0	No control		No savings, since electrical power for the pump is drawn continuously.								
1	On off control		Electrical power for the pump is drawn only as required – e.g. during occupancy, protective mode (overheating hazard).								
2	Variable speed pump control with constant Δp	5	Pressure difference does not increase at decreasing load when maintaining a constant pressure difference at the pump. The pump speed is reduced at partial load which lowers the electrical power.		•	•	•	•	•	•	•
3	Variable speed pump control with proportional Δp	6	Pressure difference decreases at the pump as the load is decreased. This provides additional reductions in speed and electrical power at partial load versus 2.								

Extract from EN 15232 section 7.4

7.4.4. Intermittent control of emission and/or distribution

One shall differentiate at least the following types of intermittent control of emission and/or distribution:

0) no automatic control;
1) automatic intermittent control without optimum start in conformity with EN 12098-1 or EN 12098-3 or EN 12098-5 or EN ISO 16484-3;
2) automatic intermittent control with optimum starts in conformity with EN 12098-2 or EN 12098-4.

7.4.5 Interlock between heating and cooling control of emission and/or distribution

For air conditioned buildings this function is one of the most important regarding energy savings.

The possibility to provide at the same time heating and cooling in the same room depends on the system principle and on the control functions. Depending on the system principle a full interlock can be achieved with a very simple control function or can request a complex integrated control function. One shall differentiate at least:

0) no interlock: the two systems are controlled independently and can provide simultaneously heating and cooling;
1) partial interlock: The control function is set up in order to minimize the possibility of simultaneous heating and cooling. This is generally done by defining a sliding set point for the supply temperature of the centrally controlled system;
2) total interlock: The control function enables to warranty that there will be no simultaneous heating and cooling.

COOLING CONTROL		BT	Reason for energy savings	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Intermittent control of emission and/or distribution											
	One controller can control different rooms/zone having same occupancy patterns										
0	No automatic control		No savings, since emission and/or distribution permanently in operation.								
1	Automatic control with fixed time program		Savings in emission and/or distribution outside the nominal operating hours					•			
2	Automatic control with optimum start/stop		Additional savings in emission and/or distribution by continuously optimizing the plant operating hours to the occupancy times.		•	•	•		•	•	•
Interlock between heating and cooling control of emission and/or distribution											
0	No interlock		Simultaneous heating and cooling possible. The additionally provided energy is uselessly absorbed								
1	Partial interlock (dependant of the HVAC system)		<u>Generation / Distribution in HVAC system</u>: Outdoor temperature controlled generation setpoints for heating and cooling can prevent, to some extent, that after treatment room temperature controllers reheat in the summer or recool in the winter. The greater the distance for heating and cooling setpoints of all individual room controllers (large neutral zones), the more efficiently the provisioning can be locked down.								
2	Total interlock		<u>Emission in the room</u>: A complete lock (e.g. a room temperature sequence controller) prevents any energy absorption in the individual room. <u>Generation / Distribution in HVAC system</u>: Treatment setpoints for heating and cooling demand-controlled from the rooms can prevent after treatment room temperature controllers from reheating in the summer or recooling in the winter. The greater the distance for heating and cooling setpoints of all individual room controllers (large neutral zones), the more efficiently the provisioning can be locked down.		•	•	•	•	•	•	•

Extract from EN 15232 section 7.4

7.4.6. Generation control

The generation control depends on the generator type. Nevertheless the goal consists generally in minimising the generator operating temperature. This enables limiting the thermal losses. For thermodynamic generators this also enables increasing the thermodynamic efficiency.

Three main types of temperature control can be differentiated:

0) constant temperature control;
1) variable temperature depending on the outdoor temperature;
2) variable temperature depending on the load (this includes control according to room temperature).

7.4.7 Sequencing of generators

If different generators are available one can differentiate at least the following types of sequence control:

0) without priorities;
1) priorities based on loads and generator capacities;
2) priorities based on generator efficiencies.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

7. This Siemens interpretation stands by the processing function in the function list from EN 15232: Switching on generators with the same nominal output is accomplished based solely on load (no additional prioritization)

COOLING CONTROL		BT	Reason for energy saving	Efficiently used in							
				Residential	**Offices**	**Lecture halls**	**Schools**	**Hospitals**	**Hotels**	**Restaurants**	**Wholesale**
Generator control											
0	Constant temperature		The generator continuously provides the lowest design temperature of all consumers. Results in significant energy losses at partial load								
1	Variable temperature depending on outdoor temperature		Generation temperature is controlled by the outdoor temperature (corresponding to the probable temperature demand of the consumers). Strongly reduces energy losses.		•	•	•	•	•	•	•
2	Variable temperature depending on the load		Generation temperature is controlled by the effective temperature demand of the consumers. Keeps energy losses at generator to an optimum (low)								
Sequencing of different generators			Priority control adapts momentary generation output (with priority to renewable energies) to current load in an energy efficient manner								
0	Priorities only based on loads	7	Only the generators required per current load are switched on								
1	Priorities based on loads and generator capacities		At increasing output stages for all generators (e.g. 1 : 2 : 4, etc.) • the momentary generator output can be adapted more precisely to load • the large generators work at a more efficient partial load range		•	•	•	•	•	•	•
2	Priorities based on generator efficiency (check other standard)		The generator operational control is set individually to available generators so that they operate with an overall high degree of efficiency or using the cheapest energy form (e.g. outdoor air, river water, geothermic heat, refrigeration machines)								

Extract from EN 15232 section 7.5

7.5.1 Air flow control at the room level

7.5.1.1 General

The type of control to use shall be specified according to EN 13779. One shall at least differentiate the following types of local (room or zone) flow control.

0) No control: The system runs constantly:
1) manual control: The system runs according to a manually controlled switch;
2) time control: The system runs according to a given time schedule;
3) presence control: The system runs dependent on the presence (light switch, infrared sensors etc.);
4) demand control: The system is controlled by sensors measuring the number of people or indoor air parameters or adapted criteria (e.g. CO_2, mixed gas or VOC sensors). The used parameters shall be adapted to the kind of activity in the space.

7.5.1.2. Air flow control at the air handler level

One shall differentiate at least the following types of control:

0) no control;
1) on off time control;
2) automatic flow control with or without pressure reset.

7.5.1.3. Heat exchanger defrosting and overheating control

When applying this standard one shall differentiate the following case:

Defrosting control

0) without defrosting control: there is no specific action during cold period;
1) with defrosting control: during cold period a control loop enables to warranty that the air temperature leaving the heat exchanger is not too low to avoid frosting.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

9. This deals exclusively with air renewal in the room.
   Note: Per EN 15232, the parts “Heating control” and “Cooling control” apply for **room** temperature control

10. This function affects the air flow in a one-room system (e.g. movie theater, lecture hall) or in the reference room of a multi-room system without room automation.
    This function affects the air flow of each room automation as part of a multi-room system. For that a supply air pressure control in the air handling unit is required (refer to Processing function 2 per Interpretation 11)

11. Processing functions 0 and 1 affect the air flow in the air handling unit as part of a multi-room system without room automation. These are, however, already contained in the function per interpretation 10. Processing function 2 was planned as air flow provisioning for a multi-room system with room automation

12. Control of exhaust-air side icing protection of heat recovery (heat exchanger)

VENTILATION AND AIR CONDITIONING CONTROL		BT	Reason for energy saving	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Air flow control at the room level		9 10	Reducing the air flow saves energy for air handling and distribution								
0	No control		Air flow for the maximum load in the room is used up continuously. Results in greater energy losses at partial load in the room and during non-occupancy								
1	Manual control		Air flow is only changed by room users when the room conditions are no longer sufficient. Seldom reset at the end of occupancy. Savings are questionable.	•							
2	Time control		Air flow for the maximum load in the room is used up during the nominal occupancy times. Results in significant energy losses at partial load in the room								
3	Presence control		Air flow for the maximum load in the room is used up during the actual occupancy times. Energy losses at partial load in room are reduced to actual occupancy		•						•
4	Demand control		Air flow in the room controlled, for example, by an air quality sensor. Ensures air quality at lower energy for air handling and distribution.			•	•	•	•	•	
Air flow control at the air handler level		11	Reducing the air flow saves energy for air handling and distribution								
0	No control		Air handling unit continuously supplies air flow for a maximum load of all rooms. Results in unnecessary energy expenses at partial load and during non-occupancy								
1	On off time control		Air handling unit supplies air flow for a maximum load of all connected rooms during nominal occupancy times. Still results in significant energy losses at partial load		•						•
2	Automatic flow or pressure control with or without pressure reset		Air flow adapts to demand of all connected consumers. At partial load, electrical power is reduced at the fan in the air handling unit			•	•	•	•	•	
Heat exchanger defrost control		12									
0	Without defrost control		As soon as exhaust air humidity ices up in the heat exchanger (the air spaces fill with ice), the power of the exhaust air fan must be increased to ensure air flow in the room								
1	With defrost control		The power of the exhaust air fan does not need to be increased with icing protection limitation control		•	•	•	•	•	•	•

Extract from EN 15232 section 7.5

Overheating control

0) without overheating control: there is no specific action during hot or mild periods;
1) with overheating control: during cooling periods where the effect of the heat exchanger will no more be positive a control loop stops modulates or bypass the heat exchanger.

7.5.1.4. Free cooling and night time ventilation during cooling mode

This control function for fan-assisted natural ventilation enables to use the cooler outdoor to cool down the indoor air inside the building. One shall differentiate the following types of free cooling:

0) no control
1) night cooling: the amount of outdoor air is set to its maximum during the unoccupied period provided: 1) the room temperature is above the set point for the comfort period, 2) the difference between the room temperature and the outdoor temperature is above a given limit; if free night cooling will be realised by automatically opening windows there is no air flow control;
2) free cooling the amount of outdoor air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures;
3) h,x- directed control: the amount of outdoor air and recirculation air are modulated during all periods of time to minimize the amount of mechanical cooling. Calculation is performed on the basis of temperatures and humidity (enthalpy).

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

13. Control heat recovery in the centralized air handling

14. Cooling and ventilation with a portion provided by passive energy (renewable and free, may however require auxiliary energy, e.g. electrical energy for pumps). This reduces the percentage of active energy (that has to be paid for)

VENTILATION AND AIR CONDITIONING CONTROL		BT	Reason for energy saving	Efficiently used in: Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Heat exchanger overheating control		13									
0	Without overheating control		Heat recovery is always on 100 % and can overheat supply air flow. Requires additional energy for cooling.								
1	With overheating control		Temperature sequence control at heat recovery prevents unnecessary re-cooling of the supply air.		•	•	•	•	•	•	•
Free mechanical cooling		14									
0	No control		Supply air is always mechanically cooled as required using active energy								
1	Night cooling		Night cooling (passive cooling): During the night, heat stored in the building mass is carried out by cool outdoor air to the lower limit of the comfort range. Reduce the use of active cooling energy during the daytime		•	•	•			•	•
2	Free cooling		Reduces energy demand on active cooling of supply air: Maximum Economy changeover (MECH): Heat recovery is opened whenever the exhaust air temperature is lower than the outdoor air. Cooling supply air with outside air: (from supply air via cooling coils and coolant directly to cooling tower) Has priority (free energy) as long as the outdoor air temperature suffices for cooling		•	•	•	•	•	•	•
3	H,x- directed control		Maximum Economy changeover (MECH): Heat recovery is opened whenever the exhaust air enthalpy is lower than the outdoor air. Reduces energy demand on active cooling of supply air								

Extract from EN 15232 section 7.5

7.5.2 Supply temperature control

7.5.2.1 General

If the air system serves only one room and is controlled according to indoor temperature of this room one shall use 7.4 “Heating and cooling control” even if the control acts on the supply temperature.

In the other cases one shall differentiate at least the following types of control:

0) no control: no control loop enables to act on the supply air temperature;
1) constant set point : a control loop enables to control the supply air temperature, the set point is constant and can only be modified by a manual action;
2) variable set point with outdoor temperature compensation: a control loop enables to control the supply air temperature. The set point is a simple function of the outdoor temperature (e.g. linear function);
3) variable set point with load dependant compensation: a control loop enables to control the supply air temperature. The set point is defined as a function of the loads in the room. This can normally only be achieved with an integrated control system enabling to collect the temperatures or actuator position in the different rooms.

This temperature control shall be considered with a particular attention if the system principle does not prevent simultaneous heating and cooling.

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

VENTILATION AND AIR CONDITIONING CONTROL		BT	Reason for energy saving	Efficiently used in: Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Supply Temperature control		15									
0	No control		The supply air temperatur is prepared continuously according to the max. load. The highest air output is continuously supplied to the rooms resp. provided for after-treatment. Results in the emission of unnecessary heat energy at partial load.								
1	Constant set point		The supply air temperature is set manually. The air is supplied to the rooms resp. provided for after-treatment. Temperature is increased manually as needed, but then often not reduced to proper levels. Behavior is suboptimum								
2	Variable set point with outdoor temperature compensation		Supply air temperature is controlled by the outdoor temperature (corresponding to the probable demand of the individual rooms). Individual load of all individual rooms is not, however, considered. As a result, there is no way to influence how many individual room temperature controllers reheat in the summer or recool in the winter.					•			
3	Variable set point with load dependant compensation		<u>One-room plant with cascading control</u>: Supply air temperature is controlled per load in the one-room plant or reference room plant. <u>Multi-room plant with room automation</u>: Supply air temperature is supplied by the largest individual load of all individual rooms. Reduces the number of individual room temperature controllers that reheat in the summer or recool in the winter. <u>Notes for both solutions</u>: • Energy demand sinks for the HVAC plant as the load decreases • The greater the distance for heating and cooling setpoints of all room controllers (large neutral zones), the smaller the energy demand for the HVAC plant		•	•	•		•	•	•

Extract from EN 15232 section 7.5

7.5.2.2. Humidity control

One shall differentiate at least the following types of control:

0) no humidity control: no control loop enable to act on the supply air humidity;
1) supply air humidity limitation : a control loop enables to avoid the supply air humidity to go below a threshold value;
2) supply air humidity control: a control loop enables to keep the supply air humidity at a constant value;
3) room or exhaust air humidity control: a control loop enable the room air humidity to be kept at a constant value.

	VENTILATION AND AIR CONDITIONING CONTROL	**BT**	**Reason for energy saving**	**Efficiently used in**							
				Residential	**Offices**	**Lecture halls**	**Schools**	**Hospitals**	**Hotels**	**Restaurants**	**Wholesale**
	Humidity control										
0	No control		Humidity at centralized supply air is not impacted								
1	Supply air humidity limitation		A limitation controller only releases the aggregate when the actual value falls below (or above) a limit value								
2	Supply air humidity control		The controller controls output of the air humidifier or dehumidifier to a setpoint. <u>Note</u>: Two setpoints required when a plant can humidify and dehumidify (with as large a energy dead band as possible!). Energy savings are less since the setpoints must be closer as is the case for processing function 3								
3	Room or exhaust air humidity control		The controller controls output of the air humidifier or dehumidifier based on load (e.g. mixing exhaust from all rooms) to a setpoint. <u>Note</u>: Two setpoint required when a plant can humidify and dehumidify (with as large an energy dead band as possible!). Energy savings are greater since the setpoints can be further apart than for processing function 2		•	•	•	•	•	•	•

Extract from EN 15232 section 7.6

One shall differentiate at least the following types of control:

a) occupancy control

0) Manual On/Off Switch: the luminary is switched on and off with a manual switch in the room;
1) Manual On/Off Switch and additional automatic sweeping extinction signal: the luminary is switched on and off with a manual switch in the room. In addition, an automatic signal automatically switches off the luminary at least once a day, typically in the evening to avoid needless operation during the night;
2) Auto On/Dimmed: the control system switches the luminary(ies) automatically on whenever there is presence in the illuminated area, and automatically switches them to a state with reduced light output (of no more than 20 % of the normal 'on state') no later than 5 min after the last presence in the illuminated area. In addition, no later than 5 min after the last presence in the room as a whole is detected, the luminary(ies) is automatically and fully switched off;
3) Auto On/ Auto Off: the control system switches the luminary(ies) automatically on whenever there is presence in the illuminated area, and automatically switches them entirely off no later than 5 min after the last presence is detected in the illuminated area;
4) Manual On/Dimmed: the luminary(ies) can only be switched on by means of a manual switch in (or very close to) the area illuminated by the luminary(s), and, if not switched off manually, is/are automatically switched to a state with reduced light output (of no more than 20 % of the normal 'on state') by the automatic control system no later than 5 min after the last presence in the illuminated area. In addition, no later than 5 min after the last presence in the room as a whole is detected, the luminary(s) are automatically and fully switched off;
5) Manual On/Auto Off: the luminary(ies) can only be switched on by means of a manual switch in (or very close to) the area illuminated by the luminary(ies), and, if not switched off manually, is automatically and entirely switched off by the automatic control system no later than 5 min after the last presence is detected in the illuminated area;

b) daylight control

0) manual: There is no automatic control to take daylight into account;
1) automatic: An automatic system takes daylight into account.

LIGHTING CONTROL		BT	Reason for energy saving	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Occupancy control			Reducing lighting to occupancy times or actual need in room areas saves energy								
0	Manual on/off switch		<u>In residential buildings</u> users can turn the lighting on and off as needed. This saves lighting energy. <u>In non-residential buildings</u> lighting is mostly on. Reason: Many users do not turn off lighting during breaks or at the end of the work (suboptimal)	•				•	•		
1	Manual on/off switch + additional sweeping extinction signal		Ensures that lights are turned off <u>in non-residential buildings</u> as well (e.g. in the evenings or weekends)							•	•
2	Automatic detection Auto On / Dimmed		Actual occupancy is recorded in each area, in large rooms, hallways, etc. Then an automated lighting control • turns on lighting in an area at the start of occupancy • reduces lighting to a max of 20 % in the area at the end of occupancy • turns off lighting in the room 5 minutes after the end of occupancy								
3	Automatic detection Auto On / Auto Off		Actual occupancy of each room or room area is recorded. Then an automated lighting control turns on lighting in a room or area at the start of occupancy and turns it off after a maximum of 5 minutes after the end of occupancy			•	•				
4	Automatic detection Manual On / Dimmed		Lighting of each area • can <u>only</u> be switched on manually • can be dimmed and switched off manually Actual occupancy of each area is recorded in the room. Then an automated lighting control • reduces lighting to a max of 20 % in the area at the end of occupancy • turns off lighting in the room 5 minutes after the end of occupancy		•						
5	Automatic detection Manual On / Auto Off		Lighting of each area • can <u>only</u> be switched on manually • can be manually switched off Actual occupancy of each area is recorded in the room. Then an automated lighting control turns off the lighting 5 minutes after the end of occupancy in the area								
Daylight control			Artificial lighting can be reduced as the incoming daylight increases, thus saving energy								
0	Manual		Lighting is manually increased when daytime light is too weak. Lighting is not always manually reduced, however, when daytime light is more than sufficient (suboptimal)			•	•		•	•	•
1	Automatic		Automatically supplemented lighting to the incoming daylight always ensures that there is sufficient lighting at minimum energy		•						

Extract from EN 15232 section 7.7

There are two different motivations for blind control: solar protection to avoid over-heating and to avoid glaring. One shall differentiate at least the following control types:

0) manual;
1) motorized;
2) automatic control;
3) combined light/blind/HVAC control.

BLIND CONTROL			BT	Reason for energy saving	Efficiently used in							
					Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
				a) Reduction of external light can prevent blinding room users b) Reduction of heat radiation in the room can save cooling energy c) Allowing heat radiation in the room can save heating energy d) Closed blinds can reduce heat loss in the room								
	0	Manual operation		Manual intervention is used mostly only done for a) dimming. Energy savings highly dependent on user behavior								
	1	Motorized operation with manual control		Motoric support eases only manual intervention and is mostly only done for a). Energy savings highly dependent on user behavior	•							
	2	Motorized operation with automatic control		Motoric support is required for automatic control. The focus of control functions is in support of reason a). Another result is that cooling energy can be saved - reason b).					•	•		
	3	Combined light/blind/HVAC control (also mentioned above)		This processing function considers all the reasons a), b), c) and d) to meet the needs of the use and energy optimized (prioritized consideration, for occupied and non-occupied rooms)		•	•	•			•	•

Extract from EN 15232 section 7.8

A home and building automation systems enables the following functions in addition to standard control functions:

– centralized adapting of the home and building automation system to users needs: e.g. time schedule, set points;
– centralized optimizing of the home and building automation system: e.g. tuning controllers, set points.

The system enables to adapt easily the operation to the user needs:

– One shall check at regular intervals that the operation schedules of heating, cooling, ventilation and lighting is well adapted to the actual use schedules and that the set points are also adapted to the needs.
– Attention shall be paid to the tuning of all controllers this includes set points as well as control parameters such as PI controller coefficients.
– Heating and cooling set points of the room controllers shall be checked at regular intervals. These set points are often modified by the users. A centralised system enables to detect and correct extreme values of set points due to misunderstanding of users.
– If the Interlock between heating and cooling control of emission and/or distribution is only a partial interlock (see 0) the set point shall be regularly modified to minimise the simultaneous use of heating and cooling.
– Alarming and monitoring functions will support the adaptation of the operation to user needs and the optimization of the tuning of the different controllers. This will be achieved by providing easy tools to detect abnormal operation (alarming functions) and by providing easy way to log and plot information (monitoring functions).

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

16. The focus is on centralized operation and monitoring:
    - Use and comfort-oriented functions
    - Manual recognition of deviations in use

17. The focus is on centralized, superposed control and coordination as well as centralized, automated preparation of data to be monitored:
    - Building services equipment and operationally optimized functions
    - Automatic recognition and reporting of on-going operational deviations

	HOME AUTOMATION SYSTEM BUILDING AUTOMATION AND CONTROL SYSTEM	BT	Reason for energy saving	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
0	No home automation No building automation and control system		No energy savings since, as a rule, the plants and rooms in the building are not operated appropriate to use and incorrect settings are not recognized								
1	Centralized adapting of the home & building automation and control system to users needs: e.g. time schedule, set points…	16	Centralized operation and monitoring of: a) Schedulers (switching times and operating modes) can be operator (e.g. operator station) and monitored centrally b) Setpoint pairs (heating and cooling) for the operating modes can be operated and monitored centrally c) Eventually additional centralized possibilities to manually monitor operating data Effect: As a rule, the user is better able to adapt BAC to meet their needs with centralized operations. Can save energy	•							
2	Centralized optimizing of the home and building automation and control system: e.g. tuning controllers, set points…	17	Centralized automatic monitoring, as well as providing the data to be monitored: a) Automatic recognition and display of ongoing deviations from specifications. Examples: - Party switch continuously active - Scheduler permanently overridden - Setpoint outside normal range for a longer period of time Effect: Centralized monitoring generally allows the user to easily recognize wrong settings and inefficient plant operation and easily eliminates them through operational optimization. This can save additional energy Even more energy savings can be achieved, e.g. by the following control and coordination functions that are <u>not required</u> by EN 15232: b) Identical setpoint in all room area controllers for each room c) The setpoints for operating modes Comfort and Pre-Comfort can be controlled to optimze both comfort and energy per weather conditions d) Centralized release of similar aggregates (e.g. electric reheaters in the rooms) e) Centralized defaults for control action applied to all controllers connected to two-pipe plants		•	•	•	•	•	•	•

Extract from EN 15232 section 7.9

7.9.1. General

These functions are especially useful to achieve the following requirements of the energy performance in buildings directive:

- Establishing an energy performance certificate;
- Boiler inspection;
- Air conditioning system inspection.

7.9.2. Detecting faults of building and technical systems and providing support to the diagnosis of these faults

Specific monitoring functions shall be set up to enable to detect quickly the following faults:

a) Improper operation schedules

   This is especially necessary in buildings which are not permanently occupied such as offices, schools.

   The monitoring function shall include at the minimum a graph or an indicator highlighting the time where: Fans are on, cooling system is running, heating system is in normal mode, lighting is on.

b) Improper set points

   Specific monitoring functions shall be set up to enable to detect quickly improper set points of room temperature.

   The monitoring function shall include a graph or an indicator enabling to have a global view of the different set points of room temperature for heating and cooling.

c) Simultaneous heating and cooling

   If the system can lead to simultaneous heating and cooling monitoring functions shall be set to check that simultaneous heating and cooling is avoided or minimized.

   Fast switching between heating and cooling shall also be detected.

d) Priority to generator(s) having the best energy performance

   When several generation systems having different energy performances are used to do the same function (e.g. heat pump and back up, solar system and back up) a monitoring function shall be set to verify that the systems having the best energy performances are used before the others.

TECHNICAL HOME AND BUILDING MANAGEMENT		BT	Reason for energy savings	Efficiently used in							
				Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Detecting faults of home and building systems and providing support to the di-agnosis of these faults			Errors, deviations, etc., are automatically determined and reported, making it possible to eliminate the less-than-efficient operation as early as possible								
0	No		Errors and defects cannot be eliminated as long as comfort changes and increased energy costs are not noticed and properly clarified								
1	Yes		First, error as well as on-going deviations from the specifications must be recognized and displayed. Only then it is possible to initiate counter-measures to (once again) establish energy-efficient operations. Examples of possible errors: • Operating mode select switch set permanently to “ON" • Party switch continuously active • Scheduler permanently overridden • Setpoint or actual value outside the normal range for a long period		•	•	•	•	•	•	•

Extract from EN 15232 section 7.9

7.9.3. Reporting information regarding energy consumption, indoor conditions and possibilities for improvement

Report shall be set to report information regarding energy consumption and indoor conditions.

These reports can include:

a) energy certificate for the building

b) the monitoring function which shall be used to obtain a measured rating as defined in prEN 15203:2005, Clause 7.

   Using the on line monitoring function enables to obtain a rating fully in conformity with requirements of prEN 15203. Measurements of the meters can be done for an exact year according to 7.2. If sufficient number of meters is installed the measurements can be done for each energy carrier. Energy used for other purposes than heating, cooling, ventilation, hot water or lighting can be measured separately according to 7.3. The measurement of outdoor temperature enables to perform the correction for outdoor climate defined in 7.4.

   The rating can be used to prepare an energy performance certificate designed according to EN 15217;

c) assessing the impact of improvement of building and energy systems
   This assessment can be done according to prEN 15203 by using a validated building calculation model as defined in Clause 9.
   Using the monitoring functions enables to take into account the actual values regarding climatic data, internal temperature, internal gains, hot water use, lighting use, according to prEN 15203, 9.2 and 9.3;

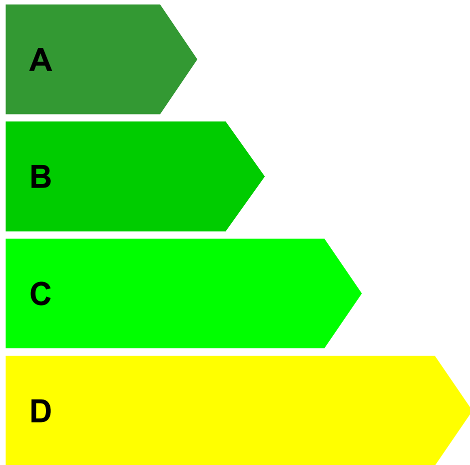
d) energy monitoring
   The TBM monitoring function can be used to prepare and display the energy monitoring graphs defined in prEN 15203, Annex H;

e) room temperature and indoor air quality monitoring
   Monitoring function can be used to provide report regarding air or room operative temperature in the rooms as well as indoor air quality. For buildings which are not permanently occupied these functions shall differentiate occupied and non occupied buildings. For buildings which are heated and cooled the report shall differentiate cooling and heating periods.
   The reports shall include the actual value as well as reference values such as set points for example.

TECHNICAL HOME AND BUILDING MANAGEMENT		BT	Reason for energy savings	Residential	Offices	Lecture halls	Schools	Hospitals	Hotels	Restaurants	Wholesale
Reporting information regarding energy consumption, indoor conditions and possibilities for improvement			Recording energy consumption and operational data provides the foundation • To evaluate the building, plants as well as their operation • For issuing an energy pass • To recognize potential improvements and plan measures								
0	No		Energy saving potential is not systematically recorded and disclosed								
1	Yes		The following BM system functions support analysis and evaluation of plant operations: • Calculate weather adjusted annual energy consumption, as well as additional weather-adjusted key variables • Compare object's operational data and the plants against standard values, class values, etc. • Etc. • As well as the ability to efficiently report deviations	•	•	•	•	•	•	•	•

4.2 Building automation and control efficiency classes

EN 15232 defines four different BAC efficiency classes (A, B, C, D) For building automation and control systems:



Class	Energy efficiency
A	Corresponds to high energy performance BACS and TBM • Networked room automation with automatic demand control • Scheduled maintenance • Energy monitoring • Sustainable energy optimization
B	Corresponds to advanced BACS and some specific TBM functions • Networked room automation without automatic demand control • Energy monitoring
C	Corresponds to standard BACS • Networked building automation of primary plants • No electronic room automation, thermostatic valves for radiators • No energy monitoring
D	Corresponds to non energy efficient BACS. Building with such systems shall be retrofitted. New buildings shall not be built with such systems • Without networked building automation functions • No electronic room automation • No energy monitoring

All processing functions in EN 15232 are assigned to one of the four classes for residential and non-residential buildings.

Function classification list

The function classification list below contains 12 columns:

Columns 1 to 3 and 5 to 12 correspond to the content of EN 15232

- Column 1 Establishes the field of use
- Column 2 Establishes the building automation and control functions for evaluation, as well as ordinal numbers for possible processing functions
- Column 3 Establishes the processing functions for evaluation
- In columns 5 to 8

  Each processing function is assigned a BAC energy efficiency class for residential buildings. The gray rows should be interpreted from the left as columns in the corresponding class.

  Example for class B:

D	C	B	A

In columns 9 to 12

Each processing function is assigned a BAC energy efficiency class for non-residential buildings.

Column 4 is a Siemens BT supplement
It refers to the Siemens Building Technologies interpretation for the functions and processing functions from EN 15232.
(BT = Remarks of Siemens BT)

<table>
<tr><td colspan="3">1</td><td>4</td><td colspan="8">5</td></tr>
<tr><td>1</td><td colspan="2">2</td><td>4</td><td colspan="4">5</td><td colspan="4">9</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td></tr>
</table>

On the following pages are
- Right side: Tables from EN 15232
- Left side: Remarks of Siemens BT

☞ Continued on the next double-page

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232: 2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

1. Plants required for "emission control" of thermal energy (e.g. radiators, chilled ceilings, VAV systems) may have different supply media (e.g. water, air, electricity). As a result, different BAC solutions may be possible for a processing function

2. The Siemens interpretation stands by the processing function in the function list from EN 15232: It includes thermostatic valves and electronic control equipment.
   - Non-communicating electronic control equipment may include a local scheduler. But experience suggests that they are often not properly set
   - Thermostatic valves are not used for “cooling control”

3. Communication between a superposed centralized unit and electronic individual room controllers allow for centralized schedulers, monitoring of individual room controllers as well as centralized operation and monitoring

4. Demand control (by use) = Demand control based on occupancy information from a presence detector or a presence button with automatic reset after a set period. Control switches from Pre-Comfort to Comfort or the other way around using this occupancy information (see EN 15500). Notes:
   - Air quality control is considered in "Ventilation and air conditioning control"
   - Occupancy information can influence “heating control”, “cooling control” and “ventilation and air conditioning control”

5. Processing function 2 also includes processing function 1 (ON/OFF control); otherwise processing function 2 would generally be less efficient than 1

6. Pump solutions with an external power control input (e.g. based of the effective load by the consumer), are more expensive overall. They do, however, allow for more precise pump control than pumps with integrated pressure control equipment. Furthermore, the risk of under-provisioning for individual consumers is reduced

7. This Siemens interpretation stands by the processing function in the function list from EN 15232: Switching on generators with the same nominal output is accomplished based solely on load (no additional prioritization)

HEATING CONTROL		BT	Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
		1								
	The control system is installed at the emitter or room level, for case 1 one system can control several rooms									
0	No automatic control									
1	Central automatic control									
2	Individual room automatic control by thermostatic valves or electronic controller	2								
3	Individual room control with communication between controllers and to BACS	3								
4	Integrated individual room control including demand control (by occupancy, air quality, etc.)	4								
Control of distribution network hot water temperature (supply or return)										
	Similar function can be applied to the control of direct electric heating networks									
0	No automatic control									
1	Outside temperature compensated control									
2	Indoor temperature control									
Control of distribution pumps										
	The controlled pumps can be installed at different levels in the network									
0	No control									
1	On off control									
2	Variable speed pump control with constant Δp	5								
3	Variable speed pump control with proportional Δp	6								
Intermittent control of emission and/or distribution										
	One controller can control different rooms/zone having same occupancy patterns									
0	No automatic control									
1	Automatic control with fixed time program							***18)**		
2	Automatic control with optimum start/stop									
Generator control										
0	Constant temperature									
1	Variable temperature depending on outdoor temperature									
2	Variable temperature depending on the load									
Sequencing of different generators										
0	Priorities only based on loads	7								
1	Priorities based on loads and generator capacities									
2	Priorities based on generator efficiency (check other standard)									

***18)** This processing function meets efficiency class D per EN 15232 for non-residential buildings. Siemens BT assigned it to efficiency class C and will submit the change to the standardization committee for EN 15232

Remarks of Siemens

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

1. Plants required for "emission control" of thermal energy (e.g. radiators, chilled ceilings, VAV systems) may have different supply media (e.g. water, air, electricity). As a result, different BAC solutions may be possible for a processing function

2. The Siemens interpretation stands by the processing function in the function list from EN 15232: It includes thermostatic valves and electronic control equipment.
   - Non-communicating electronic control equipment may include a local scheduler. But experience suggests that they are often not properly set
   - Thermostatic valves are not used for “cooling control”

3. Communication between a superposed centralized unit and electronic individual room controllers allow for centralized schedulers, monitoring of individual room controllers as well as centralized operation and monitoring

4. Demand control (by use) = Demand control based on occupancy information from a presence detector or a presence button with automatic reset after a set period. Control switches from Pre-Comfort to Comfort or the other way around using this occupancy information (see EN 15500). Notes:
   - Air quality control is considered in "Ventilation and air conditioning control"
   - Occupancy information can influence “heating control”, “cooling control” and “ventilation and air conditioning control”

5. Processing function 2 also includes processing function 1 (ON/OFF control); otherwise processing function 2 would generally be less efficient than 1

6. Pump solutions with an external power control input (e.g. based of the effective load by the consumer), are more expensive overall. They do, however, allow for more precise pump control than pumps with integrated pressure control equipment. Furthermore, the risk of under-provisioning for individual consumers is reduced

7. This Siemens interpretation stands by the processing function in the function list from EN 15232: Switching on generators with the same nominal output is accomplished based solely on load (no additional prioritization)

8. Comparable functions can be used for controlling networks for electrical direct cooling (e.g. compact cooling units or split units for individual rooms)

COOLING CONTROL		BT	Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Emission control		1								
	The control system is installed at the emitter or room level, for case 1 one system can control several rooms									
0	No automatic control									
1	Central automatic control									
2	Individual room automatic control by thermostatic valves or electronic controller	2								
3	Individual room control with communication between controllers and to BACS	3								
4	Integrated individual room control including demand control (by occupancy, air quality, etc.)	4								
Control of distribution network cold water temperature (supply or return)										
	Similar function can be applied to the control of direct electric heating networks	8								
0	No automatic control									
1	Outside temperature compensated control									
2	Indoor temperature control									
Control of distribution pumps										
	The controlled pumps can be installed at different levels in the network									
0	No control									
1	On off control									
2	Variable speed pump control with constant Δp	5								
3	Variable speed pump control with proportional Δp	6								
Intermittent control of emission and/or distribution										
	One controller can control different rooms/zone having same occupancy patterns									
0	No automatic control									
1	Automatic control with fixed time program							***18)**		
2	Automatic control with optimum start/stop									
Interlock between heating and cooling control of emission and/or distribution										
0	No interlock									
1	Partial interlock (dependant of the HVAC system)									
2	Total interlock									
Generator control										
0	Constant temperature									
1	Variable temperature depending on outdoor temperature									
2	Variable temperature depending on the load									
Sequencing of different generators										
0	Priorities only based on loads	7								
1	Priorities based on loads and generator capacities									
2	Priorities based on generator efficiency (check other standard)									

***18)** This processing function meets efficiency class D per EN 15232 for non-residential buildings. Siemens BT assigned it to efficiency class C and will submit the change to the standardization committee for EN 15232

Remarks of Siemens BT

Some functions and processing functions in the first edition of EN 15232: 2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

9. This deals exclusively with air renewal in the room.
   Note:
   Per EN 15232, the parts “Heating control” and “Cooling control” apply for **room** temperature control

10. This function affects the air flow in a one-room system (e.g. movie theater, lecture hall) or in the reference room of a multi-room system without room automation.

    This function affects the air flow of each room automation as part of a multi-room system. For that a supply air pressure control in the air handling unit is required (refer to Processing function 2 per Interpretation 11)

11. Processing functions 0 and 1 affect the air flow in the air handling unit as part of a multi-room system without room automation. These are, however, already contained in the function per interpretation 10.

    Processing function 2 was planned as air flow provisioning for a multi-room system with room automation

12. Control of exhaust-air side icing protection of heat recovery (heat exchanger)

13. Control heat recovery in the centralized air handling

14. Cooling and ventilation with a portion provided by passive energy (renewable and free, may however require auxiliary energy, e.g. electrical energy for pumps). This reduces the percentage of active energy (that has to be paid for)

15. Remark for German version of EN 15232 : 2007 only:
    Control of supply air temperature in the centralized air handling (and not flow temperature)

VENTILATION AND AIR CONDITIONING CONTROL		BT	Definition of classes							
			Residential				Non residential			
			D	C	B	A	D	C	B	A
Air flow control at the room level		9, 10								
0	No control									
1	Manual control									
2	Time control									
3	Presence control									
4	Demand control									
Air flow control at the air handler level		11								
0	No control									
1	On off time control									
2	Automatic flow or pressure control with or without pressure reset									
Heat exchanger defrost control		12								
0	Without defrost control									
1	With defrost control									
Heat exchanger overheating control		13								
0	Without overheating control									
1	With overheating control									
Free mechanical cooling		14								
0	No control									
1	Night cooling									
2	Free cooling									
3	H,x- directed control									
Supply Temperature control		15								
0	No control									
1	Constant set point									
2	Variable set point with outdoor temperature compensation									
3	Variable set point with load dependant compensation									
Humidity control										
0	No control									
1	Supply air humidity limitation									
2	Supply air humidity control									
3	Room or exhaust air humidity control									

Remarks of Siemens BT

Some functions and processing functions in the first edition of EN 15232:2007 are still not clear or do not cover all the BAC functions available at Siemens BT. This section outlines how Siemens interprets these functions and processing functions per EN 15232.

16. The focus is on centralized operation and monitoring:
    - Use and comfort-oriented functions
    - Manual recognition of deviations in use

17. The focus is on centralized, superposed control and coordination as well as centralized, automated preparation of data to be monitored:
    - Building services equipment and operationally optimized functions
    - Automatic recognition and reporting of on-going operational deviations

LIGHTING CONTROL			BT	Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
	Occupancy control										
	0	Manual on/off switch									
	1	Manual on/off switch + additional sweeping extinction signal									
	2	Automatic detection Auto On / Dimmed									
	3	Automatic detection Auto On / Auto Off									
	4	Automatic detection Manual On / Dimmed									
	5	Automatic detection Manual On / Auto Off									
	Daylight control										
	0	Manual									
	1	Automatic									

BLIND CONTROL			BT	Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
	0	Manual operation									
	1	Motorized operation with manual control									
	2	Motorized operation with automatic control									
	3	Combined light/blind/HVAC control (also mentioned above)									

HOME AUTOMATION SYSTEM BUILDING AUTOMATION AND CONTROL SYSTEM			BT	Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
	0	No home automation No building automation and control system						*19)			
	1	Centralized adapting of the home & building automation and control system to users needs: e.g. time schedule, set points…	16			*20)				*20)	
	2	Centralized optimizing of the home and building automation and control system: e.g. tuning controllers, set points…	17								

TECHNICAL HOME AND BUILDING MANAGEMENT			BT	Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
	Detecting faults of home and building systems and providing support to the diagnosis of these faults										
	0	No									
	1	Yes		*19)							
	Reporting information regarding energy consumption, indoor conditions and possibilities for improvement										
	0	No									
	1	Yes									

***19)** Siemens BT colored these fields in gray
(in EN 15232 : 2007 DE are incorrectly white, in EN 15232 : 2007 E correct)

***20)** This processing function meets efficiency class C per EN 15232. Siemens BT assigned it to efficiency class B for residential and non-residential buildings and will submit the change to the standardization committee for EN 15232 accordingly.

4.2.1 Procedure for meeting an efficiency class for BAC projects

Example
Single-room store

The building contains an open one-room store that is air conditioned using a central air handling unit. Heating and cooling occurs on the air side using heat transfer water/air.

Requirement: BAC class B.

Procedure

1. Functions relevant to the project are checked off “✓“ in column 1
2. Draw a line on the right-hand side for the required BAC class
3. A processing function must be selected for each relevant function and the classification column (at a minimum) must reach the required class. It is marked by an “**x**“ in column 1 (in the example: red)

B

VENTILATION AND AIR CONDITIONING CONTROL			BT	Definition of classes							
				Residential				Non residential			
				D	C	B	A	D	C	B	A
✓	Air flow control at the room level		9, 10								
	0	No control									
	1	Manual control									
	2	Time control									
x	3	Presence control									
	4	Demand control									
✓	Air flow control at the air handler level		11								
	0	No control									
	1	On off time control									
x	2	Automatic flow or pressure control with or without pressure reset									
✓	Heat exchanger defrost control		12								
	0	Without defrost control									
x	1	With defrost control									
✓	Heat exchanger overheating control		13								
	0	Without overheating control									
x	1	With overheating control									
✓	Free mechanical cooling		14								
	0	No control									
	1	Night cooling									
x	2	Free cooling									
	3	H,x- directed control									
✓	Supply Temperature control		15								
	0	No control									
	1	Constant set point									
x	2	Variable set point with outdoor temperature compensation									
	3	Variable set point with load dependant compensation									
	Humidity control										
	0	No control									
	1	Supply air humidity limitation									
	2	Supply air humidity control									
	3	Room or exhaust air humidity control									

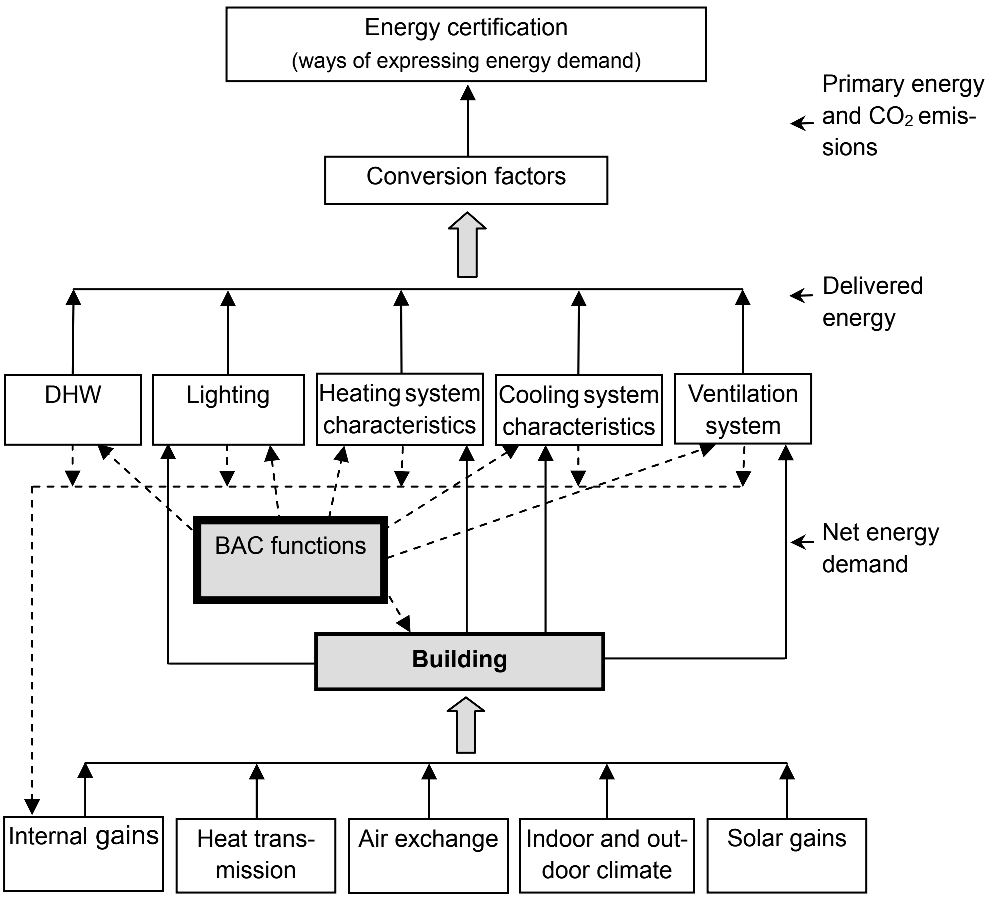
Result

To meet energy efficiency class B, the BAC must be equipped with processing functions marked with “**x**“.

4.3 Calculate the impact of BAC and TBM on a building's energy efficiency

Calculation diagram for a building

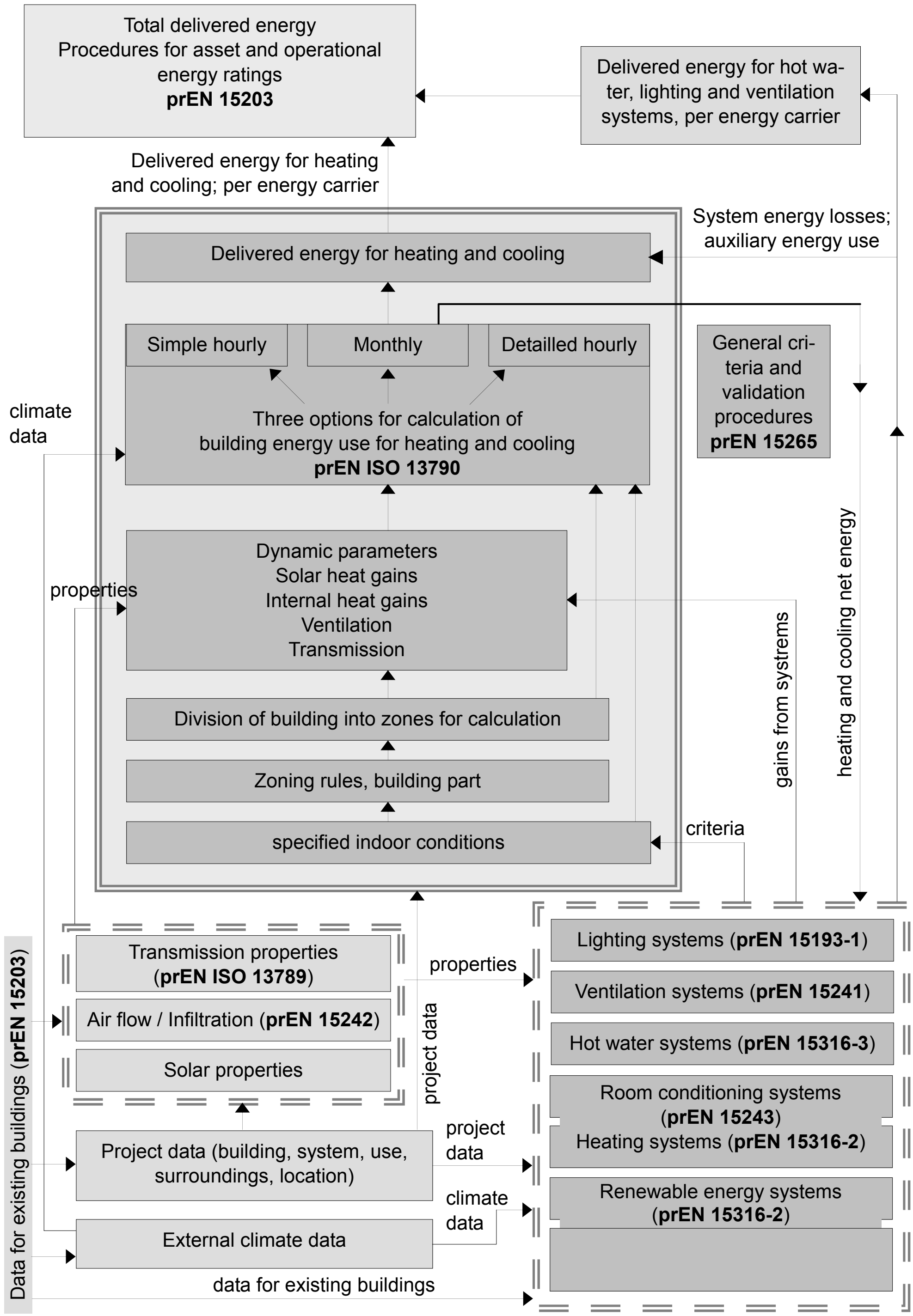
Before going into detail on energy efficiency calculations, we will outline the sequence of the individual calculation steps in the diagram below. The illustration indicates that the calculation starts with the consumers (handover in room) and ends at primary energy, i.e. in the opposite direction as supply flow.



Source: prCEN/TR 15615:2007
Declaration on the General Relationship between various European standards and the EPBD ("Umbrella Document").

Applied standards

Energy demand and efficiency for the various energy shares within a building are conducted per the following standards:



Source: prCEN/TR 15615:2007

Declaration on the General Relationship between various European standards and the EPBD ("Umbrella Document").

Calculation procedure per EN 15232

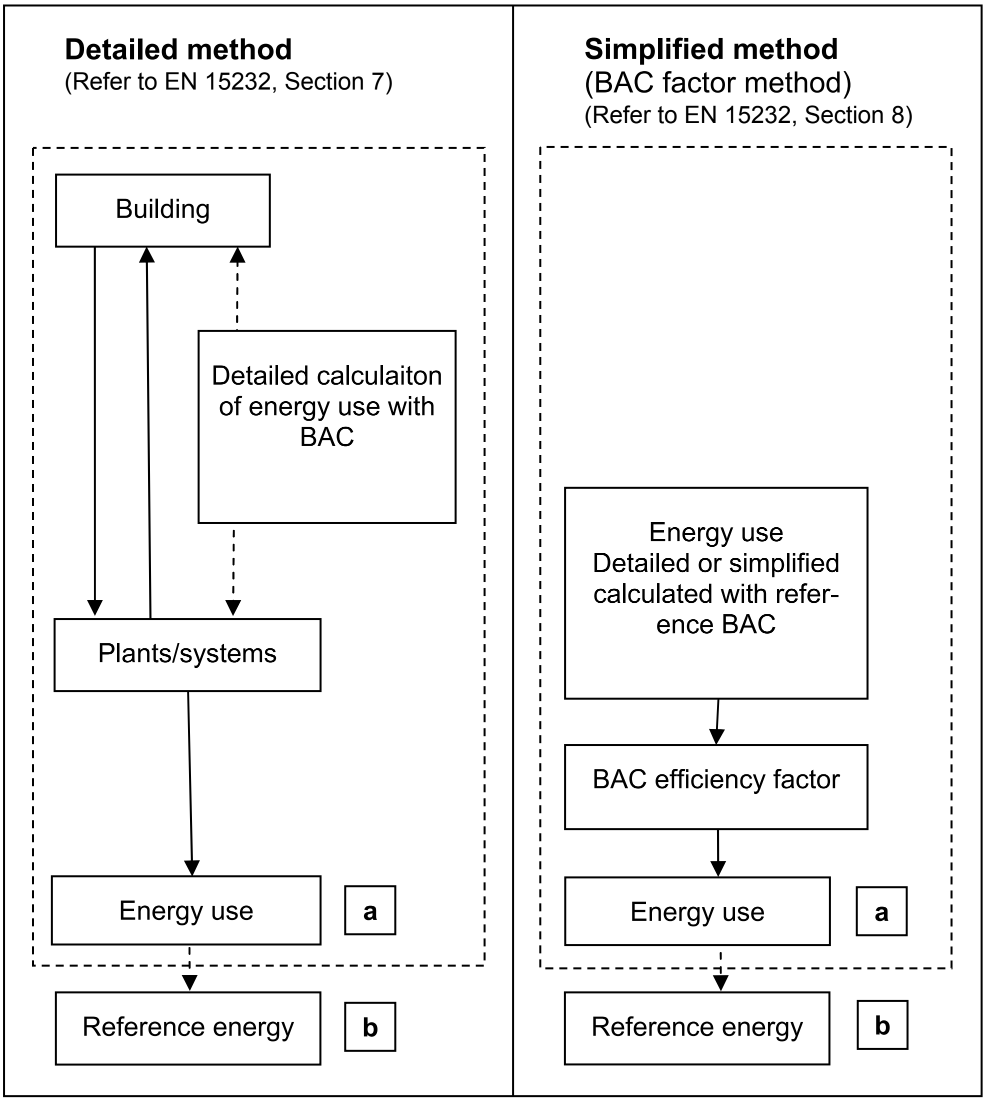
The basis for energy demand calculations in buildings are

- The "Energy flow diagram for a building" presented earlier
- Procedures per standards for the corresponding partial installations of building and HVAC partial plants

The building type corresponding to the occupancy profile per EN 15217 is considered when calculating energy demand. The building's exterior shell is subjected to defined outside weather patterns.

You can determine the impact of BAC functions on the energy efficiency of a building by comparing two energy demand calculations for a building using various building automation functions.

The calculation of the impact of the building automation and control and building management functions on the energy efficiency of a building can be accomplished using either a detailed method or a simplified one (BAC efficiency factos). The following figure illustrates how to use the different approaches.



Differences between the detailed and simplified methods in EN 15232 (the arrows only serve to point out the calculation process and do not represent the energy flow and/or mass flow)

Key:

a Energy use for heating, cooling, ventilation, DHW or lighting

b Reference energy is the total energy, expressed per energy carrier (natural gas, oil, electricity, etc.). [CEN/TR 15615, Figure 2]

4.3.1 Detailed calculation method

The detailed method can be used only when a sufficient knowledge about automation, control and management functions used for the building and the energy systems is available. There are 5 common approaches to take into account the impact of a BACS and TBM function in the assessment of energy performance indicators defined in other EPBD-CEN standards.

In the standard EN15232, the detailed calculation methods are described for each BACS and TMB function contained in the BACS function list. Usually only a short description is given in EN15232, and the link to one of the other EPBD EN standards where a complete description is given.

The detailed calculation method calculates **absolute energy demand** for an individual building **using all planned building automation and control functions**.

The detailed calculation of energy demand for a building provides rather precise, individual results. The method is, however, a significant effort. It can be used, for example, for energy consumption guarantees as part of Performance Contracting projects; PC-based tools required to perform the calculations economically.

Energy savings from BAC functions

An additional, detailed **reference calculation with building automation and control functions normally assigned to building automation and control efficiency class C** is needed to determine the energy demand of an individual building.

The impact of BAC and TBM on the energy efficiency of an individual building is derived from the ratio of the energy demand calculations:

$$\text{Savings} = 100\,(1 - \text{Energy demand}_{est}\ \text{BAC}_{planned} / \text{Energy demand}_{est}\ \text{BAC}_{class\ C})\ [\%]$$

If the energy efficiency of a building, equipped with building automation and control functions, is to be improved by equipping with additional BAC functions, the targeted savings can be determined using a detailed calculation with the additional BAC functions and a calculation without the additional BAC functions.

Important:
Changes to a building's exterior shell and/of the HVAC plant as part of the new absolute energy demand calculations result in savings from all measures and not in savings from building automation and control.

4.3.2 Simplified calculation method

The simplified calculation method **is based on energy demand calcuations of representative building models** that were conducted in all energy efficiency classes A, B, C und D per the detailed calculation methods from EN 15232.

BAC efficiency factors

The impact of BAC functions from an energy class on a building's energy demand is established with the aid of BAC efficiency factors. **The BAC efficiency factor for all building models is in the reference class C = 1** (Energy demand = 100 %):

$$\text{BAC efficiency factor} = \text{Energy demand BAC}_{planned\ class} / \text{Energy demand BAC}_{Class\ C}$$

BAC efficiency factors for all building models are published in the table from EN 15232 (Copy: Refer to part 4.4).

Energy savings from BAC functions

Energy demand for BAC efficiency class C must be known (calculated using the detailed calculation method, measures or possibly estimated) to establish energy savings from BAC functions for a BAC efficiency class:

Energy demand $BAC_{planned\ class}$ = Energy demand $BAC_{class\ C}$ * BAC efficiency $factor_{planned\ class}$.

Savings = 100 * Energy demand $BAC_{class\ C}$ (1 – BAC efficiency $factor_{planned\ class}$) [%]

Benefits and limits of the simplified method

The simplified method allows you to determine the impact of BAC and TBM on the energy efficiency of a number of buildings to a satisfactory degree without costly calculations.

As a rule, BAC efficiency factors can be used on two basic types:

- **Relative to unknown energy demand in class C**
  BAC efficiency factors are scalable. You determine the energy demand for a building in a given energy efficiency class in relationship to the energy demand of a building in energy efficiency class C.

  This allows for a sufficiently accurate determination of **energy savings in [%]** versus class C

- **Relative to known energy consumption in class C**
  When annual absolute energy demand for a building in class C is known (e.g. energy consumption was recorded or measured over three years of operation or the engineer calculates energy demand, eventually estimated as well), you can easily and sufficiently determine the absolute **energy savings** e.g. **in [kWh]** for a building in a certain energy efficiency class in relationship to a building in energy efficiency class C.

  You can also calculate savings from energy costs and the amortization period for updating BAC by applying current costs per [kWh].

Please note the following:
In the current global situation for energy and climate, amortization period should not be the only decision-making criterion when investing in updated BAC.

The application of the simplified method is limited to BAC efficiency classes A, B, C and D. A more nuanced classification of the BAC functions is not possible using this method.

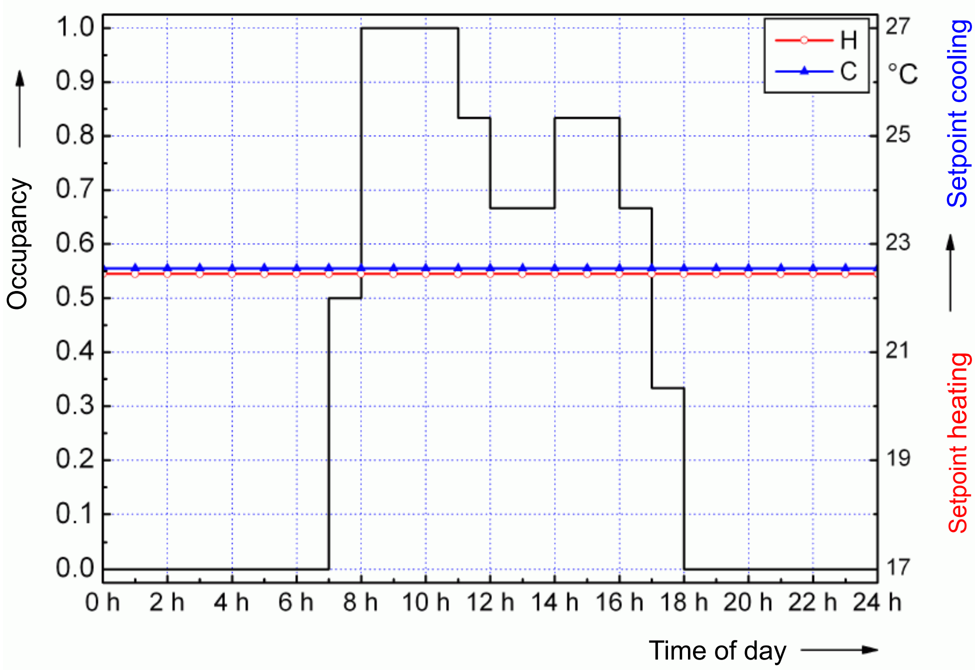
4.4 Savings potential of various profiles for the different building types

Savigns potential varies depending on the building type. The reason is found in the profiles forming the basis for EN 15232:

- **Operation** (heating, cooling, ventilation, etc., in efficiency classes A, B, C & D)
- **User** (occupancy varies depending on building type)

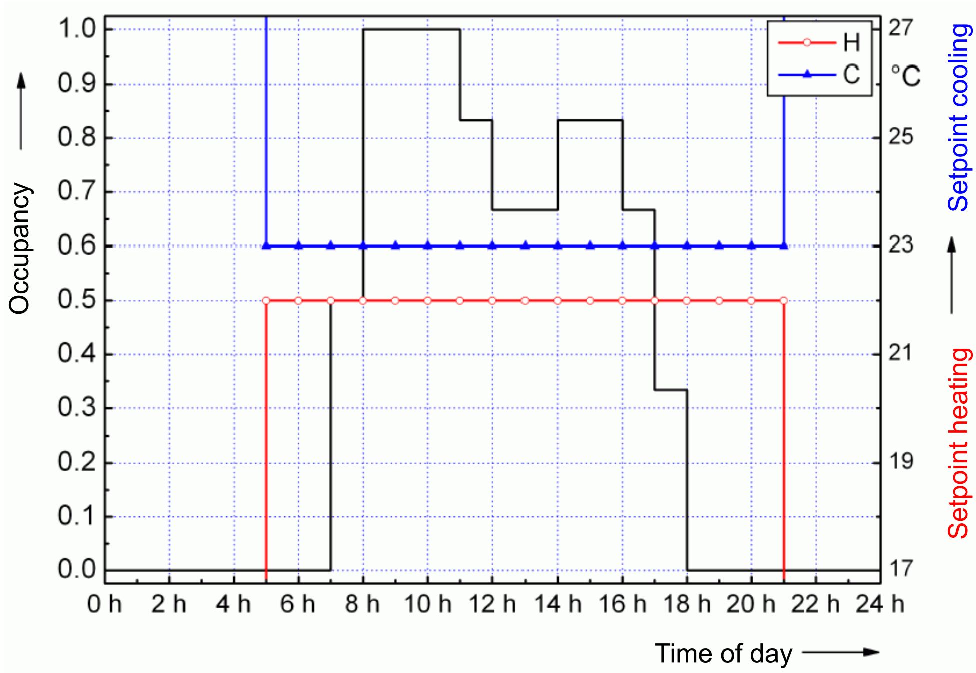
4.4.1 Operation profiles in an office building

BAC efficiency class D



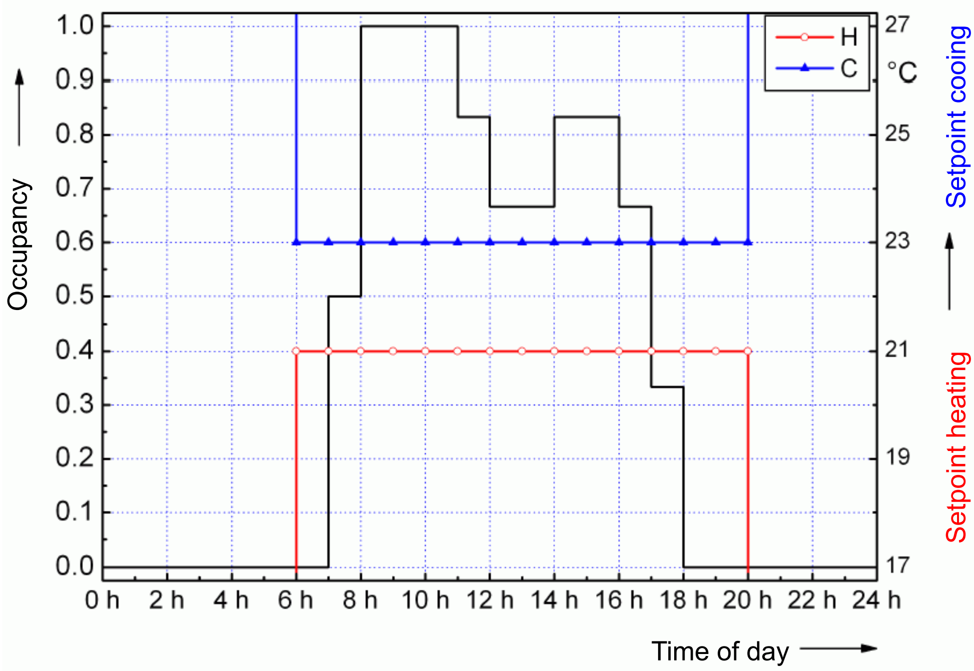
Efficiency class D represents a less beneficial case versus class C. Both temperature setpoints heating and cooling have the same value. In other words, there is no energy dead band. The HVAC plant is operated 24 hours a day; although occupancy is only 11 hours.

BAC efficiency class C (reference class)



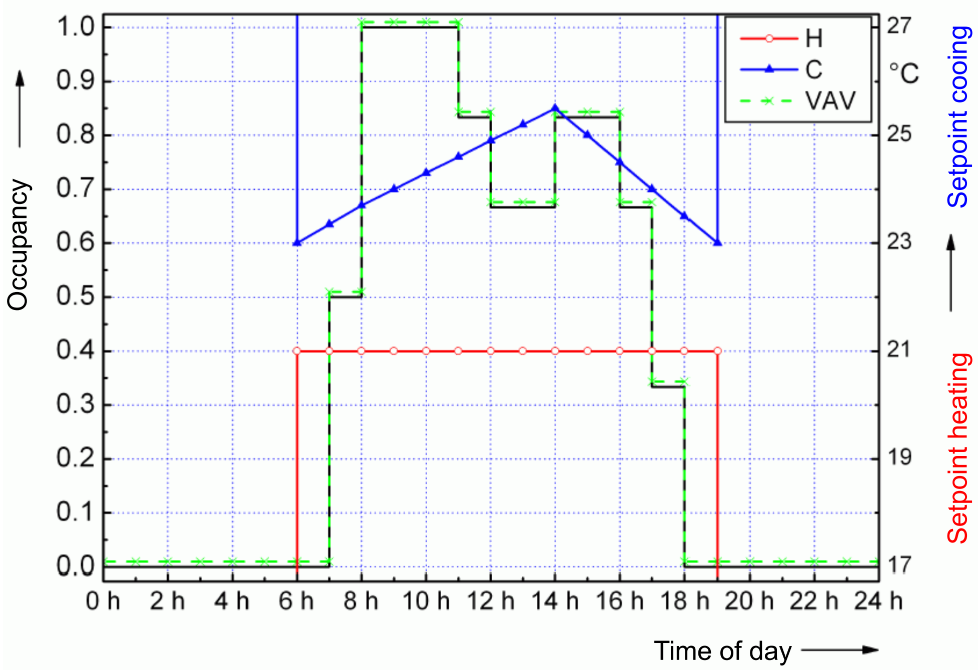
In efficiency class C, the difference between temperature setpoints heating and cooling is very slight at ca. 1 K (minimum dead energy band). Operator of the HVAC plant starts two hours prior to occupancy and ends three hours after the end of the occupancy period.

BAC efficiency class B



Efficiency class B applies better adapted operating times by optimizing switch on/off periods. The actual temperature setpoints for heating and cooling are monitored by superposed functions, resulting in a dead energy band that is greater than the one for efficiency class C.

BAC efficiency class A



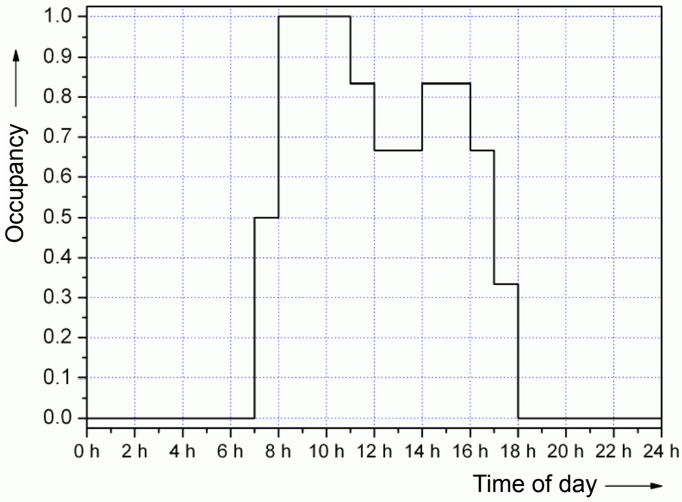
Efficiency class A provides additional energy efficiency by applying advanced BAC and TBM functions as well as adaptive setpoint adjustments for cooling or demand-controlled air flows.

Findings from the four operation profiles

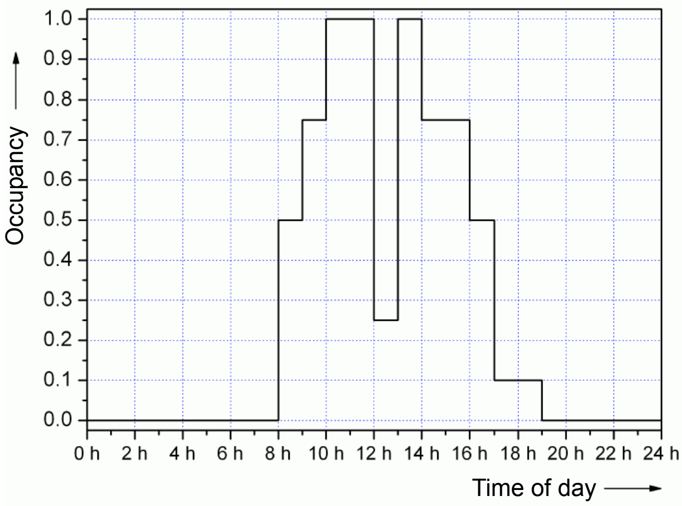
You can achieve significant improvements in BAC energy efficiency using presence-controlled plant operations, controlling air flow, as well as controlling setpoints for heating and cooling (must be as large an energy dead band as possible!).

4.4.2 User profiles for non-residential buildings

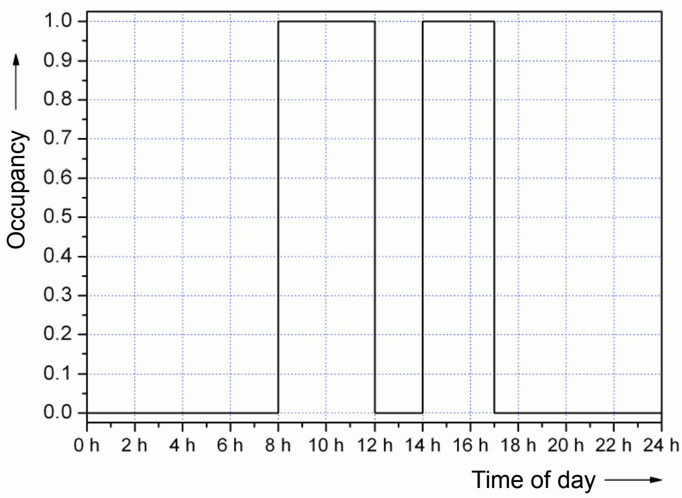
Office buildings



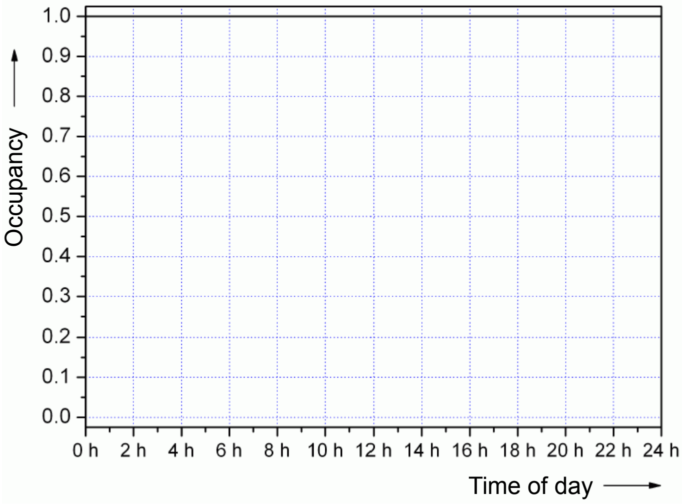
Lecture hall



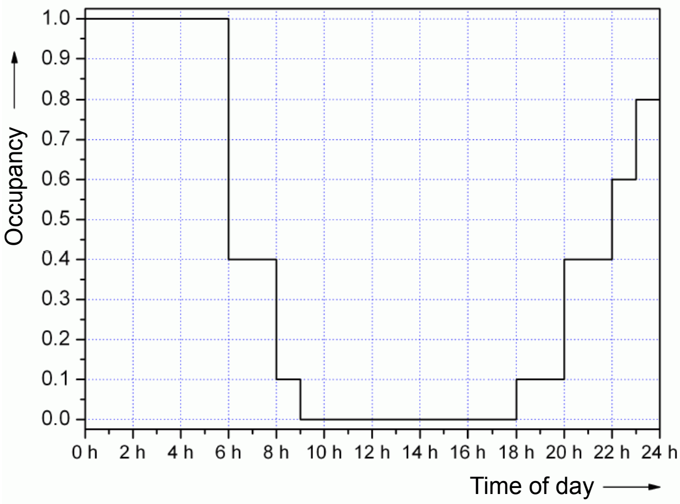
School



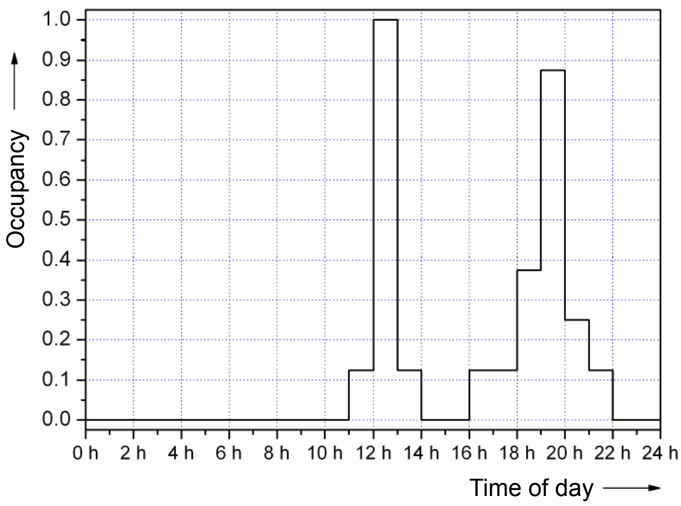
Hospital



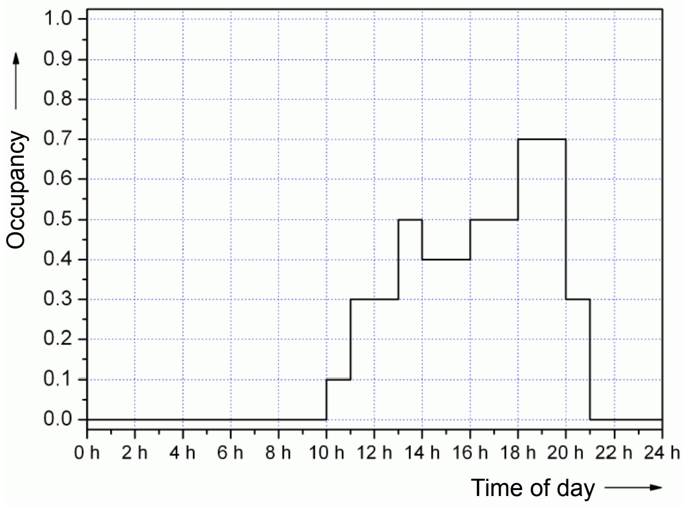
Hotel



Restaurant



Wholesail and retail



Findings from user profiles for non-residential buildings

The occupancy in the user profiles vary greatly among the different types of uses for non-residential buildings. And the BAC efficiency factors per EN 15232 clearly illustrate the point:

- Large energy savings can be achieved in lecture halls, wholesale and retail stores
- Rather large energy savings are also possible in hotels, restaurants, offices and schools
- Potential energy savings are rather small in hospitals since they are generally occupied 24 hours a day

4.5 BAC and TBM efficiency factors

You learned the following from the previous section 4.3.2:

- The origins of BAC efficiency factors
- All BAC efficiency factors for energy efficiency class C are 1
- All BAC efficiency factors are tied to efficiency classes A, B, C or D

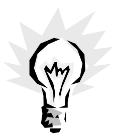
In this user's guide we generally use the term BAC efficiency factors (it is the same as BAC energy efficiency factors) instead of the more detailed term "BAC and TBM efficiency factors".

The BAC and TBM efficiency factors published in EN 15232, were calculated based on the energy demand results of a large number of simulations. The following was considered as part of each simulation:

- The occupancy profile per building type was pursuant to EN 15217
- One energy efficiency class
- All BAC and TBM functions listed in EN 15232 for this energy efficiency class

The impact of the various BAC and TBM functions on a building's energy efficiency was determined after comparing annual energy consumption for a **representative bulding model** for the different BAC and TBM functionalities.

The simplified method allows you to determine the impact of BAC and TBM on the energy efficiency of **residential** and various **non-residential building** to a satisfactory degree without costly calculations.



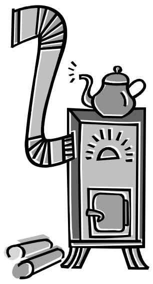
The following tables, taken from EN 15232, are aids to determine the impact of BAC and TBM on the energy efficiency for building projects.

Note

On the BAC efficiency factors for building types are set in EN 15232, for which a user profile was defined per EN 15217.

BAC and TBM efficiency factors for thermal energy

The BAC efficiency factors for thermal energy (heating and cooling) are classified based on building type and efficiency class to which the BAC and TBM belongs. Factors for efficiency class C are set at 1, since this class represents the standard case for a BAC and TBM system. Application of efficiency class B or A always results in lower BAC efficiency factors, i.e. it improves a building's energy efficiency.



Non-residential building types	**BAC efficiency factors thermal**			
	D	**C**	**B**	**A**
	Non energy efficient	Standard (Reference)	Advanced energy efficiency	High energy efficiency
Offices	1.51	1	0.80	0.70
Lecture halls	1.24	1	0.75	0.5 [a]
Educational buildings (schools)	1.20	1	0.88	0.80
Hospitals	1.31	1	0.91	0.86
Hotels	1.31	1	0.85	0.68
Restaurants	1.23	1	0.77	0.68
Wholesale and retail buildings	1.56	1	0.73	0.6 [a]
Other types: • Sport facilities • Storage • Industrial facilities • etc.		1		

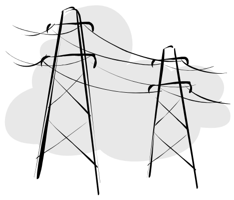
a The values are highly dependent on heating/cooling demand for ventilation

Residential building types	**BAC efficiency factors thermal**			
	D	**C**	**B**	**A**
	Non energy efficient	Standard (Reference)	Advanced energy efficiency	High energy efficiency
• Single family dwellings • Multi-family houses • Apartment houses • Other residential or residential-like buildings	1,10	1	0,88	0,81

BAC and TBM efficiency factors for electrical energy

Electrical energy includes per EN 15232 electrical energy for artificial lighting, auxiliary devices, elevators, etc., required to operate a building – but does not include the electrical energy for PCs, printers, machines, etc. from the building's user.

The BAC efficiency factors for electrical energy are classified based on building type and efficiency class to which the BAC and TBM belongs. All factors for efficiency class C are also set at 1.



Non-residential building types	BAC efficiency factors electrical			
	D	C	B	A
	Non energy efficient	Standard (Reference)	Advanced energy efficiency	High energy efficiency
Offices	1,10	1	0,93	0,87
Lecture halls	1,06	1	0,94	0,89
Educational buildings (schools)	1,07	1	0,93	0,86
Hospitals	1,05	1	0,98	0,96
Hotels	1,07	1	0,95	0,90
Restaurants	1,04	1	0,96	0,92
Wholesale and retail buildings	1,08	1	0,95	0,91
Other types: • Sport facilities • Storage • Industrial facilities • etc.		1		

Residential building types	BAC efficiency factors electrical			
	D	C	B	A
	Non energy efficient	Standard (Reference)	Advanced energy efficiency	High energy efficiency
• Single family dwellings • Multi-family houses • Apartment houses • Other residential or residential-like buildings	1,08	1	0,93	0,92

4.5.1 Reflection of the profile on BAC efficiency factors

Operation and user profile impact BAC efficiency factors differently. Their impacts are depicted in the following table on BAC efficiency factors: Thermal for non-residential buildings:

Non-residential building types	**BAC efficiency factors thermal**			
	D	**C**	**B**	**A**
	Not energy efficient	Standard (Reference)	Increased energy efficiency	High energy efficiency
	Operation profile		**User profile**	
Offices	1,51	1	0,80	0,70
Lecture halls	1,24	1	0,75	0,5 [a]
Educational facilities (schools)	1,20	1	0,88	0,80
Hospitals	1,31	1	0,91	0,86
Hotels	1,31	1	0,85	0,68
Restaurants	1,23	1	0,77	0,68
Wholesale and retail buildings	1,56	1	0,73	0,6 [a]

a The values are highly dependent on heating/cooling demand for ventilation

4.5.2 Example of calculation for an office building

Application of the BAC efficiency factors when calculating the impact of BAC and TBM on overall energy efficiency of a medium-sized office building (lenght 70 m, width 16 m, 5 floors). **BAC efficiency class C** is used as the reference. Improvements to energy efficiency by **changing to BAC efficiency class B** are calculated.

Description	No.	Calculation	Unit	Heating	Cooling	Ventilation	Lighting
Thermal energy							
Energy demand	1		$\frac{kWh}{m^2 \cdot a}$	100	100		
Plant losses Reference case	2		$\frac{kWh}{m^2 \cdot a}$	33	28		
Energy expense for reference class C	3	$\sum 1+2$	$\frac{kWh}{m^2 \cdot a}$	**133**	**128**		
BAC factor thermal Reference class C	4			1	1		
BAC factor thermal Actual case (class B)	5			0,80	0,80		
Energy expense actual case (class B)	6	$3 \times \frac{5}{4}$	$\frac{kWh}{m^2 \cdot a}$	**106**	**102**		
The expense of thermal energy must be distributed among various energy carrier to complete the calculation.							
Electrical energy							
Auxiliary energy class C	7a		$\frac{kWh}{m^2 \cdot a}$	**14**	**12**	**21**	
Lighting energy	7b						**34**
BAC factor electrical Reference class C	8			1	1	1	1
BAC factor electrical Actual case (class B)	9			0,93	0,93	0,93	0,93
Auxiliary energy actual case (class B)	10	$7 \times \frac{9}{8}$	$\frac{kWh}{m^2 \cdot a}$	**13**	**11**	**20**	**32**

Results

After transitioning the office building by updating BAC functions from the BAC efficiency class C to class B, energy consumption per the BAC efficiency factors published in EN 15232, were reduced as follows:

- Heating energy **106 kWh / $m^2 \cdot$ a** instead of 133 Reduction to 80 %
- Cooling energy **102 kWh / $m^2 \cdot$ a** instead of 128 Reduction to 80 %
- Electrical energy **76 kWh / $m^2 \cdot$ a** instead of 81 Reduction to 93 %

These improvements in energy efficiency effect an annual energy saving of 324’800 kWh for the entire building (5’600 m^2).

5 eu.bac - certification

5.1 Goal and purpose of eu.bac

EU Directives and national regulations require proof of energy consumption and the energy efficiency of buildings, provided by testing and certification. The goal is to ensure an EU reduction in energy consumption of 20 percent by 2020.
Siemens launched an initiative with leading companies, active internationally in home and building automation and control, to establish the European Building Automation and Controls Association (eu.bac) in 2003. In the mean time, eu.bac members represent ca. 95 % of the European market. (www.eubac.org)

Objectives

- To establish a European quality assurance system for building automation and control components to significantly improve the energy efficiency of buildings.
- A legally binding set of regulations for performance contracting of buildings, that rely on components and systems certified by eu.bac Cert.

Product certification

A uniform, pan-European, valid certification is decisive for the EBPD to fully unleash its effectiveness to improve the energy efficiency of buildings. Numerous, national certification systems could seriously jeopardize EBPD implementation. From this understanding, the European Association of Manufacturers of Building Automation and Control eu.bac, took the lead in certifying products.
The eu.bac certification process is based on European standards. It includes certification rules, accredited test labs, to test the performance of products, factory inspections and approvals by recognized certification offices. eu.bac cooperates with European certification offices, Intertek (former, ASTA BEAB) in Great Britain, Centre Scientifique et Technique du Bâtiment (CSTB) in France and WSPCert in Germany. They are approved by the International Accreditation Forum (IAF) and work per EN 45011.
For product testing, eu.bac authorized recognized test labs such as BSRIA in England, CSTB-Lab in France and WSPLab in Germany.

The first devices certified were a few individual room controllers in 2007. Various applications (e.g. hot water radiated heat, chilled ceilings) are following in phases. In the works, are certifications for field devices such as temperature sensors, valves, actuators as well as outside air temperature controlled heating controllers. The current list of certified devices is available at www.eubaccert.eu.

Certification documents

The following documents officially confirm the certification of products:

- License
- Test Report Summary

License

The license confirms that the licensee (e.g. Siemens) is allowed to publish the eu.bac Cert symbol for the confirmed products and applications. Each certified product/application receives its own license number (e.g. 20705) and a reference to the expiration date, or the deadline for retesting.

LICENCE

Number: 20705

eu.bac european building automation controls association

Siemens Schweiz AG

received the licence to use the eu.bac mark for the product

Desigo RXC21.1

for the application(s)

Fan Coil Unit System

based on the certification rules of eu.bac
and the Certificate 02002

This licence will expire on 29 October 2012

eu.bac Cert

020705

29 October 2007
Frankfurt am Main

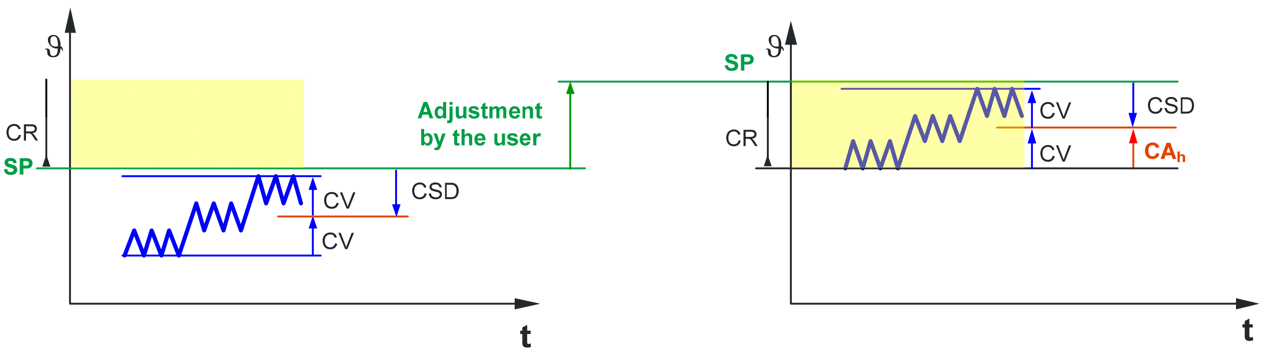
Managing Director Winfried Brandt
eu.bac

european building automation and controls Association - eu.bac
Lyoner Straße 18 - 60528 Frankfurt am Main - Germany

Requirements for issue of a license from eu.bac Cert

1. eu-bac certification body must inspect the factory for:
   - Verification of quality management system (ISO EN 9001) of the manufacturing process for the product line in question
   - Testing of relevant aspects of the quality plan include testing facilities to ensure compliance of the product with the relevant EN standards

2. Product testing based on energy efficiency criteria per EN standards:
   - In the case of the individual room controller EN 15500: Accuracy of temperature control under 3 different loads



ϑ room temperature
CR comfort region
SP Setpoint
CV Control Variation
CSD Control to Setpoint deviation
CA_h Control Accuracy for Heating

The user adjusts the deviation from the setpoint by shifting the setpoint. As a result, the average room temperature is CV higher then requested by the user and with regard to energy consumption, the CV is part of the control accuracy CA_h.

Test result
The eu.bac accredited test lab provides a test report on each license. The test information relevant to product use are compiled in the test report summary.

Since in the example for individual room controllers, the control circuit is tested (control accuracy), the report placed special emphasis on the important characteristics of field components. For example, the sensor element and its time constant for the temperature sensor and the type of actuator and its characteristic curve for the valve. Finally, the report documents the test results; in the case of the individual room controller, the measured value for heating and cooling is documented.

Test Report Summary

eu.bac Cert

Product Information	
Licence Number:	020705
Licensee:	Siemens Schweiz AG
Product Family and Model Number	Desigo RXC21.1
Test Specifications	
Tested Application:	Fan coil unit system 4 pipes
Temperature Sensor:	
- Type:	NTC 10 Kohms
- Time Constant:	8 min
Actuator:	
- Type:	Motoric
Valve	
- Characteristic:	Exponential
Test Result	
Temperature Control Accuracy CA	Heating mode 0,2 K Cooling mode 0,1 K

31 March 2008
Frankfurt am Main

Managing Director Winfried Brandt
eu.bac

european building automation and controls Association - eu.bac
Lyoner Straße 18 - 60528 Frankfurt am Main - Germany

5.2 Customer benefits from eu.bac Cert

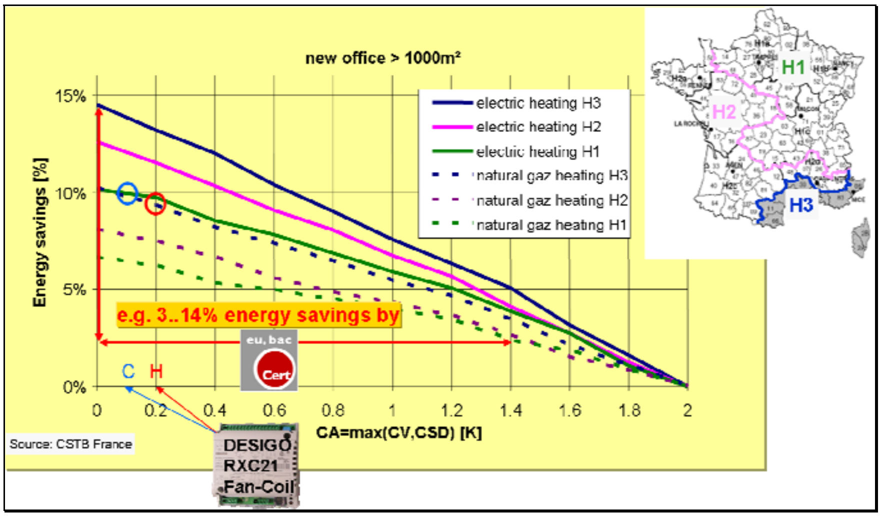
For the product user, eu.bac Cert guarantees a high-degree of
- Energy efficiency as well as
- Product quality

as set forth in the corresponding EN / ISO standards and European Directives. The energy efficiency can be documented for individual room controllers as follows:

Impact on energy savings

As mentioned earlier, the control accuracy of individual room controllers is measured and confirmed with a certificate. The control accuracy has a direct impact on the behavior of room users. The poorer the control accuracy, the more likely the user is to adjust the room setpoint as a result of poor comfort.

The chart below illustrates how much energy (in %) a controller with control accuracy of 0.2 K saves versus a controller with control accuracy of 1.4 K. Please note the following:
Eu.bac has reduced the required minimum control accuracy in EN15500 from 2 K to 1.4 K.



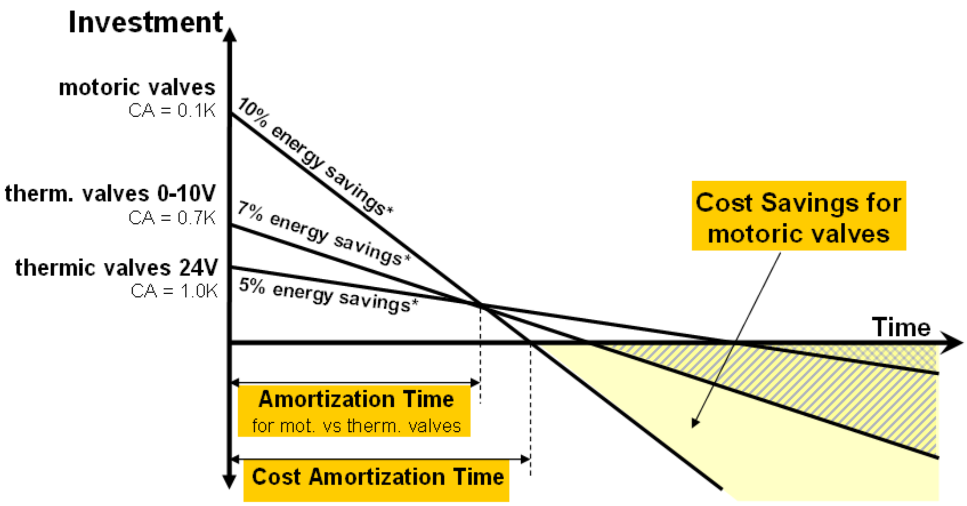
Source: “Centre Scientifique et Technique du Bâtiment (CSTB)”, France

Siemens individual room controllers achieved very solid values. For example, for DESIGO RXC21 / Fancoil with motor actuators for heating 0.2 K and cooling 0.1 K.

Impact of actuator on energy savings

It is well known that characteristics (time constants, adjustment response, characteristic curve, etc.) for field devices have a direct impact on control accuracy.
In other words, we achieve different levels of control accuracy with the same individual room controllers and temperature sensors, but using different valve actuators (motor, thermal modulating, thermal on/off) and thus different energy savings. On the flip side, the variously equipped control circuits cause differences in the costs of the control circuit.

The chart below illustrates that a higher investment in motor driven valves makes sense versus thermally driven valves (in the comparison with the previous chart, curve “natural gas heating H3” / Southern France):
- The amortization period for the investment is shorter
- Then operating costs are lower as a result of larger energy savings
- And the impact on the environment declines in line with the energy savings



Comparison with the previous chart, curve “natural gas heating H3” (Southern France)

The following table outlines the amortization for a DESIGO RX control circuit with motorized actuators compared to thermal (24V) actuators.

		Energy savings	Reduction in energy costs			Amortization		
			Heating oil	Natural gas	Elec-tricity	Heating oil	Natural gas	Elec-tricity
		kWh per annum	EUR	EUR	EUR	Years	Years	Years
Old building	Large office, 3 fan coil	1 000	80	60	90	3.1	4.2	2.7
	Large office, 1 fan coil	1 000	80	60	90	1.0	1.3	0.9
	Small office, 1 fan coil	300	24	18	27	3.4	4.7	3.0
Average building	Large office, 3 fan coil	500	40	30	45	6.6	9.4	5.8
	Large office, 1 fan coil	500	40	30	45	2.0	2.7	1.8
	Small office, 1 fan coil	150	12	9	14	7.5	10.7	6.6
New building	Large office, 3 fan coil	250	20	15	23	15.9	24.5	13.6
	Large office, 1 fan coil	250	20	15	23	4.2	5.8	3.7
	Small office, 1 fan coil	75	6	5	7	18.5	29.2	15.7

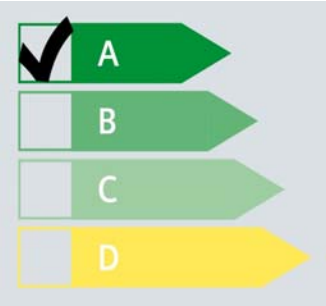
Amortization m = Additional investment I / annual return R
Annual return R = annual energy cost savings minus interest on additional investment
Annual additional interest costs = 1/2 the additional investment * calculatory interest rate

Conditions fort the table above:

Office space [m^2]:	Large office 100; Small office 30
Energy characteristics heating [kWh/m^2]:	Old 200; Average 100, New 50
Energy price [€/kWh]:	Oil 0.08; Natural gas 0.06: Electricity 0.09
Energy saving:	5% (Motorized to thermal actuator)
Basic for calculation:	5%
Additional investment:	Large office, 3 Fan coil, 6 actuators
	Large office, 1 Fan coil, 2 actuators
	Small office, 1 Fan coil, 2 actuators

6 Energy efficiency from Siemens

6.1 Products and systems



Siemens BT offers building automation and control systems and products, that achieve a high degree of energy efficiency per EN 15232 or guarantees certified quality per eu.bac Cert.
The Siemens building or home automation systems (DESIGO, Synco, Synco living) meet the requirements for energy efficiency class A per EN 15232.

6.1.1 DESIGO Insight

Display the complex simply
Workflows on the user interface for a building automation and control system are highly complex: easy to understand, graphical displays are in demand. This also includes simple, plausible operation: DESIGO INSIGHT presents the complex simply.

Flexible alarm management
DESIGO INSIGHT provides centralized recording, processing and evaluation of alarms for all integrated systems. The powerful alarm routing allows for operational alarm forwarding via SMS, fax, email or pager, regardless of where your operator is located and whether someone is actually sitting at the management station.

Economical
DESIGO integrates energy consumption meters from the various building services plants. The building automation and control system continuously registers the appropriate data. This allows you to compare consumption values with target values (budgeted).

Targeted optimization
Fully integrated, historic and real-time data processing allows for quick and targeted optimization of the plants. Powerful supplemental programs are available to operators requiring addition archiving and evaluation functions.

Costs under control
Uniform operation appropriate to the user increases the transparency and reducing maintenance costs of all the electrical and mechanical installations in the building and allows for the employment of less qualified personnel. Even inexperienced personnel know what to do.

Proven concept
DESIGO INSIGHT can be employed in any size building. Starting with small systems of just a few data points, the offering ranges to solutions for large building complexes with several thousand data points. Whether office, industrial building, hotel or hospital, DESIGO INSIGHT has the right solution.

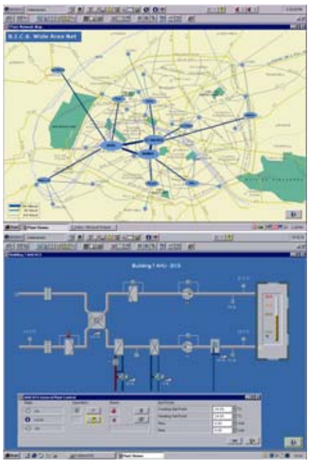
Simple integration
The consistent and targeted use of standard technologies and integrated SCADA software (Supervisory Control And Data Acquisition) ensure that third-party system can also be connected to DESIGO INSIGHT with a problem and at low cost via BACnet, OPC or Web. This allows for homogenous operation of all electrical and mechanical installations in the building.

Open interfaces
Various standard interfaces mean that customized applications such as facility management or service or maintenance management can be integrated into DESIGO at the lowest possible cost. Even more simplification: Data from DESIGO INSIGHT can be moved to MS Office with drag and drop and then used there for additional evaluations.

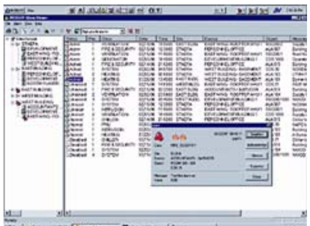
Standardized technology
The DESIGO INSIGHT management station is based on a broad spectrum of standard technologies including ActiveX, DCOM, OLE and MS SQL-Server. As a result, it can be used on a PC without a problem and quickly finds its place in modern office environments.

Reports provide and overview
Report templates to record alarm and fault states, for logbook entries and plant states. Reports can also be created to meet individual need and started based on events.

Highlights
- Flexible alarm management
- Targeted optimization for greater economic feasibility
- A system for any size building
- Standardized technologies and open interfaces for simple integration
- Individual or predefined reports provide an overview

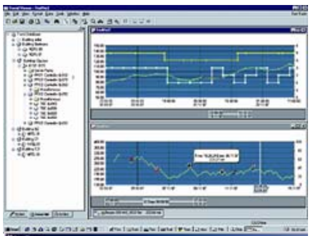


Plant Viewer
Graphics from practical experience make it possible to quickly monitor and operate the system in a targeted manner.

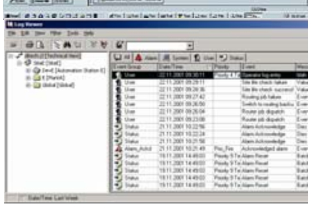


Alarm Viewer
Detailed alarm overview of multiple buildings. The user can go directly to the corresponding plant graphic to quickly find and eliminate faults.

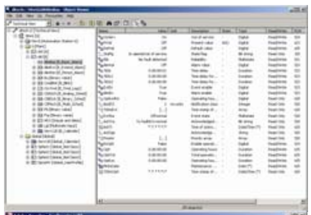
Time Scheduler
Centralized programming of all scheduled building service functions including individual room control. Easy graphical operation of weekly, holiday and exception programs.



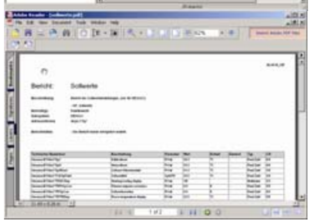
Trend Viewer
Historical and real-time data processing allows for fast and targeted operational optimization.



Log Viewer
All events (alarms, system messages and user activities, etc.) are recorded in chronological order and can be displayed at any time for additional analysis.



Object Viewer
Allows fast access to all objects and parameters in the system and building services plants.



Report Viewer
Offers reports to analyze plant operations as well as for evaluation and documentation.

6.1.2 DESIGO PX

DESIGO PX building automation and control system controls and monitors heating, ventilation, air conditioning and other building services plants. It is distinguished by its unique scalability of freely programmable automation stations, range of graded operator units as well as a high degree of system openness.

Employed universally thanks to modular system concept
DESIGO PX can adapt to the requirements and needs at hand thanks to its modular system design. The DDC technology can even be used economically and at low cost in small HVAC plants. The investment is limited to the system components that are actually needed for both new construction and remodeling. Thanks to its innovative system design, DESIGO PX can be extended at any time and in stages to a comprehensive building automation and control system.

■ Family of automation stations

The PX automation stations are used to optimally control and monitor building services plants. It is supported in this regard by comprehensive system functions including alarming, scheduling programs and trend data storage.

■ Years of experience

Siemens is a global leader in building automation and control as well as HVAC control technology. Our development is based on expert knowledge and years of experience by our technicians. The result is a reliable and user-friendly system – DESIGO.

Highlights

- Employed universally thanks to module system design
- BACnet communication for maximum openness
- Operation as needed
- Family of automation stations
- Years of experience in building automation and control

6.1.3 DESIGO RXC

DESIGO RXC offers individual room comfort as needed in public buildings, office complexes, school and hotels. This economical and user-friendly system stands for flexible control no matter the type. DESIGO RXC can be used for both existing as well as new plants and guarantees optimum energy efficiency.

■ High degree of flexibility thanks to LONWORKS® technology

DESIGO RXC is easily integrated into building automation and control systems thanks to the use of LONWORKS technology. LONWORKS also results in lower installation and life-cycle costs, offers comprehensive extension opportunities and flexibility at a lower price and improves energy efficiency, since you are able to combine numerous electrical and mechanical installations.

■ Complete product line of room units

A comprehensive product range of room units is available to directly operate and monitor setpoints and actual values in individual rooms. Units for wireless communication and flush mounted room units round out the product range.

■ Flexible room use

DESIGO RXC controllers are also highly flexible with regard to engineering and commissioning. You can quickly and simply adapt to changes in occupancy plans or room assignment–without changing wiring and or the need to lay new cables.

■ Energy savings of up to 14%

Together with room units, DESIGO RXC controllers guarantee highly accurate room temperature control also guaranteeing optimum room conditions combined with energy savings. The eu.bac certificate confirms the exceptional control accuracy of the RXC controllers, for example, a CA value of 0.1K for a fan coil. RXC achieves BACS energy efficiency class A per EN 15232. Setpoints for heating and cooling based on occupancy as well as intelligent algorithms and operating modes, etc., also contribute to reducing energy consumption to an absolute minimum.

■ Large selection of standard applications

DESIGO RXC offers a broad range of standard applications for room automation that can be downloaded, including, for example, for fan coils, radiators, chilled ceilings, VAV and integrated lighting and blinds applications.

■ Integration into the DESIGO building automation and control system

DESIGO PX integrates RXC controllers into the DESIGO building automation and control system. This provides even more functions such as schedulers, trending, heating/cooling demand, centralized monitoring of setpoints and lots more. In other words, RXC becomes an integral part of a modular and extendable, complete system that ensures economic viability for years and years.

Highlights

- Versatile thanks to LONWORKS technology
- Comprehensive room unit product range
- Flexible room use
- Simple mounting and maintenance thanks to plug-in screw terminals
- Energy efficiency certified by eu.bac
- Large selection of standard application

6.1.4 Synco – building automation and control made easy

Building automation and control – without additional programming

Building automation and control includes all equipment required for independent control and monitoring of building services plants as well as recording operating data. This covers the entire spectrum: from individual controllers up to integrated control systems. You can also control lighting, solar protection and any special plants in addition to "traditional" HVAC control. And you can implement and operate building automation and control as easy as possible and despite the versatility: with Synco 700.

Simple regulation and control

Synco consists of multiple modules and covers the entire bandwidth of HVAC applications: from heating via distribution to the room. With Synco™ 700 and Synco RXB/RXL you benefit from predefined standard applications allowing you to commission the plant with just a few manual interventions and without additional programming. The desired application for Synco™ 700 can be quickly identified using the Synco Select PC program and then selected in the controller. Preprogrammed applications can be edited and modified with supplemental functions in Synco™ 700 without the need for a special tool. Even commissioning communications is easy with Synco 700, Synco RXB/RXL and Synco living; expensive bus engineering no longer required.

Your benefits

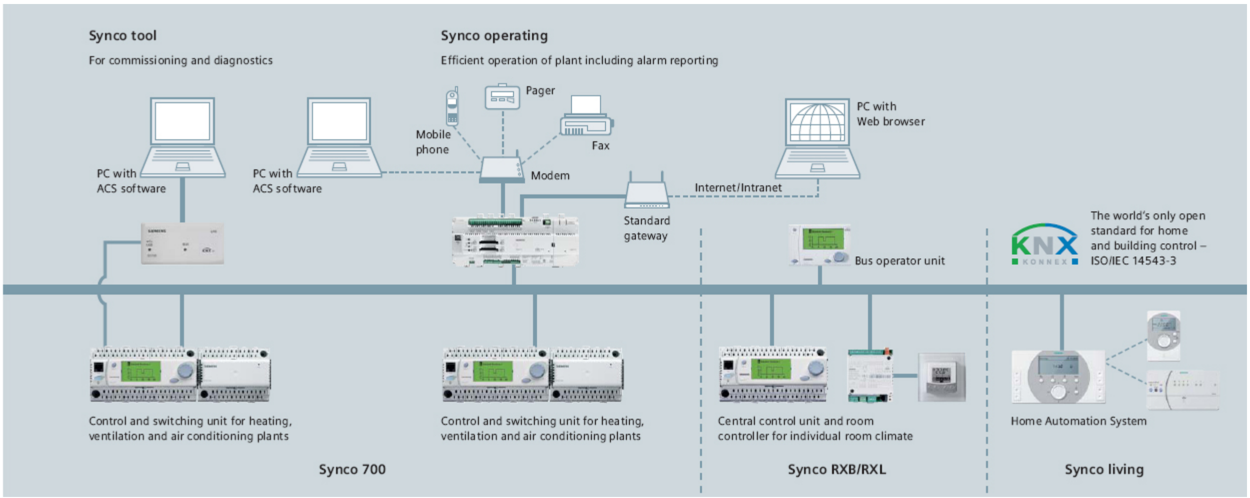
- Tested solutions: Fast commissioning
- Individual standards: Easy to adapt to special needs

Easy to operate/monitor/optimize

Synco distinguishes itself at all levels through a high degree of user and service friendliness as well as nearly unlimited flexibility. No special tool is required to commission or operate it. And thanks to its simple communications abilities, you can find out at any time what is happening with your building technology. Need additional information and graphic views, you can now extend the plant with the ACS operator station. You always have your plant under control with the various operating possibilities: on site or from afar, intuitive operation, in clear text, simple and comfortable.

Your benefits

- Stay informed about the plant's state at all times
- Access to plants regardless of location saves travel time and costs
- Simple to use thanks to intuitive operation



Simply extend
With Synco you can supplement controllers, operator units and stations at any time without a problem. There is also no barriers to future extensions. This eliminates the need to consider all future possibilities when building a building and making investments in facilities that may not even be needed, depending on the circumstances. Applications for Synco 700 and Synco RXB/RXL as well as Synco living can be matched automatically and in an optimum manner using the open communications bus Konnex (e.g. exchange of heat demand, plant states or outside air temperature). For you customers, this equates to optimum comfort using less energy. Moreover, the Konnex bus can be connected with electrical installations (e.g. lighting and blinds control) using the ETS3 Professional.

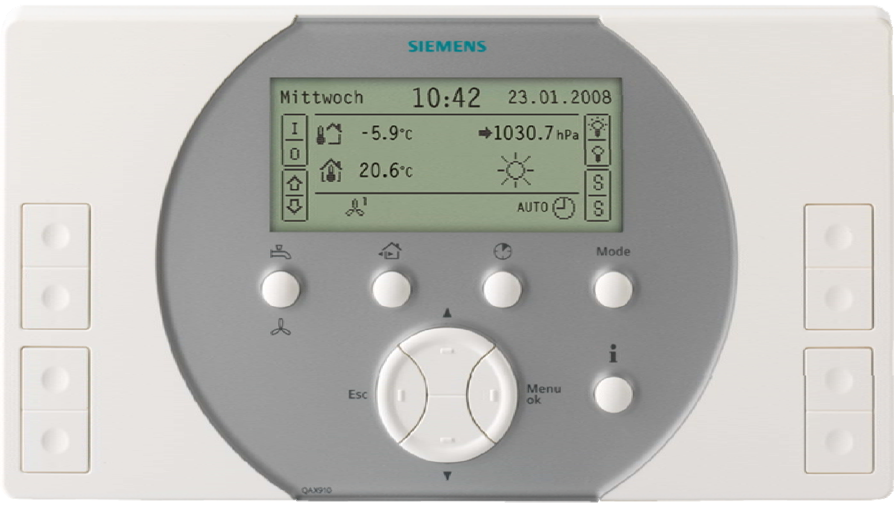
Your benefits
- Meeting subsequent customer desires
- Extends standard functions thanks to the integration of KNX components
- Eliminates costly bus engineering

Customer benefits
- Match investment to actual needs
- Lower entry costs

Simply feel comfortable
Optimum climate in the office
Synco RXB/RXL allows you to achieve the proper room temperature at work. This creates the ideal prerequisites for the comfort and optimum performance of the employees.

Comfort at home
Synco living is specially tailored to the needs of private areas. The new automation system unites all functions such as heating, ventilation, lighting, blinds as well as security technology and is easy to operate. The proper room temperature and energy consumption are matched and brought to a reasonable relationship. This creates the decisive prerequisites for living and comfort in your own home.

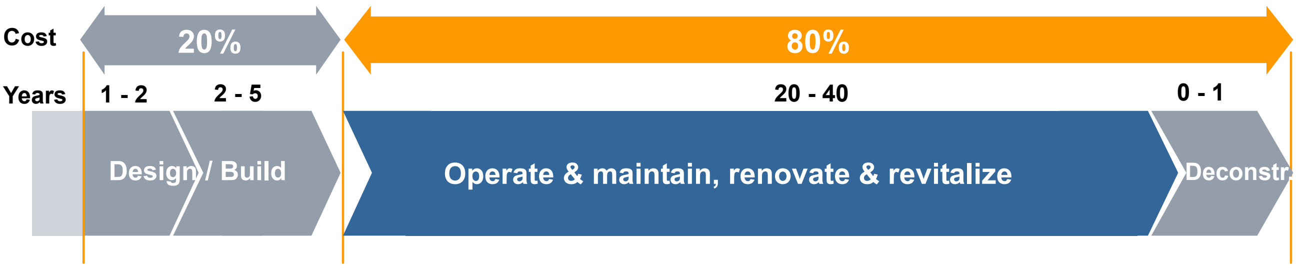
Customer benefits
- Comfortable room conditions, satisfied, performing employees and residents
- Increase level of comfort thanks to individual room conditions
- Optimum use of energy saves



6.2 Services

Siemens BT not only offers building automation and control systems and products, that achieve a high degree of energy efficiency per EN 15232 or guarantees certified quality per eu.bac Cert.

Approximately 80% of the costs associated with a building occur during operation. Energy costs in particular made up the lion's share and offer tremendous potential for optimization. The economic operation may not, however, impact the comfort at work. The negative impact of uncomfortable customers and sick employees clearly exceed the cost of operating the building.

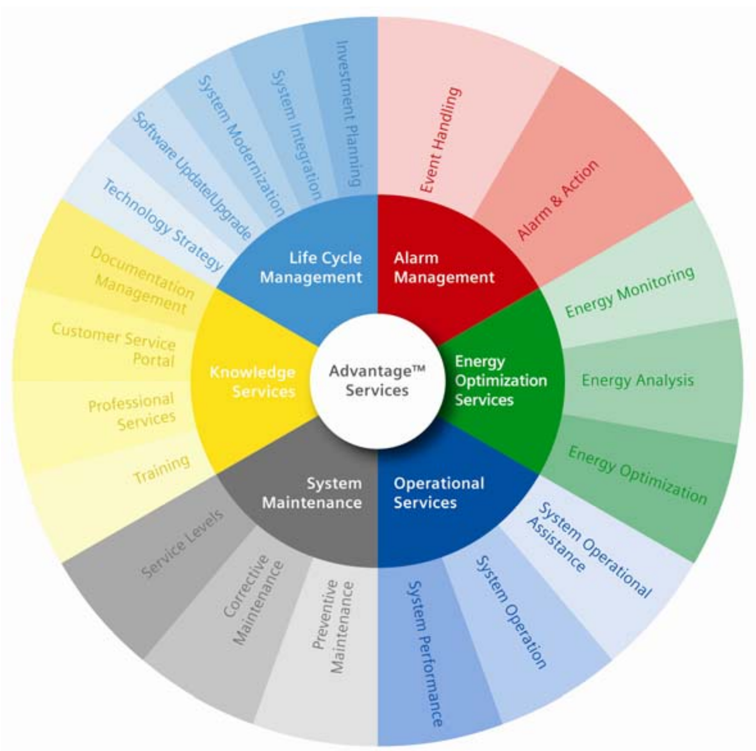


Siemens BT offers comprehensive services to the market

- that optimize the energy efficiency of buildings in a sustainable manner
- Assess existing, older building technology, re-engineer and update it. The required investments are finances from future energy savings.

6.2.1 Minimize life-cycle costs of the building

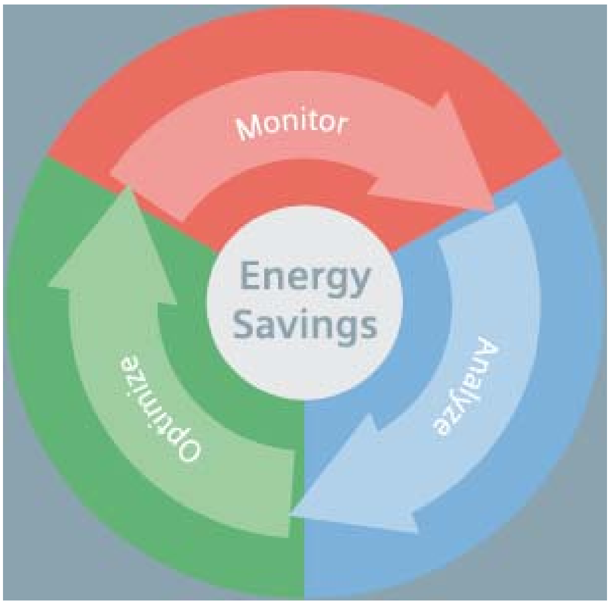
How do we ensure that your requirements are met?
First, we listen to you. At Siemens, each customer is unique. The only way to ensure that will give due consideration to your needs is to listen and take the time to understand your building and your goals.



Advantage™ Services is a comprehensive program offering, in addition to quality and reliability, flexibility to adapt solutions to meet your exact needs and requirements.

6.2.2 Continuous optimization

Our energy services pursue a simple yet proven concept:
In a first step we monitor (**monitoring**) the energy consumption of your building. We then evaluate the collected data and draft an optimization plant (**analysis**) and implement it (**optimization**). The achieved effect is then once again monitored to ensure the results. This energy optimization process allows you to save on energy consumption while keeping the impact on the environment to an absolute minimum.



Sustainable process
To ensure not only short-term savings, but rather guaranteed sustainable energy efficiency, the process should be maintained throughout the life-cycle for your technical equipment in buildings (see chart below).

Energy monitoring
Energy consumption must first be measured to control and optimize energy consumption. Based on well thought out measurement concepts, the data is compressed and prepared into power reports on energy consumption, costs and emissions. The improved transparency and information quality makes it easy to make forward-looking management decisions.

Information from energy monitoring allows you to identify energy saving potential and forms the basis for your optimization plan. Continuous monitoring not only ensures that all the potential is tapped, but also documents the success of all implemented measures.

Energy analysis
Technologies and procedures for energy savings undergo continuous development. And Siemens has the technical expertise and experience to actively analyze your building. Together with powerful comparative figures and proven documented methodologies, the knowledge is implemented into concrete measures within your optimization plan.

Energy optimization
Your energy optimization plan is specially matched to meet your needs and requirements and based on the results from energy monitoring and energy analysis. Successful implementation of the draft measures plays a key role in achieving the goals. To achieve the most benefits in the area of energy optimization, you can complete the offering with operational optimization measures as an option.

Your benefits

Cooperation with the Siemens team offers a tailored process to optimize the efficiency of your building with the following advantages:

- Reduce energy and operating costs
- Constant comfort level at work
- Increase reliability and efficiency of your technical equipment in buildings
- Extend the life of your technical equipment in your building
- Expand the competency of your operational personnel
- Ease sustainable management decisions thanks to greater transparency
- Lessen the impact on the environment

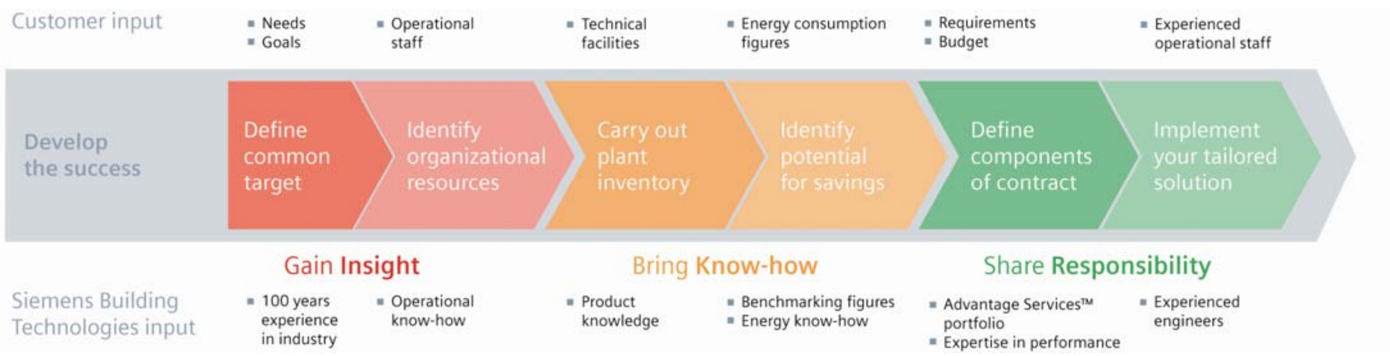
Implement and maintain, with us as your partner, a sustainable energy optimization process for your building.

Building Performance Optimization

Building Performance Optimization consists of three parts emergency and service control centers, energy services and operational service from the Advantage™ Services program by Siemens.

Phase 1

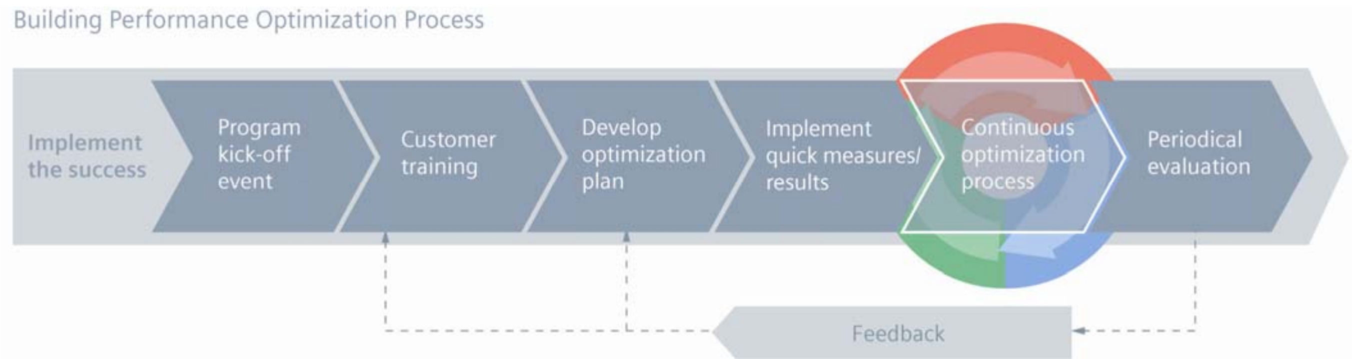
Develop success
We provide a short presentation on how to develop tailored solutions for you as a way to illustrate our customer orientation. You as well as Siemens are actively involved in the process “Gain insight, contribute know-how and share responsibility”.



Phase 2

Implement success

The following chart illustrates the systematic approach to implementing building performance optimization. In close cooperation with your personnel (workshop), we analyze your building and draft a tailored solution. Targeted training for your employees as well as implementing all measures that can be implemented on the spot are also important components of our optimization process. We then use continuous checks, supported by the Advantage Operation Center, to secure long-term optimization success and as well as improvements.



Advantage Operation Center

A remote connection via secured access to your building automation and control system creates a common data basis and efficiently implements optimization measures.
It is possible to set up a secure remote connection to your building automation and control system from the Advantage Operation Center (AOC). This allows you to implement measures in a cost optimized manner as well as ensure achieved savings success by monitoring important operational parameters (energy consumption, system messages, etc.). A refined reporting system, consisting, for example, of alarm statistics, consumption curves and logbook functions support the quality and speed of actions. Cooperation between your operational personnel and our engineers is founded on a common basis.
Optimization measures, that cannot be implemented remotely, are conducted on site by our service technicians or your operational personnel.

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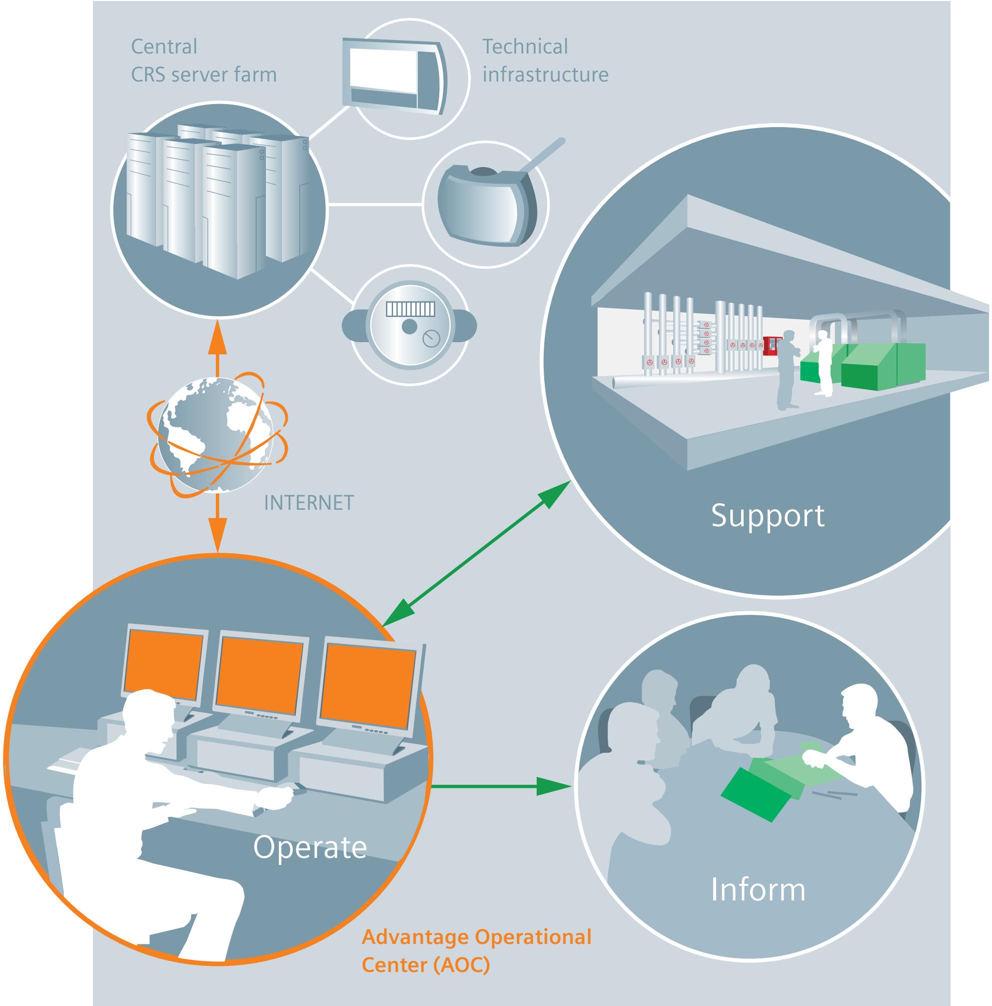


Take advantage of the benefits of the Advantage Operation Center:

- Short response times
- Access to highly qualified technicians
- Remote plant monitoring and optimization
- Cost-efficient execution
- On-going analysis of consumption data and events
- Internet access to energy data for the customer
- Powerful reports
- Documentation of services provided

6.2.3 Performance Contracting

What is Performance Contracting ?

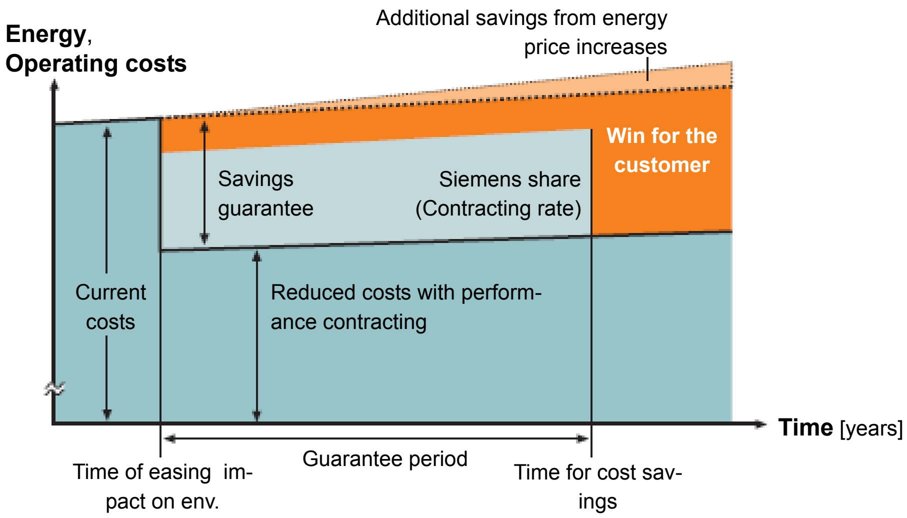
Concentration on what's important

Tap existing energy saving potential in your customer's building technology with targeted renovations and optimization. Resulting in lower operating costs and increased values. The required investments pay for themselves from savings in energy and operating costs throughout the contract period. A savings guarantee ensures your customer's business success. Updating technical plants and guaranteeing functions during the contract period also increases operational security. And we make a valuable contribution to the environment together with our customers by saving energy.

A win-win situation for the building operator with performance contracting

- Added value through modernization
- Savings pay for investments
- Risk-free thanks to success guarantee
- Function guarantee during the contract period
- Sustainable quality assurance by energy management
- Secured financing

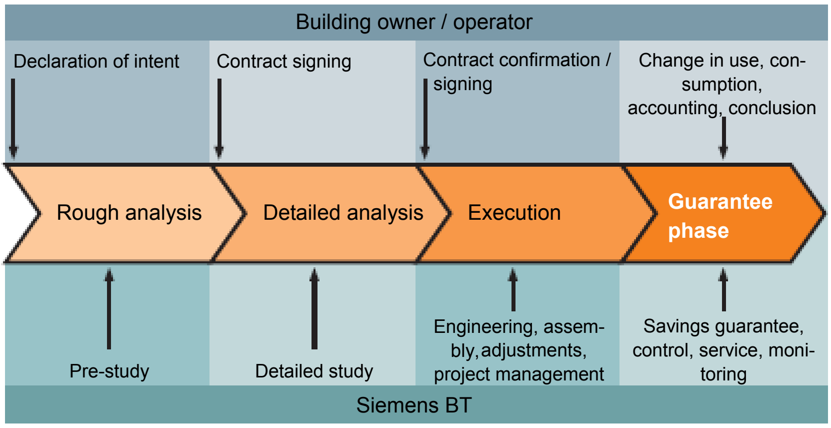
Financing model



From guarantee start to the end of the contract, guaranteed savings

- Finance all necessary savings measures
- Additional savings split among the parties
- Ensure that we take the risk of not achieving savings
- When the contract ends, you benefit 100 % from the savings.

Project workflow



Together with us, the customer defines the project workflow. After determining the suitable buildings, we estimate savings potential in a pre-study. A detailed study clarifies the potential, determines measures and calculates the economic viability. After the performance contract is signed, we commence with planning, delivery and installation. Securing the efficiency guarantee begins as soon as the project is completed, in other words ensuring guaranteed savings. Regular reports on achieved savings are provided during this phase.

7 Information and documentation

We would naturally be pleased should you like to learn more above and beyond the scope of this user's guide on the topic of energy efficiency.

We have provided some useful links on the Internet as well as a list of documents for your continued contribution to our joint efforts to create energy efficient building technologies.

7.1 Internet links

European Commission / Energy	http://ec.europa.eu/energy/
EPBD	http://www.buildup.eu
eu.bac	http://www.eubac.org/
eu.bac Cert	http://www.eubaccert.eu/
International Energy Agency	http://www.iea.org/
CEN/TC247	http://www.cen.eu
ASHRAE publications about LEED	http://www.ashrae.org
Minergie	http://www.minergie.com/
U.S. Green Building Council	http://www.usgbc.org/
Siemens Building Technologies / Energy Efficiency	https://www.siemens.com/ee
Novatlantis - Nachhaltigkeit im ETH Bereich	http://www.novatlantis.ch/
Association for the Study for Peak Oil (ASPO)	www.peakoil.ch

7.2 Document index

7.2.1 Literature

EC, EPBD Directive:
- Deutsch
http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/info/directive_de.pdf
- English
http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/info/directive_en.pdf
- Français
http://www.eco.public.lu/attributions/dg3/d_energie/energyefficient/info/directive_fr.pdf

Report on climate change 2007 by the United Nations

7.3 Relevant standards

CEN

Declaration on the General Relationship between various European standards and the EPBD ("Umbrella Document“).

prCEN/TR 15615 : 2007

Heating	EN 15316-1, EN 15316-4
Cooling	EN 15243
DHW	EN 15316-3
Ventilation	EN 15241
Lighting	EN 15193
Auxiliary energy	
Building automation and control	EN 15232

Product standard for electronic control devices in HVAC applications, e.g.

EN 15500, EN12098

Standardization for building automation and control systems:

EN ISO 16484-2	Building automation and control systems(BAC) / Part 2: Hardware
EN ISO 16484-3	Building automation and control systems(BAC) / Part 3: Functions
EN ISO 16484-5	Building automation and control systems(BAC) / Part 5: Data Communication Protocol – BACnet
EN ISO 16484-6	Building automation and control systems(BAC) / Part 6: Data Communication Conformance Testing – BACnet
prEN ISO 16484-7	Building automation and control systems(BAC) / Part 7: Project Implementation

Standards for communication protocols:

EN ISO 16484-5 /-6	BACnet
EN 14908-1 .. -6	LonWorks
EN 50090 und EN 13321	KNX

EN 45000 standardization series for eu.bac Cert

National implementation of standard EN 15232:

Austria:	OENORM EN 15232:2007
Belgium:	NBN EN 15232
Bulgaria:	BDS EN 15232:2008
Croatia:	HRN EN 15232:2008
Cyprus:	CYS EN 15232:2007
Estonia:	EVS-EN 15232:2007
Finland:	SFS-EN 15232
France:	NF P52-703; NF EN 15232:2008
Germany:	DIN EN 15232:2007
Greece:	ELOT EN 15232
Hungary:	MSZ EN 15232:2008
Iceland:	ÍST EN 15232:2007
Ireland:	I.S. EN 15232:2007
Italy:	UNI EN 15232:2007
Latvia:	LVS EN 15232:2007
Lithuania:	LST EN 15232:2007
Malta:	MSA EN 15232:2007
Netherlands:	NEN-EN 15232:2007
Norway:	NS-EN 15232:2007
Poland:	PN-EN 15232:2007(U)
Portugal:	EN 15232:2007
Romania:	SR EN 15232:2007
Slovakia:	STN EN 15232
Slovenia:	SIST EN 15232:2007
Spain:	UNE-EN 15232:2008
Sweden:	SS-EN 15232:2007
Switzerland:	SIA 386.110:2007; SN EN 15232
United Kingdom:	BS EN 15232:2007
Czech Republic:	CSV EN 15232

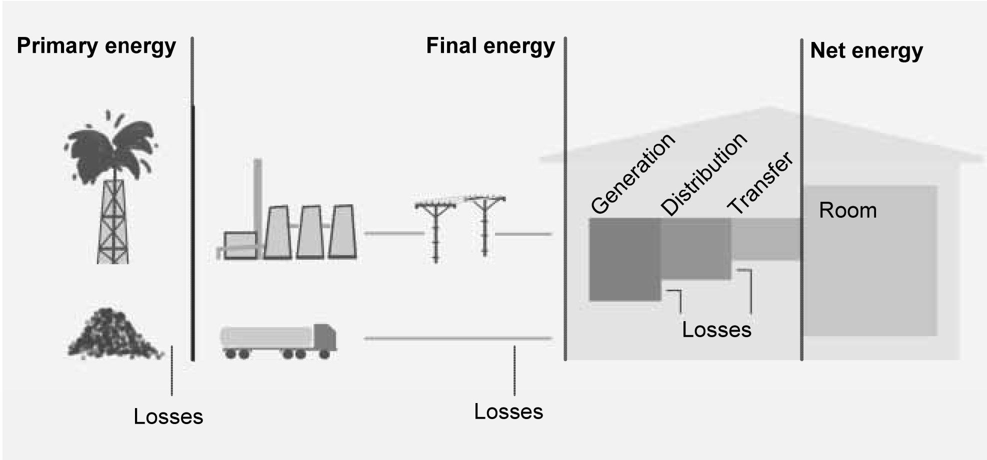
8 Abbreviations and terms

8.1 Abbreviations

BAC	**B**uilding **A**utomation and **C**ontrol
BACS	**B**uilding **A**utomation and **C**ontrol **S**ystem
CEN	**C**omitée **E**uropéen de **N**ormalisation - European committee for standardisation
EPBD	**E**nergy **P**erformance of **B**uilding **D**irective
EMPA	formerly the **E**idgenössische **M**aterial**p**rüfungs**a**nstalt. Today: Interdisciplinary research and service institution for materials sciences and technological development within the ETH
EN	**E**uropean **N**orm (Standard)
ETH	**E**idgenössisch **T**echnische **H**ochschule Swiss Federal Institute of Technology (university)
eu.bac eu**.**bac Cert	e**u**ropean **b**uilding automation and controls association eu**.**bac certification procedure
EU	**E**uropean **U**nion
HR	**H**eat **R**ecovery
IEA	**I**nternational **E**nergy **A**gency
MINERGIE®	Construction standard(s) for low-energy buildings (currently in CH and FR): Higher quality of life, lower energy consumption
TBM	**T**echnical **B**uilding **M**anagment
TC	**T**echnical **C**ommitée

8.2 Terms

Primary energy



Compound	Solution or partial solution in the form of a software building block
Night cooling	Cooling the building at night to achieve a lower cooling load or lower room temperature for the next occupancy period, where cooling is to costs as little as possible (free energy) and should be as efficient as possible
Night Ventilation	Form of night cooling using outside air

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