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ENERGY EFFICIENCY IN BUILDING AUTOMATION & CONTROL

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ABSTRACT

Intelligent building automation will cut back the energy consumption of buildings by up to 30%. The lower consumption, and so exaggerated energy potency, considerably reduces operative prices and contributes well to climate and environmental protection –without sacrificing comfort. Products and systems are designed to provide ideal climate conditions, in any work surroundings or living space, with all-time low attainable energy consumption.

The manner during which a building is made can lessen its energy consumption. Together with an energy optimized automation of the technical installations of a building, energy consumption are often drastically reduced. These energy-efficient buildings utilize less energy, produce fewer CO_2 emissions, and recommend better living or working conditions. Increasing the energy efficiency of buildings is best done throughout construction or throughout renovation. The saved energy costs typically repay the investment costs at intervals a number of years. The energy saving potential ensuing from building automation may be such as, therefore sanctionative one to derive measures that improve energy efficiency.

KEYWORDS*:* Energy Efficiency1, energy Consumption2, Co2 Emission3, and Building Automation System4.

INTRODUCTION

Buildings are accountable for just about 40% of the worldwide energy consumption and offer an enormous saving potential. All building automation components needed for an efficient energy generation, energy distribution, and energy usage. They are all designed for most favorable compatibility with each other, resulting in energy-efficient interaction.

Building automation systems (BAS) give automatic management of the conditions of indoor environments. The historical root and still core domain of BAS is that the automation of heating, ventilation and air-conditioning systems in massive purposeful buildings. Their primary goal is to understand vital savings in energy and decrease cost. However, the reach of BAS has extended to incorporate info from every kind of building systems, operating toward the aim of "intelligent buildings".[1]

Home and building automation systems are involved with improving interaction with and between devices generally found in an enclosed surroundings As such, they supply a subject with several sides and vary from tiny networks with solely a couple of devices to terribly massive installations with thousands of devices. The key driver of the building automation market is that the promise of redoubled user comfort at reduced operation value. To the current finish, building automation systems (BAS) create use of optimized management schemes for heating, ventilation, and air-conditioning (HVAC) systems, lighting, and shading. enhancements in energy efficiency will contribute to environmental protection. For this reason, connected rules typically mandate the employment of BAS.

ENERGY EFFICIENCY FUNDAMENTALS

Factors that influence energy consumption in buildings

The following six factors primarily impact the energy demand of a building1):

- Outdoor climate
- Building shell
- Building technology and energy technology
- Operation and maintenance of the building
- Building use and user behavior
- Interior room quality

Energy is consumed and inexperienced green house gases (CO2) are emitted within the manufacture of construction materials. Raising a building's insulation reduces energy consumption. Energy consumption to manufacture it will increase, however, that successively increase the number of "gray energy". In different words, multiplied insulation solely is smart wherever the reduction in energy consumption is larger than the "gray energy" of the applied materials. Building automation and management influences operation and use of building services plants because of clever management, observation, and optimization functions and plays a decisive role in reducing a building's energy consumption. These measures are enforced within the short term and are distinguished by short amortization periods. [2]

Term Energy Efficiency

Energy efficiency refers to the energy needed to accomplish a given usable impact. Technical measures are able to do larger energy efficiency, i.e. the energy needed for a similar use is reduced to a fraction of the quantity. Energy efficiency conjointly includes taking advantage of unused parts of energy conversion, like victimization waste heat and energy recovery.

Networked management of verified building automation and management functions are given high priority to realize and maintain a high level of energy efficiency; additionally to a high-quality exterior shell and fashionable plant technology. The use of energy efficient functions in building automation and management has huge potential once considering that some 40%of primary energy consumption worldwide goes into buildings. From that, 85% are for room heating, hot water, and room cooling.

ENERGY EFFICIENCY POTENTIAL ACCORDING TO EN 15232

A new European standard EN15232: "Energy performance of buildings - Impact of Building Automation, Control and Building Management" is one in every of a group of CEN (Comité Européen de Normalisation, European Committee for Standardization)

Standard EN15232 specifies ways to assess the impact of Building Automation and system (BACS) and Technical Building Management (TBM) functions on the energy performance of buildings, and a way to outline minimum necessities of those functions to be enforced in buildings of various complexities.

Building Automation and system (BACS) and Technical Building Management (TBM) have an impression on building energy performance from several aspects. BACS provides

effective automation and management of heating, ventilation, cooling, hot water and lighting appliances etc., that increase operational and energy efficiencies. Complicated and integrated energy saving functions and routines may be designed on the particular use of a building counting on real user must avoid gratuitous energy use and greenhouse emissions. Building Management (BM), particularly TBM provides info for operation, maintenance, and management of buildings particularly for energy management – trending and direful capabilities and detection of gratuitous energy use. [3]

European norm EN 15232 describes the effect of building automation and building management on energy efficiency and enables standardized representation for the first time. It includes a structured list of all building automation functions that can affect the energy efficiency of a building. It also offers systematic support for the definition of minimum requirements concerning building automation. The following can be stated as a basic principle: the higher the level of automation, the greater the energy savings.

Application of EN 15232 gives rise to different energy efficiency factors for different building types, with regard to the use of thermal and electrical energy. In the evaluation of buildings, the energy efficiency class C is the reference class for the implementation of measures for energy optimization. The thermal energy consumption of a building with efficiency class A with a factor of 0.7 can be reduced by up to 30 %. [3], [4]

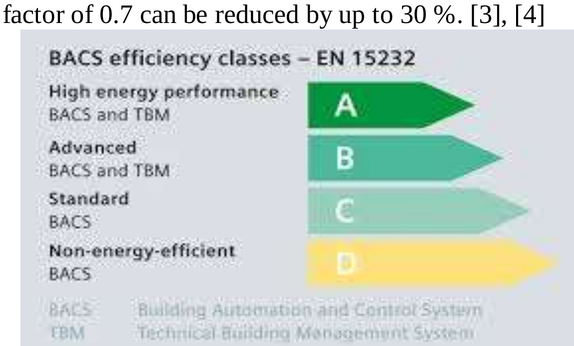


Fig 3.1 BACS efficiency classes – EN 15232

Efficiency classes to EN 15232	Efficiency factor for thermal energy			Efficiency factor for electrical energy		
	Office	School	Hotel	Office	School	Hotel
A	0.70	0.80	0.68	0.87	0.86	0.90
B	0.80	0.88	0.85	0.93	0.93	0.95
C	1	1	1	1	1	1
D	1.51	1.20	1.31	1.10	1.07	1.07

Table. 3.1 A new European standard EN15232

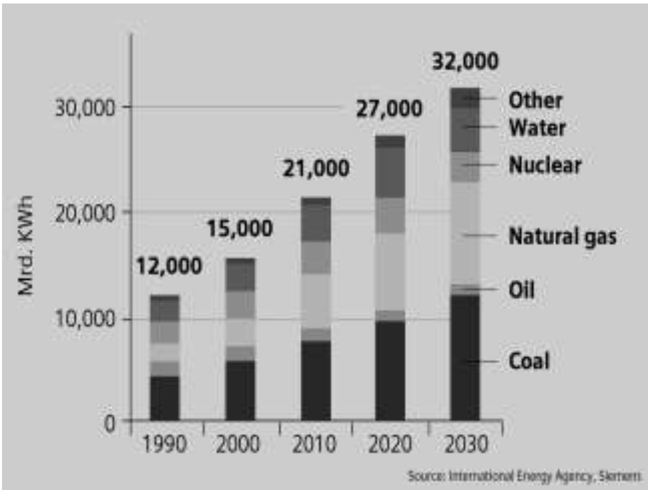
Standard EN 15232 "Energy Efficiency in Buildings – Influence of Building Automation and Control and Building Management" was introduced to take advantage of energy savings potential of control and building operation. The standard makes it possible to identify the savings potential from building automation and control and then to derive measures to improve energy efficiency. Energy consumption is classified into thermal and electrical parts. The following
consumers are important in a building:

- Heating
- Domestic hot water
- Lighting
- Auxiliary energy
- Cooling
- Ventilation (for fans, pumps, etc.)

GLOBAL SITUATION: ENERGY AND CLIMATE

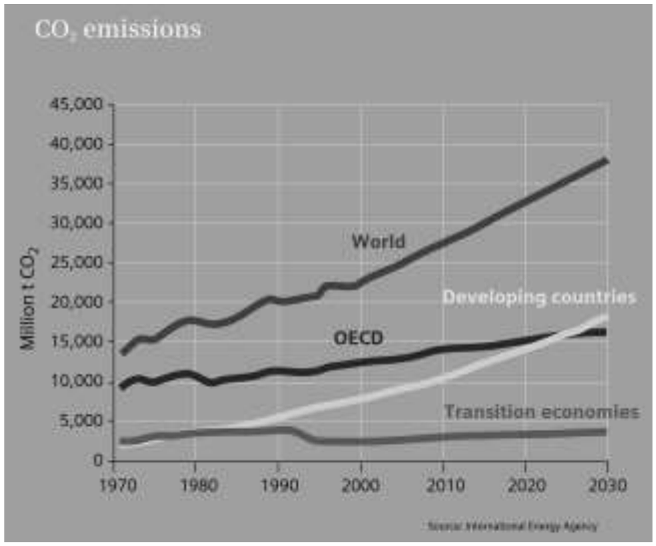
CO2 emissions and global climate

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.



Graph 4.1 Global demand for energy[Source:International Energy Agency , Siemens]

Global CO2 emissions are developing in sync with the increased consumption of fossil fuels. They have strongly increased since 1970 and will continue to do so.



Graph 4.2: Global CO2 emissions[Source:International Energy Agency]

The impact of CO2 emissions is already unmistakable: The average air temperature is continuously increasing over the long term; weather dynamics are increasing dramatically. [3]

Primary energy consumption

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% of primary energy use to achieve comfortable temperatures and 6% for electrical energy. That amounts to a significant portion.

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

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.

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 building’s 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.

You can achieve significant reductions in energy use and CO2 emissions by further updating building automation and control functions in older and less energy efficient buildings.

BUILDING AUTOMATION &CONTROL- IMPACT ON ENERGY EFFICIENCY

Heating Control

Emission control for TABS:

- **Central automatic control**

The central automatic control for a TABS zone (which comprises all rooms which get the same supply water temperature) typically is a supply water temperature control loop whose set-point is dependent on the filtered outside temperature e.g. the average of the previous 24 hours.

- **Advanced central automatic control**

This is an automatic control of the TABS zone that fulfills the following conditions: If the TABS is used only for heating: The central automatic control is designed and tuned to achieve an optimal self-regulating of the room temperature within the required comfort range (specified by the room temperature heating set-point). "Optimal" means that the room temperatures of all rooms of the TABS zone remain during operation periods in the comfort range, to meet comfort requirements, but also is as low as possible to reduce the energy demand for heating.

Reasons for energy saving

Supply output is controlled depending on the outside temperature, for example (corresponding to the probable heat demand of the consumers). Energy losses under part load conditions are reduced, but no advantage can be taken of individual heat gains in the rooms.

Supply output is controlled depending on the outside temperature, for example (corresponding to the probable heat demand of the consumers). Taking advantage of self-regulating effects during operating times fulfills comfort requirements in all the rooms and reduces heat demand as much as possible. Different set points for heating and cooling (e.g. through the use of a setpoint range for the flow temperature) can prevent unnecessary overheating or undercooling. Additional energy can be saved by compensating for known heat gains in the building (e.g. by adjusting the flow temperatures over the weekend in office buildings – if there are no internal heat gains).[3]

Cooling Control

- **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;

- **Individual room control**

By thermostatic valves or electronic controller.

- **Individual room control with communication**

Between controllers and to BACS (e.g. scheduler)

- **Individual room control with communication and presence**

Control Between controllers and BACS; Demand / Presence control performed by occupancy.

Reasons for energy saving

Supply output is controlled depending on the outside temperature, for example (corresponding to the probable heat demand of the consumers). Energy losses under part load conditions are reduced, but no advantage can be taken of individual heat gains in the rooms.

Supply output depending on the room temperature (= controlled variable). It considers heat gains in the room as well (solar radiation, people, animals, technical equipment). Room comfort can be maintained to satisfy individual needs.

Same reason as above. In addition: Central...
• schedulers make it possible to reduce output during no occupancy
• operating and monitoring functions further optimize
Operation
Same reason as above. In addition:

• Effective occupancy control results in additional energy
Savings in the room under part load conditions.
• Demand-controlled energy provisioning (energy production) results in minimum losses from provision and distribution.[3]

Ventilation and Air Conditioning Control

- **Air flow control at the room level**

Time control

The system runs according to a given time schedule.

- **Presence control**

The system runs dependent on the presence (light switch, infrared sensors etc)

- **Demand control**

The system is controlled by sensors measuring the number of people or indoor air parameters or adapted criteria (e.g. CO2, mixed gas or VOC sensors). The used parameters shall be adapted to the kind of activity in the space.

Reasons for energy saving

Air flow for the maximum load in the room is used up during nominal occupancy times, resulting in significant energy losses under part load conditions in the room.

Air flow for the maximum load in the room is only used up during current occupancy times. Energy losses under part load conditions in the room are reduced to actual occupancy.

Air flow in the room controlled by an air quality sensor, for example, ensuring air quality at lower energy for air handling and distribution.[3]

Lighting Control

- **Automatic detection**

Auto On / Dimmed Off: 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.

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.

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(ies), 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(ies) are automatically and fully switched off .

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.

Reasons for energy saving

Ensures that lights are turned off in non-residential buildings as well (e.g. in the evening or on weekends).

Auto On/Dimmed Off

Current occupancy is recorded in each area, in large
rooms, hallways, etc. Then, automatic lighting control …

1. turns on lighting in an area at the start of occupancy,
2. reduces lighting to a maximum of 20% in the area at the end of occupancy,
3. turns off lighting in the room 5 minutes after the end of occupancy.

Auto On/Auto Off

Actual occupancy times of each room or room area are recorded. Then, automatic 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.

Manual On/Dimmed

Lighting of each area …

• can only be switched on manually,
• can be dimmed and switched off manually.

Actual occupancy times of each area are recorded in the room. Then, automatic lighting control …

• reduces lighting to a maximum of 20% in the area at the end of occupancy,
• turns off lighting in the room 5 minutes after the end of occupancy.

Manual On/Auto Off

Lighting of each area …

• can only be switched on manually,
• can be manually switched off.

Actual occupancy times of each area are recorded in the room. Then, automatic lighting control turns off the lighting 5 minutes after the end of occupancy in the area.[3]

Blind Control

- **Motorized operation with manual control**

Mostly used only for easiest manual (motor supported) shadowing, energy saving depends only on the user behavior.

- **Motorized operation with automatic control**

Automatic controlled dimming to reduce cooling energy.

- **Combined light/blind/HVAC control**

To optimize energy use for HVAC, blind and lighting for occupied and non-occupied rooms.

Reasons for energy saving

Motorized support only eases manual intervention and is mostly only done for glare protection. Energy savings are highly dependent on user behavior.

Motorized support is required for automatic control. The focus of automatic control functions is in the support of solar protection, reducing the heat input such that cooling energy can be saved. Manual operation by the user must be possible at all times, allowing the user to achieve glare protection independent of automatic solar protection control for energy savings.

This processing function considers all the reasons to meet the needs of the use and energy-optimized (prioritized consideration for occupied and non-occupied rooms).[3]

CONCLUSION

1. Energy efficient buildings can contribute significantly to energy savings and thus global climate protection.
2. Building automation and control systems are the building's brain. They integrate the information for all the building's technology. They control 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.

3. Manage and promote optimization of energy use.
4. Install energy efficient equipment to reduce overall energy consumption.
5. Maintain, repair, and automate existing HVAC, lighting, water and power systems, as well as other essential equipment.
6. Track consumption and analyze market data for better understanding and control of your facility's energy usage.
7. Use actionable recommendations for energy improvements and savings.
8. Intelligent energy-efficient buildings are expected to be an important part of future energy systems. There are practically no limits to the number of functions that can be incorporated. Measurement, analysis and control are important prerequisites for effective energy management. Integrating energy-consuming components with energy-producing ones and incorporating intelligent buildings into the energy system saves energy costs and reduces CO2-emissions.
9. Efficiency in respect of receiving the highest possible output from the lowest available input. One example could be the energy supplied to a building. The efficiency of the energy usage must be at or very close to 100%. Most previous researches conclude that intelligent building is in fact highly efficient rather than intelligent. If a building is 100% efficient, then it could be said to be intelligent.

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