HI-SMART

HI-SMART: HIGHER EDUCATION PACKAGE FOR NEARLY ZERO ENERGY AND SMART BUILDING DESIGN

MODULE #5

SMART BUILDINGS

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MŰEGYETEM 1782

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1 SMART CONTROL AND AUTOMATION

1.1 BUILDING AUTOMATION

In our modern industrial society, more and more procedures and processes are being automated. The degree of automation in residential and functional buildings is also constantly increasing worldwide because residents and operators want more and more comfort, safety and economy.

In this context, building automation has developed into an important sub-area of automation technology and offers customer-oriented solutions for all types of buildings. Building automation refers to the automatic control of building functions, such as heating, air conditioning and ventilation as well as lighting and shading.

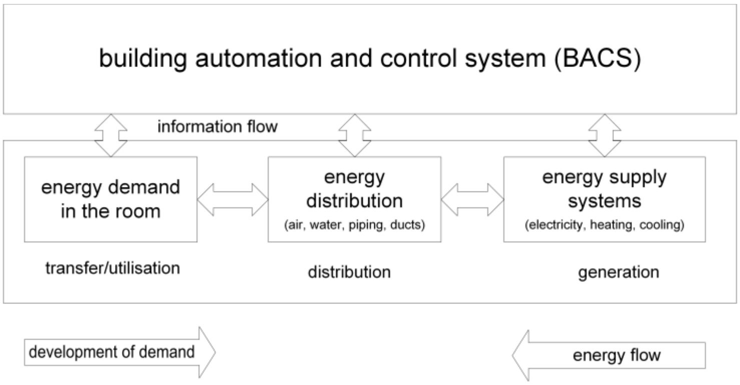
For this purpose, all sensors, actuators, control elements, consumers and other technical units in the building are networked with each other. Processes can be combined in scenarios and enable an intelligent and optimized interaction of the various components. Building automation is often confused with smart home systems. Especially in recent years, the number of smart home systems for private users has grown rapidly.

One of the most important standards for building automation at European level is the EN ISO 16484. According to EN ISO 16484, the definition of building automation is as follows:

"description for products, software, and engineering services for automatic controls, monitoring and optimization, human intervention, and management to achieve energy — efficient, economical, and safe operation of building services equipment"[1]

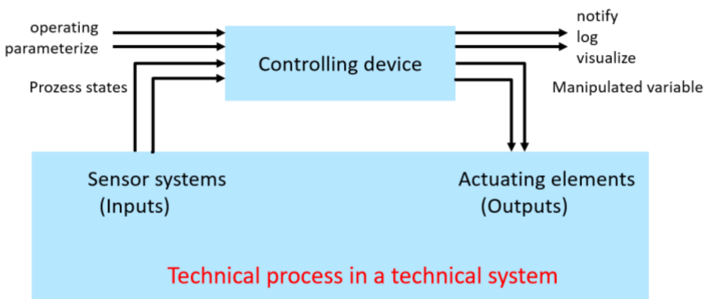
1.2 THE BAC SYSTEM

The technical implementation of the building automation is done with Building automation and control systems (BACS). The necessary exchange of information of the components of a BAC system (information flow) is done via the BAC system network and BAC functions are provided by software. There will usually be interfaces to a BAC system, through which a dialogue between the BAC system and the human being (operating and monitoring) takes place. There may also be interfaces between a BAC system and other systems, through which a dialog between the systems takes place in an interoperable manner.[2]



1.3 TECHNICAL PROCESS IN BA

The task of building automation is to make a technical process run as fully automatically as possible. A technical process is a procedure by which materials, energy or information is transformed, transported or stored. In a technical process, the physical quantities are recorded and influenced by technical equipment.

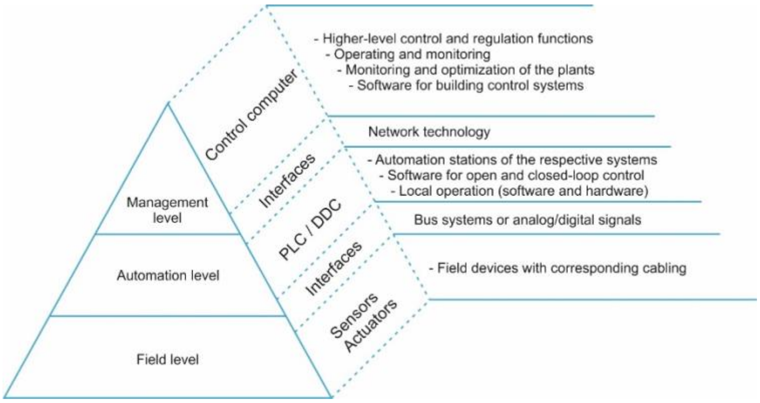


In order to automate a technical process, it is necessary both to obtain information about the process and to be able to actively interfere in the process. This process information is recorded in the form of measured values with sensors. The active intervention is done by actuators (sensors and actuators will be explained later). Therefore, the process can be influenced by the controlling device, depending on the process state recorded by the measured values. The figure shows the sphere of action.

The illustration also shows that the operator has access to the controlling system and can, for example, set parameters. In addition, the operator receives information about the technical process in the form of messages and logs, which can be displayed graphically on monitors, for example. This access and display option is also called "Operating & Monitoring".

1.4 AUTOMATION PYRAMID

Building automation systems are divided into three levels: The field, automation and management levels. The individual levels are distinct depending on the size and complexity of the object or the properties to be automated. Due to advances in digital control technology, the boundaries between the individual levels are becoming increasingly blurred.



2 SMART METERING

Power meters are applied in the energy systems to measure the energy consumption. In these days, different kind of power meters are in use and they stand at different stages of development. The power meters could be divided into two main groups on the basis of their features and capability. The older type of power meters are the electromechanical meters. The development of these meters was necessary because of their limitations. For example, they are not able to serve very accurate results because some metering factors influence their measurement, they could be applied to measure only the basic energy components and human resources is needed for their reading. Because of the human factor, the possibility of error is higher and it increases the cost of energy as well. The newer type of power meters: electronic power meters serve more accurate energy measurement results and the price of energy could also be reduced with the help of remotely monitoring systems. For this remotely access, different technologies could be applied. Automated Meter Reading (AMR) AMR is able to ensure one direction information flow from the electronic power meters to the energy suppliers. On contrary, Advanced Metering Infrastructure (AMI) is already able to ensure two direction information flow between the electronic power meters and the energy suppliers. Lately, the term “smart meters” is used for electronic power meters, but there is no uniformed description what “smart” is. Smart meters have module structure, which provides the opportunity to get flexible measurement equipment, which has all the required features. Smart meters can measure not only the total consumption between the two reading periods but because of the remote access, the consumption of shorter terms as well. Thus, energy suppliers can examine the consumption data of their consumers, analyse their consumption behaviour, and they are able to develop their system and supply the energy more efficient. [3,4]

Smart metering technology provides the possibility for consumers to get real time information about their energy consumption. Therefore, they can modify their demand deliberately, they could take part in demand side management programs and they could reach energy and cost savings. The application of smart meters is advantageous for energy utility companies as well because with the help of them several information is available about the users. It offers a great opportunity to supervise and control the power grid, handle the consumption peak and off-peak periods and improve the security of energy supply. The collected data could help the development of new pricing methods, which lead to the reduction of the electricity consumption and the cost of energy. The more efficient energy supply leads to the reduction of energy production and harmful emission. With the help of smart meters renewable energy sources, new technologies and innovations are easier to integrate into the electricity system too. [1,2]

3 DEMAND SIDE MANAGEMENT

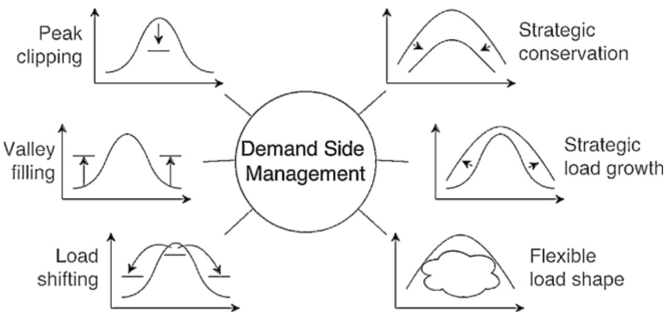
To be able to supply the growing energy needs in an environmentally friendly and quality way, the development of the electricity system and the integration of new inventions are necessary. To serve the energy demand while reducing the harmful emission, renewable energy sources and energy storages are integrated into the energy systems. In the pursuance of the energy service development, the growth of the security of supply and the maintenance of balance between generation and consumption are also required. [5]

There are two possibilities to keep the balance between the increasing energy demand and the available energy generation capacity: the supply or the demand side should be set to the other one. Using demand side management (DSM) methodologies, the energy consumption of the demand side is influenced to assimilate to the energy production of the supply side. Applying DSM, the consumers should be motivated to modify their energy consumption, which could lead to aware and efficient energy usage, and therefore the energy losses and the harmful emission could also be reduced. [6,7]

To ensure the proper operation of the energy system, the balance between the energy generation and the energy consumption have to be maintained. The energy generation changes dynamically during the day because of the integrated renewable energy sources, which production couldn't be forecasted accurately or controlled. The surplus generated energy should be consumed or stored but the problem of efficient energy storage hasn't been solved. To be able to serve the required amount of energy during the peak times reliably, plus resources should be integrated into the energy system, which resources work by fossil fuels. The availability of these extra assets would increase the cost of energy. To be able to ensure the security of energy supply, all parts of the energy system have to be dimensioned to the peak demands. The higher the peak demand is, the costlier the needed facilities and the energy generation are. Therefore, to decrease the cost of energy, the energy consumption of the consumers has to be controlled. They should be motivated to reduce their peak demand or to shift part of it to off-peak times, or to adapt to the energy generation. To ensure the possibility for consumers to react to the changes of energy generation, they should get accurate information about the current state of the energy system. The favourable situation is if energy consumption increases when renewable energy is available, and decreases during the peak times. [8]

To balance the energy generation and energy consumption two strategies are used in DSM: consumption reduction and efficiency improvement. Based on these strategies, DSM techniques could be categorised into two modalities: static DSM (SDSM) and dynamic DSM (DDSM). First, the general DSM techniques are presented, which are the electric load management (ELM) and energy conservation (ENCON). [6]

The aim of ELM is to change the electricity consumption profile of consumers and it has two modalities according to the applied strategies: static ELM (SELM) and dynamic ELM (DELM). The SELM aims to decrease the energy consumption by this energy usage modification. In contrast, the aim of DELM is to change the load shape to reach higher effectiveness in energy usage. SELM applies Strategic Conservation and Flexible Load Shape techniques; DELM applies Peak Clipping, Valley Filling, Load Shifting and Strategic Load Growth techniques. The load shaping techniques of ELM could be seen in the figure Strategic conservation is used for



decreasing the energy consumption in general, Flexible Load Shape is used for modifying the energy needs of consumers according to the available energy. Peak Clipping is used for decreasing the energy consumption during the peak time, Valley Filling is used for increasing the energy consumption during the off-peak time, Load Shifting is used for shifting the energy consumption from peak time to off-peak time and Strategic Load Growth is used for increasing the energy consumption. Peak Clipping, Valley Filling and Load Shifting techniques are applied to flatten the load curve and decrease the fluctuation of energy consumption. Strategic Load Growth technique is applied to increase the efficiency of system operation. [6]

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