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BEEM-UP

Building Energy Efficiency for Massive market UPtake

Integrated Project

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Demonstration of Energy Efficiency through Retrofitting of Buildings

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Dissemination Level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
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Deliverable description

The goal of this document is to analyse general Building Automation systems, explain how these systems can contribute to Energy Efficiency of buildings and exemplify a solution that could fulfil BEEM-UP pilot sites.
We start by a brief introduction about the advantages of control systems in residential buildings followed by a description of general control technologies, explaining the general concept. Finally we present the solution of SIEMENS in detail.

Even if the three sites have completely different characteristics, and although the main focus is on the technologies of BEEM-UP partners, we try to define a protocol that could be used in several retrofitting examples at a wider scale across Europe.

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Chapter 1 Introduction

Control Systems for Buildings are networks of sensors and actuators, interlinked and controlled by centralized software, which monitor and control comfort and environmental parameters of buildings, ensuring the comfort and safety of occupants while optimizing the use of energy.
Typically, such control systems are installed in new buildings or as part of a renovation.
We can hear some of the following designations for control systems: Building Automation and Control Systems (BACS), Building Control System (BCS), Building Management System (BMS), or even Energy Management System (EMS).
Building automation can control mechanical, electrical and plumbing systems, like heating, ventilation and air-conditioning (HVAC), lighting and blinds. Many modern systems are also integrated with security products and can include: Closed Circuit Video (CCTV), Fire detection and alarm and access control. There is also a new trend to integrate energy monitoring in such systems.

1.1 Trends of Building Automation Systems

Early control systems were pneumatic but their scope was very restricted (usually only to control HVAC systems). With the development of electronic systems, building automation began to include faster and more stable devices. The digital era has boosted the capabilities of building automation, allowing systems to be faster, smaller and easier to integrate with different components.
However, different manufacturers have developed proprietary protocols and integration of products from different manufacturers was a hard task.
There were some initiatives to develop a standard communication protocol (BACnet, LonTalk), but none of them was completely successful. One of them was KNX. This standard was based in several previous systems like EIB, EHS and BatiBUS, and ensures that all the components of a system communicate using the same language. Using this protocol, all equipment is connected by a BUS and change information about the status of each other. Bus devices can be either sensors or actuators and all of them can be monitored and controlled without the need of a centralized control module.
Modern communications technologies have a huge impact on BAS. Although wireless technology has some limitations (like short battery life, lack of communication standards, etc.) it has some advantages (especially in installation) and new wireless systems are replacing old ones based on wired communication infrastructures. Some newer building automation and lighting control

solutions use wireless mesh open standards (such as ZigBee). These systems can provide interoperability, allowing users to mix-and-match devices from different manufacturers, and to provide integration with other compatible building control systems.

Many controls applications are following the same evolutionary path followed by the computer industry. There is a trend away from centralized control systems and proprietary closed architectures to open standard architectures and intelligent distributed control using a standard communication protocol and readily available off-the-shelf communication modules. These open solutions ensure reliability, flexibility, lower cost, and faster development, and provide enhanced energy monitoring and control.

1.2 Building Automation for Energy Efficiency

Control systems can have a significant impact on the energy consumption of buildings and their occupants, with potential savings up to 40 per cent. The European Committee for Standardization has recognized this and has issued EN 15232 Standard [3] for use in conjunction with their Energy Performance of Buildings Directive (EPBD).

This European Standard describes methods for evaluating the influence of building automation and technical building management on the energy consumption of buildings.

The EN15232 standard includes the following:

- A list of control, automation, and technical management functions that affect the energy performance of buildings
- A method for defining the minimum requirements for the control, automation, and technical building management functions implemented in different types of buildings
- Detailed procedures for quantifying the impact these functions have on the energy performance of a building
- A simplified method to obtain an initial estimate of the impact these functions have on the energy performance of buildings

The EN 15232 standard defines four BAC energy efficiency classes, corresponding to the level of automation, control, and supervision installed. The definition of each class is based on the presence or absence of a set of automation functions, control, and supervision without regard to the details of their implementation as we can see in Table 1.

- Class D – Non-energy Efficient: corresponds to traditional and technical systems that provide no automation or energy-efficiency
- Class C – Standard: corresponds to standard automation systems and normal controls. Class C is considered the reference class

- Class B – Advanced: corresponds to advanced automation and control systems and some Technical Building Management (TBM) functions for centralized control
- Class A – High Energy Performance: corresponds to systems similar to those of Class B but with levels of accuracy and completeness that ensure high energy performance

	Heating / Cooling control	Ventilation / Air conditioning control	Lighting	Sun protection
A	- Individual room control with communication between controllers Indoor temperature control of distribution network water temperature - Total interlock between heating and cooling control	- Demand or presence dependent air flow control at room level - Variable set point with load dependant compensation of supply temperature control - Room or exhaust or supply air humidity control	- Automatic daylight control - Automatic occupancy detection manual on / auto off - Automatic occupancy detection manual on / dimmed - Automatic occupancy detection auto on / auto off - Automatic occupancy detection auto on / dimmed	- Combined light/blind/ HVAC control
B	- Individual room control with communication between controllers - Indoor temperature control of distribution network water temperature - Partial interlock between heating and cooling control (dependent on HVAC system)	- Time dependent air flow control at room level - Variable set point with outdoor temperature compensation of supply temperature control - Room or exhaust or supply air humidity control	- Manual daylight control - Automatic occupancy detection manual on / auto off - Automatic occupancy detection manual on / dimmed - Automatic occupancy detection auto on / auto off - Automatic occupancy detection auto on / dimmed	- Motorized operation with automatic blind control
C	- Individual room automatic control by thermostatic valves or electronic controller - Outside temperature compensated control of distribution network water temperature - Partial interlock between heating and cooling control (dependent on HVAC system)	- Time dependent air flow control at room level - Constant set point of supply temperature control - Supply air humidity limitation	- Manual daylight control - Manual on/off switch + additional sweeping extinction signal - Manual on/off switch	- Motorized operation with manual blind control
D	- No automatic control - No control of distribution network water temperature - No interlock between heating and cooling control	- No air flow control at room level - No supply temperature control - No air humidity control	- Manual daylight control - Manual on/off switch + additional sweeping extinction signal - Manual on/off switch	- Manual operation for blinds

Table 1: Class characteristics

Building automation and control functions should be selected based on their impact on a building's efficiency and EN 15232 focus on Energy efficiency-relevant functions and possible processing functions for building automation and control systems. They are grouped by the different areas of use and we can see an example on **¡Error! No se encuentra el origen de la referencia.**.

Heating control strategy	Energy savings
No automatic control of the room temperature	The highest supply output is continuously delivered to the heat emitters resulting in the supply of unnecessary thermal energy under part load conditions.
Central automatic control There is only central automatic control acting either on the distribution or on the generation.	Supply output 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.
Individual room control By thermostatic valves or electronic controller.	Supply output based on room temperature. It considers heat sources in the room as well (heat from solar radiation, people, animals, technical equipment). The room can be kept comfortable with less energy. Electronic control equipment ensures higher energy efficiency than thermostatic valves (higher control accuracy, coordinated manipulated variable acts on all valves in the room).
Individual room control with communication Between controllers and BACS (e.g. scheduler)	Same reason as above, plus: • Central schedulers make it possible to reduce output during non-occupancy, • Central operating and monitoring functions further optimize plant operation.
Individual room control with communication and presence control Between controllers and BACS; Demand/Presence control performed by occupancy	Same reason as above. In addition: • Effective occupancy control results in additional energy savings in the room under part load conditions. • Demand-controlled energy provision (production of energy) results in minimum losses in provision and distribution.

Table 2:

Chapter 2 Control Systems Technologies

2.1 Synco living, by SIEMENS

Synco living is a comprehensive home automation system offering a broad spectrum of components. It allows, for example, on-demand control of heating, ventilation, and air conditioning plants, lighting and blinds. And a new feature has been added: the easy display of consumption data for heating, cooling, hot and cold water, gas, and electricity – because Synco living's range of functions has been expanded to include consumption data acquisition and automatic trans - mission of the values to the relevant service providers.
This function means significantly more convenience for building managers.
As the consumption data is sent periodically by e-mail and can also be viewed on the Internet, access to the apartment is no longer necessary. This substantially reduces organizational effort and administrative costs. Coordination of site visits and costs for arranging readout dates on site are eliminated. And what's more, the customized, energy-efficient individual room control makes the property more attractive.
During a modernization project, Synco living can be installed anywhere – even gradually, if desired. The home automation system can be integrated into apartment buildings apartment by apartment. If a building is renovated or if room usage changes, Synco living can be flexibly adapted to the changes and expanded – thanks to battery-powered devices that communicate wirelessly.

The Synco™ living home automation system helps tenants to easily and comfortably control their heating, ventilation, and air conditioning systems as well as lights, blinds, and many other devices in their home. In terms of energy efficiency, that can mean up to 30% less heating energy used – and lower CO_2 emissions.
Synco living is a comprehensive home automation system with a wide range of components. The system allows controlling heating, ventilation, and air conditioning systems, conveniently switch electrical appliances on and off, and monitor the rooms of a home for smoke. The system also shows which windows are open, informs about the current outdoor temperature and barometric pressure, and provides an easy, convenient way to control lights and blinds.
Thanks to implementation of the internationally recognized KNX communication standard, electrical appliances, heating, ventilation, air conditioning systems, and household appliances from different manufacturers can communicate with each other. This also ensures the integration of any future comfort, security, and energy saving functions. Along with wireless

KNX capabilities, the central control unit can communicate with other devices via a wired KNX connection.

Synco living is prepared to be installed in new building or in a refurbishment; the system can be easily integrated to optimally meet your needs. Synco living can be adapted for changes by flexibly adding components.

Main features include:

- Optimal control of heating and air conditioning
- Central monitoring of door and window contacts and smoke detection
- Integration of lighting, blinds, and electrical appliances
- Remote control and remote access

Comfort:

Synco living can create the optimal cozy room climate as the system covers the following applications:

- Controlling individual rooms: up to 12 rooms with floor heating or radiators;
- Heat generation: control of heating boiler to generate heat as needed by the rooms;
- Domestic hot water regulation: to generate hot water for the entire home;
- Ventilation control: for a ventilation system with up to three stages; control of kitchen exhaust hood;
- Air conditioning control: remote control of an air conditioning unit.

Security:

Integrating safety and security components into your system will improve your home's safety and efficiency. Components include:

- Smoke detection: integration of one smoke detector per room;
- Window and door monitoring: monitoring of up to six windows per room and two doors per house/apartment.

Convenience:

You can also integrate electrical installations and devices to make daily life more convenient, e.g. thanks to the following applications:

- Lights and blinds: control of lights and blinds, including blanket commands like ALL OFF, etc.;
- Wireless plug adapter: switching electrical appliances, such as coffee machine or indoor fountain, on and off and dimming lights;

- Remote access: via PC or Smartphone;
- Time switching programs: individual for each room and each switching group.

2.1.1 Synco Living for Energy Efficiency

Synco living handles many tasks that reduce energy consumption. For example, when people leave home, the system automatically turns off all the lights and reduces the room temperature. Room temperature can also be adjusted with a time switching program to fit effective use times. And functions such as the automatic closing of all blinds are not only more convenient but save energy as well.

Synco living has many advantages over thermostatic valves that are mounted directly on a radiator:

- Synco living keeps the temperature constant within a narrow ±0,2 °C range. Thermostatic valves, however, allow temperature deviations within a ±1 °C range.
- Synco living automatically reduces the temperature at night. With thermostatic valves, we have to set each individual valve to accomplish this.
- Synco living detects open windows automatically and closes the heating valves after a preset period of time to avoid unnecessary heating. Thermostatic valves have to be manually adjusted to achieve the same result.

Optimal controlled ventilation

No over ventilation means less heat losses and lower energy costs: Synco living can run your home ventilation devices on a time-based or demand-based program. We can program the timer for each day of the week or control ventilation depending on the relative humidity or air quality: if the CO_2 level inside the house exceeds a set value, ventilation will increase for a while.

It also applies for air conditioning: depending on the outside temperature and desired comfort level, the central apartment unit will direct the air conditioning system to turn on or off as needed. If someone opens a window in a room that has the air conditioning running, the central apartment unit will turn the air conditioning off. Once the window is closed, the central apartment unit will once again switch the air conditioning on.

Synco living also allows the dimming of individual lights – for longer bulb life as well as lower energy consumption.

But potential energy savings also depend on user behavior. For example, users can increase their energy savings by closing blinds at night, by reducing the room temperature and ventilation when they are not home, by turning off lights at night and when they leave home, by dimming lights, and by reducing the default temperature.

Synco living can helps tenants because it has a set of actions that can be easily implemented. For instance, to save energy whenever people leave home, by pressing just one button on the central apartment unit, we can:

- Turn off all lights and all plugged-in electrical appliances;
- Lower all blinds;
- Reduce the temperature level of the heating system e.g. from 21 °C to 19 °C.
- Reduce ventilation to a lower level.

2.1.2 Synco Living components

2.1.3 Ease of use and upgrade

Changing settings of the systems is a quick and easy task using the central apartment unit. There's no need for a PC or any tools. Whether users want to adjust heating, cooling, or ventilation – the intuitive keys and simple menus on the central apartment unit make it simple to change system settings quickly, easily, and without making a service call.

Since most components have wireless receivers and are battery-operated, it's easy to add on to an existing system – without opening up any of the walls. And is possible to integrate radio-socket adapters, for example, with the central apartment unit by simply pushing a button – and so connect electrical devices and lights to Synco living.

International technology standards ensure that Synco living systems will be capable of handling new requirements for many years to come. New components can be added to the system at any time and expand it in the future. Wireless technology means that there is no need to run any cables or make any holes in walls or ceilings.

Chapter 4 Conclusions

Besides security and comfort features, Home Automation Systems can have a big impact on Energy Efficiency. A sophisticated control system can save up to 40% of final energy consumption.

Superior system integration means receiving one intelligent, comprehensive solution able to provide effective streamlining of operations, low installation costs and optimized energy efficiency.

Synco living from Siemens is a modern home automation system based on the KNX open communication standard, allowing the integration of third party components and ideal for renovations, since communication is wireless and the commissioning is plug & play, via push button without the requirement of a special tool, which reduces installation cost.

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