Case studies of best practice

Chapter leader: Andrei Litiu, eu.bac

Non-residential success stories

Incity commercial building, Lyon, France – Distech Controls

With 39 storeys, and a net floor space of 44,145 m² Incity will stand 200 metres high and will be the tallest building in Lyon. Furthermore, Incity will be the first HEQ (High Environmental Quality) commercial building in a French city centre that will also be BBC (Low Consumption Building) and BREEAM Excellent (Building Research Establishment Environmental Assessment Method) certified.

The Smart Room Control solution was selected in order to control the Incity's HVAC, lighting and shades/sunblind systems, as well as fulfilling the project's 3 main criteria: energy certification, modularity and to be based entirely on the BACnet protocol.

As an end-to-end system for the control of HVAC terminal equipment, lighting, and shades/sunblind modules combined with sensors and room devices, the Smart Room Control fully meets these requirements:

1. Energy certification: 'HVAC controller' control loop is eu.bac AA certified (the highest rating possible) by the CSTB. The integration of eu.bac certified products allows for up to 15% energy savings in buildings that meet European standards and directives: DEPB, RT2012, EN 15232, etc.

2. Modularity: the solution enables the installer to prefabricate electrical enclosures, integrating, for each room, the HVAC controller and the expansion sunblind module (24 or 230 V depending on the façade) and the lighting module (dimming 1-10 V). This integration of lighting, shades/sunblind and HVAC control greatly reduces the hardware and installation time required. In addition, the three functions (HVAC, Lighting, and Sunblinds) can be configured through one seamless interface meaning no additional discovery, bindings, or commissioning required.

3. BACnet protocol: Incity is the first fully BACnet tower in France. The synergistic BACnet solution lightens the network infrastructure by reducing the number of BACnet routers, as it requires only one BACnet device per room.

Bouygues "Challenger" Center, Guyancourt, France – Belimo

In 2010, the French construction group, Bouygues Construction, started to renovate its headquarters, originally built in 1988, in the Paris suburb of Guyancourt. The buildings of the Challenger area have been transformed and re-equipped in several phases to meet the highest standards in environmental protection, efficiency and sustainability. The primary consumption of energy and water will drop to between 10 and 40 percent of the original values after the renovation is completed.

Bouygues Construction employs 55,400 individuals in 80 countries and manages several thousand construction projects around the world. The renovation work in Guyancourt began in 2010 with the Triangle-South and North buildings, which were completed in August 2012. In 2013, there followed the north-west and south-west wings of the main building.

In 2008, during the planning phase, Bouygues had defined the goal to check the energy quality and sustainability of the renovated buildings by internationally recognized certification systems. In 2012 they then received the first completed section of the building with an outstanding environmental performance attaining three certificates with top marks: LEED "Platinum", "Outstanding" from BREEAM and "Exceptional" by HQE. The Bouygues "Challenger" headquarters is therefore the world's first renovation that can boast a triple certification for environmental and energy efficiency.

To improve energy efficiency, research and development the Group teams have developed numerous innovations in collaboration with industry. One of them is a new air conditioning system with variable cooling water volume flow (VRF) where automatic valves play a central role. The VRF system is a reversible air conditioning system with variable refrigerant flow control. It combines several units in the building – each consisting of an evaporator (cooling) and a condenser (heating) – with a single outdoor unit. The VRF system's controls command the automatic valves and so adjusts the flow to the load.

Depending on the temperature requirements of the VRF, a minimum allowable value for the temperature difference (delta T) is set using the web browser built into the valve controller. This is continuously measured by temperature sensors in the flow and return. Another sensor simultaneously measures the flow value for the energy calculation. The valve then regulates the flow so that the controlled range does not fall below a minimum value. The energy monitoring enables real-time sharing of all data using the automation control centre.

'The Cat's Pajamas' hostel, Berlin, Germany – Sauter

The German capital is known for its diversity, attracting visitors from all over the world. A modern hostel in the heart of Berlin is making a big impression with its stylish décor and innovative building automation that works hand in hand with the booking software.

In the Berlin hostel "The Cat's Pajamas", exciting encounters happen on a daily basis. This is no surprise, as it is located in the trendy Kreuzkölln area – effectively the intersection of the districts Kreuzberg and Neukölln. Here you will find urbanity alongside green courtyards. And in the hostel's comfortable shared rooms, globetrotters from the widest variety of countries find a place to stay together.

“The Cat’s Pajamas” wants to be different, offering its guests not only accommodation, but an incomparable experience. Whether in shared or single rooms, the hostel distinguishes itself with unconventional ideas and a high level of comfort. It also aimed to break new ground in the building automation area. The main goal was to keep energy consumption as low as possible, and to achieve a high level of energy efficiency through intelligent controlling and continuous monitoring.

As energy consumption in empty rooms is a significant cost driver in the hotel sector, connecting the intelligent unitary control with the hotel booking software enabled a major savings potential. The selected building automation has the ability to interface with third-party systems and its consistent support of BACnet made it optimally suitable to combine all the hotel equipment systems, including the intelligent unitary control as well as the booking software into a single system.

For example, a gas cogeneration unit (CHP) was installed, generating heat and electricity. The goal was to meet the building’s power consumption requirements with the electricity created. A second goal was to cover the hostel’s heat requirement primarily by means of the heat pump, with the gas heater only being used at peak times. Using the building automation’s operation and visualization software, the operators are able to monitor the interaction of the gas CHP, the gas heater and the hot water storage tank at all times on a tablet or PC, with a web-based application.

With every room booking, the booking software sends a report to the building management system. The system switches the room from stand-by to occupancy at the appropriate time. In stand-by mode, the room temperature is constantly kept under the current set point. This results in an optimal configuration of the operating times for the ventilation and heating in every room.

When the room is occupied, the guest can also use the presence button to manually adjust the operating mode of the room control unit. A multi-coloured LED indicator informs the guests about the local energy consumption, thus encouraging energy-conscious behaviour.

Majunga Tower, Paris, France – Schneider Electric

A state of the art solution was provided on the iconic project in Paris, La Défense - the Majunga tower. Ever since its design phase, the Majunga project has aimed to create a building that enables its occupants to significantly reduce their energy consumption and carbon footprint. In recognition of this, the tower won a BREEAM Award in 2012, and attained BREEAM and HQE certification in the 'Excellent' category in the design phase.

"The building automation solution we opted for meets our expectations in a digital way, which is perfectly in line with our vision of the commercial property" – Bruno Donjon de Saint Martin, Managing Director – Offices France at Unibail-Rodamco.

The selected building automation products have the eu.bac mark for the following applications: ceiling systems, fan coil unit system (4 pipe). The certified products are multi-application controllers which supply power and commands to comfort devices: Lighting, Blinds/Shutters and HVAC. They ensure proper comfort in buildings, either automatically or manually. Access to comfort control can also be done through a remote control or wall panel and also on a PC or using the dedicated Smartphone App, running on any OS.

Linking in to the Building Management System (BMS), a unique solution was developed to measure occupancy in the office buildings; it enables the measurement of the occupancy in each room and area, so as to match the services distribution with the real usage. All the gathered data provides insight to enhance the building performance and provide a wide range of services.

It provides a guarantee of quality and product performance for engineering departments, building owners, installers, maintainers, users and all stakeholders. Customers are seeking well performing and certified products to gain points towards their building certification (e.g. LEED, BREEAM, HQE, BBC). The certified products ensure compliance with specifications and standards EN 15500 and EN 15232.

'24 Prony' building, Paris, France – Sauter

The renovation of this building, constructed in the first half of the twentieth century, at 24, rue de Prony is transforming it into an exemplary low-energy building.

Founded in 2008, Covéa Immobilier combines the means and expertise of three of the biggest companies in real estate management – MAAF, GMF and MMA. Covéa Immobilier has resolved to improve the ecological footprint of its real estate portfolio and thereby lower the energy consumption of their buildings. A suitable opportunity presented itself recently in an office building in the 17th arrondissement of Paris.

The "24 Prony" building was constructed in 1930. It covers an area of 4,100 m² over ten storeys. The building was behind the times regarding certain criteria, such as energy consumption and accessibility for people with limited mobility.

Covéa Immobilier, which manages the building, saw these very shortcomings as a good opportunity for a complete conversion. The goal of those responsible for the project was to convert the property into a Green Building fulfilling the highest standards. The planners were successful: a "very good" BREEAM certification and also "very good" for the national quality labels BBC (low-energy building) and HQE (high environmental quality) make this property an excellent reference object.

At the same time, the external appearance of the building was barely altered as the most radical changes were made "behind the facade". For example, the entire automation system of the building was replaced. The technical devices and installations communicate with the building management software and automation system using the BACnet/IP standard protocol.

The energy management system visualizes all the individual energy consumption data and provides important information, enabling the energy efficiency and operating costs to be optimised. To control the installation, the building managers use building management software which processes more than 4,000 data points. This solution enables the user to manage rooms flexibly.

The automation level has eleven modular automation stations. Together with eu.bac Cert room automation stations, they provide optimum control of the climate comfort. Furthermore, 150 extension modules allow the temperature to be monitored and lighting and window blinds to be operated as needed. The package also includes CO_2 measuring sensors. The sensors measure the air quality in conference rooms and provide demand-controlled ventilation, using an acceptable amount of energy.

Besides these technical innovations, renovating various areas in the interior of the building, means that it now fulfils the latest building requirements and turns this property into a showcase for modernisation.

Eqho Tower, Paris, France – Belimo

The Eqho tower, located in the La Défense district of Paris, has undergone a major renovation over a number of years. Originally called "Descartes Tower", it is a 130 m high office skyscraper (40 floors) opened in 1988. The objective of this renovation was to modernise all the technical installations for the air conditioning and electrical systems. For heating and cooling an area of 27,000 m² has been equipped with combined heated/cooled ceilings. The Eqho tower now has 80,000 m² of office space, providing jobs for around 5,300 people.

Traditionally a grid of heated/cooled ceilings is controlled by regulating valves with thermal actuators, the temperature being controlled by 4 thermostatic valves. For the connection of the heating and cooling circuits 2 T-pieces would be required. This results in 6 components per grid. In this case, with 6,000 ceiling grids, this would have translated into 36,000 elements, with all the concerns associated with this type of installation: power supply problems, possible leakages during commissioning, poor control of the hot/cold grids leading to discomfort and excess energy consumption. The customer therefore had a different solution in mind.

Project requirements:
- Minimise the number of control elements for the renovation of the ceilings;
- Install completely zero-leaking elements in order to save energy;
- Demand for innovative solutions with the objective of also being a pioneer in the installation of these solutions.

By applying 6-way valves, the upstream circuits have four pipes and the grid downstream of the valve has two pipes feeding the ceiling circuits so eliminating the T-pieces. As a further benefit, the heating and cooling water circuits are completely separated in the valve and the risk of mixing disappears. Since the valves are installed in the ceiling panels, access requirements for maintenance are reduced for the 6-way valve system compared to a classic solution.

Customer benefits:
- Significant reduction in the number of components leads to higher installation efficiency;
- Compact valve and actuator assembly, meaning that structural modifications to the building are limited;
- A durable solution that reduces the opportunity for air-entrapment in comparison with other more traditional solutions;
- A single control element for two functional sequences;
- Maintenance-free and smaller risk of errors during the installation phase;
- Permanent support from the manufacturer;
- One 6-way characterised control valve replaces four 2-way valves with thermal actuators.

With two projects already completed (Eqho tower and Crédit Coopératif building), the Vinci Group is now planning to repeat the success of the 6-way valves with its new construction sites. The Group has noticed that commissioning was much easier and they expect a considerable decrease in issues during operation. From the point of view of energy, starting from an initial consumption of 140 kWhPE/(m²·year) before the works, the renovation (with the same room temperature as to date) has enabled a Cref of 120 kWhPE/(m²·year) and a C of 67 kWhPE/(m²·year) to be achieved, equating to energy savings of more than 50%.

Val de Fontenay, Fontenay-sous-Bois, France – Schneider Electric

At the beginning of March 2015, Jean-François Voguet, Mayor of Fontenay-sous-Bois, Jean-Marc Castaignon, Director of Real Estate with Société Générale, Pierre Berger, President and CEO of EIFFAGE, Henri du Boucher, President of SOGEPROM, and Pierre Sorel, Managing Director of SOGEPROM (Société Générale's property development subsidiary), participated at the unveiling ceremony to celebrate completion of major structural works on an office building development, comprising a floor area of approx. 90,000 m².

This innovative project located in Fontenay-sous-Bois (Paris' eastern suburbs), developed by SOGEPROM, was first conceived by the architect Anne Démians as a "landscape building", whereby the notion of horizontal density is manifested by an alternation, in equal proportions, of five buildings and five linear gardens. The incorporation of wood cladding and plant displays create a harmonious composition, in which the boundaries between workspaces and patios lose their edges.

This highly-textured, convivial and spirited architecture project was designed with constant attention paid to offering all users an opening to nature and the natural world, in addition to assembling enjoyable moments.

This real estate operation has applied for the environmental labels of Exceptional HQE, Leed Gold and RT 2012 in the 30% savings category.

The requirements of these environmental certifications were converted into a series of technical solutions and directions effected throughout the design phase. Such an environmental approach has been extended to the construction phase as well, through commitments made by contractors and solution developers to achieve these objectives.

For the project's Building Management and Controls component, Eiffage Bâtiments selected a system specially conceived for "WorkPlace Efficiency" to manage all comfort aspects and enable future activation of user-connected services.

The solution consists of installing multifunction sensors (infrared for motion detection, luminosity for well controlled lighting, and radio for wireless elements), along with multi-application control boxes hooked up to the LonWorks network. A layout calling for one box every two frames is responsible for the power supply and control of all comfort-related devices:

- 1–10 volt lighting;
- 230-volt blinds;
- Radiant ceilings with 6-way valves;
- 1–10 volt mechanical ventilation supply dampers.

The choice of control boxes is not to be taken lightly, given that the selected ones are eu.bac-certified. Since their temperature control accuracy proved to be quite high, this performance earns extra points towards the desired certifications and labels. The benefit of this system also lies in the encompassing manner in which comfort is being managed regarding: light, temperature and air quality.

The objective, as underscored by the architect herself, is to "create a link among users". This innovative project combines all the qualities of comfort, energy, societal interaction and architectural statement to succeed and welcomed its new occupants in 2016.

Saarland University Campus, Saarbruecken, Germany – Sauter

As part of the EULE project, Saarland University (SU) is currently optimising its operation and developing into a model energy campus. The goal of the project is to perform a range of inspections and measures to achieve energy savings of around 30% by 2017.

A consortium of engineers, business economists and psychologists is currently working on the project "SU model energy campus: optimised energy consumption throughout the premises" – or EULE for short.

The campus buildings of the SU in Saarbrücken were constructed across different generations. Particularly in the older, badly insulated buildings, the electricity and district heating costs were relatively high. This is one of the reasons why the German Ministry for Economic Affairs and Technology is sponsoring the EULE project.

The university administration wants to reduce the campus' energy consumption by around 30%. The project consortium has created special methods and tools to minimise energy consumption and case studies are now being used to develop them further. It is hoped that ultimately, a common theoretical model will be created for optimised energy use in the public buildings.

The project included upgrading the building's automation system and connecting buildings to an energy management system. Where buildings were technically obsolete, the necessary additional automation components were fitted. Once the new automation was in place on campus the necessary case studies could be undertaken.

During the EULE project, various devices were installed including room controllers and programmable operating devices. Heating, energy and water consumption is also being monitored in three selected buildings. The data generated by these facilities is collected by the energy management system. It is then used to systematically compare energy consumption under varying conditions. A monitoring system was especially developed that documents energy savings in detail.

The building automation work also involved upgrading all heating installations. This will improve the heating curves and switching programmes for night and weekend set-back modes. It also enables the heating to be switched off completely during summer. The cooling systems' function was examined and the ventilation system's operating times, volume flow and pressure loss, etc. were also inspected. They were adjusted and depending upon their usage, buttons or presence detectors were added for switching the systems on and off.

Via M-Bus, all the energy readings from the large, energy-intensive ventilation and cooling systems were consolidated by the building management system. Flowrates can be captured, together with consumption values, in specified time steps.

The next step is to integrate the findings of economists and environmental psychologists involved in the project into the already developed model which predicts energy consumption. This will create a shared flexible and configurable tool, enabling the forecasting of the effect of various measures. Other universities are set to apply this model. The scientific values and knowledge gained from this joint work provide a great springboard to carry out more refurbishment projects – and in the private sector too.

Geno-haus, Stuttgart, Germany – Belimo

Around 1,200 induction units have been replaced in the GENO-Haus building in Stuttgart and 2,342 QCV (Quick Compact Valve) tight-seal zone valves have been fitted into the cold water and hot water circuits in these units. The building, which was constructed in 1970, was converted on a storey by-storey basis without interrupting business activities, and therefore there was only minimal disruption to the employees working in the building. The new induction units now control the water side characterised control valves. This system is significantly more efficient than the old solution that featured pneumatically operated air damper actuators: now only the heating and cooling energy that is actually required is provided.

The reason for this upgrade were the two 40-year-old air handling units, which had a combined output of 110,000 m³/h. They needed to be replaced in order to comply with VDI (Association of German Engineers) Guideline 6022 and additionally fitted with a heat recovery system based on EnEV 2009 (German Energy Saving Ordinance). Three new energy-efficient units, each with a capacity of 39,000 m³/h.

Project requirements:

- The entire HVAC system is being converted from high-pressure induction to low-pressure induction;
- Only the cooling or heating energy that is actually required is supplied;
- The units will be converted on a storey-by-storey and zone-by-zone basis in the shortest period possible so as to avoid economic disadvantages for owners and tenants.

GENO-Haus in Stuttgart decided on the Quick Compact Valve (QCV) based on its long-term leak-tightness, precise controllability and excellent energy balance. The new LTG induction units with demand-controlled ventilation, like previous units, function in a four-pipe system. The variable and significantly reduced air volume of 30–50 m³/h is now, however, regulated via nozzles, which are adjusted by an electrical, space-saving linear actuator developed specifically for this application. At the same time, the cold water and hot water intake is supplied precisely by the motorised, compact and energy-dense QCVs.

High pressure losses and the mixing of hot and cold water are now a thing of the past in the GENO-Haus building. The new induction unit system now controls the water side characterised control valves. It is significantly more efficient than the old technology that featured pneumatically operated air damper actuators because now only the heating and cooling energy that is actually required is provided. The existing high-pressure induction could therefore be converted to low-pressure and new energy-efficient, frequency-controlled pumps now work in the background.

Customer benefits:

- Using seal-tight and wear-resistant QCVs means each room is only provided with the required heating and cooling energy and energy losses resulting from leakages are effectively and permanently prevented;
- The actuators not only allow the user to set the desired k_{vs} precisely, but also reduce electrical energy consumption;
- The compressed air station which was previously required for pneumatic actuators can be dismantled and completely removed at a later date;
- Energy monitoring systems using the newly installed energy meters are already showing a significant reduction in the electrical, heating and cooling energy consumption;
- The employees have expressed a positive reaction to the improved room climate and increased comfort in the workplace.

One year on, Dipl. Ing. Uwe Peters (managing director of GENO-Haus Stuttgart GmbH & Co. KG) confirmed that they made the right decision to use the quality products: “When it comes to room climate, employee satisfaction is our top priority. So, on this basis, the only logical choice was to fit the 1,171 induction units with actuators and characterised control valves. The actuators generate practically no noise while operating and feature excellent control accuracy. The ball lock is also very resistant, only uses power when changing state and supplies the required, adjustable k_{vs} value for hydraulic balancing across the entire system. The excellent functional safety therefore reduces user complaints and, as a result, the operating expenses and costs.”

'Flora', Cologne, Germany – Johnson Controls

To renovate the "Flora", the City of Cologne has opted for smart, multi-component building management. The Flora has been part of the City of Cologne since 1864. To preserve the splendid building for the future, the city officials decided to proceed with a total renovation of the deteriorated structure. The interior of the main building was completely stripped. In the course of a renovation that lasted three years, the Flora was converted into a splendid multifunctional facility with a new domed roof. The halls can be used for a variety of events such as meetings, conferences or weddings.

To bring the building completely up-to-date in terms of energy and the environment, so minimizing overheads and operating costs, the Cologne Facility Management Department issued an invitation to bid for an efficient building management system i.e. a building management solution, combined with multi-component equipment and control technology for heating, ventilation, refrigeration and sanitation.

Two particular challenges had to be confronted right from the start. On the one hand, the installation of the complete building management system had to consider the historical architecture of this protected building. On the other hand, the work had to be completed on a tight schedule, with the planned opening date already announced during the call for bids. The new Flora was to be ready by June 2014 to celebrate the double anniversary of Flora's

150 years and 100 years of the Botanical Gardens. Despite these scheduling pressures, the building management system and all other components were completed on time.

In order to control and monitor the various building management components, an open interface architecture building management system was selected. This enabled the flexible integration of technical solutions from various manufacturers using different communication protocols in a central system that has a total of 1,500 data points.

The measuring and control system for heating, refrigeration and sanitation is linked by using the vendor neutral BACnet data communication standard. The ventilation technology has its own independent control and is integrated into the building management system via Ethernet TCP/IP. Data communication between the ventilation units and the measuring and control system is based on MODBUS TCP/IP so that the building management system can communicate fully with the ventilation units.

In addition, energy meters for power as well as refrigeration and heating energy consumption were connected using the M-bus, while the electrical system was integrated in the building management system using the KNX protocol. This way, fault messages are registered by the building management system, triggering a clearly defined reaction cascade.

The main data-sets are saved in an SQL database for optimum control and also to be able to observe the actual consumption levels. The datasets can be visualised and exported either in tables or graphics. A particularly practical approach has been chosen for system access through an integrated web interface so that an internet connection is all that is needed to access the building management server.

Finally, the building management system provides for the optimum functionality of, and cooperation between, the various components. The individual systems work together perfectly, thus ensuring appropriate, efficient, energy generation and environmentally friendly energy management.

This has resulted in clearly reduced energy costs and significantly improved convenience thanks to the highly-automated processes.

“On the outside, the Flora once again gleams to its former splendour. Behind the scenes, it features state-of-the-art engineering. One aspect is particularly user friendly:

The selected building automation system is extremely flexible and allows the easy integration of new components and functions, thus offering the best-possible future-proof solution” says Winfried Koenigs, Operations Team Leader Building Systems, Germany Area West at Johnson Controls.

'Building 1', Basel, Switzerland – Sauter

In this 41-storey Green Building, building automation technology guarantees the highest level of energy efficiency – from the seamlessly integrated primary system to room lighting and solar shading.

Building 1 in the north-western Swiss city of Basel is 178 metres high. The internationally active pharmaceutical company, Roche, maintains workstations for about 2,000 employees in Building 1 at the group's headquarters. Apart from the distinctive architecture, another notable feature is the extremely high energy efficiency level of the building. It outshines most skyscrapers worldwide with an expected primary energy requirement of only 80.2 kWh/m²·a for heating, cooling, ventilation and lighting. The intelligent building and room automation system makes a considerable contribution to Building 1's exceptional energy efficiency.

The office spaces in the building are constructed in a modular fashion so allowing extreme flexibility. This modular system is also reflected in the building management system. For example, in future changes from individual to group offices, the room automation can be adapted to the new floor plan with just a few clicks of the mouse.

In each room module, one room automation station controls heating, ventilation, cooling, lighting and solar shading. Demand-controlled and energy-efficient room automation is ensured through the application of presence and light sensors. The system automatically switches off the light, ventilation and heating / cooling when a workstation is not in use.

The tower is heated solely using waste heat from the nearby Roche industrial area. Heat is recovered in a highly efficient process and a heat pump produces hot water. For cooling, Building 1's sustainability concept relies on ground water from extraction wells. Accordingly, low heating circuit and high cooling circuit temperatures were implemented for all consumers.

All room lighting is based on power-saving LED technology. Communication with the room automation stations is assured via the DALI protocol. In addition to the daylight-adaptive constant-light control, the employees also have LED desk lamps at their disposal.

Each room segment is also equipped with a room operating unit with bi-directional wireless EnOcean technology. The built-in solar cell renders these wireless devices independent of any external power supply and offers up to five days of availability, even in complete darkness.

Solar shading for the exposed tower is also included in the room automation concept. And as Building 1 is located right in a very densely populated part of Basel, the blinds also close automatically in darkness to avoid unnecessarily lighting up the neighbourhood.

To ensure that Building 1 maintains its high level of energy efficiency in the long-term – and even continues to improve– the energy flow is measured and monitored using the energy management system. With it, the technical staff can identify and correct any systems operating incorrectly.

Zoo, Zurich, Switzerland – Saia-Burgess Controls

Zurich Zoo is a beloved getaway destination. The newest attraction is the Kaeng Krachan Elephant Park, which opened in 2014. Its indoor and outdoor areas offer living space for eight pachyderms. A 6,800 m² roof with 271 openings covers the indoor area. The penetration of light, changing from light to shadow, creates the impression of a leafy canopy. The underwater viewing area provides an exciting location for visitors to observe the movements of the swimming elephants.

Long before the completion of the elephant park, the automation technology for the whole park was renovated. The renovation took place while the zoo was still in operation. Communication between all of the subsystems was performed according to the BACnet standard. By adopting the BACnet automation standard the operator had the option of bundling and implementing various devices and manufacturers. The client consciously decided to apply a control product in all substations that offers hardware and software compatibility for many generations of devices and thus maximises the benefits of BACnet networks.

Renovating the existing substations entailed 53 new programmable logic controllers with around 3,000 BACnet objects. In the new control system, the visualised operating infrastructure was integrated with at least 300 images.

Then in 2013/2014 the new elephant park was integrated into the building control system. The control requirements in this high-tech building are extensive. The far-reaching systems include, amongst others, ventilation systems, pool technology, gate controls, air conditioning as well as special technology requirements for security. For the Kaeng Krachan elephant area another 15 substations with 2,000 further BACnet objects were taken online.

Today the building automation reliably provides the elephants with good and stabile living conditions. It is important for the operator that energy use is optimised and that the systems operate precisely according to the plan specifications.

The elephant park has diverse ventilation systems. The largest system in the main building supplies 35,000 m³/h. The constant volume energy controllers distribute air within the building areas and provide for comfortable temperatures everywhere.

The feed dispensers can be controlled through the building automation, another special feature of the system. In order to keep themselves busy, the elephants must find their own food: to this end, there are around 20 feeding stations with feed dispensers hidden throughout the 1.1-hectare facility. These dispensers can be enabled to be time released, controlled by hand or by an event.

The most modern technical automation and control system infrastructure of the Zurich Zoo does not just provide for efficient technical system control but also helps the animal keepers provide the optimal living conditions for their charges.

'Happyland', Klosterneuburg, Austria – Belimo

Happyland in Klosterneuburg (Austria) offers a wide range of leisure activities for all ages including an indoor wellness pool, a large outdoor sports pool, various playing fields and a large sauna area.

In 2013 the operator decided to undertake major renovation, extension and modification work. State-of-the-art technical systems were used, for example in the renovation of the heating distribution and complex ventilation systems. Particular importance was attached to the perfect control technology. The electronic pressure-independent valve, more than lived up to its role as a problem-solver in this project.

Renovation projects do not always get off to a smooth start. Once the current situation has been evaluated and the system documentation put together, work to configure the individual components normally proceeds. Just like the pipework, the control valve also has to be sized. Such lengthy k_{vs} calculations often involve system parameters which are hard to gauge, such as valve authority. An additional challenge in planning this project was that all renovation work had to be undertaken during continuing operation in order to prevent loss of revenue.

Project requirements:

- Renovation during continuing operation;
- Suitable for everyday use;
- Simple operation;
- Sustainable, optimum system operation.

Helmut Doblhofer from the technical office GBT Planung GmbH was quickly convinced of the benefits of the new electronic pressure-independent valve solutions (EPIV). He recognised the benefits of the EPIV, such as reduced planning work and simple valve design, because he had already planned the operational requirements for the air-handling systems zone control (VAV). The dynamic hydraulic balancing and the large dynamic range of the EPIV make the valve authority across the entire control to equal 1.

Once the order had been placed with Bacon Gebäudetechnik GmbH (Linz branch), the costs of a conventional solution (fitting a control valve and a manual hydraulic balancing valve) were to be compared with those of the EPIV solution. This showed that the EPIV solution is significantly cheaper and that the system can be operated with greater energy efficiency.

Customer benefits:
- Greatly minimised efforts for hydraulic balancing;
- Easy to integrate the measuring, control and regulation technology;
- More cost-effective than conventional systems;
- Feedback signal provided for water flowrate;
- Constant, dynamic hydraulic balancing of entire system;
- 5-year product warranty.

Thomas Pfeiffer (overall project manager at Bacon Gebäudetechnik GmbH) was quick to opt for the EPIV thanks to its many benefits: “This solution was able to quickly and smoothly complete the challenge of modifying and commissioning each of the eight circuits during operation.” Pfeiffer was also very pleasantly surprised about practical suitability, the ease of handling and the commercial advantages: “The EPIV solution is based on state-of-the-art technology. It reduces manufacturing costs, and the five-year product warranty provides good investment protection. The system also ensures sustainable and optimum system operation for years to come.”

Microsoft German headquarters, Munich, Germany – Sauter

In mid-2016, 1,900 employees at Microsoft moved into its new German headquarters in Munich. As one of the most modern office buildings in Germany and offering multifunctional rooms and spaces, it represents the workplace of the future. LEED certification underscores the sustainability of this green building, and the integral room automation solution plays a major role in this achievement.

The cutting-edge, new atrium building at Parkstadt Schwabing in Munich has a floor space of around 31,000 m². Reflecting the motto "A new world of working", it creates the perfect backdrop for modern-day staff collaboration, deploying the latest technology and fostering employees' skills. This is made possible through open spaces, meeting places for exchanging ideas and quiet areas in which to concentrate or simply relax.

The building contractor opted for integrated, easy-to-use building management. This means that the office building operates at maximum energy efficiency and users enjoy a comfortable room climate. A modular, scalable solution base was chosen. Having received a sample version of the solution proposed, the clients could test the system live and see its performance and user-friendliness for themselves.

When the contractors selected the monitoring and control solution, key requirements included easy and direct operation of the building management system. This was achieved through smart integration – providing users with the exact level of functionality needed. Operated intuitively, the solution allows office users to adjust room conditions, such as temperature, lighting and solar shading, directly from the browser on their work PC or tablet. At an overall system level, the visualisation and control solution enables facility managers to regulate each HVAC installation from any location and at any time.

To meet employees' individual needs, cable-free room operating units – with EnOcean wireless technology – are also installed. In 800 or so rooms spread over the nine storeys – two underground and seven over ground – 280 room automation stations create the ideal climate using the BACnet/IP network protocol.

And the building administrators also benefit: The solution offers, for example, demand- and presence-controlled lighting. Around 1,600 DALI light sensors automatically switch the energy-saving lights on and off. This ensures that there is always adequate lighting with minimum electricity consumption. The integrated room automation package also regulates the heated and chilled ceilings and uses the sun's position to adjust the shading.

Because all the equipment systems are completely automated, running costs are reduced further. This intelligent solution provides employees with comfortable office conditions. As the LEED certification testifies, energy demand is kept to a minimum. All in all, a sustainable win-win situation.

'Sede Unica', Turin, Italy – Kieback & Peter

The city of Turin, famous for cars and football, has a new attraction: the Sede Unica Regione Piemonte. At 205 metres, the new headquarters for the government and administration of the Region Piemont is currently the tallest building in Italy. The complex, designed by Massimiliano Fuksas, consists of a high-rise and a lower adjoining building. It houses offices and conference rooms, courtrooms, libraries, a nursery school, a canteen, and an underground car park, and is the workplace for around 3,000 people.

This building has an enormous appetite for energy. 5 megawatts of power are required just to heat and cool the complex. In order to keep energy usage and the environmental burden as low as possible, a concept was realized that met the highest demands for energy efficiency and renewable energy. Double facades, groundwater heat pumps, a photovoltaic system and solar collectors are all part of this concept. A building automation system provides for the effective interplay and the reliable control of all of these elements.

The tender call for the building automation required a consistent, open BACnet solution from the management to the field level. Systems and components from third party providers such as the photovoltaic devices, security lighting or the fire alarms had to be integrated into the building automation system. A wireless solution was required for room automation so as to offer the facilities personnel flexibility in creating office floor plans.

The building management system with five additional operating stations delivers a constant overview of the entire Sede Unica facility, providing clarity with simple and secure operation as well as system optimisation. The automation system has been implemented for monitoring, operating, and controlling. The automation station monitors, controls and logs the heating and cooling generation and primary systems as well as control stations. Further automation stations, installed on every level, control according to the demand for heating and cooling on their respective levels. Touch screens allowing the systems to be operated on-site save a lot of 'running around'. In total the complex has around 80 automation stations of this type.

The room controller for controlling the room conditions in the offices communicates with the automation station over the EnOcean wireless protocol. Thanks to wireless communication, the room automation can be quickly and flexibly customized to meet changing requirements because there is no need to lay cable.

All foreign systems are integrated into the building automation through BACnet or Modbus/BACnet Gateways. The emergency lighting system is monitored through the Dali Controller and is also connected to building management.

The Sede Unica Regione Piemonte in Turin is an attraction today not just because of its spectacular architecture but also because of its intelligent and environmentally friendly energy concept in which building automation plays an important role.

'The Crystal', London, United Kingdom – Siemens

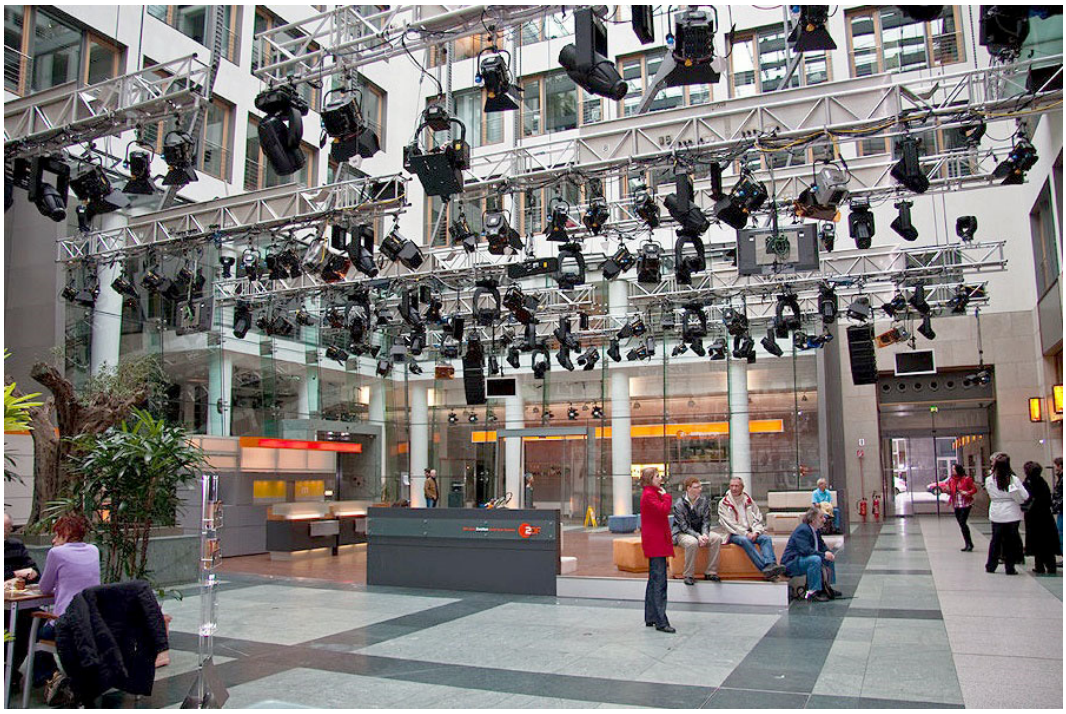
Energy efficiency in buildings is not simply a business segment for Siemens. With 15.8 million m² of floor space (2013) Siemens is also one of the world's largest real estate owners. Its portfolio includes offices, production plants, warehouses and specialty real estate across 2500 sites in 190 countries. The costs involved in running this enormous real estate inventory make up a significant proportion of total running costs and they impact directly on Siemens' ability to compete successfully. A key to reducing these operating costs lies in improving energy efficiency - a goal Siemens Real Estate (SRE), the real estate company of the Siemens group, has been pursuing for years.

Energy efficiency is one of the cornerstones that the real estate sustainability strategy is based on. The strategy applies first and foremost for new construction. The goal is an ambitious one: All Siemens new buildings should be at least 25% more energy efficient than local regulations prescribe, regardless of whether the building is a production plant or an office building. And even this self-imposed target is regularly exceeded. Since 2006 Siemens has set itself the goal of gaining LEED accreditation for all group's new construction and, wherever possible, to attain Gold status. And the goal has been achieved: 41 new builds have won LEED accreditation, 23 of them Gold. 4 have been awarded Platinum status, the highest available.

Amongst them, The Crystal in London, one of the world's most sustainable buildings. Designed by architect Wilkinson Eyre, the building houses a conference centre and its 2,000-square metre exhibition area dedicated to sustainable urban development is the largest of its kind in the world. With a total floor area of over 6,300 m², The Crystal is a shining example of energy efficiency, consuming 46% less energy than comparable buildings. This is achieved by a wide range of measures, such as solar panels, heat pumps, and roof-mounted photovoltaic panels. Additionally, a building management system is used to ensure high levels of energy efficiency.

The Crystal is a 100% electric building, around 20% of which is generated by the 1580 square metres of solar photovoltaic roof panels that cover two-thirds of the roof. CO_2 emissions for the Crystal are around 70% lower than for comparable office buildings in the UK.

ZDF Capital Studio, Berlin, Germany – Honeywell



Historical buildings and the most recent architecture are joined in perfect harmony on Berlin's splendid boulevard "Unter den Linden". The new building is situated behind the protected historic art nouveau facade. It was built using the fastest construction techniques and complies with the most recent architectural and construction criteria. Among numerous stores and restaurants, the ZDF Capital Studio is the most prominent user in the Zollernhof.

Because of discontinuation and spare part shortage, a substitute for the existing single room automation solution had to be found. The customer chose a room automation complying with the international open standard DIN EN ISO 16484-5 (BACnet). The new solution is based on the existing single room control with heating/cooling function (chilled ceiling) for 50 rooms.

Advantages of the selected solution:

- Creation of a individually programmed single room application taking into consideration user specific functions;

- BACnet is used in the primary control (DDC) up to the room automation level;
- All BACnet objects in the room controllers are visualized on the building management system. The integration of overlapping functions by the use of BACnet in the DDC of the main and supply system (target values, load requirement signals, etc.) becomes possible through adopting a demand-based, energy-optimised attitude. The partial reproduction of the global data from the existing Excel IRC room bus controller represented another challenge for the migration project;
- The room application comprises a dew point calculation and defined functions, which are not necessarily easy when using the standard applications of other room controllers;
- The supervisory application in each room controller is decentralized. A self-sufficient room control starts if the superordinate automation level fails;
- Global schedules across the building management system are easily available through BACnet;
- No interfaces (gateways, software, etc.) are required between different systems such as LON and BACnet. This leads to the minimization of possible source of error and the reduction of maintenance and repair costs.
- Neither LON engineering tools, nor LNS databases or "credits" are necessary. A replacement of the room controllers can be carried out by a local operator without undue expense.
- The new BACnet MS/TP solution at the level of room automation creates possibilities for future extensions in the areas of heating, climate, ventilation and electricity. MS/TP (master slave / token passing is one of the options of the open BACnet standard).

The functionality of the new room operation device must meet special requirements:

- Long-term investment protection;
- Offices can continue their all-day routine without interruptions;
- It is possible to display temperature and relative humidity;
- Display with background lighting, easy operation: change of the mode and of the target room temperature by a simple touch of the button;
- The existing flush-mounted wiring of the bus-capable room control devices had to be reused. Thus, the existing NYM-J 4 x 1.5 cable had to ensure all required functionality of the new operation device.

Mr. H. Zabel, ZDF Capital Studio of Berlin, is very pleased with the implementation of the solution: "With the freely programmable BACnet solution we have a flexible and secure way to handle new concepts of room use in the future. Moreover, it provides the possibility, at the level of room automation, of a safe and easy integration of further subsystems of building services."

Leibniz Computing Centre, Garching, Germany – Honeywell

On July 21, 2006, the Leibniz Computing Centre (LRZ) of the Bavarian Academy of Sciences started up a new supercomputer at its research centre in Garching near Munich. Together with two other supercomputers located in Jülich and Stuttgart, this makes for the largest European computer network.

In phase one, the new supercomputer SGI® Altrix® 4700 from Silicon Graphics has been equipped with 4,096 Intel® Itanium®2 -processors and a main memory of 17 Terabytes. It requires a floor space of 25 m x 25m. Approximately 2 MW power is required to operate and air condition the parallel computer system.

The new supercomputer is used for the simulation of complex systems and processes in physics, material research, flow dynamics, astrophysics and chemistry as well as in geo and life sciences. The construction cost for the three building sections (computer room, the institute and the auditorium with an effective total space of 5.600m²) is high at €45m. Additionally there is the investment of € 38 m in the computer. Costs are split between the Free State of Bavaria and the Federal Republic of Germany.

The LRZ is located at the south of the Technical University Garching campus.

The owner, represented by the construction authority of the Technical University of Munich, asked for the open BACnet standard when it came to building automation of the three LRZ sections. The complex automation concept consists of:

- 22 BACnet DDC systems Excel Web (approximately 3,500 data points). The DDC systems have responsibility for example for:
  - Regulation, optimisation and monitoring of the heat production and heat distribution as well as the temperature control of the building concrete core;
  - Regulation, optimisation and monitoring of the cooling and distribution by five chiller plants with a LON interface. The chillers are integrated into the automation system via the built-in LonTalk interface;
  - Temperature monitoring of the computer rooms;
  - Integration of various plant messages.
- Controlling and monitoring of eight compact air conditioning machines with integrated BACnet DDC systems (57 data points for each machine);
- Controlling and monitoring of 34 recirculation cooling systems;
- Monitoring of the fire dampers with smoke exhaust function as well as exhausting of the fire extinguishing gas.

The state of the art open integration platform of the selected building management system is used on the management layer. It enables optimal multivendor integration tasks because it includes BACnet Operator Workstation functionality.

In total 6,500 BACnet data points are supervised by the management system at Leibniz Computing Centre to support the technical staff in safely operating the critical plants.

The Meander building, Brussels, Belgium – Johnson Controls

When completed in 2017 the Meander building (Architect: Neutelings Riedijk Architects & Building services consultant: Boydens Engineering) will be the newest addition to the building portfolio of the Flemish authorities in Brussels. The building was designed as passive in accordance with the Brussels energy regulations and will achieve the highest score rating following the Flemish government's building evaluation system.

The building was designed with a thermally activated building core as the primary heating and cooling system, supplemented by a variable air flow system for fine temperature control. The base cooling and heating load is covered by an open-loop ground source heat pump system, with gas boilers for peak load support. The ventilation air is cooled adiabatically within air handling units (AHU), with additional direct expansion mechanical cooling support for the periods of high outdoor air temperature.

The main challenge from the regulation and automation point of view was to write and commission the sequences of operation for such a complex automation system. Apart from the standard PI control loops used for the temperature and CO_2 control, fan and pump speed settings, etc., a rule-rule based control technique was used for the control of the thermally activated building core. Additional systems that also had to be considered in the sequences

of operation include the solar shading system, lighting control system and ground-source heat pump system with its own specific features.

The control and monitoring of the various building services was integrated by means of open communication protocols with BACnet as the backbone protocol. Additional protocols such as Modbus, KNX, and M-bus were integrated with BACnet by means of gateways. The management of all the building services automation systems was implemented with an independent integration platform based on an open SQL database. The data stored in the database can be exported for further analysis.

eu.bac system audit

Loytec headquarters, Vienna, Austria – Loytec

In summer 2013, the headquarters of LOYTEC in Vienna was extended by a new building complex that now serves as a new home for the production department, laboratories, and offices. In the extension, the room functions of heating/cooling, solar blinds, and lighting, have been fully automated by a room automation system. Thanks to the efficiency of the room automation system, the new building received an eu.bac System Certification Mark of the highest class AA, with 87 out of 100 points.

NuOffice, Munich, Germany – Sauter

NuOffice is an office complex with a total area of 33,000 m² which is currently being built in three phases in the north of Munich, and which will already more than match the German government's energy targets for 2050 to 2100.

The first of three buildings in the NuOffice project, completed in 2013, is an almost passive house, and with 94 points in the "LEED for Core & Shell v2009" building certification programme, it set a world record and, at the time of writing, no project has achieved more points in this programme. As a result, the NuOffice received the LEED certificate in platinum, the highest certification level.

The pilot project uses new, cost-efficient technology for low-energy buildings and was developed by Hubert Haupt Immobilien Holding in co-operation with the Technical University of Munich and the Fraunhofer Institute for Building Physics (IBP). The first building is a nearly passive building which was awarded a LEED certificate as well as a class A eu.bac certificate. Efficient control of all sub-systems using building and room automation systems and energy management system is crucial in achieving the energy balance of the building. One of the ways in which they achieve the challenging energy targets is to take account of the weather forecast in the control strategy for the installation.

The high-energy efficiency is based on features including complete triple-glazing, thermal insulation to the standard of a passive building and the use of groundwater for heating and cooling. Special fittings reduce the amount of water used and an intelligent concept for lighting, ventilation and cooling reduces electricity consumption. With a photovoltaic array on the roof, the building can also provide a large amount of its own energy.

The Green Building Monitor on the first floor of the main stairway merited an additional point in the LEED certification. Users and visitors can view the current building and system operational data on screen, as well as the current energy consumption. The data comes from the in-house energy management system and is displayed in real time. For example, it indicates how much of the total energy consumed is produced internally. This makes people more aware of the building and the energy they use.

As part of the "Direction" research project, NuOffice will be monitored by researchers from the Fraunhofer IBP for a period of four years. During this time, the operational readings will be analysed and optimised with reference to deviations from the simulations. The scientists use the energy management system, which supplies maximum-resolution data for developing ideas for improvements. This is why the building was extensively equipped with heat, electricity and water meters and with additional sensors for detecting room temperature, humidity, light levels and operating room temperature. The consumption data can be analysed directly or exported to external databases. The findings obtained will also allow the new concepts to be used in future projects.

OPF headquarters, Neumarkt, Germany – Siemens
Located in Bavaria's Upper Palatinate region, OPF is a medium-sized company offering engineering services in the field of energy technology. Just as OPF places a high value on energy efficiency in the technical systems it designs for its customers, it also aims to achieve maximum energy efficiency in its own buildings.

In its newly built headquarters in the town of Neumarkt, about 50 kilometres southeast of Nuremberg, OPF has installed a building automation system to control HVAC, lighting and shading on demand and with maximum energy efficiency.

The interplay of the selected building automation system's components ensures demand based control of HVAC, lighting and shading in compliance with European Standard EN 15232. As a result, OPF's new headquarters offers an optimised room climate and low energy costs.

To obtain official validation of the building's high level of energy efficiency, OPF decided to apply for eu.bac System certification. The audit included rigorous testing of heating and cooling controls, the interaction between the building automation system and the lighting and shading in the rooms, the hydraulics of the primary systems as well as the management functions (including alarm systems and error analysis). After successful completion of the audit, OPF's new headquarters was certified as efficiency class AA thanks to the energy efficiency of its building automation and building management system. This is the highest possible rating.

DIAL office, Luedenscheid, Germany – Wago

Integrated collaboration between architects and engineers is essential for buildings that place high demands on aesthetics, functionality and energy efficiency. DIAL GmbH calls this interdisciplinary approach "Building-System-Design", and their new building is a functional showcase for this. Its building automation system has achieved the highest energy efficiency class according to the eu.bac System certification.

"First, we wanted to create a cosy environment for people," says Andreas Bossow, Co-CEO of DIAL. Furthermore, the office and training centre designed by, and for, DIAL had to be economical, updatable and efficient. The building automation technology must first serve the needs of its occupants. "In the past, the technology remained simple while the architecture became increasingly complex. This has changed, though, as building automation technology has become incredibly sophisticated," states Bossow. This has often resulted in the installation of more technology than required. Clearly, despite all the demands for innovative equipment, the primary objective for the technology would be fulfilling the purpose.

There are no light switches and room controls – instead, presence and movement sensors. In each room, the functions are operated using a PC or smartphone app. "The light goes on when I walk in," says Bossow. And automatic illumination simulates a beautiful, sunny

day with morning light, bright midday sun or evening twilight. The desire to open windows has also been accounted for. “If a window is opened, then the building control technology shuts off the volume flow controller of the ventilation system for that room”.

This synthesis between humans and technology is possible because the individual systems are completely compatible within the building – even if they are from different manufacturers. This balance works so perfectly that the highest building energy efficiency class of AA was earned during the eu.bac System audit.

The foundation for this performance is the building automation system, including the module for lighting control, KNX communication interfaces for presence sensors and volume flow controllers. Three controllers per floor regulate lighting and ventilation flow, an additional I/O node bundles lighting control and exhaust fans for the restrooms. On the upper floor, three controllers regulate the two air-air heat pumps. At the heart of the central ventilation system lies a heat exchanger equipped with a heat recovery wheel; the speed that the wheel rotates is regulated by an autonomous controller. A separate programmable logic controller communicates via a LON module with this controller, transmitting the desired air temperature.

“We have different bus systems at the field level but, thanks to the selected building automation technology, we can piece them together very easily and transfer the aggregate to a higher-level control system,” adds the trainer for Building Automation Systems at DIAL and the brains behind the software programming for their in-house building technology.

“Our building runs on CODESYS and KNXnet IP. I use the building automation system as an interface that converts everything into one standard, which I can then easily program and link to a higher-level IT system.”

WAGO headquarters, Minden, Germany – Wago

Five floors, originally constructed in 2011, and a roughly 5,000 square metre surface area describe this building case-study known as V3 at WAGO, in Minden.

One of the special features of this office and the building development is that due to its connection to a private local heating network, no additional heating is required. Therefore, a combined plant consisting of a gas boiler and a ground-source heat pump in the neighbouring building, feeds a network, and is also able to supply the other system users. For the ventilation system, there is a central plant with adjustable heat recovery.

The building is equipped with building automation and a data logging metering system, which gives feedback about the operating conditions. Daylight dependent lighting, automatic solar protection and room temperature are flexibly controlled on demand. The room automation combines the three systems into one device.

The lighting is integrated using DALI, multiple sensors within the work place record the luminance and the presence of employees. The room temperature is controlled with valves that modulate the water flow through the heating and cooling registers installed in front of the air outlets. All additional sensors are connected to the single room control. According to the energy certificate, the building has an energy demand that is under the EnEV-requirement.

With an analysis in accordance to the eu.bac system, it became clear that the ventilation system brings the highest benefit, because the building is partly provided with a constant volume flow system and it is difficult to provide an economic retrofit. Overall the audit showed that the facility management optimally controlled the systems at the required operating levels. The local heat networks with heat recovery as well as the thermally actuated automatic solar protection also accounted for the efficiency.

The building V3 was subsequently rated an A, a good result considering it is a four-year-old existing building. For WAGO, the rating provides a very good business resilient base from which to calculate building efficiency investments. “Because we compare systematically, we get the results which show where modernization in building stock is profitable”, explains auditor Martin Hardenfels, director for project sales at WAGO.