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

MODULE #5

CHAPTER 8: SMART READINESS INDICATOR

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5.8.1 INTRODUCTION

One of the most pressing challenges of the building sector in Europe is to optimize the comfort-human-energy efficiency relationship. The uptake of smart technologies is expected to lead to buildings which are more comfortable and provide healthier indoor environment and in the same time have an optimal energy consumption, while using building systems which are convenient to operate. These smart buildings have the ability to synchronize the needs of the building users with the energy grid and to optimize the energy consumption and lower the carbon footprint.

The great focus on smart technologies is reflected in the directives and regulations also at EU level. The revised Energy Performance of Buildings Directive (EPBD) published on 19th of June 2018 reflects on the importance of the uptake of these smart technologies. The EPBD proposes the development of a voluntary scheme called Smart Readiness Indicator (SRI), which has the potential to rate the smart readiness of the buildings. The goal of the SRI is to reflect the benefits of implementation of the smart technologies in the buildings.

The SRI should be a useful tool for building occupants, owners, decision makers, as well as facility managers. The indicator can sustain decision making and the operation of buildings and can also serve as a common platform for all the stakeholders, ultimately leading to a well-organized uptake of smart technologies.

5.8.2 HOW DOES THE SRI WORK?

The SRI is based on the smart ready services built in the building. The job of the assessor is to evaluate the functionalities these services can provide. During the assessment, each service can be assigned with different level of smartness.

The SRI introduces the concept of domains and impacts. The domain contains the services in a building and covers areas as heating, cooling, ventilation, lighting etc. The impacts show various aspects of these services, such as comfort, convenience and flexibility toward the energy grid.

The SRI also introduces weightings which can be attributed to the above mentioned domains and impact criteria which help balancing the attribution of the different parameters to the final SRI score.

The assessment methodology has the flexibility to be applied in different ways: on site-inspection by an external SRI assessor, self-assessment by building owners or facility managers etc. Over time, the methodology can even evolve into a more automated process provided by the smart systems of the buildings.

This methodology creates a platform for stakeholders to measure the functional capability of the smart systems and technologies. It provides an indicator which summarises the information in a transparent and understandable way without compromising the demand for sufficiently detailed information.

The other positive aspect of the SRI methodology is that it is flexible enough to be used under different climates in different building types and it allows updates in a field that is rapidly involving.

5.8.3 DOMAINS

As mentioned before, the SRI introduces domains and subdomains in the assessment procedure. These are the following:

- Heating - Heat emission control, Control of distribution fluid temperature, Control of distribution pumps in the system, etc.

- Cooling - Cooling emission control, Control of distribution network chilled water temperature, Control of the distribution pumps in network, etc.

- Domestic hot water - Control of domestic hot water charging, sequencing in case of different domestic hot water generators.

- Ventilation - Supply air flow control at room level, Air flow or pressure control at the air handler level, etc.

- Lighting - Occupancy control for indoor lighting, Control of artificial lighting power based on daylight levels,

- Dynamic building envelope - Window solar shading control, Window open/closed control, combined with HVAC system

- Electricity - Reporting information regarding local electricity generation, Storage of electricity

- Electric vehicle charging - Electric vehicle charging capacity, EV charging Grid balance, etc.

- Monitoring and control - Run time management of HVAC systems, etc.

5.8.4 IMPACT FACTORS

The indicator also introduces impact factors in relation with the user and the energy grid. These impacts are the following:

- Energy savings on site: This impact category refers to the impacts of the smart ready services on energy saving capabilities. It does not consider the whole energy performance of buildings, but only the contribution made to this by smart ready technologies (e.g. resulting from better control of room temperature settings)

- Maintenance and fault prediction: Automated fault detection and diagnosis has the potential of significantly improving maintenance and operation of technical building systems. It may also impact the energy performance of the technical building systems by detecting and diagnosing inefficient operation.

- Comfort: This impact category refers to the impact of services on the comfort of the occupants. The term comfort encompasses the conscious and unconscious perception of the physical environment, including thermal comfort, acoustic comfort and visual performance (e.g. provision of sufficient lighting level without glare)

- Convenience: This impact category refers to the way in which services impact the occupants´ convenience (i.e. the extent to which services “make life easier” for the occupant, e.g. TBS requiring less manual interactions)

- Well-being and health: Refers to the impacts of services on the well-being and health of occupants. E.g. smarter controls can deliver an improved air quality compared to traditional controls, thus raising occupants´ well-being, and implicitly positively influencing their health.

- Information to occupants: Refers to the impacts of services on providing information regarding building operation to occupants.

- Flexibility for the grid and storage: Refers to the impacts of services on the energy flexibility potential of the building. The aim is to focus not only on electricity grids, but also to include flexibility offered to district heating and cooling grids.

5.8.5 METHODOLOGY

The end result of the SRI assessment is a percentage which determines how close the building is from the maximum level of smart readiness. The assessment follows 4 steps:

1st Step: Assessment of individual smart ready services. The services built in the buildings are identified with the specific functionality levels. For every service, an impact score can be determined in each of the impact criteria.

2nd Step: Calculation of the aggregated impact score. The aggregated impact score is calculated for every domain. The domain impact score is a ratio between the individual scores of the domains' services and the theoretical maximum score.

3rd Step: Calculation of the total impact score. This represents a weighted sum of the domain impact scores. In the methodology, the weight of a domain depends on the importance for the respective impact.

4th Step: Calculation of the SRI score. The final SRI score is a weighted sum of the impact scores. Also in this case, the weight depends on the relative importance for the smart readiness of the building.

5.8.6 FUTURE OF SRI

The present form of the SRI methodology assumes the work of a third party assessor, but once the scheme becomes more well-known and used, it may shift to a more automatized way of assessment. A plausible way of support this ambition is the use linkage between Building Information Models and SRI.

Some other important segments, which are still to be discussed and clarified, are: the way of dealing with different smart technologies present only in a part of the buildings; differences in climate the weighting of different smart technologies in the final score of SRI; potential of implementation of SRI etc.

The SRI system provides a flexible framework and the applicability of the indicator is likely to depend on the characteristics of the building. In this way the building-specific circumstances will lead to situations where services are not going to be applicable and therefore the methodology should able to rescale and adapt the weightings for this case.

The implementation of the SRI is going to be voluntary for the member states of EU.

5.8.7 CASE STUDY1 – OFFICE BUILDING IN KECSKEMÉT, HUNGARY

The current document presents two case studies, the first one is going to be presented in detail, the second one only briefly, since the methodology is the same.

The first building is the office building of an HVAC manufacturer in Kecskemét, Hungary. The building was built in 2013 and has two parts:

- the first part includes a meeting room, a toilet and the main corridor;
- the second part includes the main meeting room with a capacity of 40 people.

Figure 5.8.1 shows the presentation of the building; Figure 5.8.2 presents the layout of the building.

Fig. 5.8.2: Presentation of the building

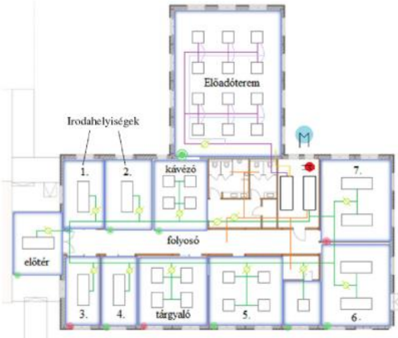


Fig. 5.8.2: Layout of the building

The building has mechanical ventilation and the whole HVAC system is connected to a central controlling unit. The heating energy is supplied by a gas boiler, the cooling energy is provided by a chiller.

HEATING – CASE STUDY 1

The building is heated by radiators, the heat source is a condensing boiler, therefore there is no need for storage since the boiler is able to modulate and to follow the power demand of the building. Thermostats control the heating system, and furthermore the company has also developed and installed their own presence sensor, so presence detection is also found in the rooms. The temperature of the heating fluid is compensated taking into account the outside temperature. The circulation of the heating fluid is ensured by variable speed pumps. Figure 5.8.3 shows the pumps, while Figure 5.8.4 shows the presence sensor.

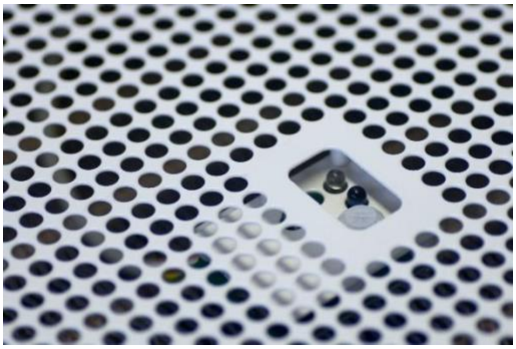


Fig. 5.8.3: Pump Fig. 5.8.4: Presence sensor

During the assessment of the heating system, the following aspects were taken into consideration:

- Heat emission control: every room has thermostats and a presence sensor (individual room control with communication and presence control) – functionality level 4;

- Control of distribution fluid temperature: the gas burner of the condensing boiler is controlled in a way that takes into consideration the outside temperature (outside temperature compensated control) – functionality level 1

- Control of distribution pumps: the pumps are variable speed pumps and are set on constant pressure mode (variable speed pump control, pump unit estimations) – functionality level 3

- Intermittent control of emission: the system operates according the temperature values detected by the thermostats and the signal of the presence detector, there is no demand evaluation (automatic control with optimum start/stop) – functionality level 2

- Building preheating control: the building states the preheating procedure according to a schedule which is set (program heating schedule in advance) – functionality level 1

- Heat generator control according to external signals: there is no possibility to control the heating system according to any external signal (no automatic control based on external signal) – functionality level 0

- Report information regarding heating system performance: the heating system parameters are registered in the building management system and the system collects historical data (actual values and historical data) – functionality level 2

Figures 5.8.5 and 5.8.6 show the impact scores of the different subdomains of the heating system.

HEATING SYSTEM:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
HEAT EMISSION CONTROL	3	0	2	3	0	1	0
CONTROL OF DISTRIBUTION FLUID TEMPERAURE	1	0	1	1	0	0	0
CONTROL OF DISTRIBUTION PUMPS	3	0	3	0	0	0	0
INTERMITTENT CONTROL OF EMISSION AND/OR DISTRIBUTION	2	0	2	2	0	0	0

Figure 5.8.5: Impact scores of the different subdomains of the heating system - 1

HEATING SYSTEM:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
BUILDING PREHEATING CONTROL	1	0	1	1	0	0	1
HEAT GENERATOR CONTROL	1	0	1	0	0	0	0
HEAT SYSTEM CONTROL ACCORDING TO EXTERNAL SIGNAL	0	0	0	0	0	0	0
REPORTING INFORMATION REGARDING HEATING SYSTEM PERFORMANCE	1	0	0	1	0	2	3

Figure 5.8.6: Impact scores of the different subdomains of the heating system - 2

COOLING – CASE STUDY 1

The cooling energy is provided by a 20 kW chiller found next to the office building. This heat source serves the energy demand of the air handling unit and the energy demand of a chilled beam system.

The air handling unit operates with a fluid temperature of 5/9 oC, the chilled beam system operates with the fluid temperature of 16/19 oC. There are two puffers in the system:

- the first one for the storage of 5 oC fluid;
- the second one for the storage of 16 oC fluid;

Figure 5.8.7 shows the chiller, Figure 5.8.8 represents one of the puffers.

Fig. 5.8.7: Pump

Fig. 5.8.8: Presence sensor

During the assessment of the cooling system, the following aspects were taken into consideration:

- Cooling emission control: every room has thermostats and a presence sensor (individual room control with communication and presence control) – functionality level 4;

- Control of distribution network chilled water temperature: the chiller only operates when there is a demand for cooling energy (demand based control) – functionality level 2

- Control of distribution pumps in network: the pumps are variable speed pumps and are set on constant pressure mode (variable speed pump control, pump unit estimations) – functionality level 3

- Intermittent control of emission: the cooling devices are operated in a way that evaluates the demand data from the rooms (automatic control with demand evaluation) – functionality level 3

- Interlock between heating and cooling control of emission: the heating and cooling systems can't operate in the same time, avoiding this way the operation modes in which the two systems would work against each other (total interlock) – functionality level 2;

- Control of thermal energy storage: the chiller is operated in a way that takes into consideration the predicted power demand (load prediction based storage operation) – functionality level 2

- Generator control for cooling: the temperature of the cooling water in the system is set as a function of load (variable temperature depending on the load) – functionality level 2

- Report information regarding cooling system performance: the cooling system is operated taking into account the demand forecast and is able manage the fault detection (performance evaluation including forecast and/or benchmarking; also including predictive management and fault detection) – functionality level 4

Figures 5.8.9 and 5.8.10 show the impact scores of the different subdomains of the cooling system.

COOLING SYSTEM:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
COOLING EMISSION CONTROL	3	0	2	3	0	1	0
CONTROL OF DISTRIBUTION NETWORK CHILLED WATER TEMPERATURE	2	0	2	2	0	0	0
CONTROL OF DISTRIBUTION PUMPS	3	0	0	0	0	0	0
INTERMITTENT CONTROL OF EMISSION	3	0	1	1	0	0	0

Figure 5.8.9: Impact scores of the different subdomains of the cooling system - 1

COOLING SYSTEM:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
INTERLOCK BETWEEN HEATING AND COOLING CONTROL OF EMISSION	3	0	0	0	0	0	0
CONTROL OF THERMAL ENERGY STORAGE	2	0	1	0	0	0	0
GENERATOR CONTROL FOR COOLING	2	0	2	0	0	0	0
REPORTING INFORMATION REGARDING COOLING SYSTEM PERFORMANCE	1	0	0	1	0	2	3

Figure 5.8.10: Impact scores of the different subdomains of the cooling system - 2

DOMESTIC HOT WATER – CASE STUDY 1

The domestic hot water is prepared with an electric boiler. The storage temperature of the domestic hot water is 50 oC, so every week a manual temperature rise has to be applied due to the legionella protection. The temperature of the periodically heated domestic hot water is 70 oC. For comfort reasons a recirculation system is operating.

Figure 5.8.11 shows the domestic hot water tank; Figure 5.8.12 represents the recirculation system.

Fig. 5.8.11: Hot water tank

Fig. 5.8.12: Recirculation system

During the assessment of the hot water system, the following aspects were taken into consideration:

- Control of DHW storage charging: the hot water tank operating in the office is a simple electric water tank, there is one single sensor which controls the automatic on/off operation (automatic control on/off) – functionality level 0;

- Report information regarding domestic hot water performance: the current temperature of the water is reported to the building management system (indication of actual values) – functionality level 1

Figure 5.8.13 shows the impact scores of the different subdomains of the domestic hot water system.

DHW:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENI ENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
CONTROL OF DHW STORAGE CHARGING	0	0	0	0	0	0	0
REPORTING INFORMATION REGARDING DOMESTIC HOT WATER	1	0	0	0	0	1	1

Figure 5.8.13: Impact scores of the different subdomains of the domestic hot water system

VENTILATION – CASE STUDY 1

The office has mechanical ventilation. The main element of the ventilation system is the air handling unit. The air handling unit (AHU) is equipped with a rotational heat recovery unit. The AHU provides fresh air for the chilled beams and also extracts the air from the toilets. The extraction of the air happens in the corridors.

Figure 5.8.14 shows the air handling unit, figure 5.8.15 represents elements of the water side control.

Fig. 5.8.14: Air handling unit

Fig. 5.8.15: Water side control

During the assessment of the ventilation system, the following aspects were taken into consideration:

- Supply air flow control at room level: the ventilation system is equipped with variable air volume units which are controlled by actuators. The signal of the actuators is given by CO2 sensors installed in the VAV units (local demand control based on air quality sensors with local flow from/to the zone regulated by dampers) – functionality level 4;

- Adjustment of the outdoor air flow or exhaust air rate: the outside air ratio is adjusted as a function of indoor air quality (variable control) – functionality level 3;

- Air flow or pressure control at the air handler level: the fans of the AHU are controlled in an automatic way in order to be in sync with the pressure distribution of the ventilation system (automatic flow or pressure control) – functionality level 4;

- Heat recovery control preventing the overheating: the rotary heat exchanger can modulate by taking into account the temperature date from the room thermostats (modulate heat recovery based on multiple room temperature sensors) – functionality level 2;

- Free cooling with mechanical ventilation system: the ventilation system can be used for free cooling if the outside temperature and the indoor demand allows it (free cooling) – functionality level 2;

- Reporting information regarding indoor air quality (IAQ): IAQ is continuously monitored, the AHU is controlled according to these parameters, also historical and predictive information of IAQ are available and the maintenance is based on sensors and historical data (real time monitoring, historical & predictive information of IAQ, fault/maintenance based on internal sensors and historical data) – functionality level 4;

Figures 5.8.16 and 5.8.17 show the impact scores of the different subdomains of the ventilation system.

VENTILATION:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENI ENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
SUPPLY AIR FLOW CONTROL AT ROOM LEVEL	3	0	3	3	3	0	0
ADJUSTING THE OUTSIDE AIR FLOW OR EXHAUST AIR RATE	2	0	2	2	2	0	0
AIR FLOW OR PRESSURE CONTROL AT AIR HANDLER LEVEL	3	0	0	0	0	0	0

Figure 5.8.16: Impact scores of the different subdomains of the ventilation system - 1

VENTILATION:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
HEAT RECOVERY CONTROL: PREVENTING OF OVERHEATING	2	0	2	2	2	0	0
FREE COOLING WITH MECHANICAL VENTILATION SYSTEM	2	0	2	2	1	0	0
REPORTING INFORMATION REGARDING IAQ	0	0	0	1	0	2	3

Figure 5.8.17: Impact scores of the different subdomains of the ventilation system - 2

LIGHTING – CASE STUDY 1

The lighting of the office building is ensured by led light sources. The occupancy sensor integrated in the front panel of the chilled beams also serves for controlling the lighting system.

The system has dimming possibility so the capacity of the lighting can be regulated, and information related to the lighting system is stored by the central automation system.

Figure 5.8.18 shows a representation of a lamp; Figure 5.8.19 represents the motion- and temperature sensor.

Fig. 5.8.18: Lamp (superiorlighting.com)

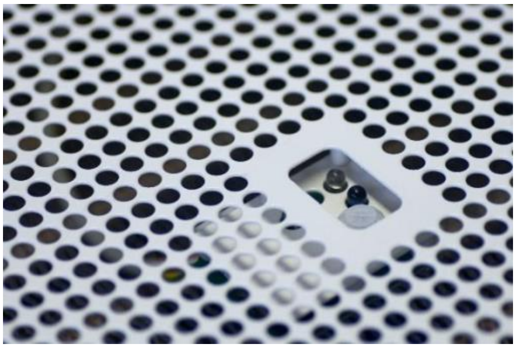


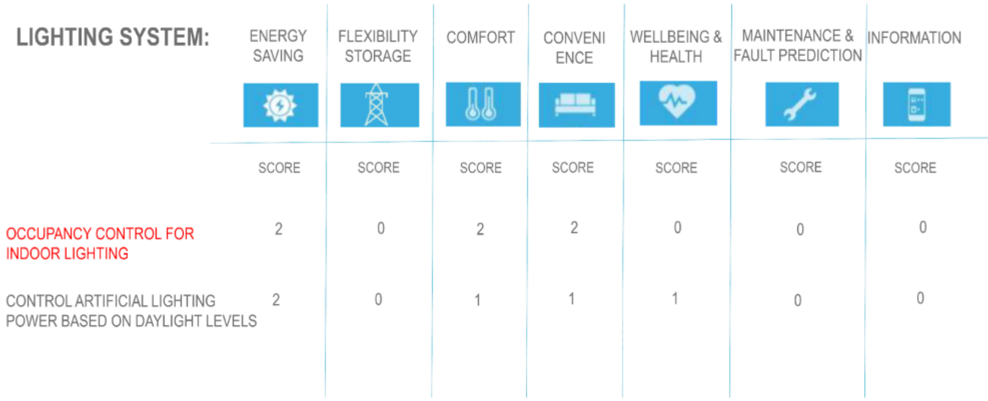
Fig. 5.8.19: Motion sensor

During the assessment of the ventilation system, the following aspects were taken into consideration:

- Occupancy control for indoor lighting: the switching of the system is automatic (auto on/dimmed) – functionality level 2;

- Control of artificial lighting based on daylight levels: the lighting system is switching automatically but there is no automatic dimming option (automatic switching) – functionality level 2;

Figure 5.8.20 shows the impact scores of the different subdomains of the lighting system.



LIGHTING SYSTEM:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
OCCUPANCY CONTROL FOR INDOOR LIGHTING	2	0	2	2	0	0	0
CONTROL ARTIFICIAL LIGHTING POWER BASED ON DAYLIGHT LEVELS	2	0	1	1	1	0	0

Figure 5.8.20: Impact scores of the different subdomains of the lighting system

DYNAMIC BUILDING STRUCTURES – CASE STUDY 1

The shading of the office is assured by blinds. These are manually operated, non-automated, not coordinated and not connected to lighting, cooling, or any other building engineering system.

During the assessment of the dynamic building structures, the following aspects were taken into consideration:

- Window solar shading control: the blinds are manually operated (no sun shading or manual operation) – functionality level 0;

- Window open/closed control, combined with HVAC system: the windows can be opened in the whole building, the operation is manual (manual operation or only fixed windows) – functionality level 0;

- Reporting information regarding performance: there is no information from the dynamic building structures linked to the building management system (no reporting) – functionality level 0;

Figure 5.8.21 shows the impact scores of the different subdomains of the dynamic building structures.

DYNAMIC BUILDING ENVELOPES:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENI ENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
WINDOW SOLAR SHADING CONTROL	0	0	0	0	0	0	0
WINDOW OPEN/CLOSED CONTROL	0	0	0	0	0	0	0
REPORTING INFORMATION REGARDING PERFORMANCE	0	0	0	0	0	0	0

Figure 5.8.21: Impact scores of the different subdomains of the dynamic building structures

ELECTRICITY – CASE STUDY 1

There are no photovoltaic panels or any local electricity generation, so no inverter has been installed. Thus, there is no local energy storage and the monitoring of different units is not provided. On the other hand, there is no cogeneration equipment in the office building.

ELECTRIC CAR CHARGING– CASE STUDY 1

There is no possibility for electric car charging on site, the employees do not use an electric car or, if they do use one, they do not charge it near the office.

MONITORING AND CONTROL – CASE STUDY 1

The building has a building management system, which is capable of measuring the operation time and sending fault signals. Occupancy sensors help control the building technology systems. The automation system is able to provide optimal comfort with optimal energy consumption, taking into account internal loads and external weather data. The automation system also has a logging and optimisation function and is available on a web interface.

Figure 5.8.22 shows the visualisation of the occupancy in the BMS software

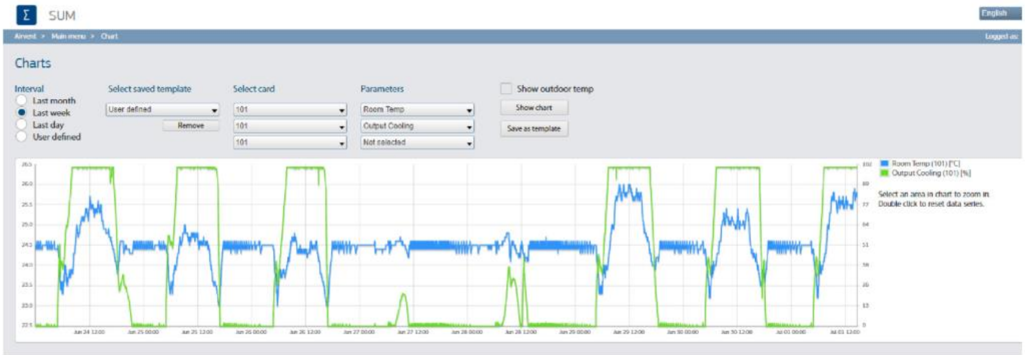


Figure 5.8.22: Visualisation of the occupancy in the BMS software

During the assessment of the dynamic building structures, the following aspects were taken into consideration:

- Run time management: the heating and cooling plants, the AHU and other HVAC units were connected to the BMS, so arbitrary conditions can be defined (individual setting following a predefined time schedule; adaptation from a central room; variable preconditioning phases) – functionality level 2;

- Detecting faults and providing support: the BMS system had was able to detect faults and had diagnosing functions (with central indication of detected faults and alarms/diagnosing functions) – functionality level 2;

- Occupancy detection – connected services: different technical building systems (TBS) are connected to the BMS. Also, some sensors serve as input for different TBS, for example the centralised presence detection is an input data for the lighting, heating, cooling and ventilation systems (centralised detection feeds in to several TBS such as lighting and heating) – functionality level 2;

- Central reporting of TBS performance and energy use: real time energy use – heating and cooling is measured (real time indication of sub-metered energy use or other performance metrics for at least 2 domains) – functionality level 2;

- Smart grid interaction: None (no harmonisation between grid and building energy systems) – functionality level 0;

- Reporting information regarding DSM: None (no reporting) – functionality level 0;

- Override of DSM control: None (no DSM control) – functionality level 0;

Figures 5.8.23 and 5.8.24 show the impact scores of the different subdomains of the monitoring and control systems.

MONITORING AND CONTROL:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
RUN TIME MANAGEMENT	2	1	2	2	1	0	0
DETECTING FAULTS	0	0	0	2	2	3	2
OCCUPANCY DETECTION	1	0	1	1	0	2	0
CENTRAL REPORTING	1	0	0	2	0	1	2

Figure 5.8.23: Impact scores of the different subdomains of the monitoring and control - 1

MONITORING AND CONTROL:	ENERGY SAVING	FLEXIBILITY STORAGE	COMFORT	CONVENIENCE	WELLBEING & HEALTH	MAINTENANCE & FAULT PREDICTION	INFORMATION
	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE	SCORE
SMART GRID INTEGRATION	0	0	0	0	0	0	0
REPORTING INFORMATION REGARDING DEMAND SIDE MANAGEMENT	0	0	0	0	0	0	0
OVERRIDE OF DMS CEONTROL	0	0	0	0	0	0	0

Figure 5.8.24: Impact scores of the different subdomains of the monitoring and control - 2

WEIGHTING FACTORS, SCORES, CONCLUSIONS – CASE STUDY 1

The weightings that should be attributed to the domains and criteria are presented on Figure 5.8.25.

The scores of the impacts can be seen on Figure 5.8.26, Figure 5.8.27 shows the score of domains.

It can be concluded that the in order to improve the smart readiness of a building, the flexibility and storage potential of the different domains should be improved. Since some domains were not present in the building, these results were not taken into consideration when calculating the final SRI score.

It can be stated that the hot water system and the monitoring and control of the TBS systems should be improved in order to improve the SRI score, which in this case is 65%.

WEIGHTING							
TOTAL	1.00	1.00	1.00	1.00	1.00	1.00	1.00
	0.29	0.27	0.13	0.1	0	0.29	0.11
	0.08	0.07	0.13	0.1	0	0.08	0.11
	0.11	0.10	0.13	0.1	0	0.11	0.11
	0.15	0.14	0.13	0.1	0.4	0.15	0.11
	0.09	0.08	0.13	0.1	0	0.09	0
	0.05	0.05	0.13	0.1	0.4	0.05	0.11
	0.03	0.03	0	0.1	0	0.03	0.11
	0	0.05	0	0.1	0	0	0.11
	0.2	0.2	0.2	0.2	0.2	0.2	0.2

Figure 5.8.25: Weighting factors

SCORES OF IMPACTS:

ENERGY SAVING: 77%
FLEXIBILITY & STORAGE: 9%
COMFORT: 76%
CONVENIENCE: 66%
WELLBEING & HEALTH: 83%
MAINTENANCE AND FAULT PREDICTION: 79%
INFORMATION: 56%

SRI 65%

Figure 5.8.26: Scores of impacts

Figure 5.8.27: Scores of domains

5.8.8 CASE STUDY2

The second building is the headquarters of AMPLIO, an automatization company in Székesfehérvár, Hungary. The size of the office is 1100 square meters and it has multiple energy sources for both heating and cooling. The building has mechanical ventilation and a central building management system controls all the technical building systems.

The assessment methodology is similar to the one presented in the first case study, thus this chapter presents a simplified description.

Figures 5.8.28 and 5.8.29 show the presentation of the building.

Fig. 5.8.28: Presentation of the building-1 *Fig. 5.8.29: Presentation of the building-2*

The office building has two heat sources: a gas boiler, which provides the energy for the radiators, domestic hot water and the air handling units, and a heat pump group which serves as the heat source for the surface heating and cooling. There are thermostats in every room and the heating system is equipped with variable speed pumps.

The heat source of the cooling system is the heat pump. In order to reduce the number of compressor modulation, the system has puffer tanks. A hydraulic system supplies the surface heating. Additionally there is a variable refrigerant volume system installed in the building and a chiller, which gives the cooling power for the air handling units.

For the preparation of the domestic hot water, the energy source is the gas boiler, which gives the necessary power to the heat exchanger of a domestic hot water tank. The storage temperature is 50 ^{o}C, and due to the legionella protection, the temperature of the water is temporarily risen to 70 ^{o}C. In order to fulfil the comfort need of the building, a recirculation system is operating.

The office building has mechanical ventilation. There are several air handling units (AHUs) with rotary heat exchanger. The energy source of these units is the boiler in wintertime and the chiller in summer. The ventilation system is a variable air volume system controlled by a building management system. Every zone is equipped with indoor air quality sensors, so that the ventilation system can be controlled accurately.

The lighting of the building is provided with LED lamps. Presence detectors are installed in every zone and automatic control of the lighting system is available. The lamps are dimmable and the lighting systems are connected to the BMS.

The building is equipped with an exterior shading system connected to the BMS. Window opening sensors are also available. Electricity generation or local storage of electrical energy is not available, nor is electric car charging.

The BMS system controls all the technical building systems.

SCORES, CONCLUSIONS – CASE STUDY 2

The scores of the impacts can be seen in Figure 5.8.30, while Figure 5.8.31 shows the score of domains.

Also in this case, the flexibility and storage could be improved. This conclusion leads to the importance of the improvement of demand side management.

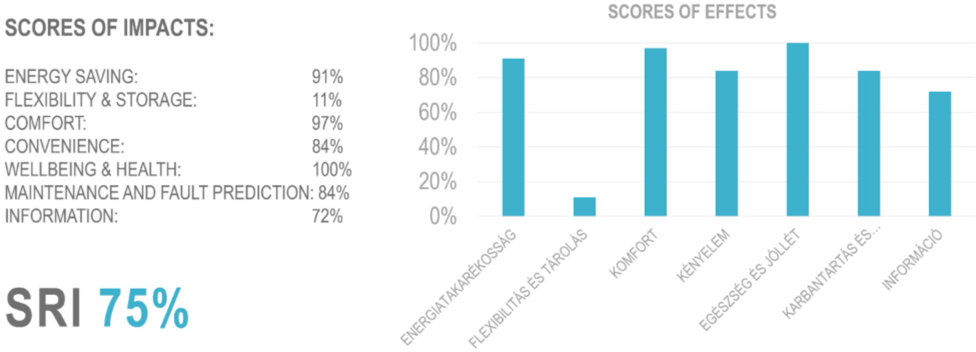


Figure 5.8.30: Scores of impacts

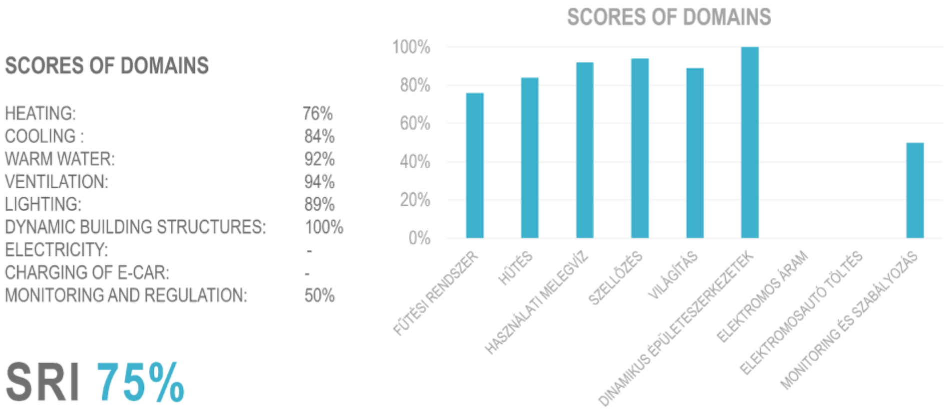


Figure 5.8.31: Scores of domains

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