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Smart-Ready Buildings: EPBD Policy Updates, National Implementation & Research Breakthroughs



Results from the application of smart-ready technologies

Results from real-life application of artificial intelligence building service technology to HVAC systems in a medium-scale pilot building in Italy



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Within the framework of the European Project “Smart Square,” artificial intelligence building service technology has been applied to HVAC systems in a medium-scale pilot building. Energy efficiency results, before and after SRI assessments, the platform for conducting SRI assessment and concept of smart ready communities is presented and discussed.

Keywords: Artificial Intelligence, SRI, Smart Buildings, Smart Ready Go, Energy Efficiency, Case Study

The project

This case study falls within the context of the European Project “Smart Tools for Smart Buildings: Enhancing the Intelligence of buildings in Europe” (Smart Square [1]) which is part of the LIFE Programme, and one of the four LIFE CET SMART-READY projects aimed to support the successful uptake of the Smart Readiness Indicator [2]. Project objectives, amongst others, include the development of tools and services that boost the uptake of the SRI scheme amongst the member states of the European Union and the rollout of ICT smart ready technologies including Artificial Intelligence (AI) and Internet of Things (IoT) for enhanced building performance and overall smartness. The presented pilot is one of a set of project pilot buildings that contributes to the realization and demonstration of the project objectives.

The pilot site

La Forgiatura is a unique business park located in the north-western part of Milan consisting of 10 mixed-use buildings (offices, restaurant, common areas, green spaces, underground parking and other facilities) covering 24 300 m² of floor area. The site is the result of a €28 million renovation and urban renewal of a former metallurgy industrial complex carried out by RealStep and Engineer Carlo Bossi, as technical supervisor, and designed by Architect Giuseppe Tortato in 2013 to create the first 100% carbon-free corporate campus in Milan [3]. The transformation featured natural lighting, carbon free technologies, renewables, and on-site water use and optimization. The buildings and complex are in their operational phase (e.g. occupied and in use). Since 2013, the whole site is under the facility

management by Engineer Daniele Bossi from Studio Bossi engineering firm.

Technical systems at La Forgiatura include systems for heating, cooling and mechanical ventilation, in addition to the other common energy consumers such as domestic hot water, lighting, and electrical appliances. A large central heating and cooling system is present which consists of 4 polyvalent heat pumps feeding two water loops forming a kind of local district heating and cooling for much of the campus.

The HVAC systems are controlled by a Building Management System (BMS). Beginning in 2022, R2M Solution and Brainbox AI have been working with RealStep to install, integrate and optimize BrainBox AI solutions to the installed HVAC components applying AI-based algorithms, automatic optimization rules, automatic control, and continuous monitoring. The reach of the AI-driven systems and number of algorithms employed is increasing each year with the next expansion of the deployed systems scheduled for 2025.



Smart Tools for Smart Buildings (Smart Square Project)



La Forgiatura, Milan – From metal works to carbon-free business park.

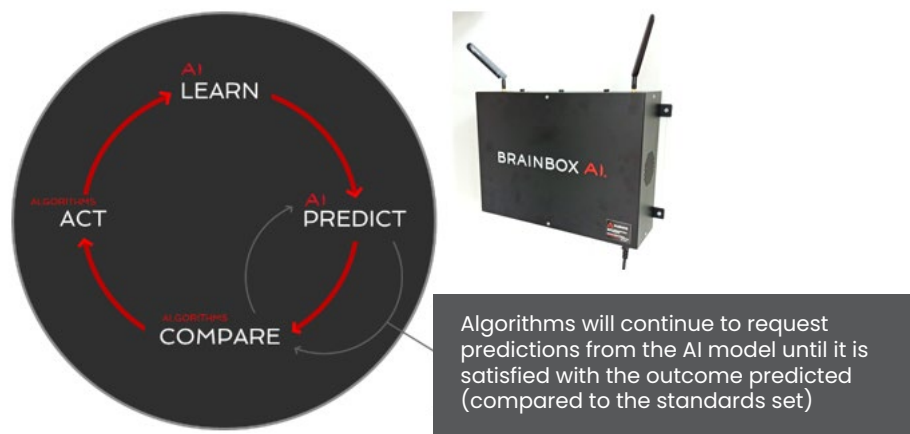
The smart-ready technologies: Brainbox AI and Smart Ready Go!

Brainbox AI provides AI solutions for various building typologies and use cases via a series of hardware and software solutions to conduct deep learning, cloud-based and local computing, algorithms and a proprietary process to support a 24/7 self-operating buildings [4]. The system communicates with the BMS, integrates other datapoints that can enrich analysis, pre-processes various data sets and communicates with Brainbox AI cloud services to receive back control actions to be sent to the BMS. In this way, BrainBox AI solutions integrate learned building performance, building occupancy and usage patterns with external data streams (weather, grid or other) to forecast and deliver pre-emptive controls in a dynamic and automatic way without human intervention that deliver energy savings and increased comfort to the indoor environment. With over 20 million square meters under management in 70 cities worldwide (2024), a wide set of algorithms are trained, validated and ready for use for various building typologies, use case scenarios, and diverse levels of pre-existing building smartness.

The BrainBox AI edge device can be easily installed and connected to the existing BMS network through a simple Ethernet LAN cable. This allows the analysis of data which are gathered by the BMS components and the deployment of the BrainBox AI's proprietary algorithms for the automatic control of the HVAC system. BrainBox AI also provides a user dashboard for the visualization of the benefits in terms of energy savings, environmental emissions reduction, and indoor comfort improvements. The dashboard also allows for functionalities related to monitoring of the

controls of the system components and of the operation of the AI algorithms. The installation and operational process allows for continuous communication with the customer and facility management team who can select the AI-based algorithms to deploy and in what priority they are applied in collaboration with Brainbox AI. Brainbox AI solutions can be also applied to buildings with no BMS, like multi-site retail buildings, where BrainBox AI can communicate with the thermostats and the available controllers connected to cloud serves via a gateway that allows the HVAC system and specifically the rooftop HVAC system (present on most retailers) to be AI-enabled.

Smart Ready Go! [5] is a web-based platform for building assessors and real estate managers for the conduct, management and delivery of SRI assessments that has been developed within the Smart Square Project. It is based on the technical framework developed at European level by the European Commission [6], through the SRI Support Team, and has been successfully assessed and validated according to them across a wide set of calibration/validation scenarios. The Smart Ready Go! software environment allows for the easy implementation of the SRI calculation for simplified Method A, the more detailed Method B (appropriate for non-residential / large buildings) and a proprietary Call Centre approach which makes the SRI assessment process accessible to non-technical users via a set of interview questions that correspond to Method A and which can be used to open conversations on the SRI and building smartness. Each user has a distinct profile / user dashboard and functionalities are present to guide the users through assessment processes, to visualize the results, and to save, manage and deliver the performed assessments of the considered buildings.



Brainbox AI Process and Gateway.

Application of Brainbox AI and Results

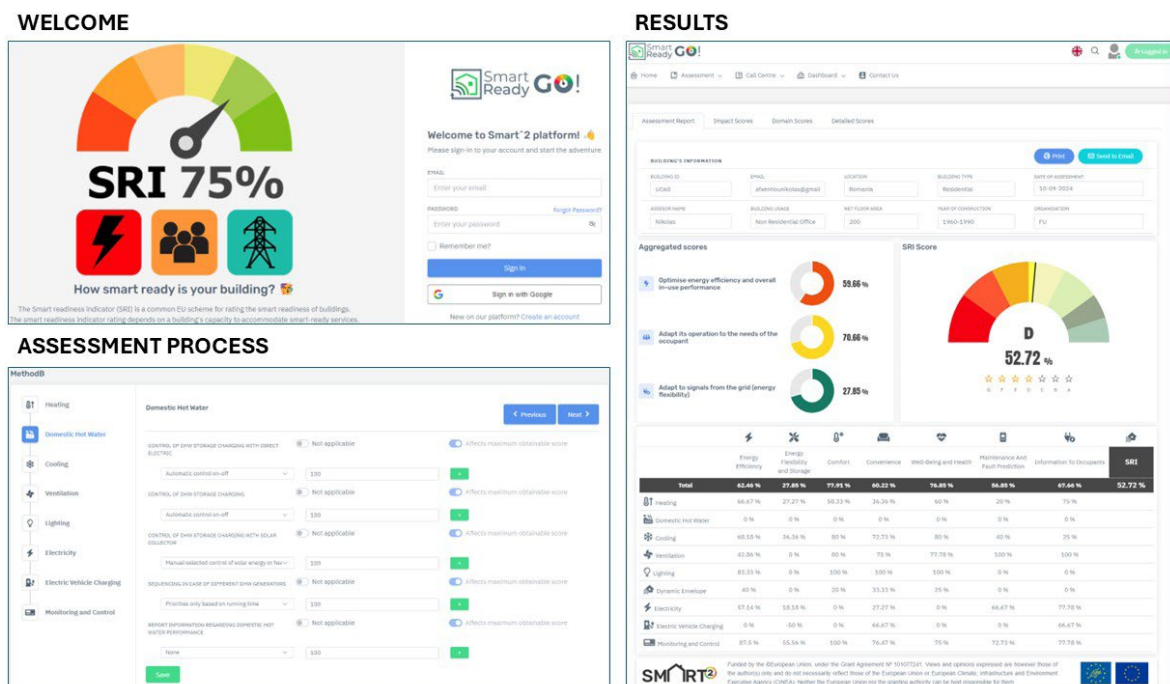
Nine buildings in the La Forgiatura campus are currently being driven or partially driven by Brainbox AI solutions. First installations and training of select buildings began late 2021 with the connection and integration of the Brainbox AI gateway to the existing BMS and customization of the dashboard for the building manager and maintenance team. The system subsequently went into full operational mode in February 2022. The BrainBox AI implementation did not require any investments in terms of upgrade of the existing systems or further interventions on the BMS already in place. In collaboration with the facility manager and according to the features of the HVAC systems present / controls layout, two AI-based algorithms were selected for implementation from the full set of the algorithms available through BrainBox AI. Specifically, they are called Optimus and Water-Clock.

Optimus' objective is to save as much energy as possible by managing optimal start and stop for the HVAC system. It uses the AI's temperature predictions as well as checking the outdoor air temperature condition and building conditions to decide when the optimal time is to start and stop the systems. The algorithm Optimus in La Forgiatura is controlling the air handling units and the fan coil units.

Water-Clock is an AI-based algorithm which modulates chillers and boilers delivery temperatures in

accordance with the present and the predictive outdoor air temperature as well as the predicted building thermal load. In the La Forgiatura campus, it controls the supply water temperatures for heating and cooling at the base of each of the nine buildings under the BrainBox AI control thus managing the percentage of openings of the supply water valves for heating and cooling, the velocity of the corresponding pumps, and consequently the thermal energy demand for each building. Since AI-based algorithms consider in continuous way the data measured in the indoor spaces, the comfort conditions, and the set points of the room temperatures, set by the users, are always satisfied.

The application and expansion of the facilities under control for Optimus and Water-Clock has been a synergic work across time between the facility management team and Brainbox AI. The other control functionalities remain, as they were, to the existing BMS and to the tasks which the O&M team wanted to continue doing. The AI algorithms can also be turned off and turned back on through a simple step on the dashboard, when the O&M responsible or the facility managers need it, for example when a specific maintenance task is foreseen, and they need to have the full control of the involved components. This increases trust and confidence in the Brainbox AI solution as one of the key aspects driving the results and expansion of system capabilities at La Forgiatura as the O&M team directly sees the results in terms of savings and



Screenshots from the Smart Ready Go! SRI assessment platform.

of systems optimizations, which would be impossible through manual optimizations, because they could not be continuous, dynamic, and automatically data-driven like with the AI.

Year	Savings (kWh)	% HVAC Savings	Economic Value
2022	26 950	12.9%	€6 710
2023	100 954	31.4%	€25 137
2024 YTD (7 Mo.)	55 937	32.5%	€13 928
Total	183 300	26.1%	€45 775

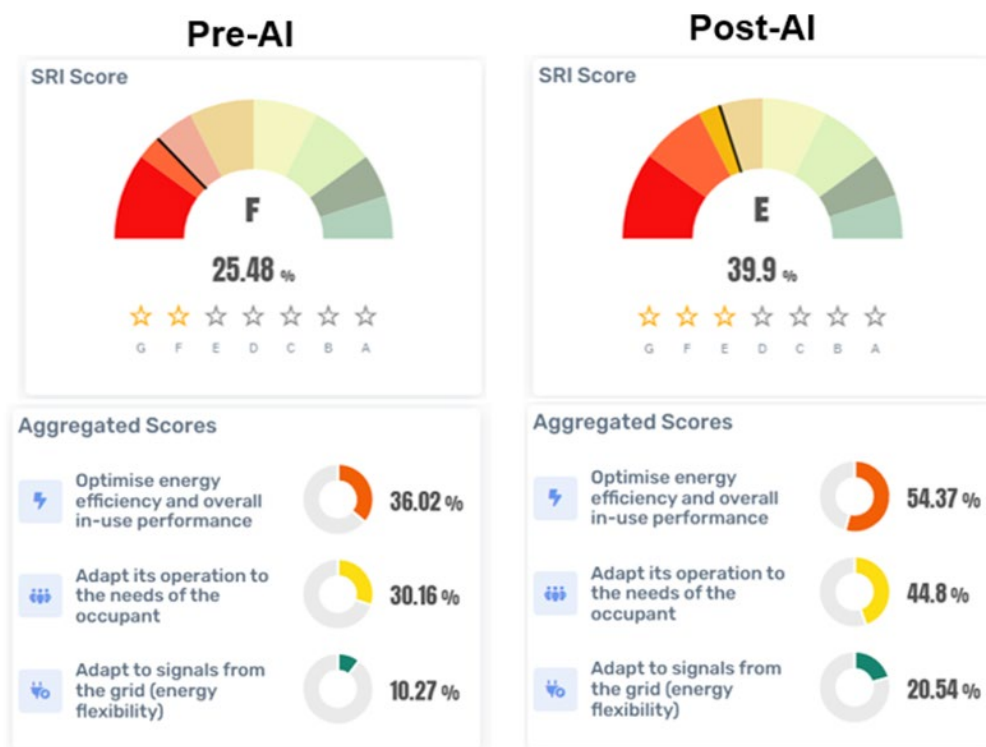
Thanks to the operation of BrainBox AI, from February 2022 to August 2024, a savings of more than 26% of electricity has been achieved on the equipment controlled by BrainBox AI, corresponding to 183 300 kWh of electricity savings and more than 45 000 € of energy costs savings (considering the average tariff of electricity of 0,248 €/kWh). The AI algorithms were not enabled 100% of the time but used increasingly across time with increased confidence in the system and disabled for planned or unplanned interruptions, maintenance, or other activities. In addition, more savings have been achieved in terms of lower demand of thermal energy for heating and cooling to the central polyvalent heat pumps, which are not included in the values above, but they were reached also in terms of further savings of electricity for the heat pumps. It can also be considered that the implementation of BrainBox AI allows for better capabilities of monitoring, data analysis, and feedback to the customers, which allowed the identification of faulty sensors or undesired behaviours of certain components, which otherwise would be very difficult to find through the human and manual activities also of expert and careful maintenance staff. These functionalities, thanks to the visualization of data trends, also allowed further considerations on optimization of the systems, for example to avoid too high thermal energy demand in specific period and to optimize the peak load of all the heat pumps installed. This also delivered concrete improvements in energy savings, in optimized operation of the components avoiding interruptions and issues, and in the indoor comfort conditions for the occupants. Over time, equipment efficiency also results in longer equipment lifespans and reduced maintenance costs. A final value also not quantified relates to brand, image, innovation capacity, the consideration of the environment and the comfort of building occupants. Several of these aspects are considered and quantified using the Smart Readiness Indicator.

Smart readiness improvement

Before and after SRI assessments have been conducted on the main campus building following the technical framework from the European Commission and following the SRI auditing process developed in the Smart Square Project proposed for standardization within the framework of an ongoing CEN workshop agreement. Building features, systems present, control capabilities and related functionality levels have been identified from the technical documentation (such as MEP drawings and data sheets of the components) and from analysis of the BMS graphical interface and functionalities it provides. In addition, a site inspection has been conducted to see further features and check the gathered information. It has been seen that the technical information in the documentation was consistent and up to date with the actual situation at the field. Final checks and feedback have also gathered directly from the building manager and from the responsible person for the system maintenance. A checklist printed out from the Smart Ready Go! Environment was used to take all the necessary information for the SRI assessment during the field visit and afterwards the information was entered into the Smart Ready Go! tool for this specific project and enabling calculation of the SRI score and visualization of the results. The SRI has been calculated according to the Method B, which is described in the reference document as “expert SRI assessment” and considers a more detailed analysis and an extended version of the catalogue of services (systems and subsystems) and their functionality levels.

Pre-AI, the building shows interesting levels of control functionalities, particularly related to the control of indoor temperature in the different rooms, to the operation of the heating and cooling systems, to the control of the hydraulic pumps, and for the presence of a BMS which some functionalities of monitoring and coordination between the systems. The rating of 25.48% is a good score considering the current assessment framework, weighting factors, and relative comparison against other building assessments. Post-AI, further control and optimization capabilities provided by the BrainBox AI solution, raise the assessment level of several of the smart ready service domains to 39.9% which is an excellent rating with respect to the current assessment framework and relative comparison.

In greater detail, the AI algorithms improved the functionality levels in the following assessment criteria of various smart ready services: providing predictive management and fault detection for reporting of KPIs and performance to the users; allowing for higher



Before and after SRI assessments at La Forgiatura.

energy flexibility levels with self-learning optimal control; improving the control of distribution fluid temperatures for heating and cooling with demand based control; providing predictive controls for the run time management of HVAC systems; allowing for automatic detection of faults; providing a platform for coordination and optimization of the HVAC systems; and providing the chance to optimize the systems based on weather. The attained results provided a new way to communicate and valorise the benefits of using a smart ready technology to the building owner and facility management team.

Conclusions and Future Work

There is robust set of existing and emerging smart-ready technologies. They work and are without doubt a part of meeting sustainability targets. Within this context, the Smart Readiness Indicator provides a common methodology and assessment for stakeholders to assess and have conversations about building smartness, smart-ready technologies and potentially to what buildings they can be applied first. This case study featured a pilot implementation from the Smart Square project at the business park La Forgiatura in Milan. Artificial intelligence solutions for HVAC provided building services by connecting to an existing BMS over a multi-year period and SRI assessments were facilitated by the software platform Smart Ready Go!.

Pilot results are promising, not only for the energy savings, but for the processes unlocked and lessons learned developed between the facility managers, Brainbox AI and R2M Solution as the system was deployed, integrated, and expanded over time both in terms of functionalities provided, buildings covered and amount of time in autonomous self-driving mode. A clear improvement in the SRI assessment was delivered by the integration of artificial intelligence and recommendations are in progress for feedback to the assessment methodology on how smart ready assessment criteria could better adapt to the emerging functionalities provided by AI. Building assessors were facilitated by the SRI assessment platform Smart Ready Go! and appreciated mostly that the platform provided a structure to conduct evaluations, store results for future use and to provide results and insights to the building owners and facility management teams.

Links

- [1] <https://www.smartsquare-project.eu/>
- [2] LIFE Projects Supporting the SRI
- [3] <https://realstep.it/case-study/la-forgiatura/>
- [4] <https://brainboxai.com/en/>
- [5] <https://www.smart-ready-go.eu/>
- [6] https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/smart-readiness-indicator_en ■

Exhibitions, Conferences and Seminars

Please send information of your event to Ms Marie Joannes mj@rehva.eu

2024

October 2024

21-25 October 2024	CAHVAC annual academic meeting (CHVAC&R 2024)	Huzhou, Zhejiang, China
24 October & 8 November 2024	IEA-Annex 88 Webinars on Heat Pumps (iea-ebc.org)	Webinar

November 2024

18-19 November 2024	REHVA Brussels Summit (rehva.eu)	Brussels, Belgium
25-26 November 2024	ATMOSphere Europe Summit 2024 (rehva.eu)	Prague Congress Centre

December 2024

11-13 December 2024	55th International HVAC&R Congress and Exhibition (rehva.eu)	Belgrade, Serbia
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2025

February 2025

8-12 February 2025	ASHRAE 2025 Winter Conference (ashrae.org)	Orlando, USA
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March 2025

5-7 March 2025	World Sustainable Energy Days (wsed.at)	Wels, Austria
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June 2025

2-3 June 2025	REHVA Annual meeting 2024 (rehva.eu)	Milano, Italy
4-6 June 2025	CLIMA 2025 (climaworldcongress.org)	Milano, Italy

September 2025

24-26 September 2025	45th AIVC & ASHRAE 2025 IEQ joint Conference (ashrae.org)	Montreal, Canada
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2026

May 2026

19-23 May 2026	Indoor Air Quality, Ventilation and Energy Conservation in Buildings conference (IAQVEC: iaqvecassociation.org)	Los Angeles, USA
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