Artificial intelligence for smartness of the efficient and predictive building

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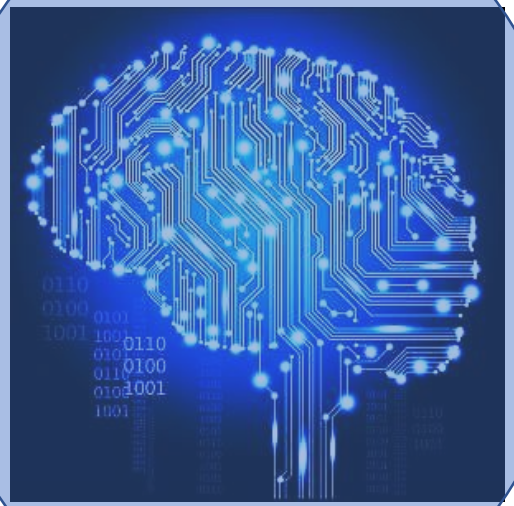
OUTLINE

- PRINCIPLES
- CRITERIA
- TARGETS
- METHODOLOGIES AND TRENDS
- STRATEGIES
- CONCLUSIONS



PRINCIPLES

scientific research

Technological Innovation with Artificial Intelligence

Qualified activity that contributes with great intensity

growth

PRINCIPLES

Technological Innovation with Artificial Intelligence

Qualified activity that contributes with great intensity

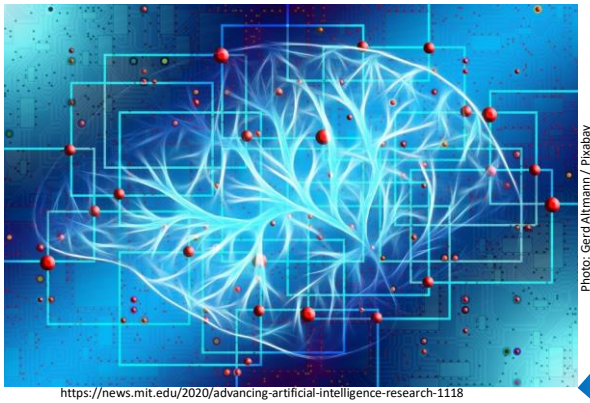


Photo: Gerd Altmann / Pixabay

https://news.mit.edu/2020/advancing-artificial-intelligence-research-1118

The predictive smart building, integrated with AI, is capable of correcting its errors, of acting with decision-making capacity, on experimentation, like human beings, and as a useful tool on which human intelligence predominates, highlighting the ethical value of man.

The **principles of the 2019 EU Code of Ethics**, leaving human autonomy to the supervision of the systems themselves, based on reliable and safe algorithms, for the entire life cycle of the system.

The efficiency of process innovation **increases productivity with a relative reduction in costs and production times** in certain supply chains in the construction sector, constituting a pollution factor of around 40% for the environment.

In fact, the critical issues are **those of an AI scalability** that does not **prevail over the activity of human intelligence.**

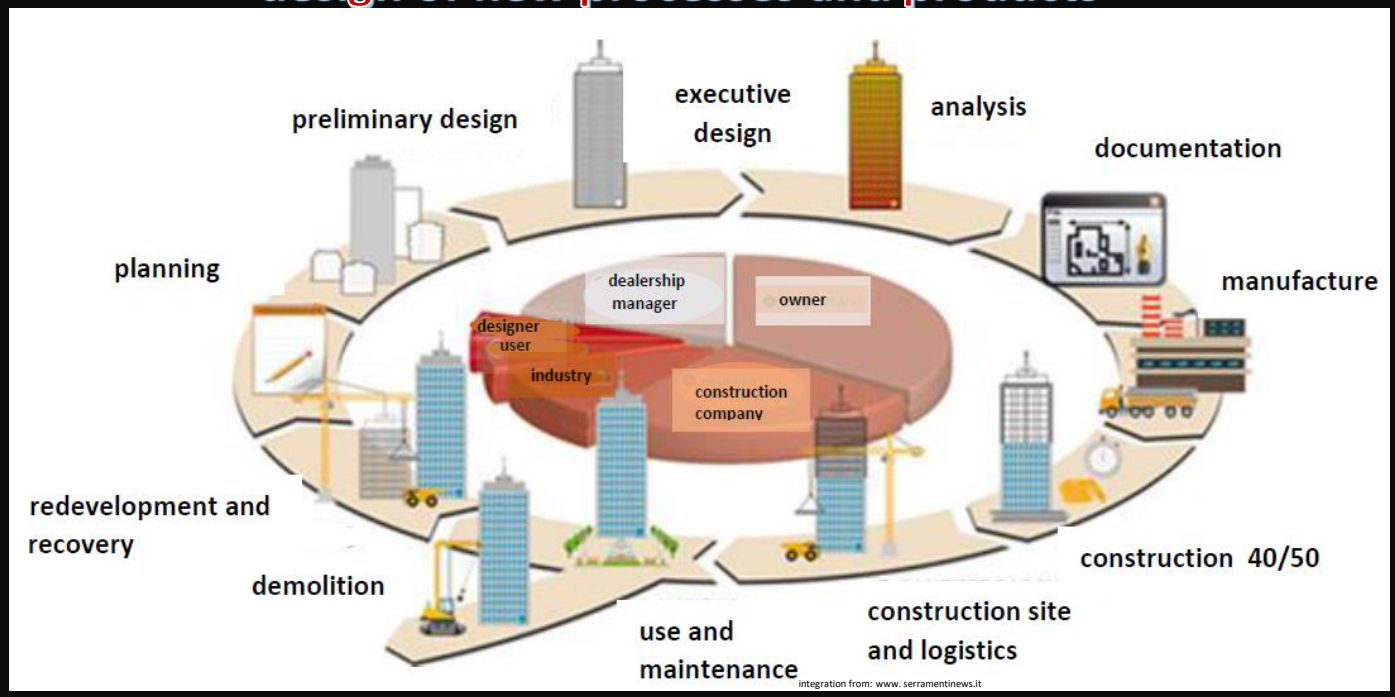
Technological Innovation, qualified activity that contributes with great intensity with AI

PRINCIPLES

According to a **study performed by McKinsey & Company "Artificial intelligence: Construction technology's next frontier**", the applications of **artificial intelligence** in business projects favors 50% more profit

The **architectural design with the intelligent integration of the systems** makes **building efficient and sustainable**, in which **AI** integrates by improving design and construction performance, on computational technologies and innovative nanotechnologies

design of new processes and products



CRITERIA

INTEGRATION

AI (Artificial Intelligence) IN **PREDECTIVE BUILDING**
Automation Systems
(UNI EN 15232)

INTERACTS WITH USER

PREDICTIVE ANALYSIS

- ❑ **SMARTNESS**
- ❑ **EFFICIENCY**
- ❑ **ENERGY SAVING**

BACS (Building Automation and Control Systems)

TBM (Technical Home and Building Management

automation and control

the technical management of the building

AI (Artificial Intelligence)

CRITERIA

Especially in commercial buildings that account for nearly 40% of total direct and indirect CO2 emissions and more, than 36% of global final energy consumption.

INTERACTS WITH USER → **PREDICTIVE ANALYSIS**

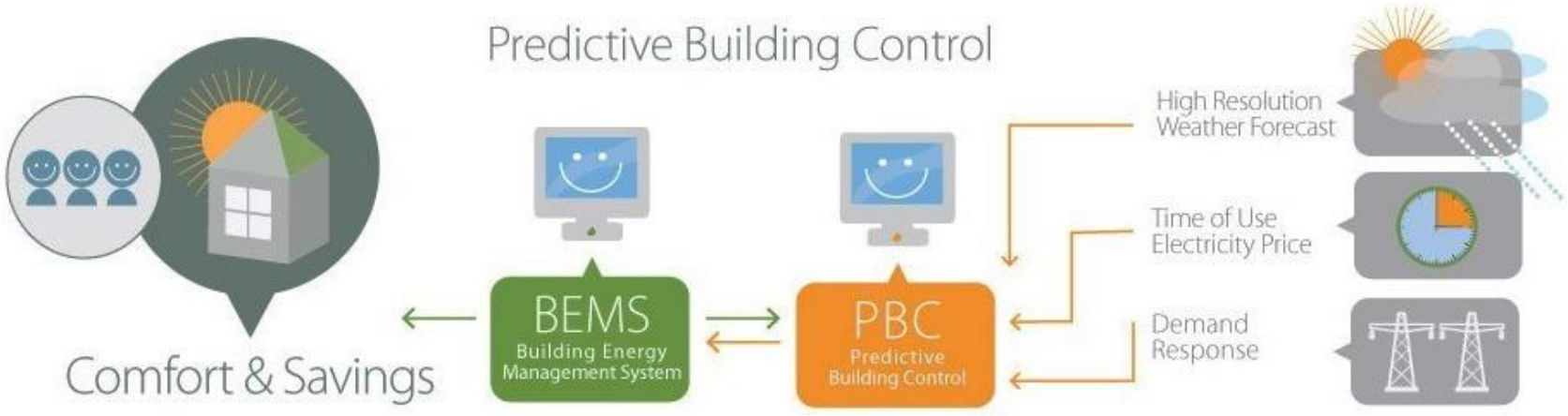
PREDECTIVE BUILDING

- ❑ **COMFORT**
- ❑ **WELLNESS**

HVAC BACS, TMB, BEMS

Advantage : Optimal Business Model

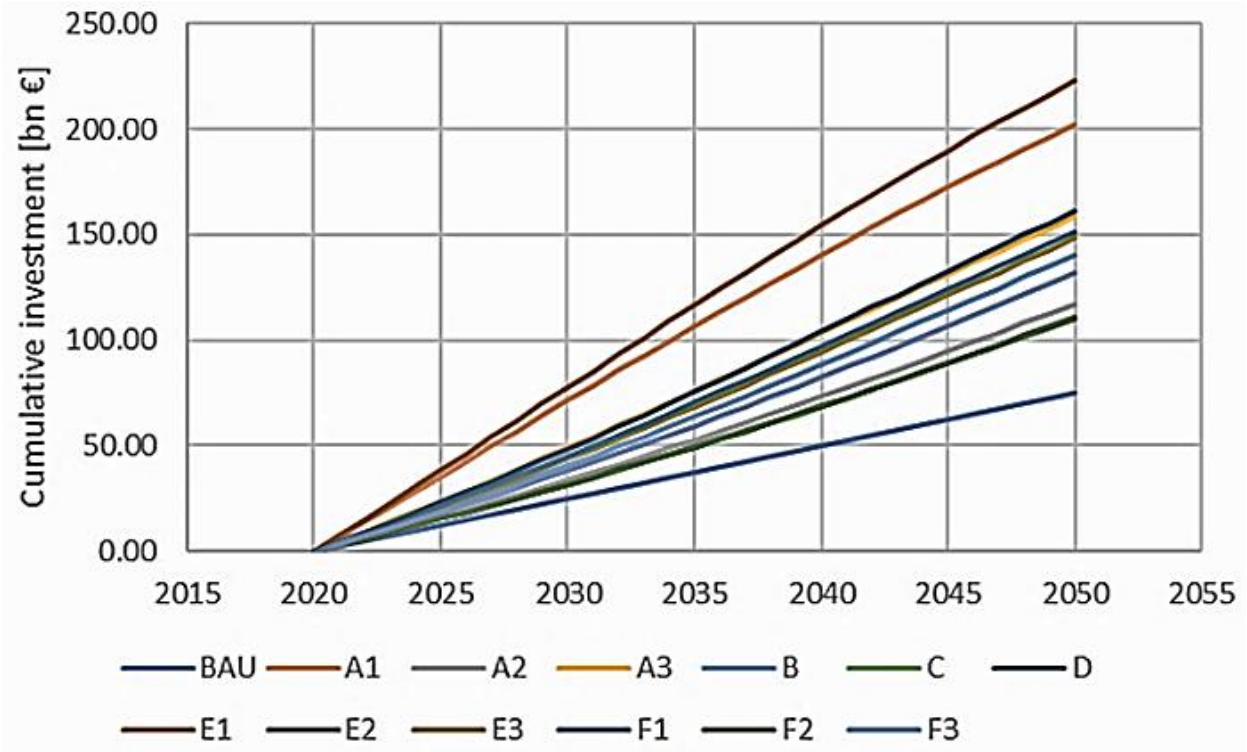
BEST RATIO BETWEEN **QUALITY** AND **PRICE**



greenpowerlabs.com/smart-buildings-smart-energy-management-buildings-building-energy-solutions/

CRITERIA

Smartness and Predective Building



Cumulative Investiment in SRTs

https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/presentation_sri2_stakeholdermeeting_2_-_2019-10-09.pdf

INCREASE

TARGETS

AI (Artificial Intelligence)

PREDECTIVE BUILDING

With Interface

ML (MACHINE LEARNING) → **Specific algorithms, capable of**

- ❑ correct their mistakes
- ❑ act with decision-making skills

↓

on experimentation, like human beings

source: shutterstock . https://uxdesign.cc/how-to-design-an-experience-for-the-global-community-by-leveraging-machine-learning-648ed214a35c

INCREASE

TARGETS

AI (Artificial Intelligence)

PREDECTIVE BUILDING

PRIMARY OBJECTIVE = **social/environmental and economic benefit, of comfort and well-being of users in smart and predictive buildings.**

SRI (Smart Readiness Indicator) for Buildings= **index** and **as energy triage**, with **building devices & solutions**, **automation technologies**, **control** and **management platforms** , **connectivity technologies** such as **communication protocols** between **sensors, actuators, control** and management, through **wireless** or wired networks.

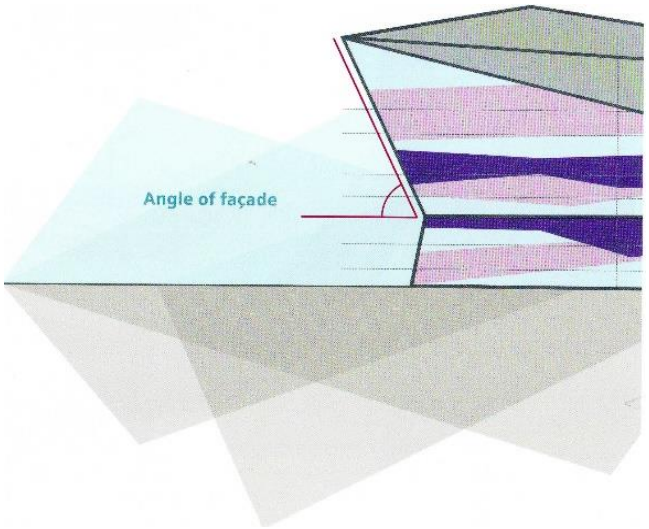
AI (Artificial Intelligence)

METHODOLOGIES AND TRENDS

PREDECTIVE BUILDING

Integration of AI implements **DIGITAL SYSTEMS** with open protocols, indicating the **exchange** with **other systems** and aimed at **greater efficiency**, both in energy and technology, of the integrated building/plant project, mainly **oriented for tertiary buildings, offices**

The Crystal, Wilkinson Eyre architects, London, UK . Photo by the author Consiglia Mocerino



Alexander J., Kiauk, The Crystal, A landmark building for Technology and Innovation, by Siemens, London. Design by Zest Communications Ltd, pag. 34. Publisher Booklink, Slovenia

The **methodologies** for the design of intelligent buildings in which passive design, as in the picture, intelligent and sustainable building from Siemens, collaborates in greater energy efficiency, also aim at the **integration of digitized automated systems**, including **BMS** and **BEMS**, which are technologically advanced, they interface, **through ML (Machine Learning) of open protocols**, with different and more manufacturers.

METHODOLOGIES AND TRENDS

The application of Artificial Intelligence in intelligent and efficient building, with support of smart technologies.

AI integrated in an automated and machine learning system PAML (Predictive Analytics and Machine Learning) for a high performance level of the building.

Parametric design, with BIM software and integration for MEP systems.

Advanced BEMS (Building Management Energy Systems), BMS for energy management.

Intelligent and computational construction technologies with support of technology innovation.

- **NEW digital performance, of systems integrated into building envelopes.**
- **AI, above all, holds a primary role for Facility Management.**

Implementation of plant efficiency with energy management, technology and **smart predictive building maintenance**

for the management and control of the intelligent building envelope and technological system

STRATEGIES

Integrated and advanced automated systems with implementation of Artificial Intelligence and use of RES to increase the self-consumption of energy product on site.

Connection to IoT on wireless networks, and use of digital technologies, with Cloud and Big Data.

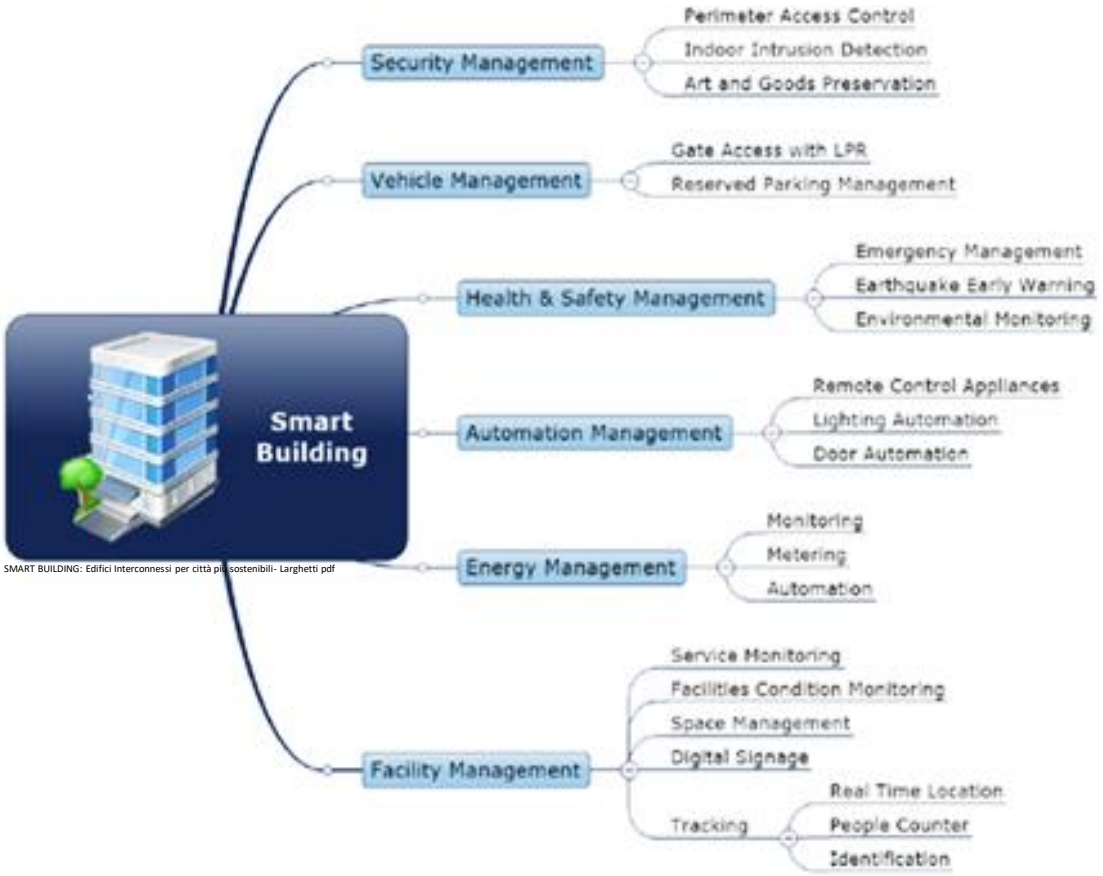
SRI (Smart Readiness Indicator), as an energy triage for energy, further efficiency of a sustainable method in the future of construction.

SRI for INTEROPERABILITY, CONNECTIVITY and EFFICIENCY of integration with grids and microgrids and for the benefits of self-production, Demand/Respons, balancing services of territorial networks and urban and peripheral agglomerations.

High digitization of buildings and the integration of RES with intelligent communication networks, ICT and IT and SRTs (Smart Ready Technologies).

SMART BUILDING
INTERCONNECTED BUILDING

STRATEGIES



SMART BUILDING: Edifici Interconnessi per città più sostenibili- Larghetti pdf

Iot, ICT, IT

SRI aims at the **FEASIBILITY** of an **ADDED VALUE** of the smart building in which **FOUR** fundamental **user figures interact:**

- ❑ owners
- ❑ users
- ❑ maintainers
- ❑ conductors

SMART BUILDING
INTERCONNECTED BUILDING

STRATEGIES

- **SMART digitization** with **SOFTWARE STRUCTURE** **for** formatting, transition, data consistency check, etc.
- **SMART digitization** with **HARDWARE STRUCTURE** (series of sensors, actuators, Web-enabled technologies, electronic meters, etc.) **for** management (lighting, HVAC, elevators, solar control, smoke presence, gas, earthquake, and other systems.

which can be interfaced with users via App, PC, tablet smartphone, etc., recognizing their voice, fingerprints, etc

- **AI (Artificial Intelligence) for PREDICTIVE MAINTENANCE** that brings benefits both in economic and safety terms, above all, of the systems and the spaces served (intensive care rooms, operating rooms and rooms for surgical use, offices, etc.).
- **AI with ML (Machine Learning) to optimize**, above all, the life cycle of a VCCC (Controlled Contamination Ventilation and Conditioning) plant of the AHU (treatment of air units).
- **IA the integration of the mathematical model of the ML algorithms**, through predictive maintenance **for EFFICIENCY**, preventing any plant failures, reducing the time for operators, errors and plant downtime through intelligent monitoring.

SMART INTERCONNECTED BUILDING
Efficiency and Smartness

STRATEGIES

DIRECTIVE (EU) 2018/844 - Energy Performance Building (EPBD) art.8

promotes	establishes	imposes	establishes
Renovation of pre-existing buildings by 2050, increasing the use of intelligent digital technologies for SMARTNESS of predective building	Non-residential buildings with rated useful power exceeding 290 kW, by 2025, are equipped with automation systems with self-regulating devices	The obligation, on the Member States, to improve the energy performance of new and existing buildings	On the basis of an optional joint system, the Smart Readiness Indicator (SRI) art.8, paragraph 10, the index that measures the ability to use Intelligence in the building in the new digital performance, of electronic systems and network integration

Possible design for high-level SRI scores: total score and score for key functionalities . ec.europa.eu/transparency/regexpert/index.

SMART INTERCONNECTED BUILDING

❖ Efficiency and Smartness

SRI : **Interoperability** for smartness in building, **connectivity** and **efficiency** of integration with grids and microgrids and for self-production benefits.

STRATEGIES

- **SRI index**, through which **all the performance**, both of the envelope and of the systems, of the building **are improved, aimed at efficiency, energy saving** with further satisfaction **of the users with whom they interact**, for safety and comfort, etc.
- **SRI index** that measures the ability to use Intelligence in the building in the new digital performance, of electronic systems and network integration.

Efficiency and Smartness in Predective Building

STRATEGIES

The SRI index points to the **energy triage** of the building sector in an integrated vision of the project for the smartness of the building and RES (Renewable Energy Sources).

Information Communication Technology **(ICT)** interact with Information Technology **(IT)** IoT (Internet of Things).

an intelligent management that aims at increasing energy efficiency on predictive models of maintenance, optimization of systems with distributed cogeneration, and EV-Driver charging

increase

Practice the dispatching services with accumulation systems and consequent **ENERGY SAVINGS** in the interconnection with "**aggregator subjects**" of mixed.

- ❑ **Aggregated Virtual Units (UVAM)** (storage systems, loads and generators, balancing the network, through consumption systems and also mixed systems that disconnect the loads for coordinated times and through energy input production systems).
- ❑ **Virtual Charging Aggregation Units** (UVAR)

In order to participate in auxiliary services, the value of 10 MW is usually set by lowering the power threshold.

Efficiency and Smartness in Predective Building

STRATEGIES

TRIAGE OF ENERGY - Platform of **DISTRIBUTED GENERATION** on **RENEWABLE SOURCES, ICT** and **IT**, **IoT** they manage and control both the input and the withdrawal of energy from the grid.

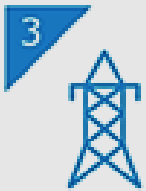
greater control in order to operate the systems and adoption of **the SRTs**, to a more conscious use of the building

three key functions :

- **intelligence** to adapt in response to the needs of the occupants,
- **facilitate maintenance** and efficient operation,
- **adapt according to** the situation of the urban and territorial infrastructural energy network.

Readiness to adapt in response to the needs of the occupant

Readiness to facilitate main-tenance and efficient operation



Readiness to adapt in response to the situation of the energy grid

https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_1st_technical_study_-_final_report.pdf

Efficiency and Smartness in Predective Building

STRATEGIES

intelligent and conscious integrated management in the building

The cloud-based Machine Learning integration optimizes building devices

by **MONITORING** and **VERIFYING** the maximum operating efficiency of these systems and **in particular Heating, Ventilation and Air Conditioning (HVAC)**

users participate by interfacing, via app with

- DIGITAL SYSTEMS
- ELECTRONIC SELF-REGULATION DEVICES

https://www.smartbuildingsalliance.org/ressources/publications-sba
https://www.smartbuildingsalliance.org/wp-content/uploads/2019/04/SBA_Manifeste_mars17-min.pdf

real-time savings
awareness and **reassurance**

Also for the purposes of **AIR PURITY,** these devices are considered useful for **ventilating the air in closed environments** and considered **most necessary even in this epidemic crisis of Covid_19**

Efficiency and Smartness in Predective Building

STRATEGIES

FEASIBILITY OF THE SRI

in the integrated and automated PROJECT system with MEP design for electrical, hydraulic and mechanical systems with simultaneous BIM with

- **the building devices & solutions**

  intelligent systems and technologies for energy management and with *safety & security* for user safety

  (photovoltaic, storage photovoltaic, solar thermal, cogeneration, heat pumps, glazed casing,etc.)

- **automation technologies**

  sensors for data collection, and plant actuators.

- **control and management platforms, collection**

  processing and sensor analysis.

- **connectivity technologies**

  such as communication protocols between sensors, actuators, control and management, through wireless or wired/wired networks.

https://www.smartbuildingsalliance.org/ressources/publications-sba SBA_B4V_Simi_dec19.pdf

Efficiency and Smartness in Predective Building

STRATEGIES

Accesso servizi su rete di circolazione dati dell'edificio con supporto cablato a Standard Ethernet-IP (Internet Protocol)

Smart Readiness Indicator → **smartness activities** → important in order to enhance digital performance → **for user well-being, for comfort, safety, environmental hygiene and indoor air quality** → **through predictive monitoring and control with improved functionality**

SRI aims at the feasibility of an added value of the Smart Building

The predictive interaction with the user and the digital systems in the building is usually based on autonomously estimated models, feedback from

internal and comfort services, atmospheric and meteorological data collection, etc. in **order to optimize the performance of the intelligent predictive building with maintenance**

SRI must provide complete information on the building technology and interface with users

Efficiency and Smartness in Predective Building

STRATEGIES

SRI ⇨ evaluated by the DOMAINS that refer to the technologies installed in the buildings, on different internal contexts defined **IMPACT categories** :

- ❑ energy efficient
- ❑ flexibility FOR GRID and conservation of energy
- ❑ self-generation
- ❑ comfort
- ❑ convenience
- ❑ health and well-being
- ❑ maintenance and fault prediction
- ❑ information to occupants

https://www.smartbuildingsalliance.org/project/cadre-de-reference-r2s
SBA_Plaquette_R2S_mars19-min.pd

In the building, smart ready technologies enable the services that are within the domains

The eight impact criteria

https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_1st_technical_study_-_final_report.pdf

SRI ⇨ TEN **SMART-READY** technical domains, in buildings are classified: **heating**, **cooling, domestic hot water**, **controlled ventilation**, **lighting**, **dynamic building envelope**, **on site renewable energy generation**, **demand side management**, **electric vehicle charging**, **monitoring and control**

https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_1st_technical_study_-_final_report.pdf

SRI = CALCULATION METHOD

based on SCORE

of each of the smart-ready services available in the building :

- **EVALUATION**
- **LEVEL OF INTELLIGENT FUNCTIONALITY**

on a predefined list of services and domains

For each service, approximately 1 to 5 levels of functionality are defined, corresponding TO A **MORE** OR **LESS** HIGH IMPLEMENTATION **defining the level of more intelligent** and **greater benefit in the building, such as :**

- functionality level 0: not present,
- functionality level 1: low charging capacity,
- functionality level 2: medium charging capacity,
- functionality level 3: high charging capacity,
- etc.

They are of different types with their intended uses such as residential, tertiary/office, commercial, production, tourism/accommodation, etc.

STRATEGIES

SRI = CALCULATION METHOD

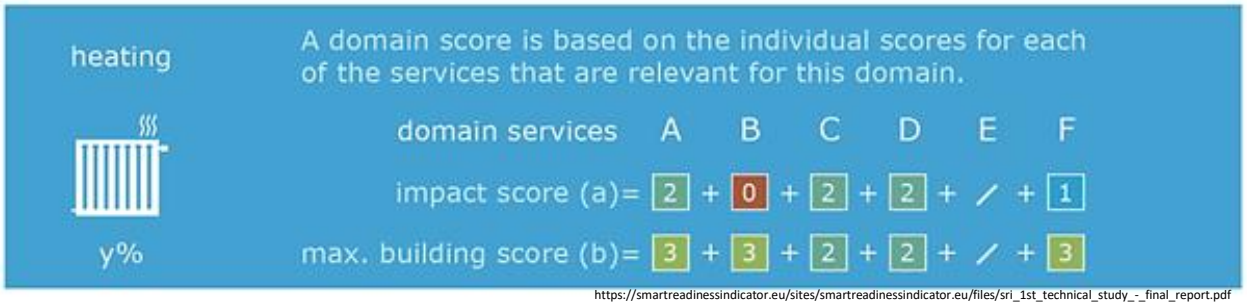
based on SCORE

of each of the smart-ready services available in the building :

- **EVALUATION**
- **LEVEL OF INTELLIGENT FUNCTIONALITY**

on a predefined list of services and domains

The weight of a given domain will depend on the relevance of a given impact



https://smartreadinessindicator.eu/sites/smartreadinessindicator.eu/files/sri_1st_technical_study_-_final_report.pdf

Heating domain score. Sum of score of all relevant services in a domain for a specific impact category

SRI	Class
>86%	A
>72%	B
>58%	C
>44%	D
>30%	E
>16%	F
16% or less	G

Example of SRI, score and scale

For example, the weight of the "heating“, the impact score of the domain will be higher than the weight of the "domestic hot water" domain, so that the score of "energy saving" results in the total impact score.

Predective Building and AI

STRATEGIES

EU Directive 2018/844 also **aims at Artificial Intelligence**, in obliging Member States to improve **the overall performance**, and in particular, the **energy performance, of new and existing buildings:**

- ❑ strong support for **automation**, **control with BACS** systems and **monitoring**
- ❑ **SRI,** as an **index of intelligence** that measures the ability to use information and communication technologies, together with electronic, etc.

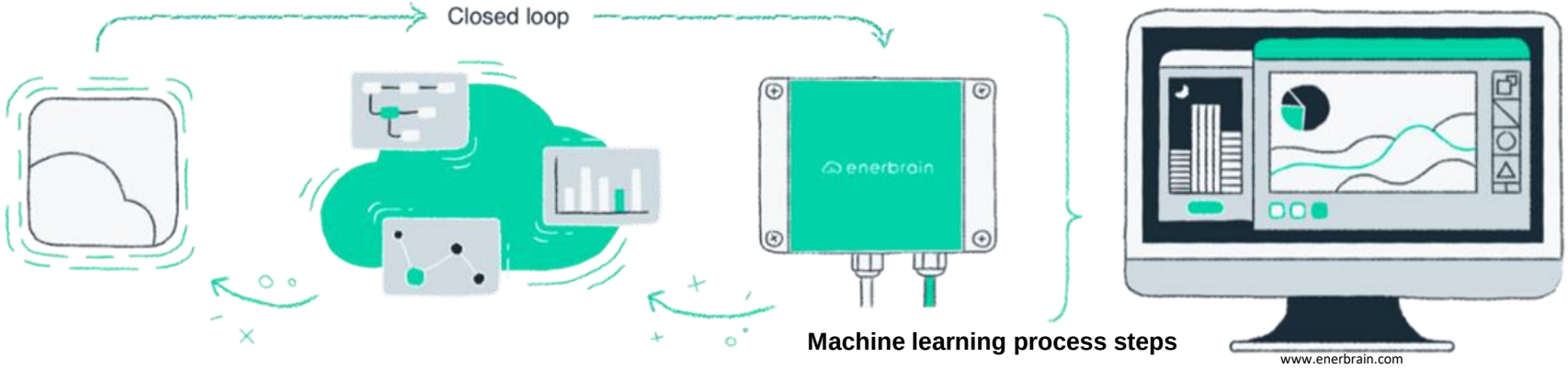
IA interfaces with Machine Learning that improve their skills and performance over time by optimizing a predictive system

Application of **ARTIFICIAL INTELLIGENCE** in an AUTOMATED and AUTOMATIC LEARNING SYSTEM **PAML** (Predictive Analytics and Machine Learning)

with the possibility of FORECASTING MODELS in the name of innovative projects

Predective Building and AI

- AI guarantees the reliability and prevention of damage, equity and correctness necessary for the predictive smart building system.
- AI represents the central unit to **which all computational technologies**, Facility Management and digital systems **are connected.**



Machine learning process steps

Example. **A building control and monitoring system**

The identifying data of the building, collected during its life cycle, **are transmitted and saved in the cloud which processes,** through a process of automatic learning, **predictive Machine Learning algorithms** with the function of **comfort**, **efficiency and for better performance**, they are analyzed and processed by the same algorithms, the KPIs (Key Performance Indicators) for **better efficiency and predictive maintenance action**, and then **convert the results into commands** for the building. Being able to manage, even with UX (User Experience) interface, in real time, the management process of the **smart predictive building.**

Predective Building and AI

STRATEGIES

- **AI- mathematical model formed by ANN (Artificial Neural Network) artificial neurons**
- **Deep Learning- method (subcategory of Machine Learning) algorithms**

are distinguished in the same way **AS THE STRUCTURE OF THE HUMAN BRAIN** with the related intellectual activities that determine the different functions and identifying themselves in the neural networks

DEEP LEARNING for

- **ASSISTIVE TECHNOLOGIES**, healthcare, construction, safety monitoring, factory inspections, self-driving vehicles, surveillance, visual search, etc.
- **COMMUNICATION** as in conversational interfaces including **Chatbot** software which allows a simulation of conversation with a human being, or Voice Assistants.

AI for Covid_19 pandemic :

- **the application** in all *sectors* (**pharmaceutical**, **healthcare**, **hospital construction**, **buildings**, **emerging services**, etc.).
- **the smart devices** improve the **performance** and **safety** in the environment **against the contagion of the virus**, **warning,** for example, **through the voice of smart services**, *not to touch the infected internal surfaces*, or *the door handles*, *thermostats*, *remote controls* , etc.

Predective Building and AI Innovative Technologies

STRATEGIES

process

Software INTERVENES with **ADEQUATE** and **UNEXPECTED** solutions, where the **POSSIBLE PREDICTION OF THE PROGRAMMERS** has not occurred

Algorithms allow the program **to LEARN**, and **to transmit the data** to the ML, acquired by the computer that REWORKS a model capable of making the connections, in a learning process

Deep Learning algorithms, which perform the analysis on Big Data, **high quantity for final outputs,** behaving **differently from Machine Learning which have a limit of scalability**, while increasing the data to the neural network

Predective Building

AI - Innovative Technologies

STRATEGIES

ISS (National Institute of Health) and the recent **REHVA** guidelines (Federation of European Heating, Ventilation and Air Conditioning Associations) **establish the appropriate values to avoid the spread of Covid_19,** indoors and in the pandemic period.

INTELLIGENT SENSORS
positive impact on
predictive maintenance

innovative technologies

Applied to all **security, control** and **monitoring systems** for **lighting, gas, HVAC, closure systems, AIQ indoor air quality**, with **CO2 levels**, etc.

Control unit for the system and integration devices on the **basis of open protocols**, through **Machine Learning** algorithms. **REAL TIME OPTIMIZATION** and **reduction in energy consumption.**

In this way and with these solutions **ACCESS the web directly**, with **understanding of consumption data** from meters on **Lonworks, M-Bus, ModBus,** etc., and with **PREDICTIVE AND EFFICIENT ALGORITHMS** capable of **reducing energy consumption by about 30%**

Predective Building . AI - Innovative Technologies

STRATEGIES

INTELLIGENT SENSORS
positive impact on
predictive maintenance

innovative technologies

For the MANAGEMENT OF HEATING or COOLING SYSTEMS, usually **plug & play sensors** are applied which, **through models on AI and Machine Learning, control** the **AIR QUALITY**, detect the CO2 and VOC indices, measure the temperature, the climate, and aimed at **improving efficiency with reduction of energy consumption costs.**

For **energy saving IEA agency** for energy saving and efficiency, **buildings could be almost 40% more efficient and intelligent by 2040,** with demand for energy **increasing by 3%** every year by 2040.

Predective Building and AI Innovative Technologies

STRATEGIES

- **EU, the European Commission** indicates a hypothesis of reducing energy consumption **by 5-6%**, promoting the **application of AI** which, together with the **NIST (National Institute of Standards and Technology)**.

- **efficiency and cost reduction, with the use of clean and renewable energy sources**

- BY 2050, for thermal energy, through **INTELLIGENT SOLUTIONS**, **energy savings** of approximately **150 TWh/a** (kilowatt hour) per year could be achieved
- **instead with the SRI Index** which affects the new performance and optimization of the building, it **could reach 350 and 420 TWh/a**

Predective Smart Building and AI Innovative Technologies

STRATEGIES

PREDICTIVE MAINTENANCE integrations

of **AI** to **IoT** and **intelligent devices**

BMS (Building Management System) and **BEMS** (Building Energy Management System)

guaranteeing AUTOMATION, management and control for **SAFETY, HEALTH, SECURETY SYSTEMS, VIDEO SURVEILLANCE, FIRE PREVENTION, ACCESS CONTROL, BUILDING ENVELOPE, such as vertical and horizontal closures**, with **COVERS , SMART WINDOWS, BLIND SYSTEMS, VIDEO CAMERAS, ELECTRICITY, GAS,** etc.

advantageous in managing assets remotely and controlling consumption with the intelligence of devices

For example: the algorithm for the ventilation function optimizes the **internal microclimate and air quality (AIQ)**, through sensors, suitably **installed on the building envelope closing systems** and in the environment, **WHICH MEASURE THE LEVELS OF CO2, RELATIVE HUMIDITY AND TEMPERATURE**.

In **summer,** on the other hand, **the heat control algorithm** intervenes on the **closing devices of the windows, automatically closing the blinds**, to avoid overheating in the rooms, and **calculating the closing and opening times, according to the external weather data received via web**.

Efficiency and Smartness in Predective Building

STRATEGIES

mathematical model of ML algorithms is used

through predictive maintenance

In numerous buildings, such as hospitals, offices, etc

to prevent, in a short time, the damage of a possible system failure and to optimize comfort,...

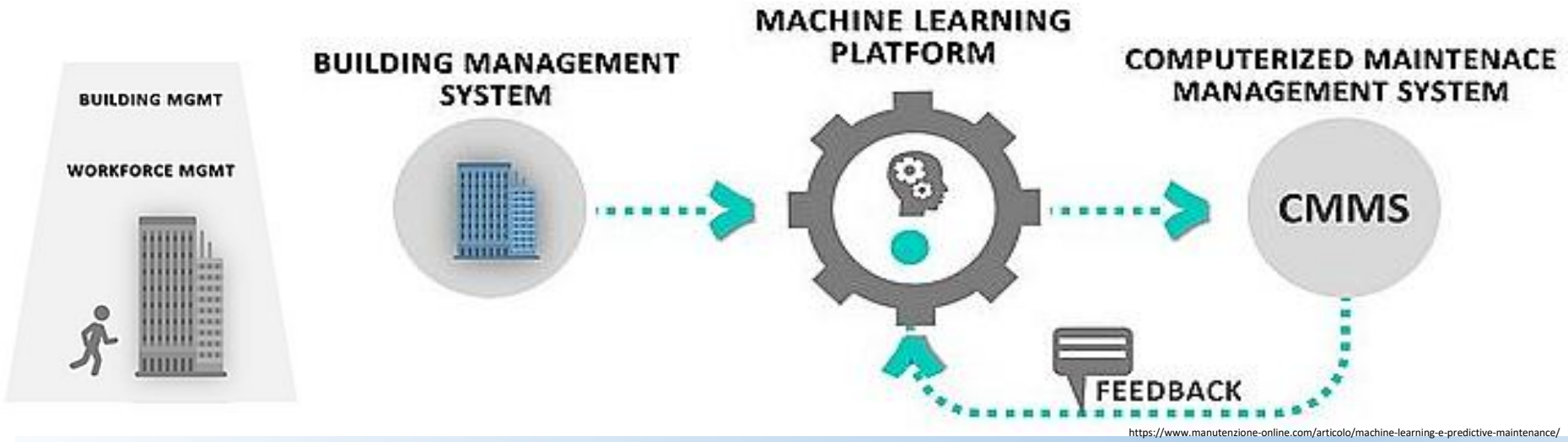
the life cycle of a **VCCC** (Controlled Contamination Ventilation and Conditioning) of **AHU** (treatment of air units), **Machine Learning algorithms are used**

hospital environments UNI EN ISO 14644-1 standard, **including the recirculated air,** with the **levels of cleanliness of the air** of the **suspended particles**, strongly linked to the levels of risk they entail surgical activities, etc.

AI becomes an **indispensable tool** for **preventing any failures and improving the plant engineering effort** throughout the predictive building with ML models.

Smart Predective Building and AI Innovative Technologies

STRATEGIES



https://www.manutenzione-online.com/articolo/machine-learning-e-predictive-maintenance/

The platforms, (collected and referred to the management of the analyzed assets and telemetry), through a Building Automation system **with BMS**, **apply to the various alarms** and to which the forecast objects are connected, **a particular and adequate ML model**, which identifies a series of correlations **between telemetry and possible faults.**

The **CMMS** (**Computerized Maintenance Management System**), **received the data from the ML Platform, transmits executive feedback to it**, in which **TO LEARN THE MAINTENANCE TECHNICIAN'S ACTIVITIES** and **optimize the forecasting capabilities of the damage to be avoided**
The ML model intervenes and prevents damage, **in the short residual times**, on plant assets, **also knowing which equipment the predictive maintenance needs,** which differs from the scheduled one, in which interventions are periodically established.

Photo by the author Consiglia Mocerino

Smart Predective Building and AI Innovative Technologies

Best Practices

Center Building Redevelopment (CBR),
London School of Economics, London, UK
Rogers Stirk Harbour + Partners (RSHP) architects, 2019

Redevelopment and construction of LSE (London School of Economics), among the most prestigious in the world of Faculty of Economics and Political Sciences, demolished most of the buildings of the associated offices and neighboring areas in the City of London.

In this context, a sustainable and efficient requalification is carried out, with the extension of teaching and research activities on strategic building quality objectives, commensurate with the international academic reputation of the LSE, in an integrated passive, low-E design approach with an annual CO2 emissions 9.9 kg /m² and a low-cost.

Smart Predective Building and AI Innovative Technologies

- **Center Building Redevelopment (CBR), London School of Economics, London, UK**
- **Rogers Stirk Harbour + Partners (RSHP) architects, 2019**

The buildings, some of which are largely from the 1800s, inefficient and obsolete, so they were planned for their demolition and intended for a new location.

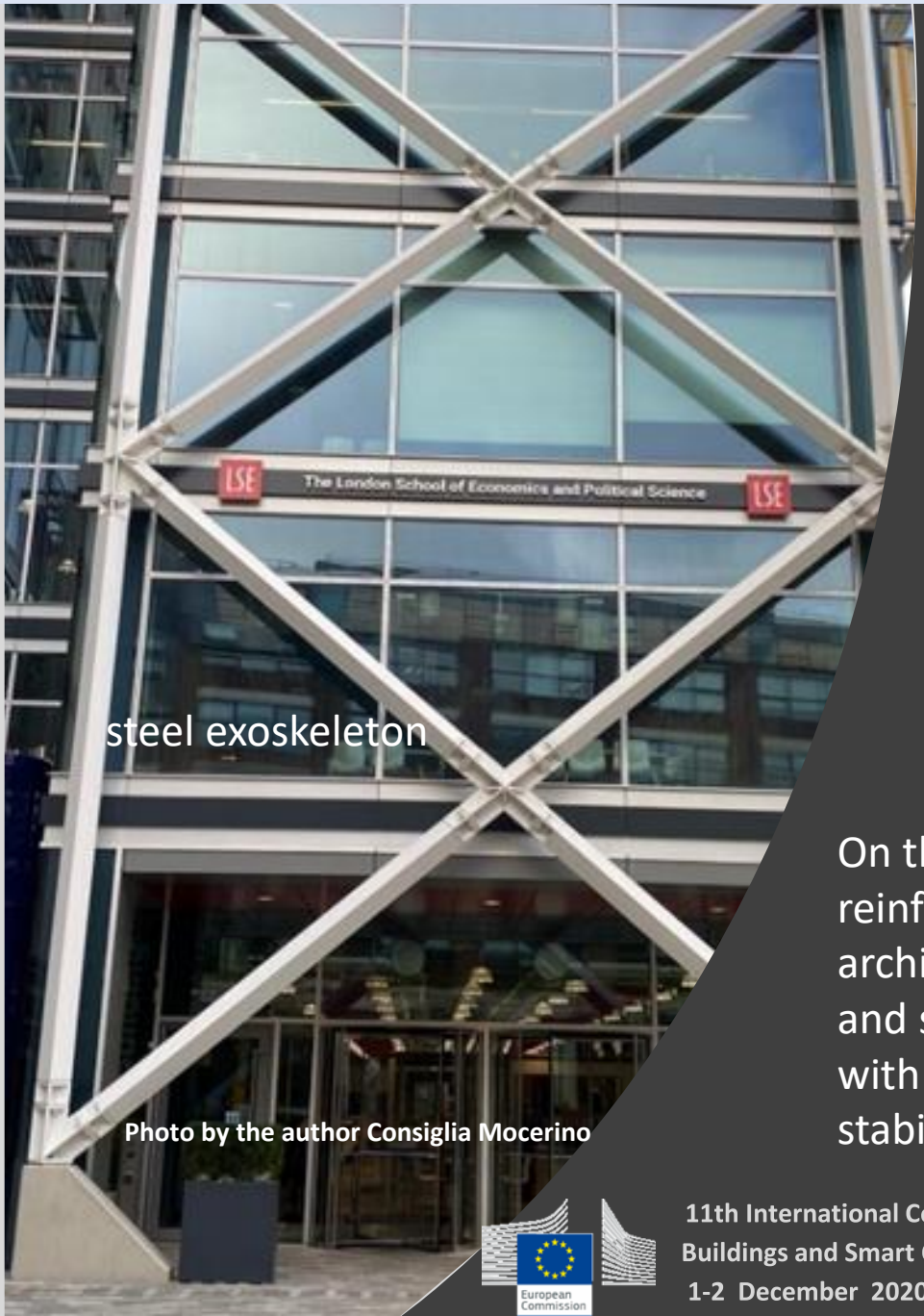
This is located south of Lincoln Inn Fields, of the LSE's Academic Building, and consists of two blocks of joint buildings :

Of which the **thirteen-storey Tower Block, which overlooks the Saw Swee Hock Student Center and includes external** terraces, and the **six-storey Houghton Block lining up with main facades on the East/West axis on sustainability objectives**, interconnected by a large central atrium and an adjacent staircase.

To the west, facade with double-height empty spaces

left Tower Block, right Houghton Block

Photo by the author Consiglia Mocerino



steel exoskeleton

Photo by the author Consiglia Mocerino

Smart Predective Building and AI Innovative Technologies

Best Practices

- **Center Building Redevelopment (CBR), London School of Economics, London, UK**
- **Rogers Stirk Harbour + Partners (RSHP), architects, 2019**

The **building is built through a prefabrication system assembled on site,** with off-site production, according to the MACE direction, it is made with concrete and steel structures, and has a glazed envelope, with triple glass.

On the facade two-story steel exoskeleton reinforcement structural grids of excellent architectural design, with the dual aesthetic and structural function, collaborating, together with the concrete structure, to the static stability of the two bodies.

Center Building Redevelopment (CBR), London School of Economics, London, UK.

Rogers Stirk Harbour Partners (RSHP)architect, 2019

Best Practices

The design concept is based on a facade design, large interior spaces, max glass envelope and low-emissive materials of the building, implemented by intelligent technologies for the supply of clean and renewable low-carbon energy with biofuel cogeneration.

An intelligence system for smart services, distributed on each floor and Departments of the CBR, **is based on intelligent sensors** which, through intelligent **monitoring and control meters**, record every 30 minutes, the consumption of biofuels with gas and electricity in the building.
BMS management is carried out to remove the heat in the rooms.

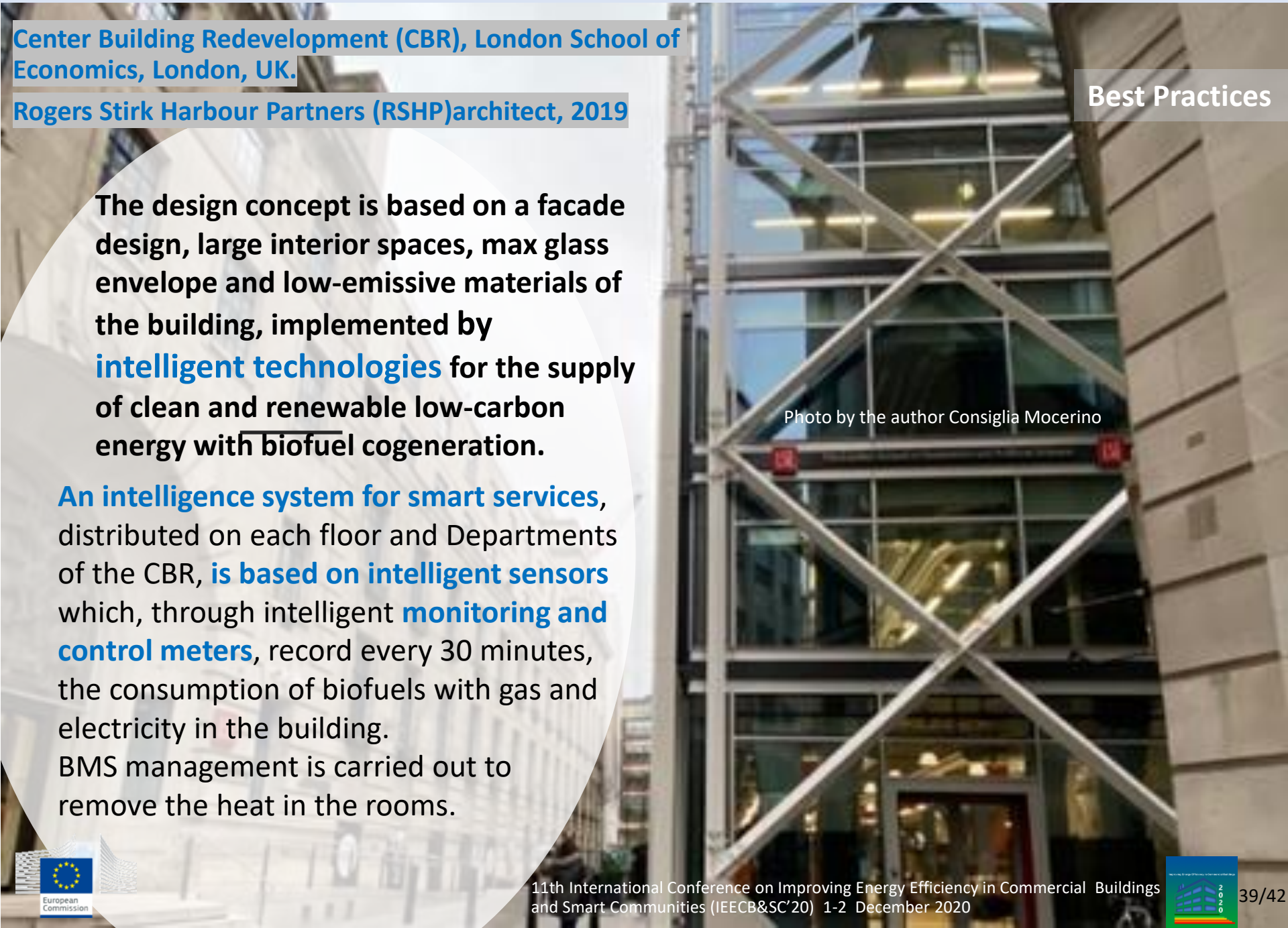


Photo by the author Consiglia Mocerino

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Best Practices

- **Center Building Redevelopment (CBR), London School of Economics, London, UK**
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- Control systems are installed for natural ventilation, Heating, Cellular Office, Windows & Blinds, fire safety and emergency evacuation, with voice alarm divided into two messages: *Evacuate and Alert*, referring to two areas that evacuate separately, for the Panel automatic window.
- **For the control of the lighting system, a system of intelligent sensors** is installed in the rooms to monitor the space by providing light and heat, with the installation of wireless eduroam (wifi).

FM (Facility Management), Predictive Building with intelligence applied to additional smart services, with presence detection sensors, which illuminate spaces, according to user movement, for air quality (AIQ), heating, adjustable also with a different setting, through control panels in the teaching spaces both heating and ventilation, for an optimal internal microclimate, are centrally controlled remotely.

Efficiency of the building process innovation aims above all at **productivity**, in the energy sector, towards integrated designs of building/plan based on BIM, MEP systems, with the application of computational hardware and software technologies, AI, Machine Learning and Deep Learning

Smartness Building, integrated with artificial intelligence and with services on **cloud** and **big data**, on principles of efficiency and intelligence with SRI with EU Directive 2018/844, EPBD, the 2019 EU Code of Ethics

Therefore, **AI with efficient and Predictive Buildings**, responding to **user needs and interacting, through architectural design**, and dynamic process methodologies, with information models and technologies of IT and ICT , IoT, aimed at saving energy, reducing production times and costs

Smart Predictive Building capable of reacting to both environmental and behavioral inputs in real time with digital and portable tools, interfaces with information models for the improvement of energy performance. Use of RES energy through automatic control systems BAC and TIM (EN 15232)

The **challenge** is energy efficiency and sustainability in Intelligent Predictive Buildings, representing with AI scalability an added value, that does not prevail over the activity of human intelligence

CONCLUSIONS

THANKS