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The Application of Minimum Environmental Criteria (CAMs) Construction and Sustainable Transformation of Public Building Stock

Antonella Valitutti[1,2], and Salvatore Roberto Perricone[1]

1. Ministry of the Environment and the Protection of the Territory and the Sea, General Directorate for Climate and Energy, Italy

2. Faculty of Civil Engineering, Telematic University UNICUSANO, Italy

Abstract: Urban and territorial regeneration involves important economic, social and cultural advantages, enhancing public building stock degraded from a structural, typological, energetic and environmental point of view. Buildings are responsible for approximately 40% of energy consumption and 36% of CO_2 emissions in the EU. Currently, about 35% of the EU's buildings are over 50 years old and almost 75% of the building stock is energy inefficient. Each year only 0.4-1.2% of the building stock is renovated. The aim of this paper is highlight how to transform the public building stock having a testimonial value, through the circular economy and energy efficiency to make urban reuse strategies more sustainable so it allows future generations to recognize the same cultural, social and environmental values that we can recognize today. In line with the above, the National Action Plan refers to specific decrees issued by the Ministry of the Environment identifying a set of "minimum" environmental criteria for the diffusion of "green" tenders in construction. In this context, the executive project assumes a fundamental role since the contracting stations, in case of works, must have an executive project already in conformity with the CAMs. Through the application of particularly significant criteria, the paper intends to provide operational indications, showing how this innovative tool is able to generate new social and economic value in existing buildings.

Key words: sustainability, architecture, green public procurement, intergenerational/intragenerational equity, executive project

1. The Paradigm of "Inter and Intra-Generational Equity" Applied to the Conservation and Protection of the Building Heritage

Brundtland Report, also called *Our Common Future*, publication released in 1987 by the World Commission on Environment and Development (WCED) identifies the critical points and global problems of the environment and highlighted, for the first time, the need to implement a strategy capable of integrating the needs of development and the environment. This strategy has been defined with the term "sustainable development" which is defined as follows: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

An apparently conflicting assumption which, on the one hand, refers to the concept of maintaining/ preserving the existing conditions over time (sustainability starting from the "state of knowledge") and on the other hand the idea of change, of transformation (development).

Corresponding author: Antonella Valitutti, Ph.D. in Environmental Design, Architect, Adjunct Professor; research areas/interests: energy efficiency of public buildings, rehabilitation and re-use of areas and settlement systems of particular environmental relevance (urban public space, abandoned areas, rural areas) with specific attention to the resilience and adaptability of built environment, Cultural Heritage prevention and protection, the technological innovation. E-mail: avalitutti@yahoo.it.

The theme of the "handed down" finds, therefore, a concrete application in what can be considered the qualifying elements of sustainable development: sharing, long term vision, inter and intra generational equity.

This last concept, in particular, emphasizes the social aspect of sustainability which implies equal access and full enjoyment by all citizens ("from generation to generation") of the public assets as they have been handed down to us.

All this can be possible by implementing strategies for the recovery and enhancement of the degraded public building heritage, which take into consideration the energy and environmental aspects as well as the structural and typological ones.

The following describes how these two factors (energy and environment) can contribute to giving new social and economic value to existing buildings, thus favoring greater usability by both present and future generations.

2. Energy and Environmental Requirements as Drivers for Building Sustainability

The Energy Union and the Energy and Climate Policy Framework for 2030 establish ambitious Union commitments to reduce greenhouse gas emissions further by at least 40 % by 2030 as compared with 1990, to increase the proportion of renewable energy consumed, to make energy savings in accordance with Union level ambitions, and to improve Europe's energy security, competitiveness and sustainability.

Taking into account that almost 50% of Union's final energy consumption is used for heating and cooling, of which 80% is used in buildings, the achievement of the Union's energy and climate goals is linked to the Union's efforts to renovate its building stock by giving priority to energy efficiency, making use of the "energy efficiency first" principle as well as considering deployment of renewables.

The European Union has defined a programmatic and regulatory framework within which the 2010/31/EU Directives on the energy performance of buildings and the 2012/27/EU on energy efficiency, have allowed to put in place instruments, criteria and harmonized and shared solutions on the specific issue of increasing the energy efficiency of existing and new buildings [1].

Finally, with specific reference to the building sector, the new Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency, defines particularly significant objectives:

- establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings;
- the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building;
- establish an smart readiness indicator should be used to measure the capacity of buildings to use information and communication technologies and electronic systems to adapt the operation of buildings to the needs of the occupants and the grid and to improve the energy efficiency and overall performance of buildings.

At national level, the first of the implementing decrees provided for by Legislative Decree n. 192/2005, the Ministerial Decree of 26 June 2015 (DM Minimum Requirements), defines, among other things, the minimum requirements concerning energy performance, for public and private buildings, and for new buildings both for the renovation of existing buildings.

The achievement of high standards of energy efficiency cannot, however, be separated from the adoption of techniques of "Green Building" and "Eco-sustainable Architecture" aimed, respectively, at the use of building materials of natural origin and low-impact construction techniques environmental and assessment of the entire life cycle of the building: from the production and transport of materials to construction, from the use phase of the building to its decommissioning.

The correct application of this approach also refers to the most recent concept of circular economy applied to construction based on which each project is developed in the logic of maximum reduction of waste.

Both of these aspects (energy performance and building sustainability) contribute concretely to the definition of urban "re-use" strategies aimed at valorization, through the restoration, maintenance and restructuring of the building heritage.

This enhancement must, on the one hand, pursue a greater durability of the artifacts and on the other improve the feeling of well-being (comfort) in the use of the buildings.

To this end, a minimal role is played by the Minimum Environmental Criteria (CAMs).

3. The Minimum Environmental Criteria (CAM) as an Innovative Tool for Building Sustainability

The desire to "integrate environmental requirements into Public Procurement" dates back to Communication 2003/302 of the European Commission, which encouraged Member States to adopt specific "Action Plans".

In Italy with the Ministerial Decree 11/04/2008 the "Action Plan for the environmental sustainability of public administration consumption" ("Green Public Procurement Plan") is launched, which aims to maximize the spread of "green tenders" at institutions public also through the introduction of the "Minimum Environmental Criteria" (CAM), adopted with specific Decrees of the Minister of the Environment for the Protection of the Territory and the Sea. Italy, thanks to the Law 221/2015 and to the New Code on Public Procurement (Legislative Decree 50/2016), has been the first country in Europe that set as mandatory the use of the Minimum Environmental Criteria in public procurement. At European level the use of these criteria is incentivated but not completely compulsory. Minimum Environmental Criteria are those criteria — inspired to environmental principles, i.e., saving energy or decreasing the use of natural resources — that the Public Administration should consider when purchasing a service or a product. Furthermore, the current legislation includes, among the criteria for the evaluation of the more advantageous offer, a consideration on the life cycle of the product and thus a perspective linked to the circular economy approach.

The CAMs, defined within specific work groups, do not completely replace the criteria normally found in technical specifications, but are added to them, in a relationship of reciprocal correlation and interaction, specifying the environmental requirements aimed at identifying the design solution, the best product or service from an environmental point of view throughout its entire life cycle.

The Decree of 11 October 2017, issued by the Ministry of the Environment, concerning the "Minimum environmental criteria for the assignment of planning services and works for the new construction, renovation and maintenance of public buildings" represents, in this panorama, the innovative tool which has placed even more emphasis on the centrality of the design moment, providing new and a great deal to think about, both for the designers and for the contracting stations, both in relation to the new technological paradigm that the CAMs propose, which revolves around the environmental product certification (LCS, Ecolabel, EPD, etc.), both with regard to the opportunity and the criteria they offer to combine the creative phase with the construction and operation phase of the buildings, without neglecting the aspects

linked to the subsequent decommissioning phase (disassembly, recovery, recycling of materials).

3.1 The Executive Project Conforming to the CAM

The redevelopment measures must be carried out with greater resource efficiency, which requires operational policies and instruments that take into account the environmental impacts throughout the life cycle of the building-plant system. The existing project does not necessarily concern only the energy upgrade but is influenced by multiple input factors such as the impact of the technical components, the deterioration and obsolescence conditions of the building as a whole, the quality of the internal environment and also by environmental, social and economic factors.

In this direction, it is important to ensure that measures to improve the energy performance of buildings do not focus only on the building envelope, but include all relevant elements and technical systems in a building, such as passive elements that participate in passive techniques aiming to reduce the energy needs for heating or cooling, the energy use for lighting and for ventilation and hence improve thermal and visual comfort.

In the field of Public Procurement, the aim is to direct the Public Administration towards a rationalization of consumption and purchases from an environmental sustainability point of view, ensuring environmental performance above the sector average, starting above all from a careful analysis of your needs.

According to Directive 2018/844 it is appropriate to use concepts such as trigger points, namely opportune moments in the life cycle of a building, for example from a cost-effectiveness or disruption perspective, for carrying out energy efficiency renovations.

In this sense, the Construction CAMs represents a targeted action and a tool to achieve a a highly energy efficient and decarbonised building stock and to extend the life cycle of buildings. The Minimum Environmental Criteria allow to qualify the building as sustainable and constitute the minimum endowment of technical specifications, suitable to guarantee an adequate response from the market to the proposed offer.

The building is a complex system where all the subsystems influence the environmental and efficiency performances and where the interdependence between the subsystems plays a significant role.

The integration of the environmental aspects in the transformation process of the existing is based on a vision of the whole, of the entire life cycle of the building thus allowing to create synergies between the actors of the building process and to improve the overall performance of the building guaranteeing high sustainability performance.

To identify eco-efficient technological solutions by stimulating eco-innovation in sectors relevant to economic and environmental importance, it is then necessary to be able to refer to a repertoire of codified criteria.

In this context, the Construction CAMs define a set of criteria referable to different aspects, although related to each other and oriented towards the user as the recipient of the asset, such as: protection of soil and habitats, energy consumption, use of renewable energy sources, energy consumption monitoring systems, user well-being, water, waste and site management.

Specifically, the CAMs prescribe:

- *technical specifications for groups of buildings*: these are prescriptions and indications relating to one or more groups of buildings, neighborhoods and settlements. There are, for example, the types of criteria concerning the naturalistic and landscape insertion, the situation of the intensive green areas and/or connected to the settlement, the reduction of soil consumption and maintenance of soil permeability, the preservation of the characters existing morphological, etc.;
- *technical specifications of the building:* they concern specific provisions for the individual

building and/or construction (renovation and/ or maintenance) which consist of internal environmental quality, energy, water and materials savings, etc.;

- *technical specifications of the building components:* they refer to the components or products and materials constituting the building and/or buildings and their environmental characteristics;
- site specifications;
- rewarding technical specifications;
- conditions of execution.

In practice these are quantitative and qualitative requirements that involve building systems and subsystems (described by units of measurement, limit values and initial conditions, quality and performance levels, etc.) that define the reference variables on which to intervene, but whose analysis requires verification campaigns and methods for determining their values and their weight.

For example, for criterion *2.3.2 Energy performance*, to demonstrate compliance with this criterion the designer must present the technical report referred to in the Ministerial Decree 26 June 2015 and the Energy Performance Certificate (APE) of the ante and post-construction building , guaranteeing, for example in the case of first-level restructuring, the following services:

1) compliance with the conditions set out in Annex 1 par. 3.3 point 2 lett. b) of the ministerial decree of 26 June 2015, providing for the application of specific performance and energy efficiency indices that this decree provides for public buildings;
2) adequate conditions of thermal comfort in indoor environments, through a design that foresees a periodic internal thermal capacity (Cip) referred to each single opaque structure of the external envelope, calculated according to UNI EN ISO 13786: 2008, of at least 40 kJ/m²K or by calculating the summer operating temperature and the waste in absolute value evaluated in accordance with the UNI EN 15251.

In this context, the executive project assumes a fundamental role as, among other things, confirmed by the recent clarifications provided by the same Ministry in relation to CAM Construction, where it is stated that "*the contracting station, [...], in the case of works, must have an executive project already compliant with the CAM*". Specifically, it is envisaged that Public Administrations must necessarily include in the project and tender documentation at least the technical specifications and contractual clauses contained in the CAM.

The professional who participates in the design or who is entrusted with the work by the Public Administration is required to comply with the minimum environmental criteria and to certify their correct application at the end of the work.

However, in view of this potential, as well as the cogency of the issues in question, there is no adequate focus on the subject by the sector operators and, even more rarely, it is possible to trace examples of concrete application of CAMs, from the ideational phase to the realization.

4. Verify the Compliance of the Executive Projects

To verify the correct application of CAMs to the sustainable transformation process of public buildings it is therefore necessary to examine the interrelation between the project documents (reports, tables, metric calculations, specifications, etc.), concerning the application of CAM.

For this purpose, it is desirable to insert an ad hoc document (Report on Minimum Environmental Criteria), or in any case an equivalent report, which contains the description of the design criteria adopted through the definition of the following information:

- *introduction*: brief description of the criterion;
- *reference design documents*: indication of the project documents (reports, tables, etc.) in

which the references to the requirements of the criterion are reported;

- *methods for applying the requirements of the criterion:* description of the ways in which the requirements of the criterion are satisfied (description of the technical specifications of the components and building materials);
- *verifications:* description of the information and documentation to be attached at the time of participation in the tender, the means of proof required, and the methods to carry out checks during the contractual execution;
- *for each criterion not applied*: detailed description of the reasons that led to the failure to apply the criterion.

Below are some examples of the application of particularly significant criteria for the purposes of this paper, just as they could be reported in a hypothetical *Specialized Report on Minimum Environmental Criteria*.

1) ***Criterion 2.3.2 Energy performance:*** verification of the requirements defined by the DM 26/06/2015 (DM Minimum Requirements), of the periodic internal air capacity (CIP) and/ or of the summer operating temperature for the most unfavorable environments.

Building subject to energy efficiency: School
Climatic zone: C
Methods of application: within the executive project, of the requirements set by the Criterion: as shown in the Energy Performance Verification Report (ex Law 10/91) the internal heat capacity of the enclosure vertical walls and partition walls towards unheated rooms was verified.

In particular it results:

- external tuff wall with coat, CI: 65.102 kJ/m2K
- septa in c.a., CI: 69.370 kJ/m2K
- block partition wall, CI: 61,863 kJ/m2K
- fireproof masonry, CI: 57.339 kJ/m2K
- fireproof masonry, CI: 59.937 kJ/m2K
- atrium roofing slab, CI: 69.969 kJ/m2K
- acoustic floor covering of classrooms, CI: 19.572 kJ/m2K
- floor covering of classrooms, CI: 12.239 kJ/m2K
- attic and first hall floor slab, CI: 49.526 kJ/m2K
- floor slab of first foot traffic, CI: 55.987 kJ/m2K

Reference design documents:

- Energy performance verification report (Ex L. 10/91)

2) ***Criterion 2.3.3 Energy supply:*** verification of the use of renewable sources

Building subject to energy efficiency: City Hall
Climatic zone: D
Methods of application: within the executive project, of the requirements set by the Criterion: as far as the present project is concerned, the solutions provide for the integration of a 54.59 kW photovoltaic system, a solar thermal system and a heat pump air conditioning system with a coverage of the overall building requirement of 91.50% > 66.5% (minimum value of Legislative Decree 28/11 + 10%).

Reference design documents:

- General Report
- Specialized thermomechanical plants report
- Energy performance verification report (Ex L. 10/91)
- Technical report Law 10
- Heating and cooling system.
- Ventilation system and air exchange with heat recovery
- Heating, cooling and ventilation system, functional scheme and dimensional characteristics
- ACS and solar thermal system calculation report
- ACS and solar thermal system specialist report - Tables
- DHW system, solar thermal and technical room
- DHW system, solar thermal, cover and functional diagram

- Specialized electrical and photovoltaic system sizing report
- Specialist photovoltaic system report
- Photovoltaic system Floor coverage plan

3) ***Criterion 2.4.1.2 Recovered or recycled material:*** The content of recovered or recycled material in the materials used for the building, even considering different percentages for each material, must be equal to at least 15% in weight, assessed on the total of all the materials used. Of this percentage, at least 5% must consist of non-structural materials.

Building subject to energy efficiency: Historical building

Climatic zone: D

Methods of application: within the executive project, of the requirements set by the Criterion: the total of materials that can be subjected to selective demolition and non-structural recyclable is equal to 87.41%> 50% of which 11.74% of the total can be disassembled and reassembled on another building.

Reference design documents:

- General Report
- Special tender specifications and descriptive and performance specifications of the technical elements.

	m^2	m	kg	Thickness m	Specific weight kg/m^3	Surface mass Kg/m^2	Mass by length Kg/m	Total Kg
External plaster in natural lime*	2100			0.020	1400			58800,00
Natural lime finish*	2100			0.005	1450			15225,00
Insulation for blowing*			99		23			2277,00
Putty in bastard mortar	2100			0.01	1800			37800,00
Descendants in galvanized sheet metal *		355		8/10			2,11	749,05
Polycarbonate	30			0.01	1200			360,00
TOTAL								330810,58
Total non-structural recyclable materials								289159,60 (87.41%)
Total removable and reusable materials								38843,10 (11.74%)

* recyclable materials

5. Conclusions

The current needs related to building redevelopment and the integrated conservation of the public building heritage make it necessary to adopt a design methodology addressed to the specific context of intervention and capable of suggesting integrated operational strategies able to increase the livability and environmental quality of the environments but above all to guarantee those values attributed to specific aspects of the building heritage and that the community, in the context of public action, wishes to support and transmit to future generations.

Regarding the intervention strategies, a fundamental aspect concerns the technical impact of the choices to be made from an economic and temporal point of view (cost and benefit analysis, return on investment, improvement of the energy-economic efficiency of the interventions, benefits for administrations, etc.) and the qualitative increase that can be pursued through different types of intervention. All this also presupposes the intellectual willingness of the designers to “conceive” (interpret and adapt) the technologies and, more generally the choices of a technical nature, as fundamental elements of a matrix of ideas and a whole with the ideational and realization

phase of the design process, without this reducing the planning moment to a mere application of regulations.

In this context, the energy-environmental criteria defined within the Minimum Environmental Criteria (CAM) must be conceived as a "toolbox" available to the designer, a combination of different technological solutions that makes it possible not to reduce the intervention of energy requalification to a mere list of project interventions. It is therefore essential that the designer makes use of multiple solutions capable of optimizing all the differentiated performances of the envelope and guaranteeing the comfort and liveability of the interior spaces.

References

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[2] Communication from the Commission to the Council and the European Parliament COM, 302 final, *Integrated Product Policy Building on Environmental Life-Cycle Thinking*, 2003.

[3] *Action plan for environmental sustainability of consumption in the Public Administration sector* (PAN GPP), Ministry of the Environment and Protection of the Territory and the Sea, 2008.

[4] Law of 28 December 2015, n. 221 *Environmental provisions to promote green economy measures and to contain the excessive use of natural resources*

[5] Legislative Decree 18 April 2016, n. 50 *Code of public contracts.*

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