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GETTING TO ZERO
beyond energy transition, towards carbon-neutral Mediterranean cities

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THESIS TITLE

ARCHITECTURAL ASPECTS OF THE RENOVATION OF PUBLIC BUILDINGS IN PODGORICA IN ACCORDANCE WITH THE PRINCIPLES OF ENERGY EFFICIENCY

Case Study: Technical Faculties Building in Podgorica

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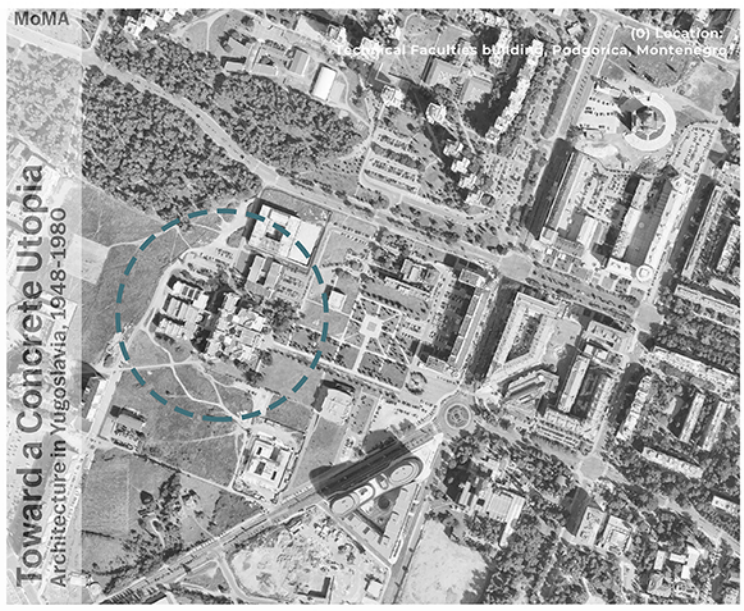
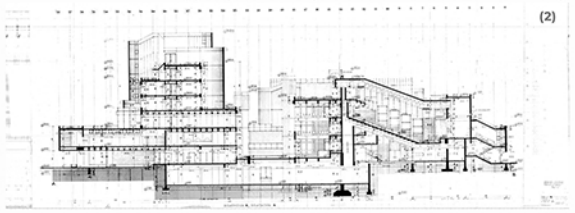
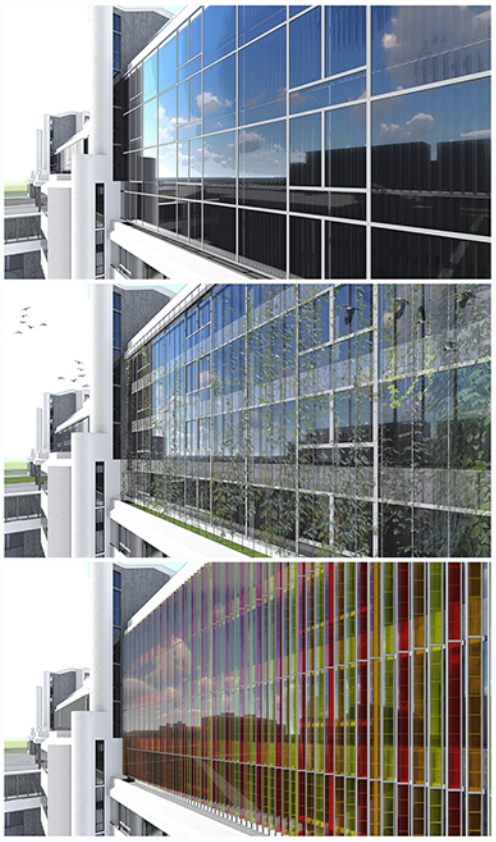


(1) Photo of the Technical Faculties building soon after finished construction
(2) Original drawings of the Technical Faculties building

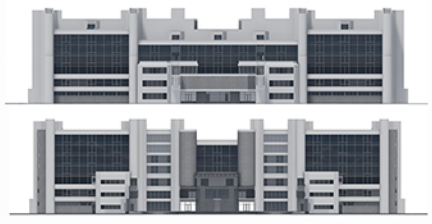


Podgorica is the capital city and represents the largest urban agglomeration of Montenegro. Podgorica is characterized by the direct influence of the Mediterranean climate conditioned by the proximity of the Adriatic Sea, but also the mountainous hinterland, which results in the appearance of a modified Mediterranean type of climate with warm and hot summers and mild and rainy winters.
Buildings in Montenegro from the period up to 1990 were built in accordance with the standards of the former Socialist Federal Republic of Yugoslavia and mostly have poor energy characteristics. Even though some of these buildings were initially thermally insulated, due to long-term exploitation and the effect of external influences, the insulation materials were generally degraded. Also, parameters such as compactness, passive heating/cooling strategies, etc. were not taken into account - the topic of energy efficiency was simply not in focus at the time of construction of these facilities.
The building that is the subject of the renovation project is the so-called "Dilatation B", a two-track administrative/office building within the complex of Technical Faculties of the University of Montenegro.

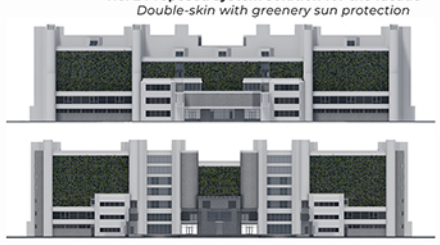
FACADE RENOVATION



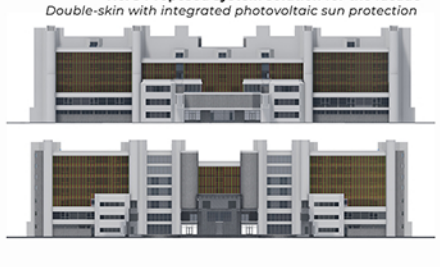
No. 1 Proposed system solution for the facade
Double-skin with sun protection in the intermediate space

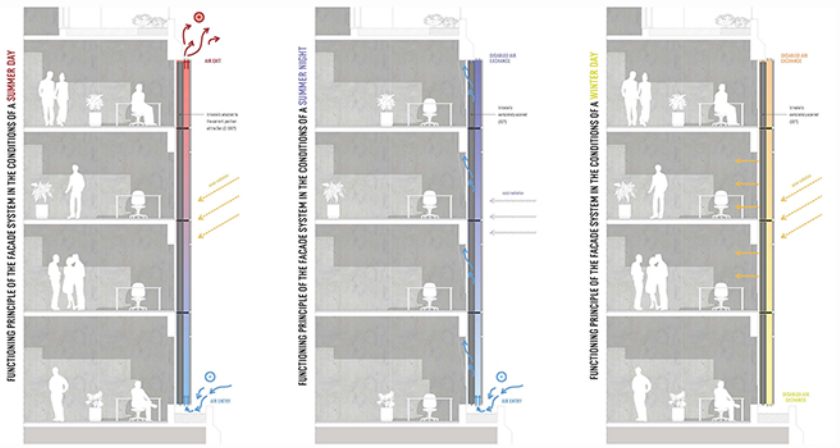


No. 2 Proposed system solution for the facade
Double-skin with greenery sun protection



No. 3 Proposed system solution for the facade
Double-skin with integrated photovoltaic sun protection

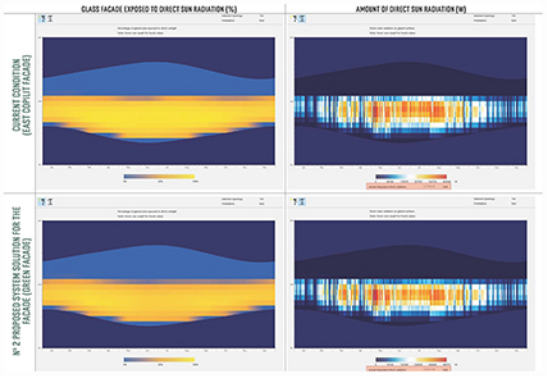




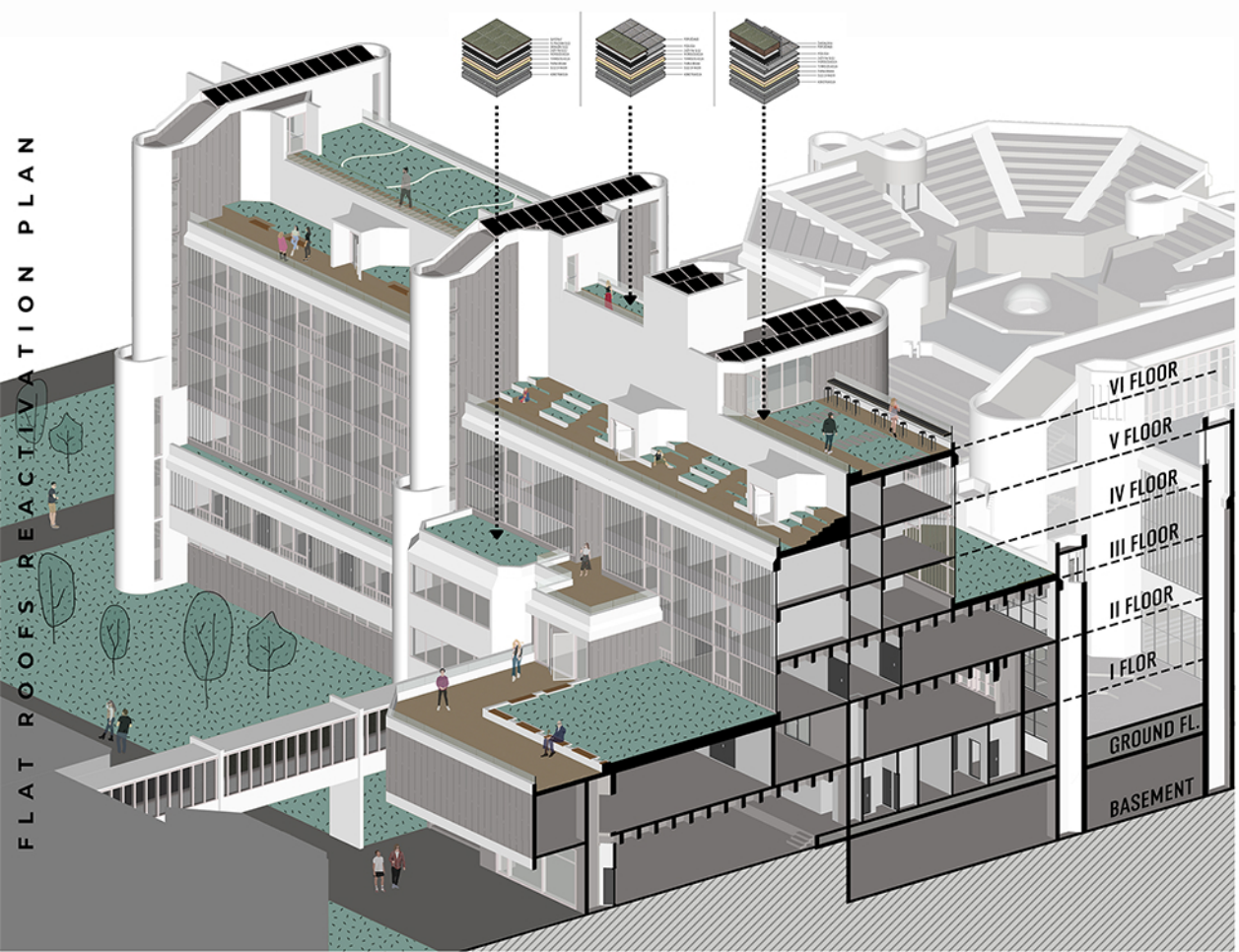
The main goal of this renovation project is to improve all aspects of the comfort of staying in the building through the modernization of the envelope, where the key applied principles are the preservation of the material and formal integrity of brutalist architecture.

The envelope of this building is made up of non-transparent parts in natural concrete, as well as transparent parts glazed with "copilite" glass. According to the existing parts of the exterior envelope of the building, the renovation project is divided into 3 parts:

- **Renovation of zone 1: "copilite" facades,**
- **Renovation of zone 2: natural concrete facades,**
- **Renovation of zone 3: flat roofs.**

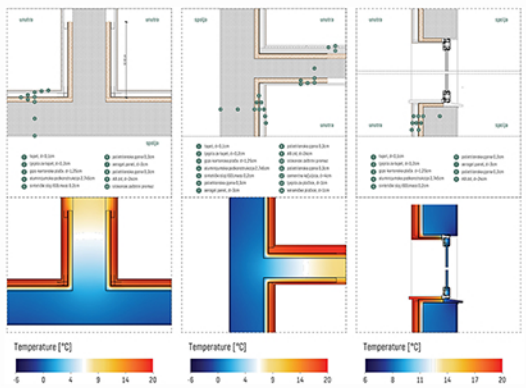


FLAT ROOFS REACTIVATION PLAN



From the energy efficiency aspect, the existing glass walls generate enormous transmission and ventilation losses during the heating season, as well as large heat gains from excessive solar radiation in the cooling season. Façade walls which are made of visible reinforced concrete, are exposed to external influences and continuous degradation, and do not achieve a satisfactory coefficient of heat transfer that would enable an optimal level of comfort for the users of the building. Part of the envelope, which consists of geometrically complex flat roofs, is characterized by: the loss of the function of the space as a meeting place due to its inadequate maintenance and unattractiveness, a continuous problem with the management and regulation of atmospheric precipitation that leads to the degradation of the already insufficient thermal insulation and further - the degradation of the interior.

NATURAL CONCRETE FACADE



New possibilities in the form of modern facade systems represent a significant factor in achieving a high level of energy efficiency of the building. Façade systems that primarily had a positive impact in terms of reducing high temperatures in the building during the summer and reduced heat losses during the winter are double-skin systems.
Reduction of losses of useful space during the renovation of non-transparent parts of the building envelope from the inside (facade walls) is made possible by high-quality insulating materials of small thickness and density, with thermal conductivity λ=0.025-0.050 W/mK.
In order to protect, isolate and reactivate flat roofs, different "green" systems (intensive, extensive and combined green roof) were applied. This method of remodeling the existing roof construction ensured the functionality of the roofs, extended the service life of the primary and secondary construction of the flat roof, slowed down and managed the runoff of atmospheric precipitation, as well as meeting the requirements for thermal protection.