



LINDIHANA GOXHA

# ODREĐIVANJE MODELA NISKOENERGETSKIH ZGRADA S PRIMJENOM OPTIMALNIH RJEŠENJA KORIŠTENJA FOTONAPONSKIH SUSTAVA INTEGRIRANIH U DVOSTRUKE FASADE

## DOKTORSKA DISERTACIJA [SAŽETAK]

# DETERMINATION OF THE MODEL OF LOW ENERGY BUILDINGS WITH THE USE OF OPTIMAL SOLUTIONS USING PHOTOVOLTAIC SYSTEM INTEGRATED INTO A DOUBLE FAÇADE

## DOCTORAL DISSERTATION [SUMMARY]

Integration of photovoltaic panels into new and existing architecture offers an opportunity to design energy-efficient and environmentally friendly buildings. Building envelope is the main element responsible for energy needs within a building. This study investigates integration of photovoltaic systems into double façades in the existing public facilities in northwest Macedonia, in public administration buildings and educational institutions. While reconstruction, the double glass with integrated photovoltaic placed on the existing structure, taking into account the need for daylight and natural ventilation. As far as Macedonia is concerned, this issue has not been sufficiently explored, especially the integration of photovoltaic systems into double-glazed façades.

Optimal photovoltaic systems that will integrate into the double façades of the Regional Local Administration and the Educational institutions will consider four systems of double construction as vertical walls with integrated photovoltaic modules (system A), vertically-toothed walls with integrated photovoltaic modules (system B), accordion wall (system C) and horizontally-toothed wall with integrated photovoltaic modules (system D). Each system has variations depending on the position of the photovoltaic modules and the angle of inclination, which are important factors for the conversion of solar radiation in which the installation of double façades planned as an additional layer during the renovation in order to increase energy efficiency.

Using scientific methods as well as the modeling process provided by the computer program, all system of envelopes analyzed at three local Regional Administration buildings and three educational institutions, settled in different topographic environments, differently oriented at six municipalities in northwestern Macedonia. The computer program offers a broad meteorological database and data of photovoltaic components using two methods of analysis – preliminary design of the project and project design method. The optimal model of the double façade will be determined. The optimal model of double façade, i.e. the optimal orientation of the build-

ing and the inclination angle of photovoltaic modules are among the most important issues when designing a photovoltaic system used in double façades. The final architectural solution, i.e. accordion profiled curtain wall with integrated transparent and semi-transparent photovoltaic modules offers an adequate orientation, using the material such as amorphous hydrogenated silicone (a-Si: H triple) filled in 100% in non-transparent parts of a double façade and 50% in semi-transparent photovoltaic modules. The model consists of semi-transparent modules that are integrated in newly designed double façades in the window area or under the roof rails 90 cm high, tilt at 120° (-60°) to 50% transparency, giving the impression of solar glazing. The use of solar glazing produces electrical energy while simultaneously passing a certain amount of light inside the building and provides the possibility of sanding. Visibility through semi-transparent modules reaches about 50%. The glazed part has a height of 120 cm below the semi-transparent part, which is designed without photovoltaic modules, because building categories such as educational and administration, require constant daily light and non-transparent integrated photovoltaic modules tilted at a 60° angle, set in the opaque façade walls, represent the opaque facade wall coating.

The buildings with the newly-designed envelope and its tested parameters will be designed as a low energy building. Durability of the system guaranteed by aesthetic, high-quality integrated modules, as well as by accompanying equipment. The model thus obtained can be implemented in other buildings as well. The concept of low energy buildings represents a modern way of managing life processes based on energy efficiency and environmental protection.

The key scientific contribution and achieved results give a great contribution to environmental conservation by using unlimited (sustainable) energy resources and economic sustainability. Multidisciplinary approach and cooperation of all professions needs to achieve the desired results.

Autorica: mr.sc. LINDIHANA GOXHA, dipl.ing.arh [1978., Skoplje]  
Fakultet primijenjenih znanosti, studij Arhitekture, Drzavno sveuciliste u Tetovu, Makedonija

Mentor: Izv.prof. dr.sc. ZORAN VEŠIĆ  
Znanstveno područje: Tehničke znanosti  
Znanstveno polje: Arhitektura i urbanizam

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Povjerenstvo za ocjenu teme i predlaganje mentora:  
– imenovano: 59. sjednica Vijeća DS, 15.10.2013.  
prof. dr.sc. ALEKSANDAR HOMADOVSKI  
prof. dr.sc. ANDREJ UCHYTIĆ  
izv.prof. dr.sc. ZORAN VEŠIĆ  
prof. dr.sc. IVANA BANJAD PEČUR, dipl.ing.grad.  
Prihvata teme i imenovanje mentora:  
483. sjednica FV, 10.6.2014.  
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Povjerenstvo za ocjenu disertacije:  
– imenovano: 521. sjednica FV, 19.12.2017.  
izv.prof. dr.sc. IVA MURAJ  
doc. dr.sc. RENE LISAC  
prof. dr.sc. IVANA BANJAD PEČUR, dipl.ing.grad.  
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■ U radu se istražuje obnova ovojnice postojećih objekata javnih namjena u sjeverozapadnoj Makedoniji. Prilikom obnove postavlja se dvostruko stakleno pročelje s integriranim fotonaponskim sustavima na postojeću konstrukciju. Konačno arhitektonsko rješenje, odnosno ovješena fasada profilirana kao harmonika s integriranim netransparentnim i polutransparentnim fotonaponskim modulima, omogućava adekvatnu orijentaciju. Zgrada s novoprojektiranom ovojnicom projektirana je kao niskoenergetska zgrada. Tom se prilikom dobiva model primjenjiv i na ostale zgrade. Koncept niskoenergetske zgrade nasliva se na energetske učinkovitosti i zaštiti okoliša.

[Translated by author]