🏆 *reviewed paper*

Energy Efficieny and Solar Renewable Energy through Minimalism

Dragana Vasilski,, Svetlana Stevović

(Dragana Vasilski, PhD, Faculty of construction management, University Union, Belgrade, Serbia, dvasilski@fgm.edu.yu)
(Svetlana Stevović, PhD, Faculty of construction management, University Union, Belgrade, Serbia, sstevovic@fgm.edu.yu)

1 ABSTRACT

Within contemporary architectural discourse and practice, there seems to exist a wide consensus on the urgent need to promote environmental innovation in building design. The goal is to reduce energy consumption by designing the building in an energy conscious way, in terms of architecture and building techniques as well as exploiting the local sunshine and climate conditions.

Minimalism in architecture, as the new civilization paradigm, allows facades that the buildings are with high energy-efficiency and that promote cooling by natural ventilation instead of by air-conditioning. The buildings are composed of simple rectangular volumes, ensuring rational constructions. These are features that take advantage of the sun's rays, either passively, using thermal massing and high-efficiency glass or actively through photovoltaic panels, to turn sunlight into electricity.

The thesis, that minimalism is energy efficient design and that it presents the environmentally friendly architectural solutions, will be developed in the process of exploring the case studies.

2 INTRODUCTION

The word's population has grown from around 1,5 billion in 1900 to 6 billion in 2000. This impressive rise in the numbers of humans sharing the planet raises the questions of availability to all of food, energy and quality. Modern man has, at aspiration to carry out strong development, aided by endless series of new technical-technological discoveries, stepped over allowable boundary. He has, not only degraded and pollute environment, but has compromised also his own survival. For several decades experts have been warning of irreversible damage being done to the planet, with correspondingly serious consequences for the human race.

This is linked to four major issues:

- Rapid population growth
- Squandering of natural resources and fossil fuel reserves
- Decline in air, water and soil quality
- Volume of waste

It is rare to find a book about sustainable architecture that does not highlight the contribution of buildings to various forms of environmental degradation. The main outcome of this global focus for sustainability in terms of building production has been a continuing emphasis on improving physical performance in general as well as efficient use of energy. [9]

3 MINIMALISM

Minimalism is now found in fashion, music and decoration, as well as architecture, and it has come to define the result of the use of pure and simple lines, the reduction of idiomatic elements and, as far as architecture is concerned, the investigation of the treatment of space and of building possibilities. [7] Minimalism in architecture is characterized by the emphasis on essential elements like light and the way it falls on the volumes and masses that make up buildings and shape space, design and structure. Simplicity is treated as a person lifestyle and a road to individual freedom. [5]

The architects design concrete forms to interrelate them with their surroundings. Functionalism, linear structures and essential geometric forms define identity, but despite the apparent simplicity of these works the effect they make is extremely complex.

The aim of this exploration is to point out minimalism in architecture as a way of the best implementacion of energy-efficiency and solar renewable energy in our environment.

4 DESIGNING SUSTAINABLE FUTURES

The energy efficiency and energy conservation strategies are the use of:

- daylight to reduce the consumption of electricity for artificial lighting;
- separately operating zones for artificial lighting and control by daylight sensors;
- natural forces such as air pressure and wind for ventilation, to minimise power used for fans;
- control of airflow, heat recovery and low-emitting building materials;
- geothermal heat;
- alternative building materials, e.g. transparent, environmentally friendly insulation in façades.

Within contemporary architectural discourse and practice, there seems to exist a wide consensus on the urgent need to promote environmental innovation in building design. We are learning that in order to achieve very low energy use, a simple compact building form is a necessity. Einstein said “things should be as simple as possible – but no simpler”. A simple box is the obvious solution and architects such as Peter Zumthor have demonstrated that even simple boxes can look refined and elegant. [4]

5 CASE STUDY

“Making the simple complicated is common place; making the complicated simple, awesomely simple, that's creativity.” Charles Mingus.

Architects and engineers use computer technology and innovative products to create buildings whose minimalism places them firmly in the modern age. Energy-saving and other environmental features are integrated into the designs without fuss or ostentation. Strong ideas and precise design are combined to respond appropriately to the site and the project brief, while familiar principles and techniques are used with pure, unadorned materials. There is something graceful - even elegant - in striving for simplicity. Frequent use is made of prefabrication in order to reduce construction time and cost.

Solar House I, Glassx AG, Dietrich Schwarz, Domat/Ems, Switzerland (Fig.1.)

Solar House I is a zero-energy house built in the depression of the Rhein. The opaque photovoltaic panels on the eastern, western and southern facades are separeted by windows reachung floor level. The shell of the building is made of concrete and acts as a heat sink. Inside, the bright space is divided by exposed-concrete walls which radiate gentle heat like an enormous slow-burning stove in winter. The total amount of thermal and electrical power required is entirely supplied by solar energy. The external appearance of the constructed glazing varies according to the weather conditions and the time of day, sometimes turning black with light iridescent reflections.

Fig.1: Solar House I

Solar House III, Glassx AG, Dietrich Schwarz, Ebnet-Kappel, Switzerland, (Fig.2.)

Solar House was designed as a zero-energy house with low construction costs, in 2001.it received the Prix Solaire Suisse Award thanks to the extensive 474-square-foot solar wall. The latent accumulator is crucial to this wall and its distinctive feature is the material it contains: a special type of paraffin which melts and freezes according to the ambient temperature. Apart from its practical advantages, the solar surface is also quite attractive as the brightness of the wall interacts very well with the surrounding environment.

Fig.2: Solar House III

R128 in Stuttgart, Werner Sobek Ingenieure, Stuttgart, Germany (Fig.3.)

This four story glass residence is an elegant and so efficient home, it actually generates more energy than it uses. This creation is a high-tech wonder, with open plans interiors, touch screen temperature controls, computer controlled heating system, voice-activated doors, radar-controlled faucets This is an emmision free house that requires no external energy input for heating or cooling. The house brings together ideas and research about sustainability, energy conservation and recycling. [1]

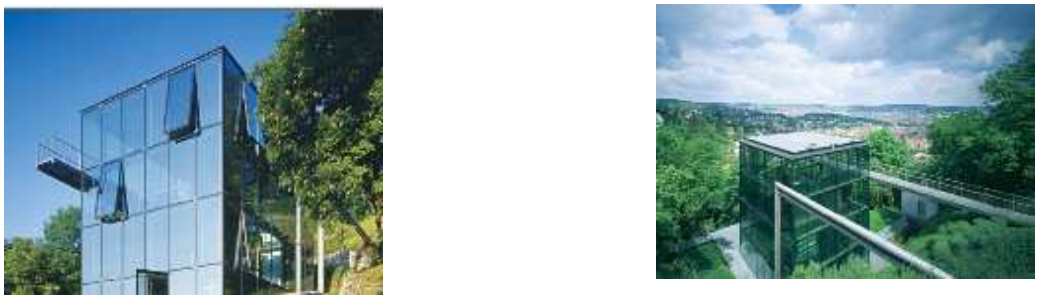

Fig.3: R128 in Stuttgart

House on the island of Omo, Ole Holst, Island of Ome, Denmark (Fig.4.)

This house shows, through an elemental layout in which it mainly uses indigenous materials, how an ecological, sustainable, and singular building can be created. A determining requirement in the construction was the thermal insulation that, in this case, allows great energy savings. The fifteen centimeter thick floors and walls and the roofs of twenty centimeters guarantee great insulation. [8]

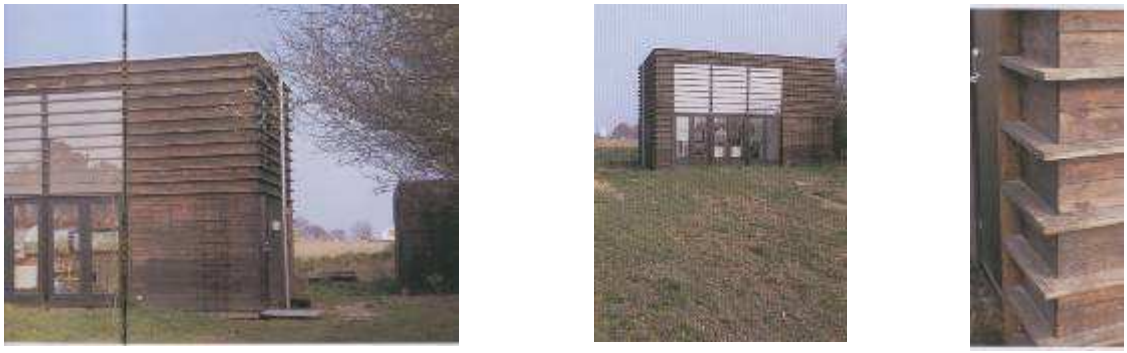

Fig.4: House on the island of Omo

Riera House, Estudio BC Architects, Sant Andreu de Liavaneres, Spain (Fig.5.)

The challenge was to create a house that exploits the natural insulating and cooling properties of earth-sheltered construction, but at the same time feels comfortable and open. Both counts were achieved by taking advantage of the thermal mass of the ground, which keeps the interior cool in summer, and the double-glazed windows, which can be shaded from direct sun by horizontal shutters and a canvas awning that extends over the living room terrace. [8]

Fig.5: Riera House

Buildings located around Lake Constance

A few buildings we have chosen to highlight are the buildings located around Lake Constance, examples of the environmental building movement which generated a number of impressive and innovative projects. Also, building by the architects D'Inka + Scheible (Fig.6. – Children yard), Kauffmann Theilig (Fig.7. – Casa Lenz) and Schaudt Architekten (Fig.8. – House Oswald), all provide examples.

Fig.6: Children yard

Fig.7: Casa Lenz

Fig. 8: House Oswald

Parkhaus am Bollwerksturm, Mahler Gunster Fuchs, Heilbronn (Fig. 9.)

A monumental timber palisade reveals itself inside to be a technically perfect realisation of the model: deck and ramp, structure and matter, ventilation and light.

Fig.9: Parkhaus am Bollwerksturm

Passivhaus-community-centre, Hermann Kaufmann, (Fig.10.)

Hermann Kaufmann is famous in mainland Europe for demonstrating how technically advanced low energy buildings can also be inspirationally designed. Hermann Kaufmann's work represents the pinnacle of architectural design because he achieves the highest quality architectural design standards whilst also being constrained by the discipline of Europe's most advanced energy saving standard, the Passivhaus standard.

Fig.10: Passivhaus-community-centre

Flatz Residence Schaan (FL), Baumschlager&Eberie (Fig.11.)

Amidst a scattered neighbourhood the villa rises stoically, made up of stacked cubist volumes. On the completely closed north side especially, the compact house appears like a minimalist sculpture. Due to its position on the slope, the building does not reveal that it stretches over four levels. The basement contains besides a cellar and garage, an apartment with a patio of its own. The privileged location of the site was the main criterion for the orientation and functional organization of the building. There are three materials that make up the functionally elegant character of the house: maize-yellow pigmented concrete on the outside covered with a white plaster on the inside, plantain wood, and greenish stone.

Fig.11: Flatz Residence Schaan

6 DRASTICALLY INCREASE THE USE OF RENEWABLE ENERGY

"There is no problem, no matter how complex, which if looked at in the right way cannot be made even more complex." Poul Anderson

The use of renewable energy in the building sector is today dominated by the application of solar domestic hot water and photovoltaic (PV) systems in single-family houses. The Cost-Effective European project (partly funded by the European Commission under the Seven Framework Programme), running from October 2008 to September 2012, aims at developing and implementing new technologies and concepts to increase the use of renewable energy in existing high-rise buildings. In these buildings, hight fractions of the energy demand can only be met with renewable energy sources, when the facade is used for energy conversion in addition to the roof. This is especially true for buildings with a small roof area compared to the floor area („high-rise buildings"). Also, for existing buildings, which generally have a higher energy demand than new buildings. (Fig. 12.)

Europen key actors from construction industry and energy research have agreed to collaborate within this project. The project results will be an important support for the European technology platforms ECTP, ESTTP and PV – platform in which the project partners have a leading role.

Converting facades of existing „high-rise building" into multifunctional, energy gaining components, is the main goal of this project. The goal will be achieved through the development of:

- Integrated building concepts, suitable for a major share of the high-rise building stock, which can be characterised as the most Cost-Effective combinations of existing and/or newlydeveloped components,
- New multi - functional facade components, which combine standard features and the use of renewable energy resources,
- New business and cost moduls, which consider the whole life cycle of a building and which incorporate the benefits from reduced running costs and greenhouse-gas emissions.

Several new components, based on newly patented ideas will be developed. For istance, a transparent solar thermal facade collectors will simultaneously provide solar heat, protection against overheating and glare protection (Fig. 13.). The new components will in particular profit from the application of nano-structured coatings and films which will enhance their perfomance and durability due to antireflective, anti-soiling and seasonal shading functionality [2].

Fig. 12: „High-rise buildings“

Fig.13: Transparent solar thermal facade collectors

This component will enable architects to create buildings with large areas where an outdoor view is possible, but with reduced cooling loads and with an energy-generating facade that can be used as a heat source for solar heating, cooling and hot water.

The implementation of innovative materials on the facades with large areas, introduce minimalism as the best way to form the new skin of the buildings.

7 CONCLUSION

With 20th century along came a significant increase of energy consumption and a serious ecological crisis caused by the extensive usage of fossil fuels. About 40% of the lifetime running costs of a building can be saved by the optimization of energy conservation measures. The geometric shape of a building membrane is determining for the energy performance of a building. Sustainable construction is by no means an independent architectural language. Sometimes, the implementation of innovative materials (for example PV moduls) continually leads to new aesthetics.

„Architecture is environmental design. It therefore mirrors society, its behavior and ambitions“ –Werner Sobek. Many architects, engineers, planners, developers, and clients have come to think more strategically about the environmental implications on building, especially in domestic realm. Moving well beyond the simplistic inclusion of a few green materials or features, they are increasingly conceiving of houses as coherent, holistic systems, with extended life cycles that must be considered throughout the design process. Environmental concerns in form the architecture, but the results can be as aesthetically rich as even the most abstract or theoretical of projects. [10] Sustainability thus assumes another dimension beyond its mere pragmatic and ethical dimensions.

Minimalism promoted ecological, low-energy architecture. The buildings are composed of simple rectangular volumes, ensuring rational constructions. Technical solutions integrated into the design contribute to energy saving and a better indoor climate. The goal is to reduce energy consumption by

designing the building in an energy conscious way, in terms of architecture and building techniques as well as exploiting the local sunshine and climate conditions. Minimalism is not primarily energy design. It is associated with the site and the program. The environmental part is a part of the program, and the compact situation is the answer to that. [3]

It is wrong to claim that a sustainable building could have any form [6], what is true is that a minimalism allows the designer to optimize the built form for minimal energy consumption and optimum comfort. Minimalism lead us to introduce a few basic ways to build in energy efficiency and how to use solar renewable energy. By no means, minimalism is future in architecture.

8 REFERENCES

[1] - Alanna Stang, Christopher Hawthorne: The Green House – New Directions in Sustainable Architecture, Princenton Architectural Press, New York, The National Building Museum
Washington, D.C. 2003.
[2] - Cost Effective, BAU Munchen, 2009.
[3] - DraganaVasilski, Svetlana Stevović: Minimalisms – the new civilisation paradigm and the way how to manage ecological problems in modern environment, Integracion - Deintegracion of the Town, Beograd, pp.219-226, 2008. (ISBN 978-86-907727-4-2).
[4] - DraganaVasilski, Svetlana Stevovic: Minimalist architecture and renewed revelation advances of physical through its relation environment - International conference on Environment today, Beograd, pp.130-131, 2008. ISBN 978-86-904721-4-7
[5] - DraganaVasilski, 2008: Minimalism as civilisation paradigm at the biginning of the 21. century, In: Arhitektura i urbanizam, Vol. 22 - 23 Issue 2008, Beograd, pp. 14 - 24, 2008. ISSN 0354-6055 COBISS.SR-ID 8014860
[6] - Howard Liddell: Eco-minimalism: the Antidote to Eco-Bling, RIBA, UK, 2008.
[7] - Minimalism Design Source, Collins Design, Spain, 2005.
[8] - Simone Schieifer: Small Eco-houses, Taschen Gmbh, Spain, 2007.
[9] - Svetlana Stevovic, DraganaVasilski: Energy efficiency and renewable energy sources in urban environment, The New Urban – Integracion - Deintegracion of the Town, Beograd, pp. 267-274, 2008. (ISBN 978-86-907727-4-2).
[10] - Svetlana Stevovic: Legislation on Preparation of Environmental Impact Assessment Studies in Compliance with Criteria of the World Bank, Conference: “Water 2002”, Vrnjacka Banja, Yugoslavia, June 2002