

# DYNAMIC SUN PROTECTION STRUCTURES FOR HOT-DRY CLIMATE CONDITIONS

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## Abstract

Protecting buildings from excessive solar radiation in hot and dry climates is one of the main factors in increasing energy efficiency and ensuring indoor comfort. Dynamic sunshield structures play an important role in this process, as they are able to operate in accordance with environmental conditions and help maintain the indoor temperature of the building at an optimal level.

This article analyzes the types of dynamic sunshield systems suitable for this climate zone, their operating principles, materials used and their efficiency. The results of the study can be useful in developing energy-efficient and environmentally friendly construction solutions.

Keywords: Sunshield, dynamic structures, hot and dry climate, energy efficiency, ecological construction, thermal comfort, solar radiation, innovative facade systems.

## Introduction

Today, in hot and dry climates, protecting buildings and structures from solar radiation is one of the most pressing issues. In such regions, high temperatures and low humidity levels significantly affect the internal microclimate of buildings. Therefore, it is necessary to use modern solar protection technologies and structures to maintain a comfortable internal temperature and reduce excessive energy consumption.[1]

While traditional static sun protection measures (sunshades, pitched roofs, blinds) are effective to some extent, their flexibility is limited. Therefore, the use of dynamic sun protection structures that can adapt to environmental conditions is of great importance. These systems can be automatically or manually controlled depending on sunlight, temperature and wind speed, and play a major role in improving energy efficiency and maintaining a comfortable temperature in buildings.[2]

This study analyzes the importance of using dynamic solar shading structures in hot-dry climates, their mechanisms of operation, types, and advantages. The results of the study are expected to contribute to the development of energy-efficient and environmentally sustainable construction technologies.

In hot and dry climates, high levels of solar radiation can significantly increase air temperatures. Low humidity levels increase the risk of overheating inside buildings. Therefore, the use of



effective solar shading systems is essential to ensure a comfortable microclimate inside buildings in such areas.

Although traditional static solar shading elements (external canopies, sloping roofs, curtains) can help to some extent, their effectiveness may be limited. Dynamic solar shading structures, on the other hand, can change their position in accordance with environmental conditions, which allows maintaining the temperature inside the building at an optimal level and effectively using solar energy. The main advantages of such systems are:[3]

- Flexibility – Can be controlled automatically or manually depending on the angle of the sun.
- Energy efficiency – Protects buildings from overheating, reducing the need for cooling systems.
- Aesthetic appeal – Combined with innovative technologies and modern design.
- Environmental sustainability – Saves electricity and reduces the overall carbon footprint.

In hot-dry climates, dynamic sun protection structures are divided into different options:[4]

1. Electromechanically controlled systems – Sensor-operated or manually controlled awnings and blinds can open and close in accordance with solar radiation.
2. Bioclimatic sun protection systems – Provide natural ventilation and shading. For example, green walls or movable wooden blinds.

There is a growing trend in the world to use dynamic sun protection systems in architectural projects. For example:[5]

Al Bahr Towers (UAE, Abu Dhabi) – Covered with automated blinds that move in accordance with the sun's rays.

- Institut du Monde Arabe (France, Paris) – Mechanical blinds on the facade of the building allow for the regulation of the amount of light.
- Masdar City (UAE) – Innovative sun protection structures are widely used in the concept of an ecological city.

Today, as energy efficiency and environmental sustainability are becoming increasingly important in the construction industry, sun protection systems are being further developed. In the future, systems integrated with solar panels, controlled by artificial intelligence and based on the principle of biomimicry are expected to be widely used.[6]

Dynamic sun protection structures play an important role in increasing energy efficiency, improving the comfort of the building's interior, and ensuring environmental sustainability in hot and dry climates. Their increasing use in modern architecture and construction indicates that this trend will continue to develop in the future. Therefore, further improvement and widespread implementation of these technologies is an urgent task.[7]

The results of this study show that in hot-dry climates, protecting buildings from excessive solar radiation is of great importance for energy efficiency and indoor comfort. Dynamic solar shading structures are more effective than static systems and play an important role in regulating the thermal regime of a building through their adaptability to the environment.

Key points to be discussed:[8]

1. Energy efficiency – Dynamic systems optimize the temperature inside the building, reducing the need for cooling systems. As a result, electricity consumption is reduced and environmental sustainability is increased.



2. Innovative solar protection solutions – The use of photosensitive materials, automated blinds and bioclimatic systems not only effectively protects buildings, but also makes them aesthetically attractive.

3. Climate adaptability – Since temperature and solar radiation in hot and dry climates are constantly changing, dynamic structures adapt to these conditions and provide optimal results.

- Dynamic solar protection systems were found to be an effective tool for reducing energy consumption and creating comfortable living conditions.
- During the study, the principles of operation of various systems were studied and the most effective solutions for hot and dry climates were proposed.
- The widespread implementation of these technologies in modern architecture and construction has proven to be environmentally and economically beneficial.
- There are prospects for the development of more effective and innovative solar protection systems in the future.

Overall, this study demonstrates that dynamic solar shading structures play an important role in improving energy efficiency and indoor comfort in hot-dry climates. It is desirable to expand research in this area and introduce new technologies in the future.

In hot and dry climates, protecting buildings from solar radiation is important not only to improve energy efficiency, but also to ensure indoor comfort. While traditional static protection methods provide a permanent protection function, their effectiveness may be limited due to their inability to adapt to environmental conditions. Dynamic solar protection structures, on the other hand, allow the building to regulate its internal temperature by adapting to climate changes.

The results of the study show that dynamic solar protection systems have the following main advantages:

- Energy efficiency – Prevents overheating of the building, reducing the need for cooling systems.
- Flexibility – Allows for automatic or manual control depending on environmental conditions.
- Environmental sustainability – Helps reduce carbon footprint through efficient use of electricity.
- Aesthetic appeal – Allows for innovative designs that blend in with modern architecture.

In the future, these technologies will be integrated with advanced innovations such as artificial intelligence, IoT, and photosensitive materials to develop more efficient systems. The widespread implementation of dynamic sun protection structures will ensure environmental and economic benefits in accordance with sustainable construction principles.

Overall, the study shows that dynamic sun protection systems are an effective solution for controlling the indoor microclimate of buildings and increasing energy efficiency in hot-dry climates. Future research in this area is expected to be related to the development and widespread implementation of advanced technologies.

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