



Review

Solar considerations in high-rise buildings



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ABSTRACT

One of the fundamental challenges in today's world is substituting fossil fuels with renewable energies. All the frequent practices have been intensified in order to utilize the earth and its environment as a source of energy. Hence, architects and planners have a special responsibility toward energy efficiency development. Here, the overall objective striven for is to introduce solar energy as a permanent renewable source in order to reduce energy consumption and building initial investment. Thus, the variable output of utilizing active and passive solar systems and their impact on the decrease of energy usage and total energy demands for cooling and heating buildings should be considered as the main objective of this research and the result could be a new definition of architecture and construction, so, this branch of industry can supply the necessary contributions for sustainable and viable development. Thereby, this study is mainly based on a theoretical approach supported by the outcomes of literature review and case study analysis from the solar design aspects. Finally, as skyscrapers are indispensable in modern cities and as they consume a great deal of energy, considering new ways of benefiting renewable energies can have a vital role in reducing building energy consumption.

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1. Introduction

In a country's development, one significant role is played by energy. As fossil fuels encompass a very large portion of today's world energy consumption, renewable energies that could substitute fossil fuels have been sought [1]. Renewable energies result

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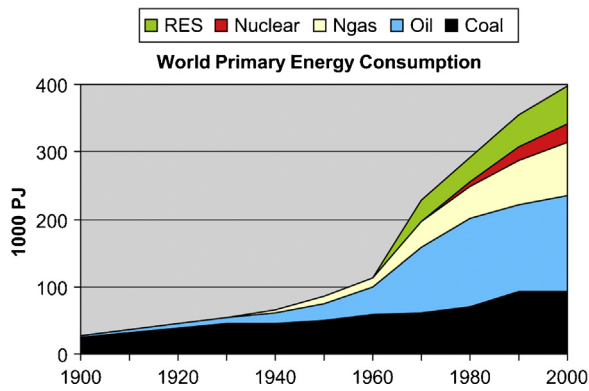


Fig. 1. World Primary Energy Supply [6]. RES: renewable energy sources.

from two distinct issues. Concerns about preserving energy supplies against unexpected crisis and the issue that fossil fuels will come to an end have led to the renewability [2]. Mal-adaptation, the exploitation of the earth's energy sources, which has led to sustainability, may cause next generations to have a poor life in future. During the past three or four decades, a lot of attention has been paid to these two important matters and obviously to the influence of international relations and the political decisions in all levels [3].

However, although in many countries around the world, renewable energies are considered as a very important supply, less than 10% of primary energy supplies are renewable energies [4] (Fig. 1). If the whole globe is considered, the initial energy supplies are renewable energy sources. In developing countries the most significant ones are hydro energy and fuels are based on wood, solar and wind energy seems to consist a small portion [5].

Using renewable energy sources surely reduce environmental damages and lead to sustainability. The rate of these kinds of energy consumption is nearly 8%. Those renewable sources help to decrease the global warming or to create a sustainable waste [7]. Nevertheless, each kind of renewable energy sources imposes some kind of damage to the environment. However, in comparison to the current conventional systems, the use of this new source of energy is much cleaner and sustainable [1,8,9].

It is conveyed, that many of today's technologies are still in the developing phase and other fields require further research, however, the current era, compels humans to develop new ideas and seek for innovative concepts. Therefore, the idea of developing and designing future buildings is actively supported by a number of architects, engineers, and civil engineers [10]. There are so many renewable energy alternatives, but under the study limitation and scope, just solar energy, which seems to be more practical in high-rise buildings, will be analyzed.

Correspondingly, in today's world, the rate of energy usage is growing rapidly in accordance with the industrial development, and the population growth is becoming greater. Thereby, as few studies have been done by architects such as Ken Yeang on the amount of energy consumed in high-rise buildings, the author attempts to make viewpoints of some architects, construction builders and also users more clear about the influences of using passive solar strategies and active solar technologies on tall buildings. Therefore, by considering the use of solar passive strategies and active technologies as an alternative in high-rise buildings, this study tries to fill some of the current gaps as much as possible and its proposed fundamental message is changing architects' and construction builders' view in dealing with the subject.

1.1. Research methodology

This research is mainly based on a theoretical approach, which is supported by the outcomes of a literature review and case study analysis. Therefore, the descriptive research method is used in this study. This method is used in order to gather information about the existing type and the amount of energy consumption in the building sector. So, at the first phase, it is a type of study, which is essentially concentrated on describing the degree and the condition of the current renewable energy usage situation in detail.

On the other hand, it involves fieldwork and more especially systematic review as a combination of two main phases, qualitative and quantitative methods of data collection. As the first step, the research is performed to become aware about the effectiveness of using passive solar strategies and active solar technologies that architects would like to apply in the skyscraper design. Then, the study aims to prioritize and compare the effectiveness of these issues by analyzing the case study and summaries the results in Table 4. Therefore, for data evaluation and computation the 'Autodesk Green Building Studio' and also 'EnergyPlus' software are used.

The simulation tools can generate the design alternative that explores the energy performance of the range of options. With relative minimum options you can get simulations results that taking into account of the proposed building climate and building type, envelope properties and active systems. Because the simulation taking into account the interdependency of the building as a whole system, energy simulation results are useful to keep score as the work to reduce the building energy use.

'Autodesk Green Building Studio' automatically reads all building geometry data produced by a gbXML-enabled BIM or 3D-CAD programs, such as 'Autodesk Vasari' and 'Autodesk Revit', which are used in this research, to perform a thermal simulation analysis (Chart 1). In this case, minimum manual inputs, which are required, are 'zip code' and 'building type'. Users may specify additional input parameters to the extent they have been enabled in the BIM/CAD program's GUI. All other simulation variables supplied by the software may be viewed and edited in other DOE-2.2 or gbXML compatible applications in order to calculate building hourly energy usage, which has been used and trusted in industry for many years.

2. Current energy situations

2.1. World energy concerns

In today's world, energy sources have performed necessary functions, such as creating heat, supplying drinking water, generating power for certain appliances, electrical products and so on [5]. With efficiency in mind, it is worthwhile for us to create tools that can produce usable energy without excessive consumption. This means striving to equalize the power input and output of a given system, so that, the running of the system consumes no more than is absolutely needed to perform the intended function with minimal or no residual waste [11].

Accordingly, in recent years, energy demand is growing. It is certainly because of the annual population growth rate, which is now about 2% and is also more in some countries. This quantity is expected to double by 2050, and improving standards of living by continuing economic development, must be considered as a result. Also, by 2050, global energy services demand will increase up to 10 times, while primary energy demand is anticipated to intensify by 1.5–3 times [5,12].

Thus, more environmental considerations should be taken from the public and industry section, both in developed and

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