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High-rise buildings and environmental factors

Pooya Lotfabadi *

Eastern Mediterranean University, #72, Haftom Tir 3, Vakilabad Blvd, Mashhad, Iran

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ABSTRACT

Today, energy has a key role in socio-economical development of a country. By exhausting fossil fuels as one of the largest energy consumption sources throughout the world, it seems to be vital to find renewable alternative energy sources or ways of reducing energy demands, especially in tall buildings with their great potential to use sustainable sources because of their height. In this study, the main problem is that the construction builders and users do not know the excessive energy saving potential of high-rise buildings. So, as a priority, this matter should be more concentrated on while designing by architects. These days, in my own country Iran, due to population growth and industrial development, the amount of energy consumption is increasing. This can show the importance of the problem. So, the Tehran International Tower, which is the highest residential tower in Iran, was chosen as a case study. Thus, the overall objective of this study is making tall building architects more aware of the neglected sustainable potential ways to diminish energy consumption. Meanwhile, this study tries to illustrate the effects of some environmental factors, such as air pressure and density, wind speed and other similar factors in high-rise buildings, from architects and ordinary people's points of view and comparing these attitudes with each other in the case study. Finally, as buildings use a huge amount of generated energy in the world, and high-rise buildings are an inevitable part of the community, they can meaningfully contribute in reducing energy consumption by using renewable energies and new ideas in designing. Moreover, the result of this research shows that sustainable skyscrapers can be energy efficient and are closely related to their site and environment.

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* Mobile: +98 533 871 8887, +98 915 309 3425.
E-mail address: Pooya.lotfabadi@gmail.com

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1. Introduction

Living without using energy is really far beyond reality, especially in today's modern societies. Energy is significantly used nowadays and one of the concerns of governments and the public is the global warming phenomenon and decreasing carbon dioxide content of the atmosphere [1] and increasing energy usage which damages the environment as well [2]. On the other hand, when population grows the demand for buildings as shelters increases, which in turn leads societies to choose high rise buildings as a solution [3]. So, regarding the environmental issues these structures should be '*environment friendly*' and substitute fossil fuels with renewable energies. But, unfortunately, the first built skyscrapers neglected this vital issue and considered their functional efficiency instead [4]. So, in order to achieve more energy efficient constructions a new balance needs to be applied between these two factors, which are also motivated by both economic and environmental concerns.

Iran is one of the largest countries in the southwestern part of Asia, and Tehran is its capital city with approximately 8.5 million inhabitants in 2011 [5]. This metropolis is plagued by severe air pollution. So, each effort toward reducing this problem will be vital. Thus, the Tehran International Tower was selected as a case study, which is located in a 35,000 square meters site.[1] Being more accurate, it is situated in the Amirabad neighborhood in the northern part of Tehran, which is one of Tehran's 22 districts.

One of the fundamental challenges over the past decade has been acquiring more renewable energies to substitute fossil fuels. Therefore, all the common practices have been intensified and efforts done to utilize the earth and near-grade environment as a source of energy [6]. Apart from wind and solar energies, architects do not usually consider the sky as a source of additional benefits and only a few studies have been done on the effect of height on high-rise buildings' energy consumption. So, what the sky can offer and its impacts on the environment should be a question, which in turn can be considered as a problem to better understand the effects of the environmental factors, which vary with altitude and have a consequent effect on the annual total buildings cooling and heating energies. In other words, the problem is that skyscraper architects and constructors have not paid attention to the great potential of their buildings via their vast facades.

Considering the above data, this paper emphasizes on finding out the effect of the main environmental factors, which can be considered as a way of reducing building energy demand instead of seeking for substitute energy sources. Therefore, specifically, the effects of these environmental factors on high-rise buildings, the way these factors would change with altitude and their impacts on the annual total buildings cooling and heating energies would be considered as questions. Thus, the main objective of this paper is to make high-rise building designers and builders more aware of the extra sources of sustainable energies in the sky.

2. The high-rise buildings and skyscrapers

These days, "Buildings are the main destination for the nation's power supplies and hence the main sources of carbon dioxide emissions" [7] and high-rise structures are an inevitable part of our society building forms. Furthermore, skyscrapers are becoming more necessary, according to the effective use that they make of the available limited land [8]. Ecological design and sustainability of tall buildings are in fact more crucial than those of ordinary buildings. Constructing these buildings are inevitable, because of their scale and their huge amount of energy and material usage [8,9]. Therefore, tall buildings have a great potential for maintaining and recycling resources. Moreover, high-rise building design is complicated and requires more experience [10]. So, for many reasons, the sustainable design of skyscrapers needs to be addressed.

Some advantages of tall buildings are as follows:

- Material saving because of repetitive type plans.
- Observing standards and efficient contractors, especially in large quantities, lead to lower costs.
- More potential to reduce energy and material waste by using sustainable materials in elevations.
- Tall buildings occupy less land.
- Better use of daylight and thermal mass.
- Prepare better horizontal access for its inhabitants [11].

3. Sustainability

Sustainable architecture

People always consider the terms '*ecological building*', '*energy-efficient structure*', '*bioclimatic architecture*' and so on, instead of sustainable architecture, but these are just part of it, and sustainability in architecture is something more complicated. Thus, there are some kinds of buildings, which contribute the principle of a careful deal with natural sources with no functions [12]. In other words, sustainable buildings are "causing as little environmental interference as possible, such as, the use of friendly environmental materials that do not constitute a health hazard, low energy requirements, renewable energy use, high-quality and longevity as a guideline for construction, and last but not least, an economical operation" [13].

As shown in Fig. 1, it consists of three parts; economy, ecology and society [14]. Economical and ecological attentions are intensifying questioning the principle of effectiveness, because this fundament adopts an idea that our environmental sources are unlimited. However, the society largely depends on non-renewable sources.

Hegger et al. argued that, "with sustainable construction, apart from anything else, the architects' self-image is on trial" (p. 21). There are a number of ways and methods to assess buildings sustainability and also several different criteria for it, but this research concentrates on renewable energy potentials, especially in high-rise buildings as a part of sustainable architecture.

3.1. Sustainable building services

In essence, there are three essential aspects of sustainable building services: first, designers should pay more attention to the ecological consequences of the technical systems. Furthermore, it is a key factor for achieving extensive renewable energy

[1] The A.S.P Corporation management, personal communication, March 4, 2012.