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# Study on technical and economical solutions for improving air-conditioning efficiency in building sector

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**Abstract**

Climate change is an increasingly important global concern at this moment. Fossil fuels meet a majority of world energy needs and because buildings are large energy consumers, they are also a major contributor to global carbon emissions and greenhouse gas (GHG) production. It's important for the European Union, including Romania to avoid these problems.
Buildings are responsible for 40% of energy consumption and 36% of $CO_2$ emissions in the EU, according to United Nations Environment Programme (UNEP). The construction sector is developing since 2013 so in the future the energy consumption will increase very fast. As a result, renewable energy sources represent one of the main directions in reducing conventional energy consumption in buildings. In this paper the authors analyze solutions for decreasing the energy consumption required by the air-conditioning system in an office building of 6466 $m^2$, located in Bucharest. The current air conditioning solutions are the classical ones, based on either fan coils, supplied with chilled water of 12/7 °C, or air-coolers, as part of an Air Handling Unit (AHU). In the latter case, the cooled water is prepared by a vapor compression refrigeration unit chiller of 190kW cooling capacity, working with R22. The solutions analyzed in this paper consider each of the following alternatives: a. Heat recovery from the exhausted air by using a heat exchanger integrated in the AHU; b. Replacement of the vapor compression refrigeration unit chiller with an one stage lithium bromide/water absorption refrigeration unit driven by solar energy; c. Coupling the above mentioned solutions. All these solutions are discussed and analyzed from both technical and economical points of view.
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## 1. Introduction

Residential and tertiary sectors (offices, shops, hotels, restaurants, schools, hospitals, gyms, indoor swimming pools) are the largest consumers of energy, especially for heating, air conditioning, lighting, appliances and equipment [1]. Numerous studies as well as practical experience have shown that in these areas there is great potential for saving energy using recovery systems, renewable sources [2]. The European Parliament and the EU Council adopted Directive 2002/91/EC, [3] and Directive 2010/31/EU [4] on "Energy Performance of Buildings". The main objective of this Directive is to promote the improvement of energy performance of buildings within the EU. Law 372/2005 [5] on the energy performance of buildings implements Directive 2002/91 into Romanian law. Under this law, it was instituted mandatory evaluation of energy performance of new and existing buildings and minimum energy performance requirements were specified for new buildings to conform to.

The scope of this paper is consistent with current concerns related to reducing energy consumption in buildings, due to air conditioning systems [6]. This paper proposes several feasible solutions to decrease the energy consumption of an office building air-conditioning system.

## 2. Existing Air-Conditioning System

The office building under study is located in Bucharest. It is a 15-story flat roofed building of 6750m$^2$ (Figure 1). It is occupied by approximately 600 persons during normal weekday business hours (8/day) all around the year.

Fig. 1. Office building under study

The Air-Conditioning system in place uses cooled water of 7/12°C for both fan-coils, placed inside conditioned spaces and cooling coils placed inside the Air Handling Unit. The latter works with 100% fresh air and prepares cooled air that is distributed to consumers by a rectangular duct system.

a b

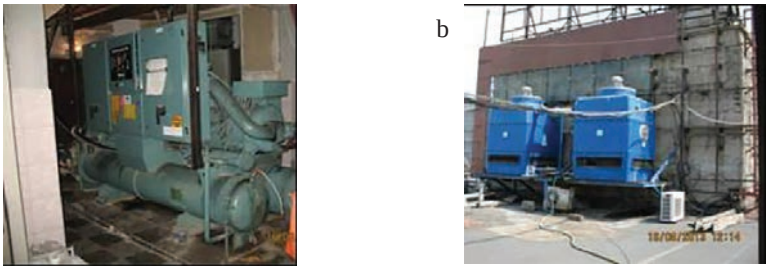

Fig. 2. One stage vapor compression R22 refrigeration system. (a) Chiller; (b) Cooling towers

The Air Handling Unit cooling capacity is 115kW and the fan-coils cooling capacity is 75kW. Cooled water is prepared by a chiller of 190kW cooling capacity working with R22. The refrigeration system also includes a water-cooled condenser, coupled with cooling towers (Figure 2).

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