

# An Investigation of the Energy Saving of Windows in Halil Raif Özmuhtar Apartment, Salamis Yolu<sup>1</sup>, Famagusta, Northern Cyprus

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## Abstract

These days, buildings use energies a lot so they have the most influence on climate changes or global warming. This paper is an investigation of windows energy saving capability as a result of energy loss through windows in Halil Raif Özmuhtar Apartment so a survey is done on different kinds of solutions in order to reduce energy wasting such as window's material, new types, and kinds of window insulation. First of all, there was some information window which leads us not only to understand rules of windows design in hot-humid climate, but also discover the importance of windows in building for reducing usage of energy in it.

The method used in this paper is problem solving, and data analysing of observations, and interview with residents are basis of data collection method to realize the general problem of windows in this apartment. There are many problems about windows in this building such as; size, proportion, orientation, insulation, sealing, and single glaze. Finally, recommended strategies such as renovation windows with double glaze, it helps to reduce energy consumption and makes more suitable conditions for people. Moreover, it can help in energy saving and reducing costs, as well as helping the environment.

Keywords: Energy saving, Window insulation, Window material, Thermal comfort

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## 1. Introduction

These days, energy is an important subject all around the world. The price of energy is high globally, so there has been a forcing to decline the using fossil fuels and afterward energy consumption [1]. Moreover, using the fossil fuels cause many problems including; climate change and global warming which have a considerable impact on the designing and details of buildings.

Not only some of the scientists and researchers try to find new solutions for saving energy, but also it is the important topic in Architecture. One of them is; adjusting materials depend on Cyprus climate. Scientists examine materials which has the important role in energy saving. "The subject of Material is clearly the foundation of architecture, said William Morris in 1982, and now over a century later, with a far wider range of materials at the designer's disposal and more awareness of the environmental impact of materials, the statement has added significance" [2]. Material should have all of these characteristics like: cost of production, insulation, usage, climate, technology, beauty, and structure. Also, the materials in window should have these features for being beneficial. Other ways are to consider insulation, sealing, size, and direction of the windows.

This article includes two parts such as (1<sup>st</sup>) how window can help to improve energy saving which is about window characteristics, and importance of insulation including insulation definition, and glazing; (2<sup>nd</sup>) second one explain importance of materials has some part such as characteristics, and strategies.

There are numerous new techniques for improving energy saving through windows like Smart windows, Electrochromic, new intelligent materials by scientist researches are preferred.

## 2. Windows characteristics

Windows are one of the major parts of the building for controlling indoor environment, thermal comfort, and energy use [3].

Energy flows that occur through windows are classified into three major types:

1. "Non-solar heat losses and gains as conduction, convection, and radiation;
2. Solar heating gains in the form of radiation;
3. Air flow, both intentional (ventilation) and unintentional (infiltration)" [4] (Figure 1).

After increasing the energy consumption, the amount of studies on the lessening of energy usage to make building warm and cool has increased. Major of them examine influence of every part such as; window type, frame type, orientation, climate, and so on. Further to these studies, scientist understood that; the most amount of energy wasting is through windows [5].

As the envelope building is well connected and technology of coated double-glazing windows has installed, the heat losses are drop [6] which have increased energy benefits and comfort for people. Therefore, architects, owners, and designers notice to select variable windows depend on the climate issues, type of building and so on [4].

## 3. Importance of insulation in windows

Insulation levels have been used from the past and it is principal for saving energy. There are many aspects that must be considered for choosing the suitable kind of insulation; environmental consideration, durability and build ability [2]. It is obvious that; "The durability of materials specially their optical properties, through losing of their surface quality and colour changes" [7].

## 4. Glazing

"Glazing depends on high-energy materials but provides the priceless possibility of views and the more easily priced potential for passive solar gain and day lighting" [2]. Designers use sealing and insulation windows which have high - efficiency glazing system to reduce the cost of energy consumption [2] (Figure 2).

It is obvious that building should be constructing and apply with new windows technologies to decline the infiltration's impact on cooling load [8]. Double-glazing window result in reduce the energy consumption [9]. Triple glaze is the other types of glazing that has better result than double glaze with gas between sheets of glass.

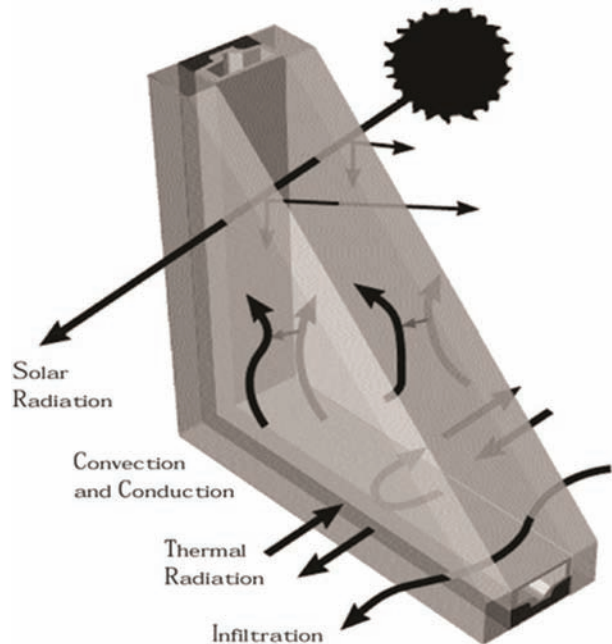


Figure 1. Three main kinds of energy movements through windows [4]

| Double-glazed unit (6–12–6 mm) | $U$ ( $W/m^2 K$ ) | SHGC | $T_{SOL}$ | $T_{VIS}$ |
|--------------------------------|-------------------|------|-----------|-----------|
| CLR                            | 2.7               | 0.70 | 0.60      | 0.78      |
| LECLR3                         | 1.9               | 0.66 | 0.53      | 0.72      |
| LECLR2                         | 1.8               | 0.36 | 0.27      | 0.46      |
| HABLU                          | 2.7               | 0.38 | 0.24      | 0.37      |
| HAGRN                          | 2.7               | 0.40 | 0.27      | 0.58      |
| HRCLR                          | 2.7               | 0.45 | 0.37      | 0.34      |
| HRBLULE2                       | 2.7               | 0.32 | 0.19      | 0.34      |
| HRGRNLE2                       | 2.7               | 0.32 | 0.19      | 0.42      |

Figure 2. Performance comparison of energy and economy beside a payback period of the investigated double-glazed units [5]

## 5. Importance of windows and frame materials and installation

"The subject of Material is clearly the foundation of Architecture", said William Morris in 1892 [2]. Glass has a significant role in modern buildings [1].

Material should have all the characteristics like; appropriate with its usage purpose, cost, mechanical resistance, stability, safety, impact on health, and environment. Besides, designer not only should use the kind of materials in their buildings that are not harmful for nature but also they should be recyclable. An example of harmful materials is; the ODP of the CFC known as refrigerant that can affect the Ozone layer. It also contributes greenhouse effect, or global warming. Therefore, "Generally designers should consider how their buildings will be constructed and deconstructed. They should allow for upgrading of the building during its lifetime" [2].

Furthermore, different types of windows frame are Aluminium, Composite, Fiberglass, Vinyl, Wood, PVC, and so on. For the proper selection of the frame, material durability and features of the project climate should be considered. In addition, the other important issue is installation of the windows and its components that have influence on decreasing the heat loss and heat gain through the building windows.

## 6. Strategies

There are new strategies for making indoor warm such as:

- Glass with two different surfaces, glass plus shadow surface with some holes, control of wave transmission in this window is high. It can be single/double [10] (Figure 3).
- Smart window which has two parts (1) high performance high reflective glass, (2) coated with low emissivity (low-e) covering. The advantage of this type of window is that can make enough day lighting, and makes low energy efficiency [1].
- Electrochromic window: "an original device was made using complementary materials. The active working electrode was tungsten trioxide, deposited by r.f. sputtering onto 'k-glass'. The storage counter electrode was nickel oxide lithium doped, electrochemically deposited. The solid ion conductor was (PEGMA)<sup>ii</sup>, containing appropriate dissolved salts" [11]. This type of window has memory for controlling daylight, loading, and thermal (Figure 4).

## 7. Case Study

(HALIL RAIF ÖZMUHTAR APT., SALAMIS YOLU, FAMAGUSTA, NORTHERN CYPRUS – Figure 5)

### 7.1. Observations

This building has four levels with six units; including a single flat in basement and in first floor as well, plus the second and third levels with two units (Figure 6 and 7).

Every unit in this apartment has five windows. Except the sitting room where two windows are placed in southeast and southwest of it, the other room (south), W.C. (south), and kitchen (void) have just one window.

Depending on the observations, there are problems like:

- Simple windows without any insulation
- Unsuitable size and orientation
- Humidity

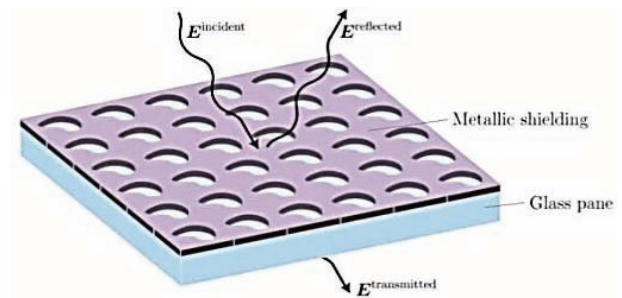


Figure 3. Surface with a periodic pattern of slots [10]

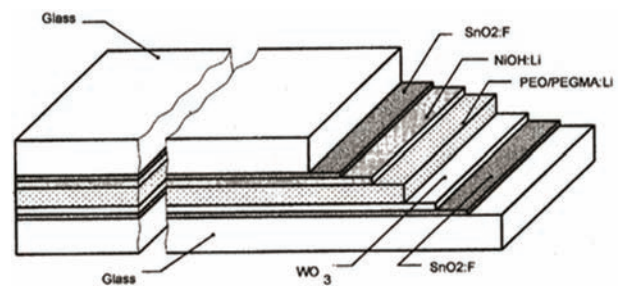


Figure 4. Schematic Structure of Electrochromic window [11]

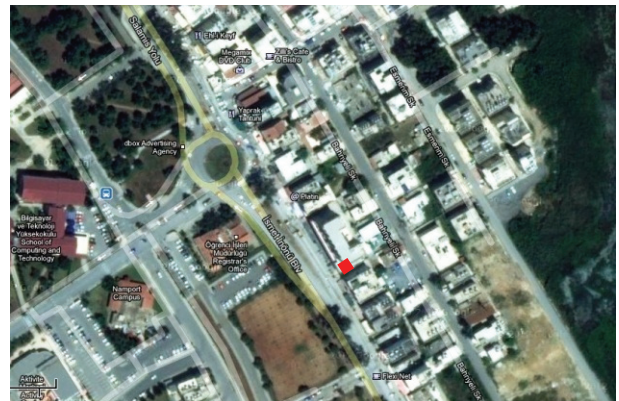


Figure 5. Site plan [12]



Figure 6. View of apartment outside (Photo by Authors)



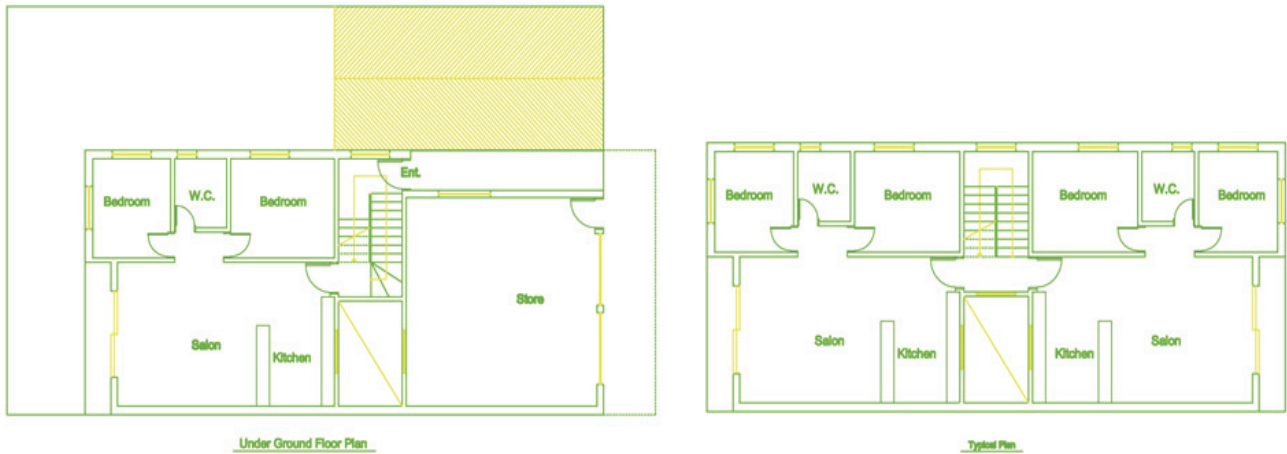


Figure 7. Halil Raif Özmuhtar Apartment plans (Drawn by Authors)



Figure 8. Mildew (Photo by Authors)

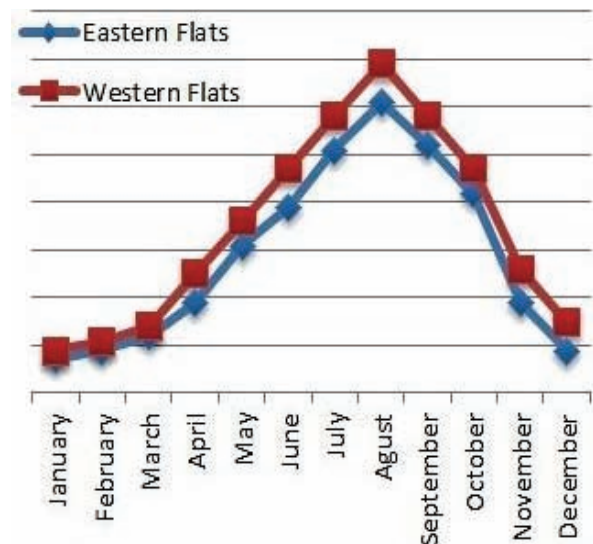


Figure 10. Satisfaction of windows (Source: Authors)

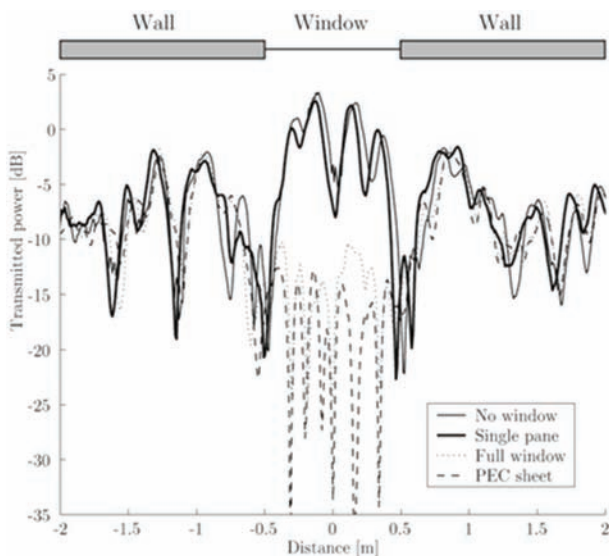


Figure 9. As a symbol of loss of energy in windows [10]

- Hard life
- Thermal comfort
- Mildew (Figure 8)

The Figure 9, is an analyse level of energy saving in windows part [10].

### 7.2. Interview

This report provides an evaluation and a conclusion for current situation of Halil Raif Özmuhtar Apt. This information is from analyzing the data which resulted from interviews of people who are living in Halil Raif Özmuhtar Apartment which the level of their satisfaction in every units and flats is considered.

Most of the people who are living in this apartment they are students of the Eastern Mediterranean University (EMU) including Males and Females. In every unit, 2-3

persons are living but underground floor because of some problems such as moisture, mildew, and bad condition is empty. Authors interviewed 12 people during 15-20 minutes.

The line Chart (Figure 10) revealed that people how much are satisfied with their windows function. Most of the people who are living in West flats have problem with their windows like; construction, insulation, and sealed but they are satisfied with their windows function in summer because of the suitable ventilation.

These column charts illustrate that every level and situation of flats have important influence on the weather of every flats. For example, the weather of western flats is better than eastern flats in every floor in cold days. Eastern flats have problem with the cold weather during cold seasons but in summer seasons, they have different idea about the weather of their flats. One of the people told that they rent this flat because of the good condition in the summer (Figure 11 and 12).

Size of windows percentage shows that they are agree with the size of the windows and most of them more than 50%. Depend on the hot-humid climate size of windows choose with big size in terms of thermal comfort and ventilation which helps to save energy. Direction of the windows in one room with two windows is suitable but in whole of flats is not suitable. Proportion of windows to area is not enough (Figure 13).

In pie chart clarify that percentage of using air conditioner in Halil Raif Özmuhtar Apartment is high. Therefore, usage of electricity is very high and depends on electricity is expensive in Famagusta, it makes problem for the tenant and owner should respect to these strategies for their building (Figure 14).

### 7.3. Discussion (Charts and Observations)

Finally, the differences between eastern and western units of our examined building, cause many differences in energy saving methods as well as thermal comfort of them. For example, eastern units are colder than western ones in regard with their position. However, it is a good profit on the hot weather of summer, in cold seasons, it causes many problems for making these units warm and energy consumption is very high, consequently. The other important factor for temperature of the unit; is level of its floor. On this basis, upper floors are hotter than the lower ones. Therefore, designer should use some strategies for saving energy in upper levels. The first noticeable problem of this building is lacking of windows insulation and its relevant sealing. Secondly, in spite of this fact that residences of this building were agreed with measure of windows, it is not enough for Cyprus climate. Thus, proportion of windows is not suitable. Thirdly, materials of windows need to be improved since they could not help to save energy in this building.

### 8. Conclusion

At the end, windows have the main role in saving energy in a construction, but designers and owners do not respect to this part of building as they think it is an ordinary part of building. Depends on the researches through articles and books; windows are the blind spot in terms of energy saving issues. There are many strategies, which not only help to save energy but also improve thermal comfort in apartments. Designer should respect to materials and appropriate selection of windows material, insulation, size of windows, onsite

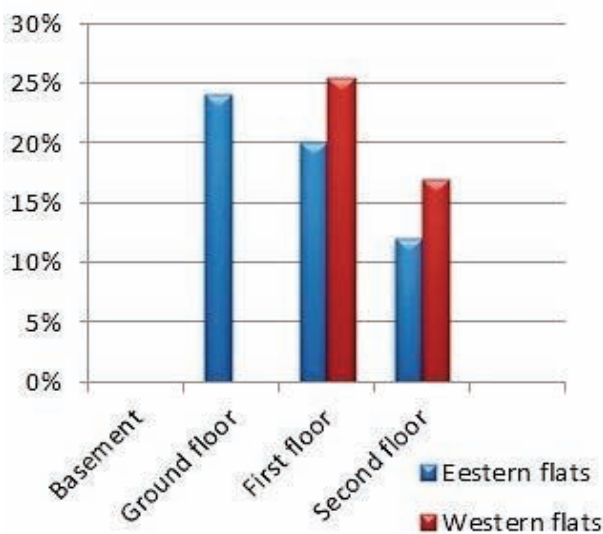


Figure 11. Suitable weather in Cold season (Source: Authors)

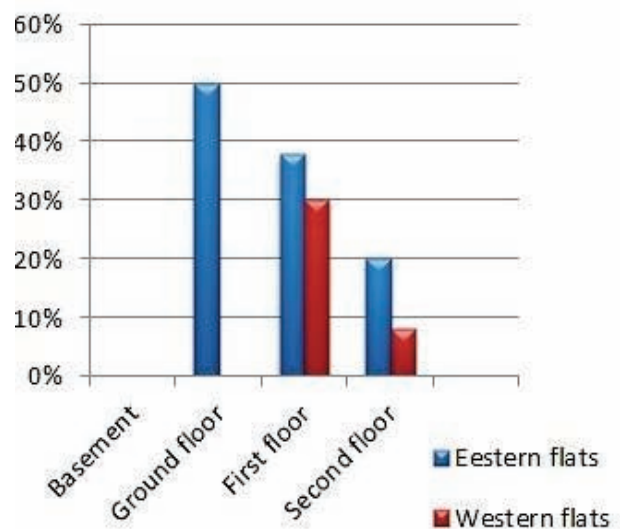


Figure 12. Suitable weather in hot season (Source: Authors)

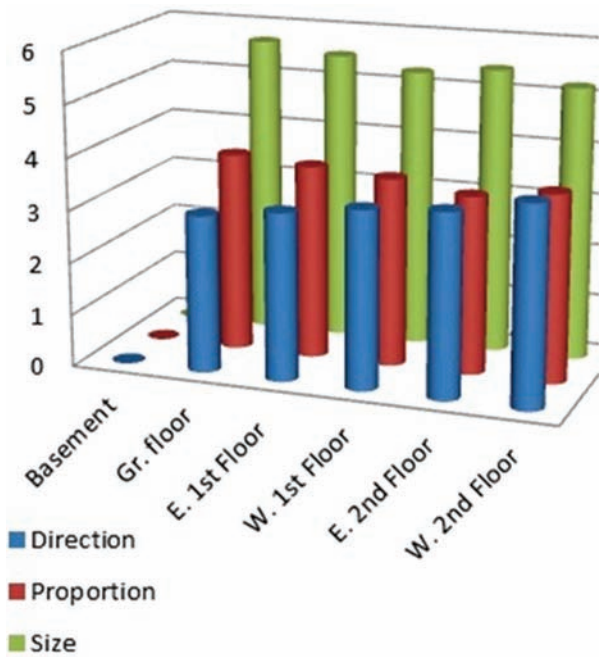


Figure 13. Windows satisfaction in terms of direction, size, and proportion to every part (Source: Authors)

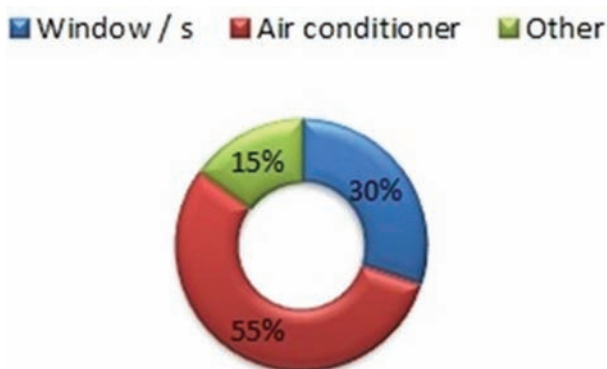


Figure 14. Ventilation devices in hot months (Source: Authors)

installation of windows, and direction of building according to the noticeable effect of them on the energy saving of apartment buildings.

Authors found that there are many problems in selection of windows material in Halil Raif Özmuhtar Apartment and they are not suitable for saving energy in apartment building. The other essential issue that may have influence on the increasing energy consumption is heat loss and heat gain of the windows. Furthermore, windows of traditional houses in the past were larger than windows in new constructions. Moreover, they had a vertical shape and their length was longer than the width, which is more appropriate regarding the Cyprus climate. The other issue is the size of windows on every

direction or side of façade and designers should revise dimension of windows, on base of this investigation.

The other matter is about the material of windows. Window has some components which its two special elements are; material of frame and glass. As the first element; Aluminium is the appropriate material for frame for wet climate according its characteristics of stability and anti-corrosion (ferrous oxide), or combination of aluminium and wood but from now by inventing new materials and importance of energy saving in building, it is not suitable for hot-humid environment. Therefore, it should be adjusted it with new material that can optimize the usage of energy in apartment. The other principal matter of windows is glass that has a significant role for daylight, view and so on. Designer can use double and triple glaze windows with argon gas between the panes. Furthermore, some of the designers and architects agree to use double glaze windows in Famagusta, North Cyprus due to double glaze may is cheaper than triple glaze and they may believe that there is not very much difference between performance of double and triple glaze windows. The proper type of glass should be used because it has the most efficiency on reduction of building energy usage. In addition, the importance of technology is explicit in modern buildings these days. Many scientists are searching for new ideas through energy saving of windows and they try to invent new materials or tactics. For example, they supposed that some strategies are used like: Electrochromic, and smart windows. These approaches boost improvement of condition in units.

Finally, the most important way for energy saving through windows is size, orientation, natural ventilation, insulation, sealing, onsite installation of windows, proper selection of frame and glazing. All of them have a positive influence of energy consumption in buildings.

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i Road

ii Poly Ethylene Glycol Methacrylate