

# Design Technologies to embody Sustainable Army Barracks.

Chanhyuk Park, Wooseok Cho, Enyul Kang, Junghee Lim, Jongchan Lee,  
Taesub Lim and Byungseon Sean Kim

Yonsei University, Seoul, 120-749, Korea, [chrispark@yonsei.ac.kr](mailto:chrispark@yonsei.ac.kr)

## ABSTRACT

Purpose of this study is embodying the sustainable military facility model of Republic of Korea Army that is applied renewable energy, passive design method and high efficiency equipment. In the introduction of this study, defined problem of existing military facility and classification of military facility are performed. In the renewable energy chapter, photovoltaic system and wind turbine system are considered. And then, LED light, photovoltaic panel, motor, inverter are considered in the high efficiency equipment chapter.

**Keywords:** military facility, renewable energy, renewable energy, barracks, High efficiency equipment

## 1 INTRODUCTION

Recently, most countries in this world trying to recover the eco-system and environment for make preparation to the dearth of resources and environmental disruption. Especially, technology propagation of sustainable energy, exploitation of resources and reusing existing energies are made progress around Europe, United States and Japan. In the case of Korea, supply rate of the renewable energy is insignificant condition that slightly 2.58% (based on 2008) and now it is spread out around a government agency and public enterprises.

Type	Conditions	Reason	Harmful effect
Inefficiency energy consumption	- Hard to handle the loads	Central distribution A/C system	- excessive energy consumption
Using of unsuitable material	- Poor living surrounding of military personnel	Impractical cost reduction	- poor serve condition
Destruction of the surroundings	- Occur the building waste - Much of temporary structure	Inappropriate planning	- pollution of surrounding - the lost reputation of army

Table 1: The real states of Korea army barracks

In addition, government of Korea announced “green-growth policy” including encouragement of renewable energy to improve energy efficiency of each individual

building. That announced means consideration of environmental problems level almost just as economy and industrial problem level, so improvement of Korean green building and renewable energy industry are expected.

Compared with another country, building industry of Korea has cultural difference which caused from division of Korea peninsula. Follow that reason, many of military facilities including barracks are exist in Korea. Nowadays many sustainable building design guide like LEED to sustainable building operation. On the other hand, military facilities not only do not have specific design guide but also lying with problems those are inefficiency energy consumption and using of unsuitable material for cutback the construction cost. Nevertheless, those problems were not easily find because specialty of tight military security. However, diffusion of public opinion about environmental problem is perceiving people that most of buildings need a change to eco-friendly building not only public buildings but also military facilities.

This study is base research for develop the sustainable eco-friendly army barracks through deducting effectively passive design method and applications of renewable energy.

### 1.1 Procedure for research

As for study to have read, it is accompanied with an aim embody sustainable technology to army barracks. For this study, first of all, discharge the case study of existing barracks to analyze the problem and the actual condition. Secondly, indicate the basic form of sustainable barrack through the examination of the applicable low energy technology. Thirdly, analyze possibility of applying about eco-friendly technology those renewable energy system, high efficiency electrical product and passive design. Finally, propose basic data for sustainable barrack development through the deducting conclusion based on analyzed data.

## 2 OUTLINE OF SUSTAINABLE MILITARY BARRACKS

Scales of military facilities in Korea are classified by division class, regiment class, company class, and platoon class.<sup>1</sup> Also, those facilities classified by assignment like general outpost. This study focused on residential facility, though military facilities consist of many forms.

Sections	Contents
Barracks	Battalion, Company, Platoon, Individual outpost
Administration	Headquarter office, Educational facility
Welfares	Welfare facility, Medical facility, bachelor officers' quarters
Operation	Warehouse, General outpost, Observation post
Storage and Engineering	Engineering bay, Depot
Correctional institution	Courtroom, Guardhouse
Others	Servicing facility, Religion facility

Table 2: Classification of military facility

In Korea, central distribution heating system is applied to most of army barrack. This condition can be a cause of unnecessary energy loss. Generally, in spite of probability to efficiency heating supply by fixed army daily timetable, usually energy loss which is unnecessary heating is occurred by central distribution heating system. For this reason, adopting the system which can control the heating by zone is acutely required. According to sundry records, a few opinion and discussion show that in the winter season, improvement of heating regulation and policy is needed.

## 2.1 Low energy army barracks

First key of the realizing sustainable army barracks is low energy using army barracks through reduce the excessive energy loss. For embody the low energy using army barracks, some of solution can be applied. First device is applying passive design in a planning progress to reduce the demand of total building energy fundamentally. Secondly, replace the building equipment of existing building to economize on energy. Also, another solution is installing the renewable energy system to achieve the total energy demand. In this study, apply the renewable energy, passive design and high efficiency equipment are analyze to develop low energy using army barracks.

## 3 SUSTAINABLE BUILDING TECHNOLOGIES

Sustainable building technologies are mostly related with the energy consumption. In this study, those technologies are in anticipation of the may reduce the Carbon Emission and be an Environmental friendly methods. In addition, electrical and Building equipment standards of REPUBLIC OF KOREA ARMY facilities which related with the energy consumption of are on the following tables 3 and 4.

Most of all, it is important to reduce the energy consumption to realize the sustainable military facilities. To solve these problems, there are 3 ways those are applying the renewable energy, reducing energy use with Passive Design and using the High efficiency equipment.

Section	Temp.(°C)	Heating	Cooling	Ventilation
Barracks	20	Radiator	Ceiling fan	Natural
B.O.Q	20	Radiant panel heating	Air conditioner	Natural
Official residence and apartment	20	Radiant panel heating	Air conditioner	Natural

Table 3: Building equipment standard of R.O.K ARMY<sup>ii</sup>

Section	Illuminance (lux)	equipment
Barracks	250	fluorescent light, Light bulb Spot light
B.O.Q	200-300	fluorescent light, Light bulb Spot light
Official residence and apartment	200-300	fluorescent light, Light bulb Spot light

Table 4: Electric equipment standard of R.O.K ARMY

## 3.1 Renewable energy

The renewable energy means that use the existing natural energy consist of solar energy, water, geo-thermal and precipitation to converting to the energy. In spite of the high initial cost of installation, many developed country have pushed ahead the Research and Develop and dissemination Policy. In Korea, using renewable energy can be supported maximum 60% by The Ministry of Knowledge Economy's regulation<sup>iii</sup>. Nevertheless, Military facilities are not supported by government<sup>iv</sup>, because it is included in state property. However the use of renewable energy in military facilities is extremely necessary because of the high energy consumption.

Solar heat, photovoltaic, wind power, and geo-thermal heat energy are the most commonly types of 11 ways in renewable energy. Solar heat and geo-thermal energy are difficult to use in military facilities because solar energy is usually used for water heating in Korea and geo-thermal heat energy is not only initial costs is expensive but also be limited by geography. This research will suggest the way to use the renewable energy based on them because photovoltaic system and wind power energy are most suitable for the military facilities.

Section		Characteristic	Application
Renewable energy	Photovoltaic	- High performance is expected through ample duration of sunshine - Lower price than another renewable energy system - Availability of direct installing to the building	- Installing on the pitched roof of barracks - Installing on the top of searchlight and streetlight
	Wind power	- Necessity of annual wind amount - Advantage of forward mountain area like Gangwon-do, Korea	- Apply to forward unit barracks and O.P - Integrate with large scale building
High efficiency product	High efficiency LED light	- Higher efficiency than ordinary light bulb and fluorescent light - Semi permanent life	- Apply to electric equipment of barracks - Apply to the searchlight and streetlight.
Passive design	Light shelves	- Use high reflectance material at the inside and outside of side wall window - Improvement of indoor visual performance - Reduce the artificial light loads	- Low efficiency because most of barracks are empty at the Daytime (daily working time)
	Trombe wall	- Using storage heating energy at the night time from day time solar radiation - Advantage to cold climate - Reduce the night heating load	- Usage profile of barracks is highest at the night (fit) - Advantage to forward unit barracks at cold climate (ex. Gangwond-do)
	Double skin façade	- Installing double skin façade at the south side wall - Use to the heating through collecting heat in winter season	- Suitable to division or regiment scale building - The burden of high construction cost to small scale barracks (ex. battalion scale)
	Cool tube	- Underground heat exchange system through underground duct - Reduce the air load through preheating and prechilling	- More effective to large scale building - Effect is expected very high because most of barracks exist in mountain area

Table 5: Design elements and application for sustainable barracks

### 3.1.1 Photovoltaic system

Photovoltaic is a way using solar cell and converting sunlight directly into electrical energy. This system consists of solar cells, battery and converter. Fortunately, most of Korean army Barracks have a pitched roof, so those can be installing on the roof of the barracks. Also in military facilities, more effective energy operating plan can be possible by fixed daily time army timetable. Operating plan will be established if generate when low electricity uses because almost troops participate the training program like morning and afternoon and use electricity at night.

### 3.1.2 Passive design

While the basic principle of environmental architecture is to be safe and sanitary, at the same time there is the desire to create a pleasant space. There are two methods to attaining this goal. The first method is the architectural opposition of the design theory ‘passive control’. Also, the second is the mechanical difficulty in the architectural equipment engineering ‘active control’.

The objective of environmental regulation is to produce an optimal effect without leaning too strongly toward either of the two methods. In this chapter, analysis of possible passive design methods can be applied to military facilities in environmentally friendly ways. While several methods are discussed, such as atrium, underground architecture,

wall surface surveillance, etc, the difficulties associated with installation cost and the many unique restrictions of a military facility have been kept out of the applicable subject. Namely, suitable natural design methods for military facilities can be summarized as "Light shelves, trombe wall, double skin façade and cool tube system.

Section	Passive control	Active control
Merit	-Indoor environmental control without mechanical system -eco-friendly(natural resources)	-Indoor environmental control with mechanical system -Active environmental control
Demerit	Impossible to prompt to action to change of outdoor environmental	Excessive energy consumption for active control

Table 6: Passive and active control

### 3.2 Wind power system.

Wind power energy is the production of induction electricity through the conversion of the wind's energy using a turbine. For electric companies or those demanding this type of energy, the supplying technology and types include vertical as well as horizontal power generators. Military facilities are usually located in areas with a lot of wind, such as mountainous or coastal areas, and analysis shows that there is a sufficient amount of wind for the

generators to produce large amounts of electricity in these places.

### 3.3 High efficiency equipment

While introducing renewable energy and a natural design to military facilities reduces the use of energy, and using alternative energy sources is important, with respect to energy use, using high efficiency products is another way of reducing overall energy consumption. Recently, high efficiency military products have been judged suitable to be applied to military facilities and an operation is underway to classify and analyze these products.

#### 3.3.1 High efficiency LED flashlight

LED, an abbreviation for Light Emitting Diode uses a semi-conductor to convert electrical energy into light energy through a device easily attained with IT technology. Comparing the energy cost with other standard flashlights, the LED flashlight has the advantage of being much lower in energy consumption. In the event that military facilities replace their fluorescent lighting with LED lighting, energy consumption decreases due to the high efficiency system, and it can be expected that there will be a steep drop in maintenance costs due to the semi-permanent longevity of the LED lighting. Particularly during night time patrols or where there has been horizontal lighting installed, a higher color rendering can be seen using the LED. On top of this, if the LED is used in conjunction with solar panels, there is no need to install electric wiring and the LED can be used on a semi-permanent basis.

Section	Light bulb	Fluorescent light	LED
Life	4000hr	8000hr	100,000hr
Power consumption	Large(100w)	Normal(40w)	Small(5w)
Pollution	Dust induction into the atmosphere	Mercury lamp fluorescent material	Low heat (eco-friendly)
Power	AC 220v	AC 220v	DC 12v
Fatigue degree	low	high	none

Table 7: Classification of light fixture

### 4. Conclusion

Currently in military bases, since 2008 "Gachil-bong" Observation post's solar and wind power energy system application had started, the introduction of renewable energy has increased. In order to promote active installation of renewable energies from now on, our research has analyzed a suitable scheme for the special case of the current military facility. Currently, not only South Korea, but all over the world, there is non-stop research and effort being made to make environmentally friendly buildings a

reality. As much as the rest of the world, within Korea I see the importance of showing the possibility of making the heavy cost incurring military facilities into environmentally friendly ones. Our research results and future direction are as follows:

1) The Korea army's energy reduction scheme can be largely summarized in 3 parts. Those are using renewable energy, application of passive design and the use of highly efficiency equipments. Depending on the particular characteristics of each military facility, these three parts need to be introduced on a terminable status.

2) Among the various renewable energy sources, the most effective energies put in place by the military have been solar and wind. Most military facilities have been located in mountainous or coastal areas, where the natural wind and solar energies are in abundance. Being in these locations, these two energies are more effective to use than other energy sources. With this as our background, there is a need to have further research that determines the most economic and efficient energy sources for the various army bases.

In this research, we analyzed design factors for deducing environmentally friendly military facility models. During the research, we could see that there were still environmental problems with the military facilities but our research did not go into depth on many of these points. This paper is to be a guideline for the development of environmentally friendly military facilities and to show the need for further research on the system applications through analysis.

### REFERENCES

- [1] C.Park and B.S Kim, "A Eco-friendly Technologies for Sustainable Army Barracks" KSES conference, 2009.
- [2] B.S KIM, "Sustainable remodeling technologies", Journal of KRA 30<sup>th</sup>, 2008
- [3] Y.Choi, "Evaluation of characteristics and improvement method for maintenance management of military facilities", Han-nam University, 2008
- [4] Research on renewable energy application, The Ministry of National Defense, 2009
- [5] National defense facility standard, The Ministry of National Defense, 2008
- [6] S.KIM, "a study on improvement methods for future military facility" AIK, 2008

<sup>i</sup> Y.Choi, "Evaluation of characteristics and improvement method for maintenance management of military facilities", Han-nam University, 2008

<sup>ii</sup> National defense facility standard, The Ministry of National Defense, 2008

<sup>iii</sup> The Ministry of Knowledge Economy's regulation

<sup>iv</sup> Korea energy management corporation