# Design of Green Community Rediscovery Center with Community Gardens and Social Integration Functions

## 공동체정원과 사회통합기능이 있는 Green Community Rediscovery Center의 설계

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Abstract

The aim of this study was to study the functions and roles of Green Community Rediscovery Center (GCRC) in terms of community integration, to design GCRC with various types of green roofs, and to investigate the possibility of applying a renewable energy system (e.g., PV) to the building greenery systems. The four major functional modules for GCRC were suggested: implementation of ecopark and community gardens with environmental education programs, implementation of green housing model with education programs, Discover Science Center, and implementation of green business model with education programs. Three major functions of the center are also presented in terms of design: 1) functions of community gardens; 2) establishment of a green business model, community composting system and an urban farming system; and 3) roles of community gardens in social interactions within GCRC. GCRC provides residents with the opportunities of community gardens, urban farming based on a successful recycling system, as well as a green business model and environmental education programs near their homes. The air temperature of the green roof (utilizing Sedum sarmentosum as a cover plant) was approximately 3℃ lower than that of the non-green roof, indicating a potential efficiency increase in PV systems for GCRC. It was concluded that the GCRC suggested would enhance the neighborhood satisfaction, improve the quality of life and contribute to social integration and community regeneration.

Keywords : community gardens, green roofs, green business, community integration, photovoltaic (PV)
키워드 : 공동체정원, 녹화지붕, 녹색비즈니스, 공동체통합, 태양광발전

## 1. Introduction

The ecological sustainability issue has recently evolved into a holistic concept harboring social, cultural and environmental aspects. Building a sustainable city becomes necessary in the context of this holistic approach which includes a concept of regeneration of the degenerated city communities. To establish a community center that can provide the residents with social, economic, cultural and environmental integration opportunities would be a vital part of the city regeneration (rediscovery).

In this study, the community center named "Green Community Rediscovery Center" (GCRC) is suggested as one of the model facilities to function for the purpose of these integration. The center with a sustainable building concept can be implemented based on a building greenery system (ecopark and gardens, green roofs etc.) utilizing renewable energy. In addition, ecological and sustainable architectural facilities can be also provided for the citizens as a dynamic community. Two major directions will be taken into account for design of the center. One is the implementation of an ecopark and gardens on and/or near the residences, where people can enjoy the nature and quality environmental and ecological educations could be performed. The other is to secure or build environment-friendly and sustainable residential welfare spaces for the implementation of photovoltaic (PV) systems, solar thermal systems and an organic waste recycling center.

Building greenery systems means all the systems dedicated to improve the building environment in terms of physical conditions (i.e., temperature and moisture, etc.) and non-tangible values (i.e., aesthetic values) through the

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vegetation of buildings (indoors and outdoors). These systems include implementation of green roofs and green walls, and their maintenance systems.

One of the primary benefits of green roofs is to protect the roof from solar radiation by absorbing heat and minimizing temperature fluctuations. Green roofs also have the following advantages: the ability to alleviate urban storm water runoff problems, reducing the total runoff by retaining part of the rainfall and distributing the runoff over an extended period of time [1], ability to remediate the pollution of urban rainwater runoff by absorbing and filtering pollutants [2][3], and help keep buildings cool in summer and reduce a building's energy consumption by direct shading, evaporative cooling and additional insulation [4]. Green roofs also have aesthetic value, which is one of the most apparent ecological benefits [5]. PV solar cells transform light energy directly into electricity. In order to generate sufficient energy, the individual solar cells are fabricated in modules. The characteristic data of a module are its output voltage and power under solar radiation (1000W $m^{-2}$) and cell temperature (25℃). There is a positive correlation between the amount of solar radiation and electric power output, whereas there is a negative relationship between the module temperature and power [6][7][8].

The installation of PV modules in an outer wall and a roof of a building is known as a building integrated PV (BIPV). Although this is one of the most efficient installations, it may not be applicable to all kinds of PVs. A mounting type (module fixed by a fixture on a roof) is usually used for a flat roof and it can be tilted toward the south to maximize its exposure to the direct sunlight. If installed in rows, sufficient intervals should be allowed to minimize the effect of shadows from the row on the neighboring row. The thermal quenching effect of greenery systems will also benefit a PV system. Consisted of the three layers (vegetation, surface soil and drainage), green roofs as a thermal insulation unit can lead to an increase in refreshing air as well as reduced energy consumption in a building. In addition, the installation of a PV system on the green roof top could increase efficiency of the PV system and reduce the consumption of fossil fuels, and make possible a low carbon building with a renewable energy. This is the synergistic effect of green roofs and a PV system. The aim of this study was to study the functions and roles of GCRC in terms of community integration, to design GCRC with various types of green roofs, and to investigate the possibility of applying a renewable energy system (e.g., PV) to the building greenery systems.

## 2. Methodology and study approach

### 2.1 Approach for design and planning of GCRC

There is an increasing demand for the establishment of environment friendly architecture and habitat systems because the sustainable growth is necessary, and energy and natural resources are being depleted rapidly. This leads people to realize the importance of a sustainable community in which the quality of genuine health and social diversity is possible. The major roles of GCRC will be emphasized on the two aspects as following:

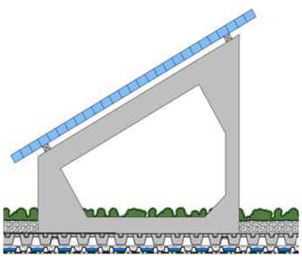
1) Establishment of education programs for sustainable growth; Program for green growth, green home supply, green business information, and ecosystem conservation; Discover Primary Science Program for students

2) Implementation of green business that allows the recycling and reuse of organic wastes and wastewater, and building greenery systems in a community setting; Running a feasible composting system and training program; Construction of building greenery systems combined with green energy (PV) and composting systems

### 2.2 Setup of green roof with PV system

A scheme for setting up a PV system on the green roofs is suggested in Fig. 1(A), and a model arrangement of PV modules is shown in Fig. 1(B) [9]. The PV on a green roof system functions best on flat roofs. The system is installed at 30° elevation to the roof and above the vegetation to avoid shading. It is mounted facing south as usual to enhance the efficiency. Designed frames of aluminum are especially used to suspend the panels above the height of the vegetation. The whole profile is fixed on a framework made of plastic boards that are covered by the substrate. This allows rainwater to drain through and the plants to grow under the PV panels without being totally shaded. To avoid the roof being damaged by point loads, the PV panels mounted on the plastic boards are distributed evenly on the roof. The spacing between the panels is such that panels cannot shade each other.

A



B

Fig. 1. A scheme of setting up a photovoltaic (PV) system on the green roof (A), and a representative PV module (B)[9]

### 2.3 Design approach for green roof with PV system

The following factors need to be considered in the design a green roof with PV modules: 1) the loading capacity of the roof particularly for renovated roofs; 2) the shape of the roof; 3) the space in the roof; 4) the type of greenery or plants that can easily grow; 5) the shading effect on the roof by the adjacent structures; 6) the capacity of the PV modules to be installed. PV modules with green roof integrated systems carries extra load compared to normal roofs and are designed to withstand the extra stress caused by the weight of the PV, the weight of the substrate, the weight of the growing plants and wind force. The roof is designed to allow the drainage of water from the substrate without leakage to the roof. The shape of the roof will determine the optimal arrangement of the panels and greenery. For flat roofs, a separate structure with a more optimal tilt angle is mounted on the roof. The space on the roof also affects the design a larger space on the roof allows more panels and plants with adequate spacing. The greenery used in this system should be selective. Vegetative plants should be able to grow under the PV. The plants should not develop strong roots that could affect the roof with time. The vegetation must withstand partial shading from the panels. The factors affecting plant selection are thedesign intent, aesthetic appeal, environmental conditions (climate and microclimate), media composition and depth, installation methods and maintenance [10].

Where there are other adjacent structures or buildings, the design should consider their shading effect on the PV because shading reduces the performance of the solar panels. The installation capacity of the PV system is also dependent on the space available in the roof. A typical 2-kW PV system will require usually 200-400 square feet of the site [11]. Consideration should also be given to the access space which may reach 20% of the total installation area.

### 2.4 Measurement of temperature at potential test sites for PV installation

A green roof of a school located in Jecheon, South Korea (Fig. 2B) and a non-green roof nearby were selected to compare the temperature distribution of a green roof and non-green roof (general roof) (Fig. 2A). Most green plants on a roof were stringy stone crop (*Sedum sarmentosum)*, which was highly resistant to dry conditions and the total thickness of the green area was approximately 20cm. An instrument used for the temperature measurements was a temperature recorder (Model TR-71U; T&D Corporation, South Korea) that was operated simultaneously with two sensors. The measurement was performed on sunny days near the autumnal equinox in 2009. The temperatures were measured every hour from 9am to 3pm. Each sensor was located on the green roof and general roof and measured the air temperature approximately 1 meter above the surface and recorded the results automatically.

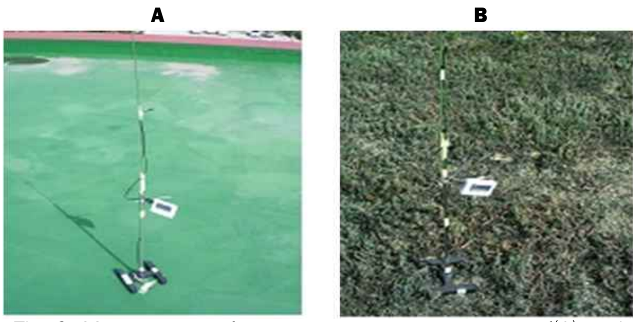



Fig. 2. Measurement of temperatures on non-green roof(A) and green roof(B) using the automatic temperature recorder (TR-71U).

## 3. Results and discussion

### 3.1 Eco-friendly design of Green Community Rediscovery Center and its functions

The Green Community Rediscovery Center (GCRC) would reduce storm water runoff and energy needs for air conditioning, and help extend the life of the roof membrane. The center will be designed eco-friendly by using bio soil mix, biodegradable coir mats, as well as native plants which are adaptable to the site attracting local butterflies, birds and insects. The GCRC can be established in available spaces in residential areas, which can be accessed easily by residents and visitors. The four major functions of the center are as follows: 1) functions of an ecopark and gardens, a small scale park with artificial streams and ponds, green roofs/green walls, greenhouses, and outdoor/indoor landscapes; 2) implementation of education programs for green homes, green growth and wellness, and global environmental changes; 3) function of a science discovery center for students, multi-disciplinary hands-on scientific education and workshops on recycling and the sustainable environment; and4) establishment of an urban green business model, an urban farming system with a community composting system (Table 1). In this paper, three major functions of the center will be described and discussed in terms of design: 1) functions of community gardens; 2) establishment of a green business model, community composting system and an urban farming system; and 3) roles of community gardens in social interactions within the GCRC.

#### 3.1.1 Functions of ecopark and community gardens

The design of two types of gardens was initially attempted to establish a basis for the GCRC. The essential purpose of the center is to function as a

Table 1. Representative modules for the Green Community Rediscovery Center (GCRC) and their functions.

| Modules | Functions |
|---|---|
| Ecopark and community gardens, and environmental education programs | - Ecopark or gardens in appropriate places, accommodating artificial stream and vegetable gardens<br>- Green roofs and greenhouses for horticultural therapy and others<br>- Indoor or outdoor landscape<br>- Education program for sustainable environment and green growth through hands-on experience |
| Green housing model and education programs | - Model green home with PV and solar thermal power systems<br>- Model green home with green roofs, indoor or outdoor landscape<br>- Education program for future green homes |
| Discovery Science Center | - Science education program for children and students after school emphasized on waste recycling, reuse and recovery<br>- Participation program for recycling based on incentive ("ecopoints")<br>- Customized education programs for green homes and green growth |
| Green business model and education programs | - Community composting system in the residential areas: local employment and marketing opportunities<br>- Urban organic farming and landscape: self-consumption or marketing<br>- Education programs for local people: curricula (lecture and workshop) on resource recycling, urban greening, and urban sustainable agricultures |

community place where residents can take a rest and be educated on green homes/buildings, green growth and ecosystems, and interact with each other. Education or meetings can be held in spacious wooden decks. The PV system implemented in roof gardens could be a good object to demonstrate how renewable energy can be used effectively for the maintenance of gardens and preservation of the environment.

One example of community gardens would be a garden functioning as a resting place and a place for interactions between people (Fig. 3). This type of garden could be established on the rooftops of office buildings in urban centers or public office buildings. The garden may play a role as a "green island" in areas with a high density of

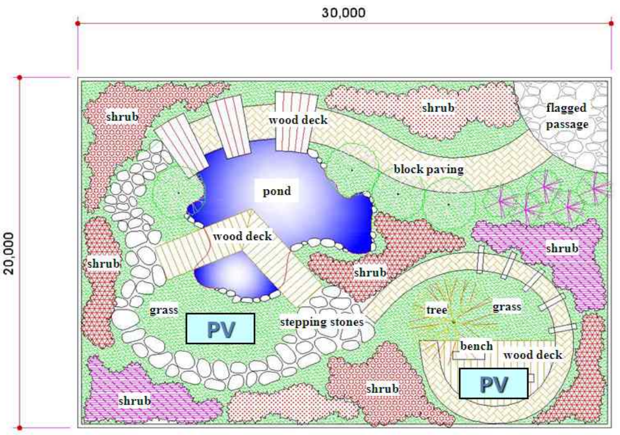



Fig. 3. Design of water garden on the rooftop where photovoltaic (PV) system is implemented. Note that PV can be installed on the lawn. Unit, mm

concrete buildings or could become a "small oasis" in the heart of the city. If necessary, this garden can be installed in the middle stories of a building so that the residents or exhausted urban

workers can easily access the place, enjoy nature and take a rest in their break time.

Another example of community gardens will be a rooftop garden with a greenhouse, in which the limited space can be utilized more positively (Fig. 4). A greenhouse made of glass or vinyl can allows herbs or medicinal plants to grow regardless of the seasons using sunlight and heat, leading to secondary production processes. These plants can be used to set up a horticultural healing program for the residents and/or marketed for commercial purposes. This garden can be also set up as a learning place for nature when a variety of plants bearing flowers and seeds are planted.

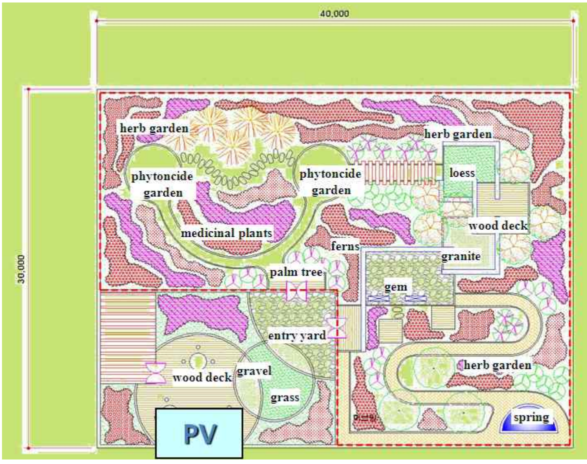



Fig. 4. Design of a green house to accommodate an aroma therapy garden (dotted line) on the rooftop where photovoltaic (PV) system is implemented. Unit, mm

3.1.2 Establishment of a green business model

Urban farming utilizes a small parcel of land to grow crops or horticultural plants (vegetables and ornamental plants) within an urban environmental setting. It can not only provide citizens with agricultural products but can also absorb and recycle rainwater runoff, prevent urban warming and clean air pollution. It can also help to recycle domestic organic wastes through composting. It takes one part of the urban ecosystem in terms of materials and energy recycling. Community gardening may increase the availability and intake of fruits and vegetables by urban residents. A recent study reported that adults with a household member who participated in a community garden consumed 1.4 times more fruits and vegetables per day than those who did not [12]. This will be a good way of positively encouraging fruit and vegetable intake by urban residents and aged people, which is quite important for their health.

Another important facility for GCRC would be a vegetable community garden of a rooftop with PV system (Fig. 5). People can grow vegetables and herbs for their own consumption or for sale. The greening of rooftop spaces for urban farming could be applied to the rooftops of kindergartens, senior citizens' community centers and other social welfare facilities in Korea. Urban farming provides children and students with an educational opportunity to appreciate natural phenomena and benefits. In addition, it also provides seniors with an opportunity for work as well as a pastime. Therefore, this facility can be a place for green business practice and education, and can provide work for the available labor force inthe community. Vagneron [13] performed an economic analysis of the profitability and sustainability of peri-urban agriculture in Bangkok, which spans horticulture, aquaculture and crop production. This kind of approach for business feasibility could be applied to the urban farming suggested in this paper.

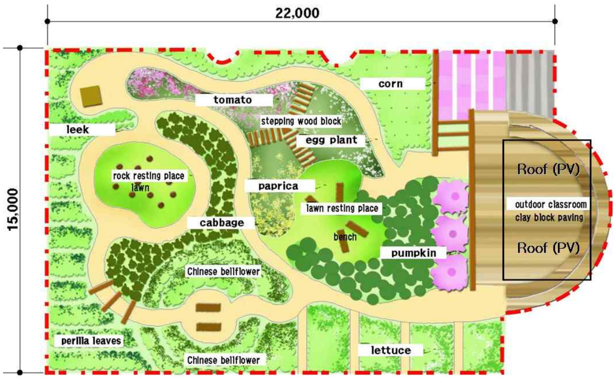



Fig. 5. Design of vegetable gardens on the rooftop where photovoltaic (PV) system is implemented as a part of the roof of the outdoor classroom. Unit, mm

The limiting factors for the water garden and the aroma therapy garden, however, would be higher initial investment cost and maintenance costs (labor charge, energy charge, water cost and materials cost, etc.). The vegetable garden will require a work force for the daily maintenance despite its lower initial investment cost. Home composting or backyard composting, i.e. the self-composting of the biowastes and the use of the compost in a garden belonging to a private household [14], has several potential advantages compared to the industrial composting process. It makes the collection of the organic fraction of municipal solid waste (OFMSW) unnecessary, it reduces the economic, material and energetic investments significantly, and provides direct control of the process and organic materials input [15,16]. Home composting can be a good alternative to industrial composting in low density urban areas where a large transport investment is necessary for the separate collection of OFMSW. However, composting at home cannot replace industrial composting in high density urban areas due to site, hygienic and monitoring requirement [17]. An appropriate size of in-vessel composting system can be utilized for the home composting in residential areas in Korea, and can be operated successfully in association with a GCRC.

### 3.2 Roles of Green Community Rediscovery Center in social interactions

Community gardens play an important role in developing community ties in high-density apartment complexes in Korea as well as business or public buildings. Participation in a community gardening program encourages the residents to meet others with similar interests and helps forge a sense of community ownership and stewardship. Studies have found that gardens represent a range of activities that have purpose and coherence, promote social inclusion, and give rise to health benefits [18,19]. Community gardens have a positive social influence in neighborhoods and can act as a catalyst for other positive place-based social dynamics. They also encourage interactions between different age groups and serves as a neighborhood place to resolve conflicts and organize community members [20]. Community gardens provide safe, recreational green space in urban areas with little or no park land and offer residents some access to green spaces, which reduces the level of stress and increases a sense of wellness and belonging. The effects of exposure to nature on stress recovery [21] and the restorative qualities of gardening [22] are well known. In addition, community gardens have the potential to promote physical activity, social engagement, and mental health.

Successful community gardens are community centers that bring neighbors closer together with a range of environmental and educational events. For example, the Peralta Community Garden in Berkeley, California, was established in 1997 by the efforts of the community to transform an unused lot owned by the City into a community identity [23]. The neighbors worked together to remove broken bottles, metal, concrete, and other debris, and went through a lengthy and challenging process of discussion and design of a community garden. The garden serves as a showcase for local artists displaying artworks and a place for educational workshops, cultural and social events, birthdays and other celebrations.

Along with the increasing demands for exposure to nature, recreational activities and food security, the participation of residents in community gardens is expected to grow in Korea. Therefore, providing residents with the opportunity of urban farming nearby their homes will also increase the level of neighborhood satisfaction, improve the quality of life and contribute to social integration.

### 3.3 Potential effects of building greenery systems on photovoltaic system for Green Community Rediscovery Center

A greenery system generally protects the base membrane of the roof against radiation by reducing its temperature and minimizing the daily or seasonal temperature fluctuations [24]. It has the ability to reduce the degree of urban rainwater pollution by absorbing and filtering pollutants. It also helps in keeping buildings cool in summer and reducing a building's energy consumption by direct shading, evaporative cooling and additional insulation [2, 25-29]. The exchange of carbon-dioxide and other gaseous pollutants for oxygen that occur in greenery can also help improve the air quality. The evaporation and oxygen-producing effect of vegetated roofs can help improve the microclimate. Considering the above-mentioned benefits, green roofs can mitigate the urban heat island effect [30, 31,]. Planted roofs can also provide food and a safe habitat for many kinds of plants, animals and invertebrates [32]. Green roofs beautify the environment and enhance the image of a city. Green roofs can also mitigate noise pollution [5]. In a metropolis where access to green space is limited, green roofs create space where people can rest and interact with their friends and associates. Green roofs also provide psychological benefits because of their appearance, which differs greatly from ordinary roofs. Therefore, a green roof helps enhance the aesthetic appeal of a building.

It has been proven that the module temperature of a PV affects the performance. The electrical characteristics of these modules, such as current, voltage and power, were similar under the standard test conditions (STC) of 1000 W $m^{-2}$ solar radiation and 25℃ PV module temperature [33]. The ambient temperature often varies during a typical day in summer and winter. The average ambient temperature is approximately 21.1℃ and 6.4℃ during summer and winter, respectively.

Power generation by a PV module varies with the PV module temperature. The electrical performance of PV modules is also related to their temperature variation. A PV module that has a higher temperature can decrease its electricity generation. The results show that the voltage decreased by approximately 0.49% per 1℃ increase in the PV module temperature and the current increased about 0.01% per 1℃ increase[33]. This shows that the PV module temperature affects its electrical performance: an approximately 0.48% decrease in power generation with each 1℃ increase in PV module temperature.

Synergy between the PV and a green roof will help balance temperature and radiation on the roof. In summer, the excess heat energy that could increase the PV module temperature will be absorbed by the greenery system while enhancing the radiation to PV. In the winter, when the temperature is usually lower in non-green environment, the greenery buffers the air temperature changes surrounding the PV and does not allow the temperature to fall below the optimum, even when the substrate temperature is low due to ice.

### 3.4 Installation of PV system and factors affecting the system

The energy consumption of building comprises 25 % of the total energy consumed in Korea, and greenhouse gases emitted from buildings including construction materials are 40 % of total emission in Korea, Therefore, the Korean government is encouraging 'Green Home' and 'Green Building' projects to reduce the building energy consumption and carbon emission rate by using more renewable energy. From this perspective, eco-friendly construction technology is under development to accomplish the goal of building energy reduction and low carbon use. In particular, a green roof is becoming more popular because it allows many benefits such as insulation of the building, reduction of urban heat islands and an enhanced eco-friendly image of the building. As for efficient energy use, a photovoltaic (PV) system can produce electricity from solar energy, and replace some of the fossil fuel energy. These two technologies can be applied to both new and old buildings.

Before a PV module is installed, the optimum efficiency should be considered based on the characteristics of the building and external elements [34]. On a flat roof top, it has the highest performance when installed at an angle of 30° from the roof surface, facing south [35]. On the other hand, the roof top is hottest during summer. The performance of a PV module decreases with increasing temperature [36]. Therefore, it is essential to develop a way of reducing the temperature of PV panels during summer [37]. In this sense, a green roof top can reduce the roof top temperature and prevent heat from reducing the efficiency of a PV module.

PV modules in Korea are generally installed on non-green roof tops. No attempts have been made to accommodate PV modules on green roofs so far. However, PV modules installed on a flat roof top encounter with the following problems. There is a difficulty in being accommodated to the existing building structures. Even if the generation of electricity is the priority, the PV module should be installed considering the building design. when the weight of the PV system considered, a single panel can only be installed above a construction that can withstand weight of the PV system plus the wind and snow loads. This weight has a detrimental impact on the roof and the internal structure of the building. Potential damage by the strong wind creates static and negative pressures depending on the size of the building and shape of the roof. The wider and higher the PV system is, the more vulnerable it is to wind damage. Damage to the roof top caused by the PV module base installation may lead to a leaky roof. However, this leaky roof problem can be avoided by installing the module base under the green roof system. Here, the bottom of the PV module is covered with plants and soil, which can secure the PV module. Moreover, the module weight is spread over the roof and the module is less prone to damage by wind. In addition, no holes will be necessary to fasten the module, leading to no direct damage to the roof top.

### 3.5 Comparative analysis of temperature profiles of non-green roof and green roof

The measured temperatures varied as shown in the five day measurement results (Fig. 6). The temperatures on the green roof measured 1m above by the sensors appeared to be approximately 2-4℃ lower than the non-green roof. In particular, the temperature difference appeared to be higher in the afternoon. This is possible because the heat radiation from the ground is more significant. On the other hand, this temperature difference is expected to increase in summer due to the much higher level of solar radiation.

According to these results, the air temperature of the green roof was approximately 3℃ lower than that of the non-green roof. If a PV-Module is operated at that height, then it would show greater efficiency because the PV cooling speed on a green roof is faster than that on a non-green roof. Theoretically, if the temperature is reduced by 3℃ the efficiency of a PV-module is expected to rise by approximately 10%. Obviously, this can lead to an increase in the amount of power generated. As a result, since the temperature difference in winter with strong heat radiation is increased, a combination of green roof and a PV-panel can increase the power generated by at least 20%.

In summer, the sun is very high in the air. Therefore, flat roofs may be exposed to the maximum amount of sun light among the external surfaces of a building. The general surface temperature of concrete is highest in the afternoon and heat radiation greatly affects the air temperature near the roof surface. However, green roofs can minimize the effects of heat radiation through the use of greenery systems carrying plant and soil layers. It can reduce the roof surface temperature and increase its indoor heat-blocking effects. It also has positive effects on the neighboring microclimates.

## 4. Conclusion

Design ideas for GCRC with green roofs loaded with a renewable energy model (a PV module) were presented, and the functions and roles of GCRC in terms of community integration were discussed. The four major functional modules for a GCRC were suggested: implementation of ecopark and community gardens with environmental education programs, implementation of green housing model with education programs, Discover Science Center, and implementation of green business model with education programs. Three major functions of the center were presented in terms of design: 1) functions of community gardens; 2) establishment of a green business model, community composting system and urban farming system; and 3) roles of community gardens in social interactions within a GCRC. Along with the increasing demands on exposure to nature, recreational activities and food security, the residents' participation in community gardens is expected to grow world-wide including Korea.

This study also examined the effects of a green roof system (utilizing *Sedum sarmentosum* as a cover plant) on the thermal quenching on the rooftop. The air temperature of the green roof was approximately 3℃ lower than that of the non-green roof, indicating a potential efficiency increase in PV systems for GCRC. Therefore, a GCRC with a renewable energy system could provide the residents with community gardening, urban farming based on a successful recycling system, a green

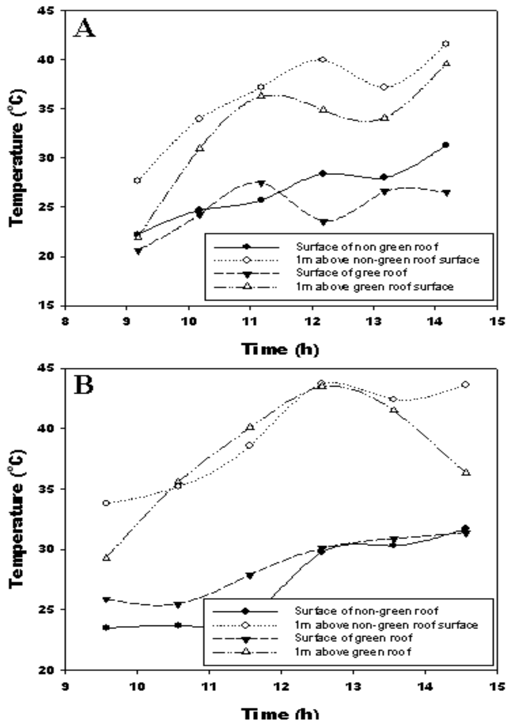



Fig. 6. Temperature fluctuations of the non-green roof and the green roof in Sept. 22, 2009 (A) and Oct. 1, 2009 (B).

business model and environmental education programs near their homes. In addition, it is expected to enhance neighborhood satisfaction, improve the quality of life and contribute to social integration and community regeneration.

## References


1. Carter T, Jackson CR. Vegetated roofs for stormwater management at multiple spatial scales. Landscape and Urban Planning 2007;80:84 - 94.
2. Santamouris M, Pavlou C, Doukas P, Mihalakakou G, Synnefa A, Hatzibiros A, et al. Investigating and analysing the energy and environmental performance of an experimental green roof system installed in a nursery school building in Athens, Greece. Energy 2007;32:1781 - 8.
3. Teemusk A, Mander U¨. Rainwater runoff quantity and quality performance from a greenroof: the effects of short-term events. Ecological Engineering 2007;30:271 - 7.
4. Del Barrio EP. Analysis of the green roofs cooling potential in buildings. Energy and Buildings 1998;27:179 - 93.
5. Green Roofs for Healthy Cities. ZinCoCanada, Inc.; 2006 /http://greenroofs. nets.
6. Schmitz-Guenter T, Lebensraeume, Koenemann, Koeln, 1998
7. Staiss F. Photovoltaic, Vieweg & Sohn, Braunschweig, Wiesbaden, 1995
8. Wolfgang B. Sonnenenergie, Verlag Technik, Berlin, 2000, p.47
9. International Green Roof Association. Special constructions: Green roofs and solar panels 2010 http://www.igra-world.com/engineering/solar_energy.php
10. Getter KL, Rowe. DB. Selecting Plants for Extensive Green Roofs in the United States Michigan State University Extension Bulletin E -3047 July 2008
11. A guide to photovoltaic (PV) system design and installation Endecon Engineering 347 Norris Court San Ramon, California 94583, 2001
12. Alaimo K, Packnett E, Miles RA, Kruger DJ. Fruit and Vegetable Intake among Urban Community Gardeners. J Nutr Educ Behav. 2008;40:94-101.
13. Vagneron I. Economic appraisal of profitability and sustainability of peri-urban agriculture in Bangkok. Ecological Economics 2007;61:516 - 529.
14. European Commission. Green Paper on the Management of Bio-waste in the European Union 2008. In: Official Journal of the European Communities.2009 Home page: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008-DC0811:EN:NOT> (accessed January 2009).
15. Jasmin S, Smith S. The Practicability of Home Composting for the Management of Biodegradable Domestic Solid Waste. Centre for Environmental Control and Waste Management, Department of Civil and Environmental Engineering. London, England, 2003
16. Boldrin A, Andersen JK, M_øller T, Christensen TH, Favoino E. Composting and compost utilization: accounting of greenhouse gases and global warming contributions. Waste Management and Research 2009;27:800 - 812.
17. Martinez-Blanco J, Colon J, Gabarrell X, Font X, Sanchez A, Artola A, Rieradevall J. The use of life cycle assessment for the comparison of biowaste composting at home and full scale. Waste Management 2010;30:983 - 994
18. Sempik J, Aldridge J. Social and Therapeutic Horticulture in the UK: The Growing Together Study, Centre for Child and Family Research, Leicestershire, 2005, p.1-5
19. Tieg E, Amulia J, Bardwell l, Buchenau M, Marshall JA, Litt JS. Collective efficacy in Denver, Colorado: Strengthening neighborhoods and health through community gardens. Health & Place 2009;15:115 - 122.
20. Glover TD, Parry DC, Shinew KJ. Building relationships, accessing resources: mobilizing social capital in community garden contexts. Journal of Leisure Research 2005;37:450 - 474.
21. Ulrich RF, Simons BD, Losito E, Fiorito MA, Miles and M Zelson. Stress recovery during exposure to natural and urban environments. J. Environ. Psychol 1991;11:201- 230.
22. Kaplan R, Kaplan S. Preference, restoration and meaningful action in the context of nearby nature. In: Barlett, P. (Ed.), Urban Place: Reconnecting with the Natural World. The MIT Press, Cambridge 2005, p.271 - 298.
23. Peralta Community Garden in Berkeley, California. http://www.urbanhabitat.org/node/1858
24. Teemus A, Mander U. Green roof potential to reduce Temperature fluctuations of a roof membrane: A case study from Estonia. Building and Environment 2009;44:634-650.
25. Bass B, Baskaran B. Evaluating roof top and vertical gardens as an adaptation strategy for urban areas. Institute for Research and Construction, NRCC- 46737, Project No.A020, CCAF Report B1046. Ottawa, Canada: National Research Council, 2003.p.110 /http://irc.nrc cnrc.gc.ca/pubs/fulltext/ nrcc 46737/nrcc46737. pdfS.
26. Theodosiou TG. Summer period analysis of the performance of a planted roof as a passive cooling technique. Energy and Buildings 2003;35:909 - 17.
27. Wong NH, Cheong DKW, Yan H, Soh J, Ong C L, Sia A. The effects of roof top gardens on energy consumption of a commercial building in Singapore. Energy and Buildings 2003;35:353 - 64.
28. Del Barrio E P. Analysis of the green roofs cooling potential in buildings. Energy and Buildings1998;27:179 - 93.
29. Eumorfopoulou E, Aravantinos D .The contribution of a planted roof to the thermal protection of buildings in Greece. Energy and Buildings 1998;27:29 - 36.
30. Takebayashi H, Moriyama M. Surface heat budget on green roof and high reflection roof for mitigation of urban heat island. Building and Environment 2007;42:2971 - 9.
31. Wong NH, Chen Y, Ong CL, Sia A. Investigation of thermal benefits of rooftop garden in the tropical environment. Building and Environment 2003;38:261 - 70.
32. Brenneisen S. The benefits of biodiversity from green roofs —key design consequences. In: Proceedings of 1st North American green roof conference: greening roof tops for sustainable communities. Chicago, IL: The Cardinal Group, Toronto; 2003.p.323 - 329.
33. Park KE, Kang GH, Kim HI, Yu GJ, Kim JT. Analysis of thermal and electrical performance of semi-transparent photovoltaic (PV) module. Energy 2009xxx:1
34. PV database by IEA-PVPS Task7 (http://www.pvdatabase.com/serach_form.cfm)
35. Hagemann I. PV in builing - the influence of PV on the Design and planning process of a building, Proc. of Renewable Energy 1996;8
36. Manfred K. Photovoltaic Panels on Greened Roofs, RIO 02 World Climate &Event, January 2002
37. The German Energy Society. Planning and Installing Photovoltaic systems. Earthscan, London, 2008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