

Implementation of Smart Green City in Response to Climate Change

—With focus on the Reference Case of the Ministry of Land, Transport & Maritime Affairs of Korea

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Abstract— As the global community is stepping up measures to respond to climate change attributable to greenhouse gas emission, the Korean government has established an organ to work on countermeasures against climate change and developed policies to reduce greenhouse gas emission. The Ministry of Land, Transport & Maritime Affairs (MLTM) has adopted eco-friendly urban planning techniques, implemented relevant policies and supported pilot city construction projects in an effort to directly respond to climate change. In addition, the focus of new town development trends in Korea is now changing from u-City to smart green city and such trend is likely to go on into the future. This paper studied a smart green city implementation strategy in reference to the reference case of the MLTM of Korea as a response to climate change. First, global trends pertaining to climate change and responses by the overseas projects and Korean government with focus on the reference case of the MLTM and the implementation of Smart Green City project. In addition, the transition from u-City to Smart Green City was described in both overview and details in relation to the response to climate change. Then, it was indicated how urban planning and management efforts could contribute to the accomplishment of national climate targets, along with implications derived from policy and research cases.

Keywords— Smart Green City, Climate Change, MLTM

I. INTRODUCTION

As people are increasingly aware of the importance of carbon emission cuts worldwide, the global efforts to reduce carbon emissions are on the increase. Since the Kyoto Protocol was adopted in 1997, international organizations have been making various efforts for carbon emission cuts through various international pacts such as Bali Road Map in 2007 and Copenhagen Climate Change Conference in 2009. The governments of developed nations also carry on a variety of eco-friendly projects and policies to reduce greenhouse gas.

Currently, the urban population accounts for about 50% of the entire global population and consumes 60% to 80% of energy. The urban population is expected to reach 60% of the entire global population and consume 73% of energy in 2030 because of the ongoing urbanization [2].

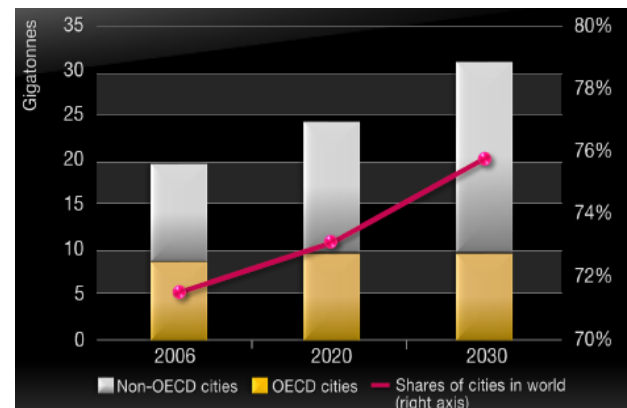


Figure 1. Increase in Urban Carbon Emission[8]

Urban carbon emission reduction projects and researches in city transportations, constructions, energy systems and other areas are required to cope with the accelerating urbanization. Many cities in US, Japan and Europe have already launched eco-friendly urban projects to cope with climate changes. The Korean government also started Smart Green City Project. Based on the fact that the urban developments cause climate changes but also offer solutions to such problems, the transition from U-City to Smart Green City in Korean urban development projects is described in this research paper. The intensive research on Smart Green City projects of the Ministry of Land, Transport and Maritime Affairs showed that the urban planning and management can contribute to accomplishing the state carbon emission reduction goal.

II. OVERSEAS EFFORTS AGAINST CLIMATE CHANGE

A. International Organizations

According to the UN General Assembly resolution in 1988, the World Meteorological Organization (WMO) and United Nations Environment Programme (UNEP) have set up the 'Intergovernmental Committee on Climate Change (IPCC)'. Starting with the first assessment report disclosed in 1990, the IPCC published its fourth assessment report in 2007 through

its annual Conference of the Parties (COP). The Convention on Climate Change (UNFCCC) was formed at Rio Earth Summit held in Brazil in June 1992 to prevent climate changes caused by global warming, and the Conference of the Parties (COP) have been held every year to set out agreements on climate change. The first COP was held in Berlin in 1995, and the 'Kyoto Protocol' was adopted in the third COP held in Japan. The protocol specified the countries committed to cut carbon emissions and the types of greenhouse gas to be reduced. The developed countries agreed to reduce their collective greenhouse gas emissions by 5.2% from the 1990 level by 2008 to 2012. In the 13th COP held in Bali, Indonesia, in 2007, the member countries adopted 'Bali Road Map' to specify the carbon emission reduction plan after 2012 when the Kyoto Protocol is expired.

B. Overseas Climate Change Project

Various urban projects are going on across the world to reduce greenhouse gas. Such projects include green city project and carbon-free city project. The carbon-free urban planning applies mostly for the urban redevelopments in industrialized countries while such concepts are being adopted for new city developments in industrializing countries and the Middle East. UAE's Masdar Project, New York's green project, and Canada's Dockside Green Project are notable cases as follows.

1) UAE Masdar Project

The government of Abu Dhabi plans to invest 22 billion dollars to develop a new city with the population of 50,000 near Abu Dhabi in the UAE by 2016 for Masdar Project. The government broke ground in 2008 for the mammoth project, aiming to build a smart carbon-free city on high-tech infrastructures.



Figure 2. Proposed Master Plan of Masdar City[11]

An intelligent power network will be established for the entire city to be connected to power highway. Smart grid system was adopted not only to supply power to the city but to make the city more sustainable. The developer also plans to install 280,000 intelligent street lamps and 1.2 million smart

power meters and establish a system to monitor and control substations. It looks to connect all the land, transportation, power, and urban infrastructures to the carbon-free system and smart grid.

2) Empire State Building in New York, USA

The US government has announced 'Green New Deal' and started spurring smart projects. In line with the new project, hybrid city buses and taxis began to operate in 2008 to reduce carbon emissions. As high-rise buildings consume 60% of energy in New York and 90% to 95% of buildings were constructed before, the existing buildings are being redeveloped into smart structures. Empire State Building is also part of such a move. About 600 billion won is to be plowed into the 5-year project to revamp the entire building for less energy consumption. More than 6,500 windows were reinstalled to block external heat in summer and prevent heat loss in winter more effectively. The building's entire control system was upgraded, and the air-conditioning and ventilation system including air processor were replaced. The building adopted energy-saving facilities and energy monitoring system equipped with high-tech sensors and added heat insulators to heating system to reduce heat loss. It also adopted the sectional temperature control system to control the temperature of each floor more efficiently. The respective air ventilation system was applied to each floor. The lighting is also automatically controlled according to the sunlight. The developer estimated that the energy consumption would decrease by 38% after the completion of project, which will save about 3.4 million dollars annually.

3) Dockside Green Project of Canada

Canada's Dockside Green Project is to develop the industrial zone in the inner harbor of Victoria near Vancouver into a carbon-free town. About 2,500 people will reside in the newly developed town with the land area of 120,777 m². The project adopts passive design to save as much energy as possible by arranging the directions of buildings and applying insulators and LED lamps, which will reduce energy consumption by 50 to 52%.



Figure 3 Dockside Green Master Plan[12]

The development also aims to reduce carbon emissions by running car pool programs and water taxi service and selling parking lots separately to home owners. An online system to monitor the usage of water, power and heat will be installed at each house to lead residents to save energy voluntarily.

III. SMART GREEN CITY PROJECT OF THE MINISTRY OF LAND, TRANSPORT AND MARITIME AFFAIRS

A. Outline of Smart Green City

As the integration of information technologies and ecological cities created a new paradigm, the government began to carry on policies to promote the renewable energies, and people increasingly pay attentions to climate changes and demand more comfortable and safe lifestyle, the public interests in the sustainable and convenient cities are growing fast. Smart green city offers the environments for high quality of life on sustainability and convenience, creates values for residents, and minimizes the environmental burden for sustainable developments. In the smart green city, high-tech ubiquitous technologies are integrated with ecological technologies based on the eco-friendly and energy-saving facilities and service infrastructures to offer comfortable and harmonious urban environments to human beings.



Figure 4. Smart Green City [6]

B. Background

As the urbanization and fast-improving quality of life raises the energy consumption, over 72% of carbon emissions come from cities[3]. The urban carbon emissions are expected to expand further in the coming years. Although 90.5% of population live in cities in Korea, there are still insufficient urban efforts to stall the climate changes. Many cities have energy-intensive urban structures with large carbon emissions because of the development of new cities and strict regulations over residential and commercial districts. The energy-guzzling road transportation with high carbon emissions is more

developed than other transportations. The transportation demand is expected to grow further as the economy grows and international trades expand. the Ministry of Land, Transport and Maritime Affairs of Korea designates 'Smart Green City Technology' as one of the country's 'Green Up 30 Future Core Technologies'.

C. Transition from U-City to Smart Green City

The ministry has made investments in U-City(Ubiquitous City) projects to expand the nation's growth potentials and develop a new information society. Many U-Cities are being built or operated in various areas such as Dongtan, Hwaseong, and Pangyo, Seongnam. The features of U-City include intelligence, network, platform, and service. The details are described in the following table.

TABLE 1. FEATURES AND DETAILS OF U-CITY [9]

Feature	Description
Intelligence	Control urban infrastructures such as road and airport in a ubiquitous environment on a real-time basis
Network	Provide consistent connections among people, objects and computers in the city
Platform	Apply a common platform for the entire system to guarantee safe and convenient service
Service	Provide a ubiquitous environment to enable to access to transportation, administration and health information online at home, school, and office.

However, the once-popular U-City projects are facing many challenges because urban developers are increasingly required to prepare for international climate change pacts, secure a more stable energy supply, make more efficient energy consumption, and improve the quality of life with more comfortable urban environments. Given such demands, they started applying eco-friendly technologies to all the urban development processes including planning of spatial structures and land, construction, green zone development, establishment of transportation system, resource circulation and energy supply system. In line with such efforts, the ministry is carrying on Smart Green City Project to cope with climate change and energy problems simultaneously. The core technologies and research assignments for the Smart Green City Project are as table 2

D. Smart Green Cities of the Ministry of Land, Transport and Maritime Affairs

1) Gangneung Smart Green City

The Ministry of Land, Transport and Maritime Affairs has designated Gyeongpo, Gangneung, for the nation's first smart green city project and announced a plan to invest 1 trillion won in 29 projects for the region by 2020. The region has the area of 18.3 km², and the ministry plans to increase the regional

TABLE 2. CORE TECHNOLOGIES AND RESEARCH ASSIGNMENTS FOR SMART GREEN CITY PROJECT[5]

Core Technologies	Research Assignments
Technologies for planning, design, construction and maintenance of carbon-free city	- Establish a strategy to reduce carbon emissions and energy consumption for the entire urban life cycle - Develop application methods for renewable energy system and new transportation system in connection with spatial planning and design methods
Advanced urban spatial planning simulator on human behaviors	- Develop source technologies for agent-based modeling & simulation - Develop methods to forecast and optimize the functions of complex urban system with a simulator
Zero emission clean supply and treatment system technology	- Apply zero emission hierarchy - Commercialize complex supply and treatment system integrated with sewage treatment and bio-energy plant
Technology to control and monitor energy use on smart grid	- Commercialize smart grid system technology to meet various spatial scales - Establish an energy management plan through the analysis of energy demand, use of land and integration of facilities by city, district, and area
Development of carbon-free city model and assessment of greenhouse gas reduction capacity	- Develop and commercialize a carbon-free city model to be applied to various urban projects for exports - Develop a carbon business model compatible with the international standards on greenhouse gas reduction capacity such as IPCC

population from 13,000 to 23,400, cut energy consumption by 35.9%, and raise the green zone ratio to 60%. The project consists of the following three phases based on the six core elements of eco-friendly land development, green transportation, ecological system, efficient energy use, recycling of water and resource, and eco-friendly travel and lifestyle.

TABLE 3. GANGNEUNG SMART GREEN CITY PROJECT[10]

Phase	Descriptions
Phase 1 (~2012)	- Establishment of Green Renaissance Landmark - Establishment of ecological road - Wetland restoration of Gyeongpo Lake - Development of 10 major bicycle-free cities
Phase 2 (~2016)	- Establishment of healing forest near hometown river - Gyeongpocheon - Construction of forest path - Installation of LED security lighting - Renewable energy development project
Phase 3 (~2020)	- Establishment of green technology park for research of renewable energies such as solar power, solar heat and wind power - Development of smart green city on intelligent infrastructures

Gangneung City Government expects the smart green city project to help revitalize the regional economy and create more jobs through travel promotion. It also expects the project

to contribute to enhancing the national competitiveness and raise the value of city by using regional resources and green technologies.

Figure 5. Air View of Gangneung Smart Green City[10]



2) Sejong Smart Green City

The Ministry of Land also plans to build Sejong Smart Green City from 2008 to 2020, aiming to reduce the carbon emissions by over 70% by 2030 through six different projects on urban plans, energy and transportation. The projects are being implemented under green city and green energy strategy as described in the following table.

TABLE 4. CATEGORICAL CARBON EMISSION REDUCTION TARGETS FOR SEJONG SMART GREEN CITY[1]

Category	Reduction Strategies
Urban Planning	Establish an urban plan for low carbon emissions, secure large green zone, ecological areas and windy path, and set up an efficient utilization system
Construction	Recommend the preparation of carbon management plans by individuals and businesses and apply low-carbon technologies to construction sites
Building	Apply more energy-efficient designs through energy efficiency grading system and energy performance indices(EPI), and assess the carbon emissions over the life cycle of building
Transportation	Minimize the use of vehicles through eco-friendly high-tech mass transportation system and establish a green transportation system by constructing bike roads and sidewalks
Energy	Use renewable energies and set up a collective energy system. Establish an LED lighting system and install intelligent street lamps.
Forest and Wetland	Build an ecological city through forestation plan and establish anti-flood forest and ecological wetland (430,000 m ²)

3) Other Smart Green Cities

Some developed cities other than Gangneung and Sejong Smart Green City have adopted smart and green technologies based on their existing infrastructures. Eunpyeong-gu of Seoul, Namyangju, and Naju are those forerunners in smart green city projects. In Eunpyeong-gu of Seoul, the government is establishing a real-time emergency alert system as the region is vulnerable to natural disasters in the rainy season due to Mt.Bukhansan. The government also plans to build a wooden 4-story residential town in Namyangju to maximize the energy efficiency. The wooden houses will be built with highly efficient insulation materials and equipped with solar power water-heating system and geothermal boilers to utilize renewable energy more effectively. Naju City Government looks to carry on a smart grid project to reduce energy consumption and carbon emissions, aiming to develop the city into Energypia City in connection with an innovation town[13].

IV. CONCLUSIONS

The efforts of international organizations and overseas governments to slow down the climate change and Smart Green City Project of Korea's Ministry of Land, Transport and Maritime Affairs were reviewed above. As about 60% of global population is expected to reside in cities in 2030, the greenhouse gas emission will be a more critical issue for urban residents. Based on the fact that the urban developments cause climate changes but also offer solutions to such problems, it is necessary to establish urban strategies to reduce greenhouse gas emissions. The Korean government has set up greenhouse gas and energy plans and carbon credit trading system in an effort to cut the country's carbon emissions by 30% compared to BAU by 2020. Smart Green City Project is one of the urban strategies to reduce greenhouse gas, which is expected to help reduce carbon emissions substantially. If the ongoing Smart Green City Project is verified to help reduce greenhouse gas, it will be a great model for such efforts. The research results will apply not only to domestic urban developments but also to overseas development projects.

The government, local administrations, and industries are increasingly interested in Smart Green City Project, and the concepts about green economy and city become increasingly popular among people. Many people are trying to save resource and energy and reduce greenhouse gas through more ecological lifestyle. As more smart green cities are established on the back of supports from the government, local administrations and residents, the greenhouse gas reduction target will be more likely to be accomplished. The development of segmented models will help reduce the country's carbon emissions.

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