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A Study on Spatial Planning Model of Living Area Unit for Carbon-Neutral 2050

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SUMMARY

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## Chapter 1. Introduction

'Carbon neutrality' has been emphasized as a key global and national policy agenda and issues related to building and urban space for carbon neutral are emerging. The international community has recognized the seriousness of the climate change problem and has made efforts to adopt the Kyoto Protocol(1997) and the Paris Agreement(2015) to solve it. The Korean government has established 'the 2050 Carbon Neutral Roadmap' as a strategy to reduce greenhouse gases in buildings and urban spaces, and has been promoting various tasks for carbon neutral in buildings, transportation, land, cities, and overseas reduction by 2050.

In December 2021, the Ministry of Land, Infrastructure and Transport revised and implemented 'Guidelines for the Establishment of Basic Plans for Cities and Guns' and 'Guidelines for urban development' to realize carbon neutral at the regional and urban levels in the case of establishing 'Basic Plans for Cities and Guns' and an urban development plan.

As the importance of carbon emission management at the regional and urban levels increases, a carbon neutral strategy is needed for the space unit including individual buildings. Furthermore, it is necessary to prepare a spatial strategy according to the reorganization of the urban planning legislation. To this end, it is necessary to urgently conduct research to prepare a planned and designed alternative that combines urban planning and carbon neutral strategies.

As a major strategy for carbon neutral in architecture and urban space, this study aims to develop an optimized spatial planning model at the living area level and to present the direction of introduction and application when promoting urban planning and development projects. In detail, the study focused on finding ways to reduce and absorb carbon emissions in urban planning and design, developing a model to optimize carbon emission and absorption in living area unit, and proposing a direction to establish a district unit plan for carbon neutral.

In detail, the study focused on three major points; (1) finding ways to reduce and absorb carbon emissions in urban planning and design for living area unit space, (2) developing a model to optimize carbon emission and absorption in living space, and (3) proposing a direction to establish a district unit plan for carbon neutral.

## Chapter 2. Concepts and Policies on Carbon Neutral in the Living Area Unit

In December 2020, the Korean government announced the "2050 Carbon Neutral Strategy". The vision of this strategy is from 'adaptive reduction' to 'proactive response', and three policy directions and ten tasks were presented. In addition, the Ministry of Land, Infrastructure and Transport announced the 'Carbon Neutral Roadmap for Land and Transport'. The roadmap specialized in the field of land and transportation is divided into buildings, transportation, national and urban infrastructure, and overseas reduction sectors. The ‘Guidelines for the Establishment of Basic Plans for Cities and Guns’ revised in December 2021 shall reflect the direction of carbon-neutral plans in sectoral plans such as spatial structure, transportation system, residential environment, parks and green areas. By planning sector, the planning directions are classified into 10 categories: spatial structure, land use, transportation plan, logistics plan, urban

maintenance, residential environment plan, atmospheric and water environment conservation, waste, energy, and park green plan.

The most fundamental means of promoting carbon neutral in land and cities at the macroscopic level is to design an efficient spatial structure and systematically apply detailed elements in each field. On the other hand, typical carbon-neutral space planning elements of the building unit at the microscopic level include passive energy buildings, zero energy buildings, and green remodeling that can save energy in the building. The carbon-neutral strategy can be implemented in a variety of spatial hierarchies, ranging from national to local(urban) to development project(new town) to living area unit(district) and building at the bottom.

However, it lacks knowledge and information to quantify the effects of carbon absorption and emission at the national and urban level, and it is difficult to quantify due to differences in carbon reduction effects depending on the size, industry, population composition, and lifestyle of the applied area. In other words, as the inventory is too large at the national and urban level, there are many parts that are difficult to manage comprehensively and realistically only with urban design. In addition, it is difficult to expect a carbon reduction effect above a certain level due to its size at the individual building unit. Accordingly, it is necessary to comprehensively consider the urban level while changing the perspective from the individual building unit to the concept of building group collection. It is necessary to prepare an empirical carbon-neutral policy and system that considers the increase in demand for new land use, changes in demand for commercial and business areas, changes in demand and functions of public infrastructure, and complexation of functions and uses of facilities in neighborhood dwellings.

## Chapter 3. Building of Carbon Emissions Inventory in Living Area Unit and Planning Elements

In this study, among the various scales constituting the urban space, the path of emitting greenhouse gases from the living area unit was identified, and elements of living area space planning were discovered. In relation to the greenhouse gas emission path in urban

space, existing literature was investigated and organized to establish an inventory of the living area unit. In particular, inventory construction was considered as a process of inferring and linking planning elements for the creation of a carbon-neutral space derived later.

The results of a survey of documents that have built a carbon emission inventory for urban spaces are summarized as follows. First, listing energy sources consumed within the space range should take precedence over inventory construction. Second, the main sources of energy consumption can be organized into fossil fuels, electric energy, heating energy, water supply energy, and waste disposal. Third, the inventory of emissions from industrial processes or agriculture and forestry depends on the land use characteristics of the target site.

A planning element pool was formed by conducting literature studies and case studies to derive carbon-neutral space planning elements in the living area unit. Most of the existing discussions are organized in the form of discourse at the urban level, but in this study, planning factors were summarized focusing on the effectiveness at the living area unit. In order to derive carbon-neutral planning elements, an advisory group of experts in related fields such as cities, architecture, landscaping, transportation, and energy was formed to collect opinions. Through this, elements of carbon-neutral space planning such as space structure and land use, transportation plan, park green area plan, building and energy plan were derived.

# Chapter 4. Development of Carbon-Neutral Space Planning Model for Living Area Unit

In order to develop a carbon-neutral spatial planning model for living area unit, the scale of living areas suitable for research purposes was established, and related cases were reviewed to create a spatial planning scenario according to the characteristics of planning elements. A spatial planning model applied with a planning element scenario and an optimization model were developed.

First, in order to select the size of the living area unit, the size of the living area unit of National Agency for Administrative City and the size of the walking-centered living area unit were compared and analyzed. In this study, the scale of the basic model of the

living area unit is set at a radius of 600m, a 10-minute walk away.

Through literature research, the analysis data of carbon emissions and reduction rates in the living area unit were summarized, and the land use ratio in the living area unit was derived through the analysis of the district unit plan and the urban development plan. Through the low-carbon green pilot village plan and the National Agency for Administrative City low-carbon energy city plan, the plan to reduce carbon emissions in living space unit, the district unit plan, and the land use of urban development projects were investigated and analyzed.

Based on this, a scenario was prepared to develop an alternative model for comparative analysis of carbon emissions according to the space plan of the living area unit. Scenarios were categorized through quantitative changes based on the basic model developed earlier for spatial planning elements. As previously derived, the planning factors for the model are (1) to develop a comprehensive and compressed use of land to compact the living area unit, (2) to minimize the travel distance within the living area unit as a transportation sector, and (3) to expand the park green area to secure carbon absorption sources. A spatial planning model was developed by constructing a scenario that reflects changes in spatial planning through a combination of planning factors.

Finally, an optimization model that can minimize emissions was proposed based on the elements of carbon-neutral space planning in the living area unit. Based on the set conditions, the model derived a spatial arrangement that minimizes the sum of carbon emissions in the transportation sector, the building sector, and the park green sector.

## Chapter 5. Conclusions and Recommendations

The direction of establishing a space plan for the living area unit for carbon neutral summarized through this study is as follows.

- To place commercial and business districts with a large amount of movement at the center of the living area unit
- To place high-density residential and some low-density residential areas around commercial and business districts
- To place proper distribution of medium and low-density dwellings in addition to high-density dwellings in consideration of the effect of

reducing carbon through renewable energy production in buildings

- To distribute schools and public facilities around residential areas to reduce travel distance
- To require a space plan that prioritizes the role of land use necessary for the net function of park green areas in urban spaces rather than simply the role of carbon absorption sources

In order to promote the carbon-neutral living area unit space plan in policy, the application of the carbon-neutral model is required when establishing a district unit plan for the size of the living area unit. In addition, it is necessary to present the principle of carbon neutral in the implementation guidelines of the district unit plan. Furthermore, horizontal land use distribution and vertical floor space system can be used to minimize the distance traveled within the living area unit. In addition, it is necessary to reflect the carbon-neutral space plan per living area unit in the district unit planning system, such as preparing carbon-neutral means by presenting standards for renewable energy production and energy independence.

This study developed virtual models and used a simulation methodology with conditions and scenarios to suggest a spatial planning direction to realize carbon neutrality in the living area unit. Although it has various significance, such as laying the foundation for calculating carbon emissions, visualizing carbon emission optimization models, and suggesting policy application plans, research based on actual data on various spatial scales, including building units, needs to be continued.

Keywords :

Carbon Neutral, Living Area, Spatial Planning, Optimization Model, District Unit Planning