

Toward Carbon-Neutral Smart Cities: A Carbon Spatial Mapping Approach



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Focusing on Analysis of Digital Footprint Data

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Pilot Project

2022. 8. 26. ~ 2023. 5. 22

Establishment of a mapping system
to spatially assess and analyze carbon emissions
and absorption status for the promotion of
carbon-neutral city policies



1. Development of a carbon spatial mapping and establishment of utilization strategies
2. Pilot implementation of a carbon spatial mapping system
3. Establishment of operation and utilization plans

Lead:  KOREA INSTITUTE OF CIVIL ENGINEERING
and BUILDING TECHNOLOGY

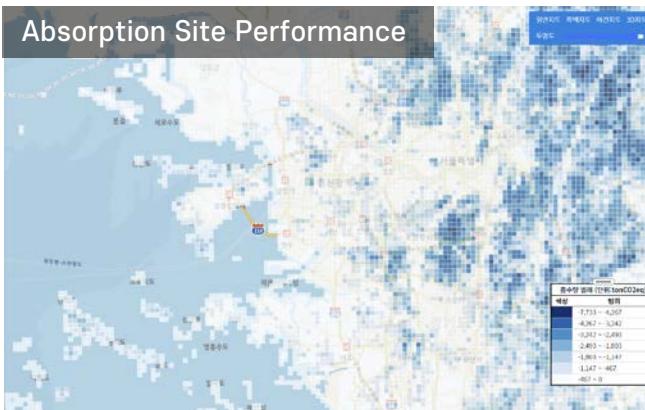
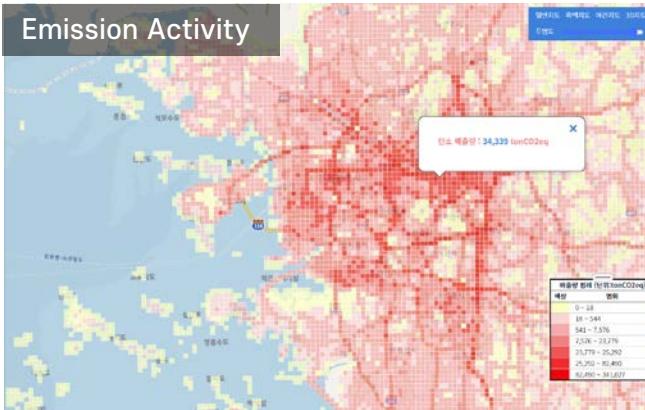
Joint:   

01 Overview

Listed GHG Inventory

Sector	1990	2000	2010	2018	2019	2020	Change 1990-2020	Change 2019-2020
Energy	240.3	411.6	565.7	632.6	611.6	569.9	137.2%	-6.8%
A. Fuel Combustion Activities	235.2	408.9	561.9	628.2	607.4	565.7	140.5%	-6.9%
1. Energy Industries	48.4	136.1	254.8	286.4	266.2	237.0	390.2%	-11.0%
2. Manufacturing Industries and Const.	76.6	130.6	162.9	188.0	187.6	181.6	137.2%	-3.2%
3. Transport	35.5	69.9	85.4	98.1	101.0	96.2	171.0%	-4.8%
4. Other Sectors	74.6	69.8	55.8	52.5	49.6	48.0	-35.7%	-3.2%
5. Non-Specified	0.2	2.4	2.9	3.1	2.9	2.9	1502.0%	-1.2%
B. Fugitive Emissions from Fuels	5.1	2.7	3.8	4.4	4.2	4.2	-17.7%	0.2%
1. Solid Fuels	4.8	1.2	0.6	0.3	0.3	0.3	-94.1%	-6.0%
2. Oil and Natural Gas	0.3	1.5	3.2	4.1	3.9	3.9	1302.5%	0.7%
Industrial Processes	20.4	50.9	53.0	55.8	52.2	48.5	137.4%	-7.0%
A. Mineral Industry	18.8	29.7	31.7	35.0	35.1	32.3	71.8%	-7.9%
B. Chemical Industry	0.4	7.5	0.7	1.0	0.9	0.9	144.6%	-3.1%
C. Metal Industry	0.1	0.1	0.3	0.2	0.2	0.1	42.7%	-28.1%
E. Halocarbons and SF ₆ Prod.	1.0	3.2	0.001	-	-	-	-	-
F. Halocarbons and SF ₆ Cons.	0.2	10.3	20.4	19.6	15.9	15.1	8633.2%	-4.9%
Agriculture	21.0	21.4	22.1	21.1	21.0	21.1	0.4%	0.4%
A. Enteric Fermentation	3.0	3.4	4.3	4.5	4.6	4.7	60.2%	3.4%
B. Manure Management	2.8	3.9	4.8	4.9	4.9	5.0	75.4%	1.9%
C. Rice Cultivation	10.5	8.9	7.8	6.3	5.9	5.7	-45.9%	-3.6%
D. Cropland	4.6	5.2	5.2	5.5	5.5	5.6	21.7%	1.0%
F. Biomass Burning	0.03	0.02	0.02	0.01	0.02	0.02	-44.5%	-4.6%
Waste	10.4	18.9	15.4	17.4	16.5	16.7	60.9%	1.3%
A. Solid Waste Disposal	7.5	9.5	7.8	7.8	7.7	7.7	3.2%	0.1%
B. Wastewater Treat. and Disc.	1.5	1.6	1.7	1.7	1.5	1.6	9.6%	4.8%
C. Incineration and Open Burning	1.4	7.6	5.6	7.1	6.4	6.6	361.3%	2.9%
D. Other	-	0.1	0.3	0.8	0.8	0.8	-	-5.9%
Total GHG Emissions (including LULUCF)	292.1	502.7	656.1	727.0	701.2	656.2	124.7%	-6.4%
(ref.) LULUCF	-37.9	-60.1	-56.1	-40.3	-37.7	-37.9	-0.2%	0.4%
A. Forest	-38.2	-61.4	-58.8	-42.7	-40.3	-40.5	6.0%	0.6%
B. Cropland	0.4	2.2	3.3	2.7	2.8	2.8	538.6%	2.2%
C. Grassland	-0.6	-0.7	-0.2	-0.04	-0.02	-0.02	-97.6%	-33.0%
D. Wetland	0.3	0.3	0.3	0.3	0.3	0.3	9.3%	2.0%
G. Harvested Wood Products	0.2	-0.5	-0.6	-0.7	-0.5	-0.5	-338.3%	-3.6%
Net GHG Emissions (including LULUCF)	254.2	442.6	600.0	686.6	663.5	618.3	143.3%	-6.8%

GHG emission activity and absorption site performance mapping



Carbon Spatial Map

Carbon Emission Activity

Amount of urban activities* contributing to carbon emissions



Purpose of planning and policy making for emission reduction

Carbon Absorption Performance

Map the ability of a specific space to absorb carbon



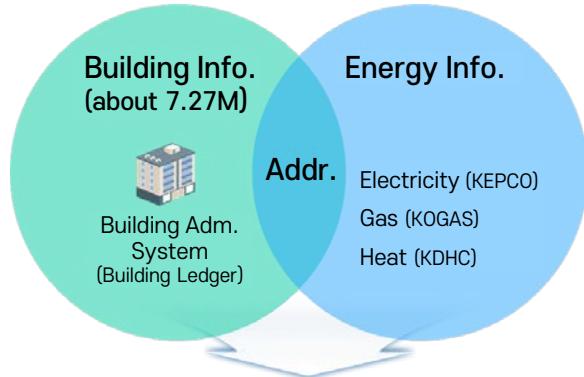
Purpose of expanding the absorption source to improve the absorption performance

- Tier : GHG Inventory Calculation Classification Level
- Scope : Matters concerning emission boundaries
 - Scope 1 : GHG emissions from sources within city limits
 - Scope 2 : Emissions from the use of electricity, heat, steam, etc. provided by supply chains within the city limits
 - Scope 3 : All other emissions occurring outside the city limits as a result of activities within the city limits

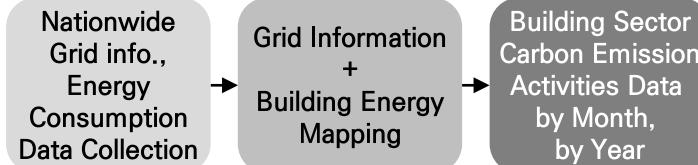
* Energy use of buildings, vehicle movement, etc., and the resulting carbon emissions

02 Data

Building

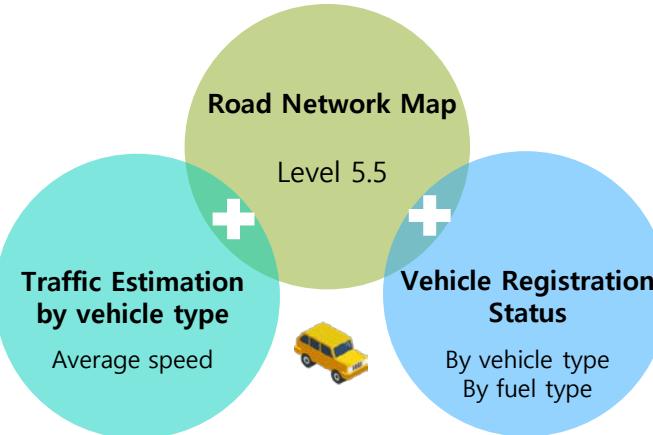


Integrated Management System for National Building Energy



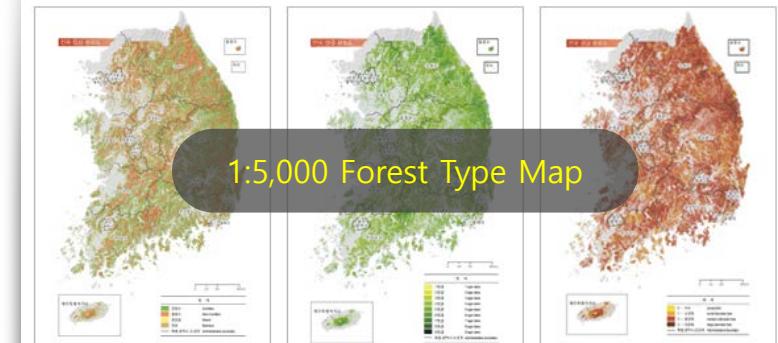
- ▣ Calculated by classifying activities that contribute to direct emissions from fuel combustion and indirect emissions from the use of electricity or heat supplied from outside (Tier 1)
- ▣ Utilization of energy consumption data for each building in the 'Integrated Management System for National Building Energy'

Transport



- ▣ Calculate emissions by applying country-specific coefficients using fuel consumption by vehicle fuel type, vehicle model, and control technology (Tier 2)
- ▣ Utilization of road network map and speed data by vehicle type of information platform of Korea Transport Institute
- ▣ Utilization of e-country index vehicle registration status data

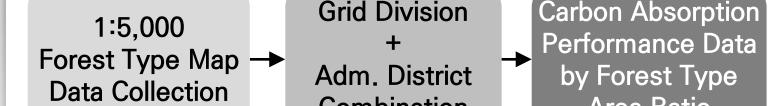
Carbon Sink



Forest Area

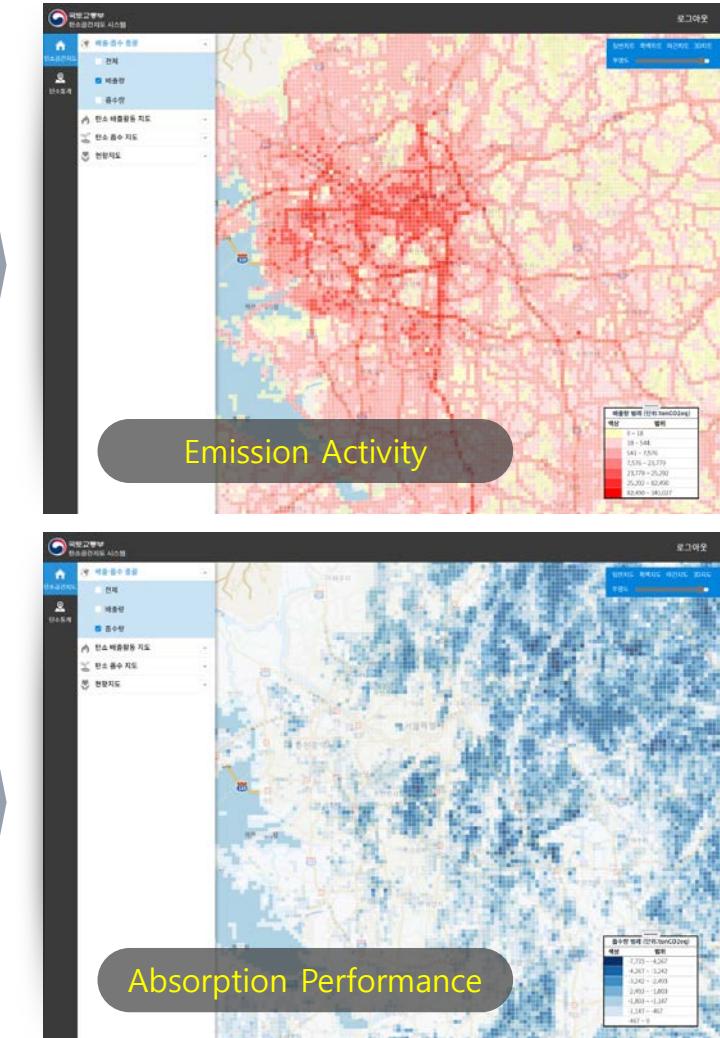
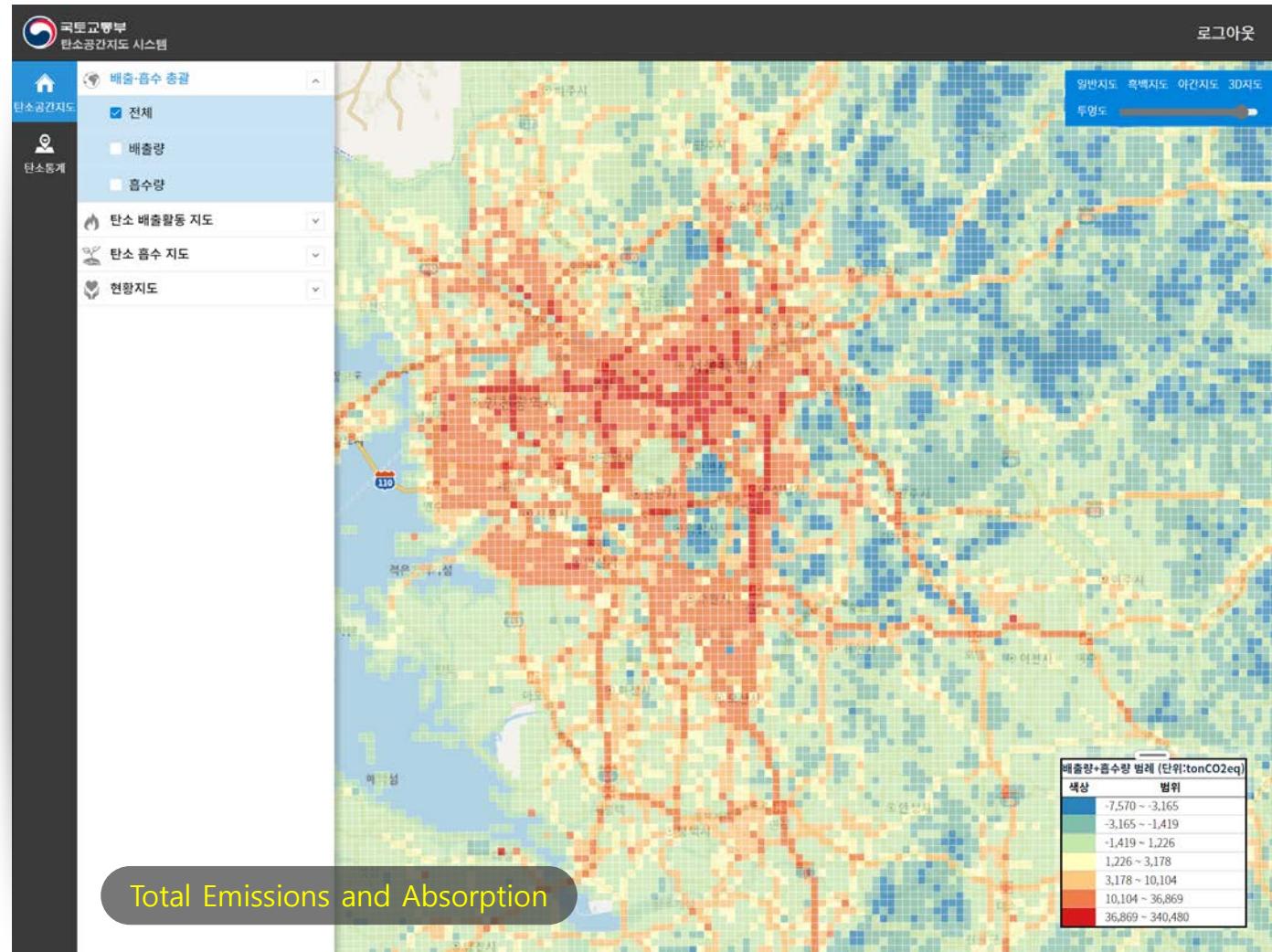
Forest Type

Tree Height

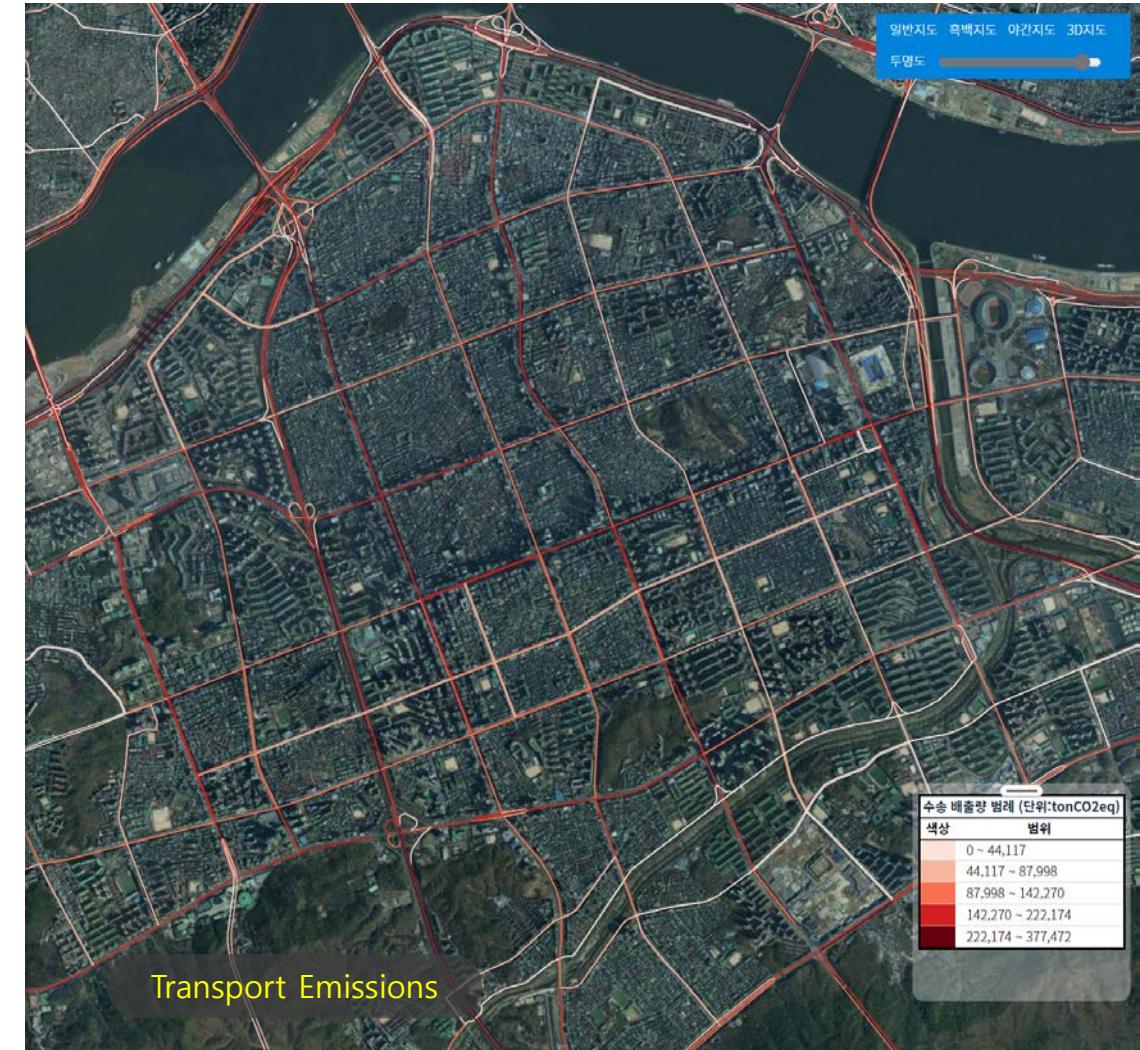
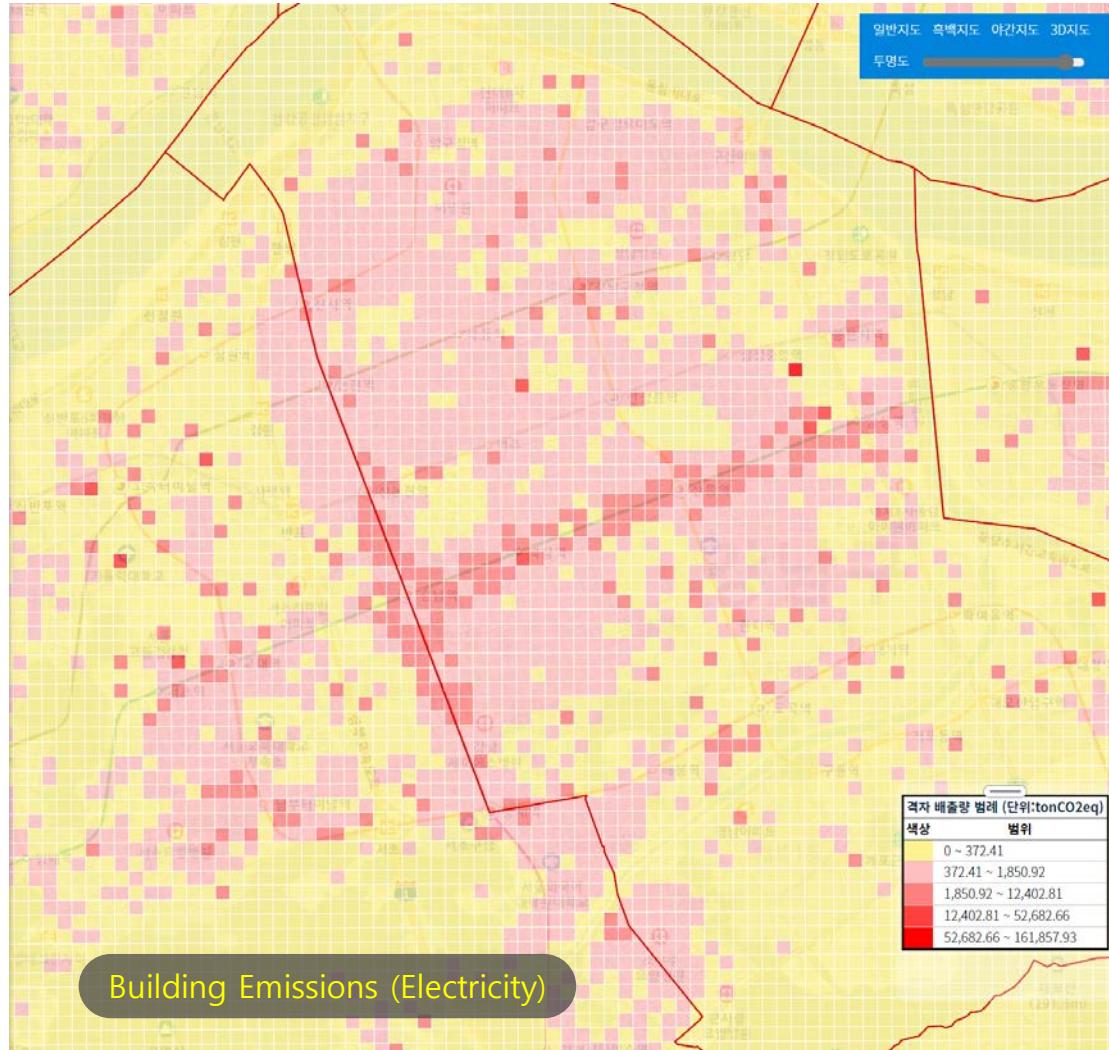


- ▣ Calculate the amount of absorption in the forest area by applying the country-specific absorption coefficient for the forest area (Tier 1)
- ▣ Using 1:5,000 forest type map data of the Korea Forest Service, utilizing tree species, height, and area data

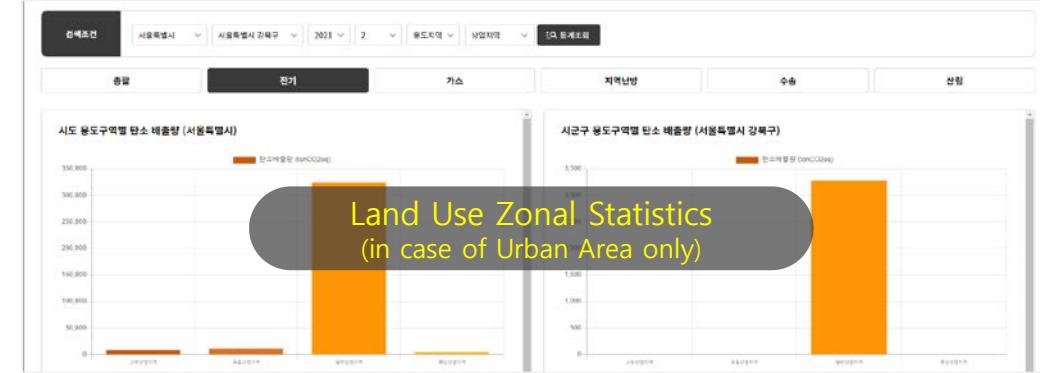
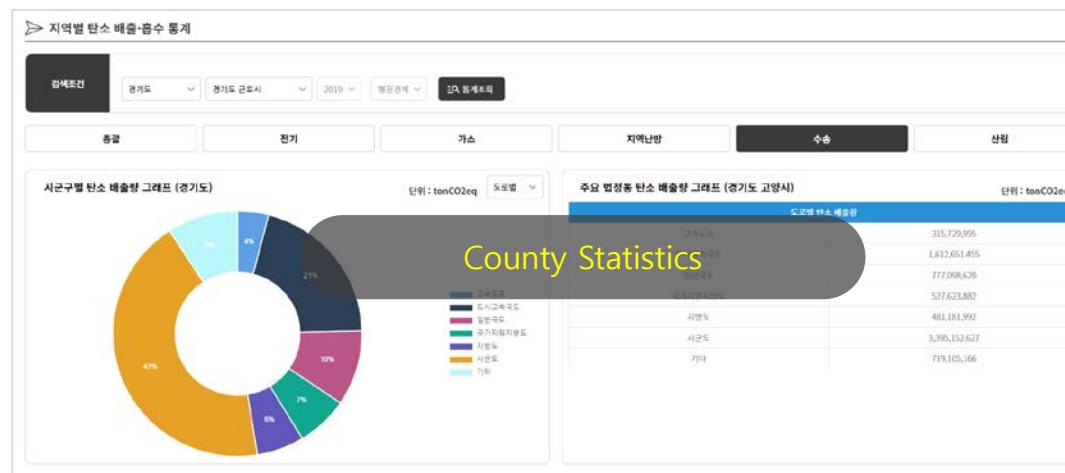
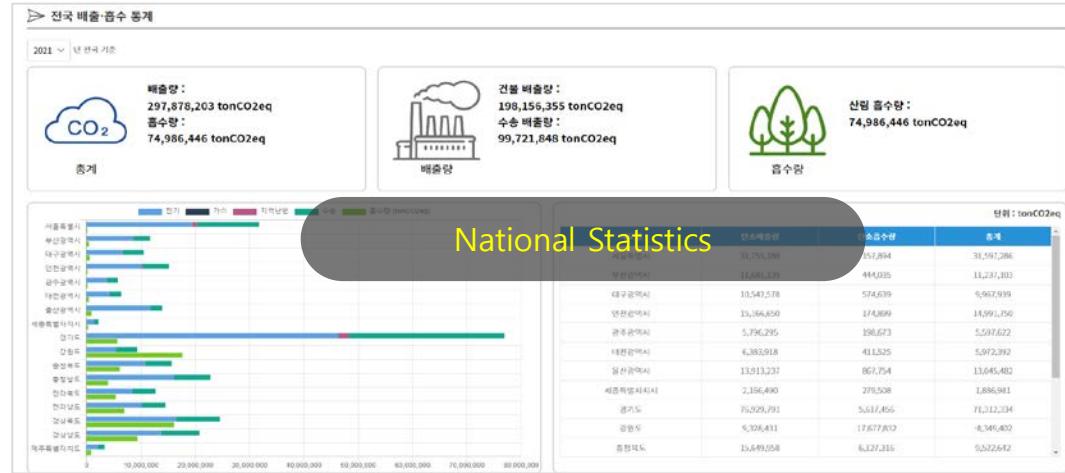
03 Carbon Spatial Map System



03 Carbon Spatial Map System

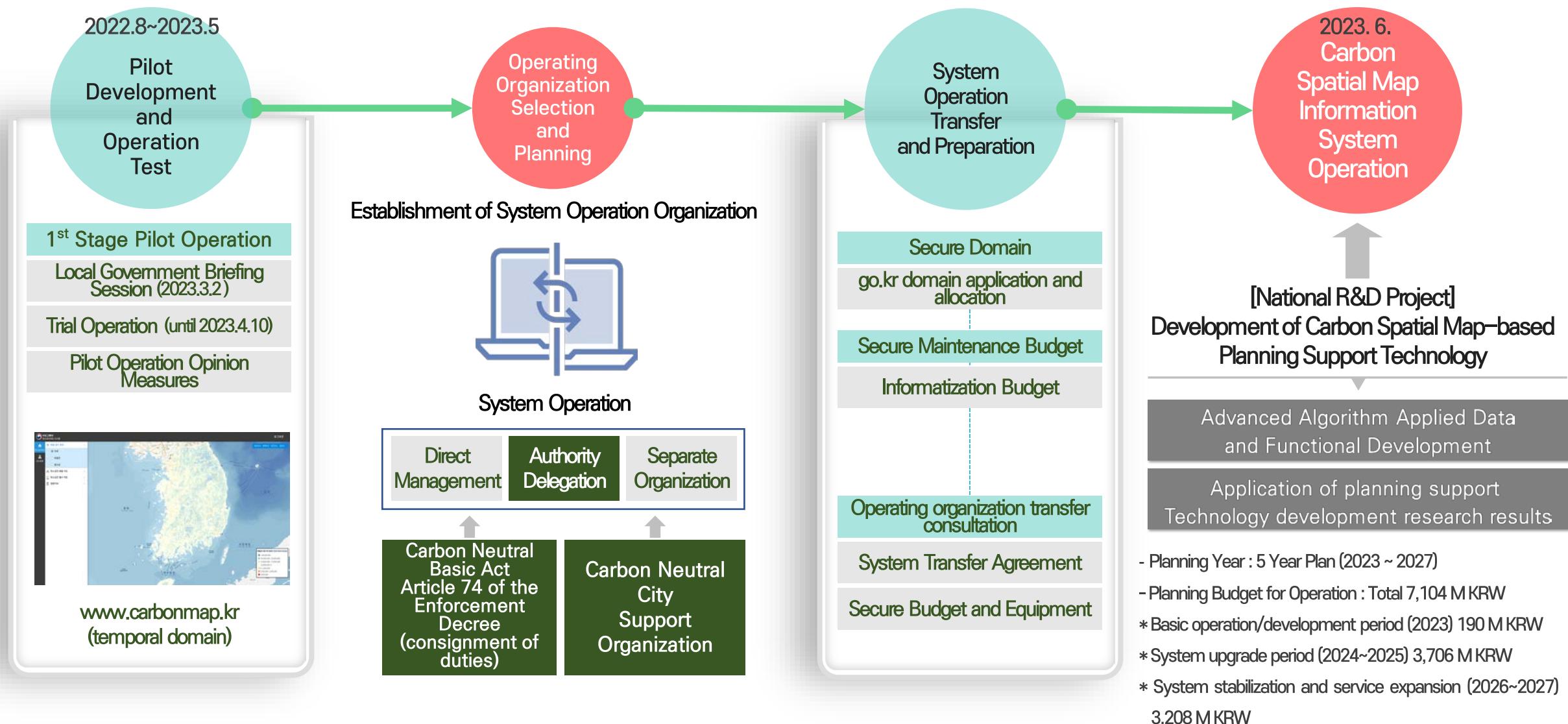


03 Carbon Spatial Map System



Res.	Com.	Ind.	Green	Agri. and For. Area	Other Land Uses
Planning Mgmt. Area	Production Mgmt. Area	Conservation Mgmt. Area	Natural Environment Conserv. Area	Other Mgmt. Area	

04 Carbon Spatial Map System Operation Plan



R&D Project



01 Overview

Objective

To enhance the carbon spatial mapping and support the development and demonstration of technologies for the establishment of local government's carbon-neutral plans and the implementation of emission reductions in carbon-neutral cities

Title Development of Carbon Spatial Map-based Planning Support Technology (R&D)

Period 2023.04.01. ~ 2027.12.31. (4 Years 9 Months)

Funds 21 Billion KRW (Government Contribution)

Lead KICT 한국건설기술연구원
KOREAN INSTITUTE OF CONSTRUCTION AND BUILDING TECHNOLOGY

Joint



Carbon Neutral Monitoring



Carbon Neutral Policy Making



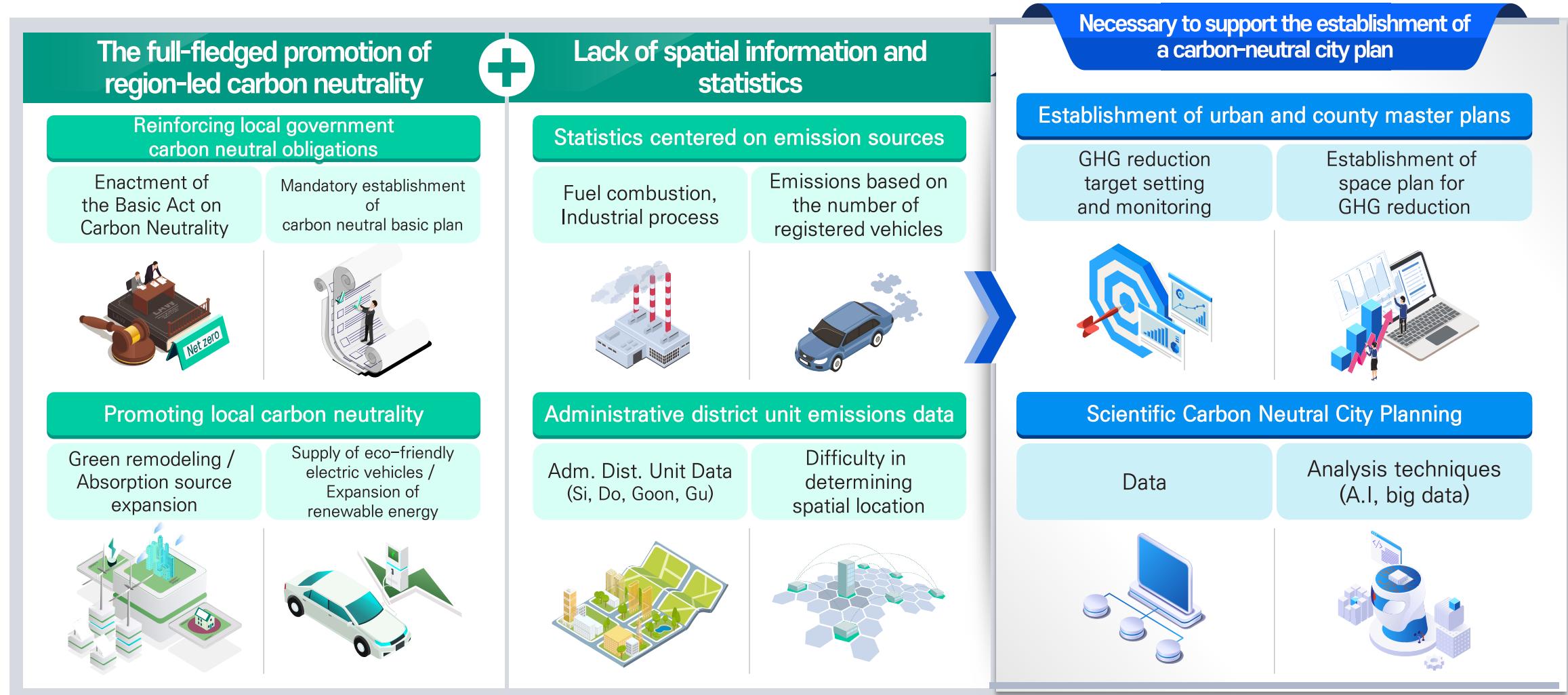
Urban Planning Support



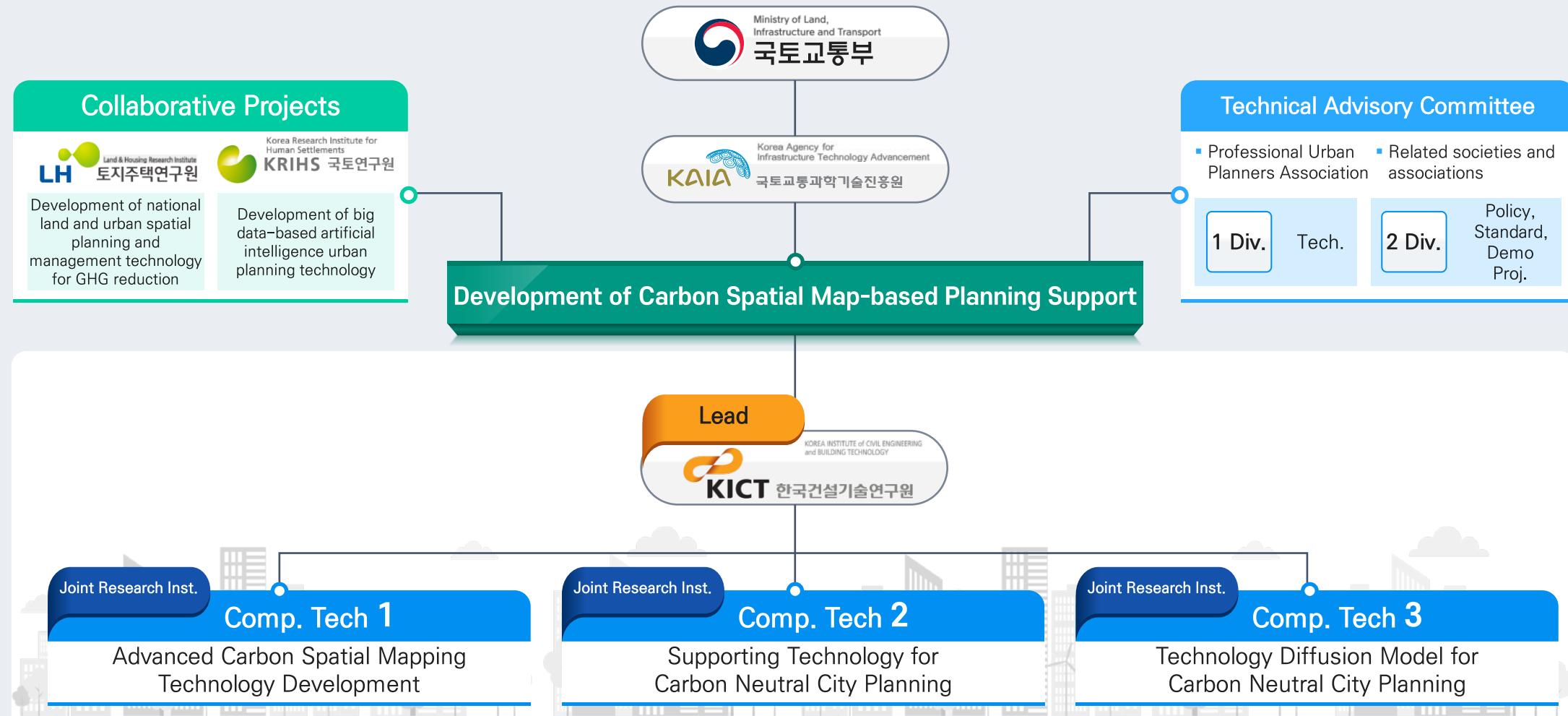
Carbon Neutral Information Provision



02 Necessity

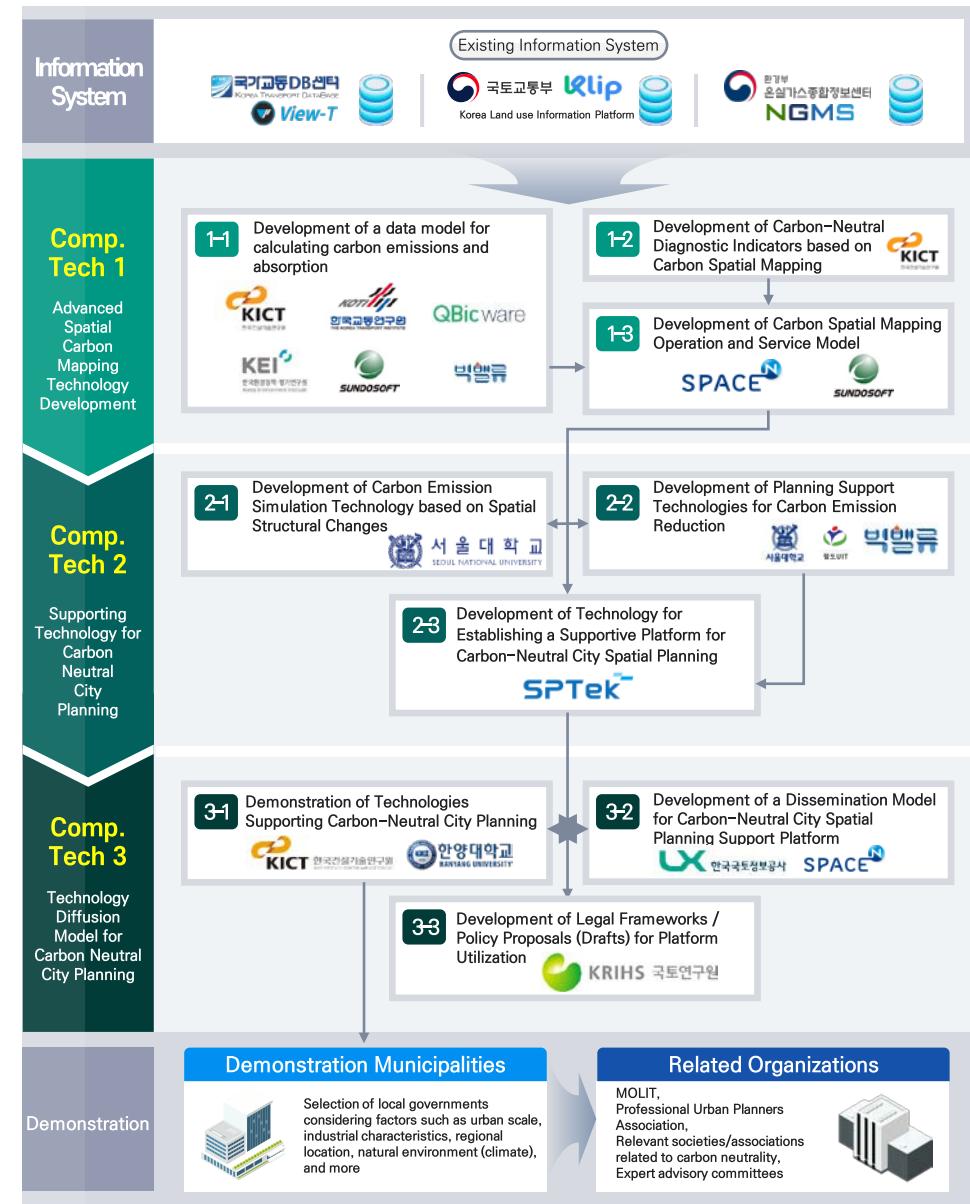


03 Research Implementation System



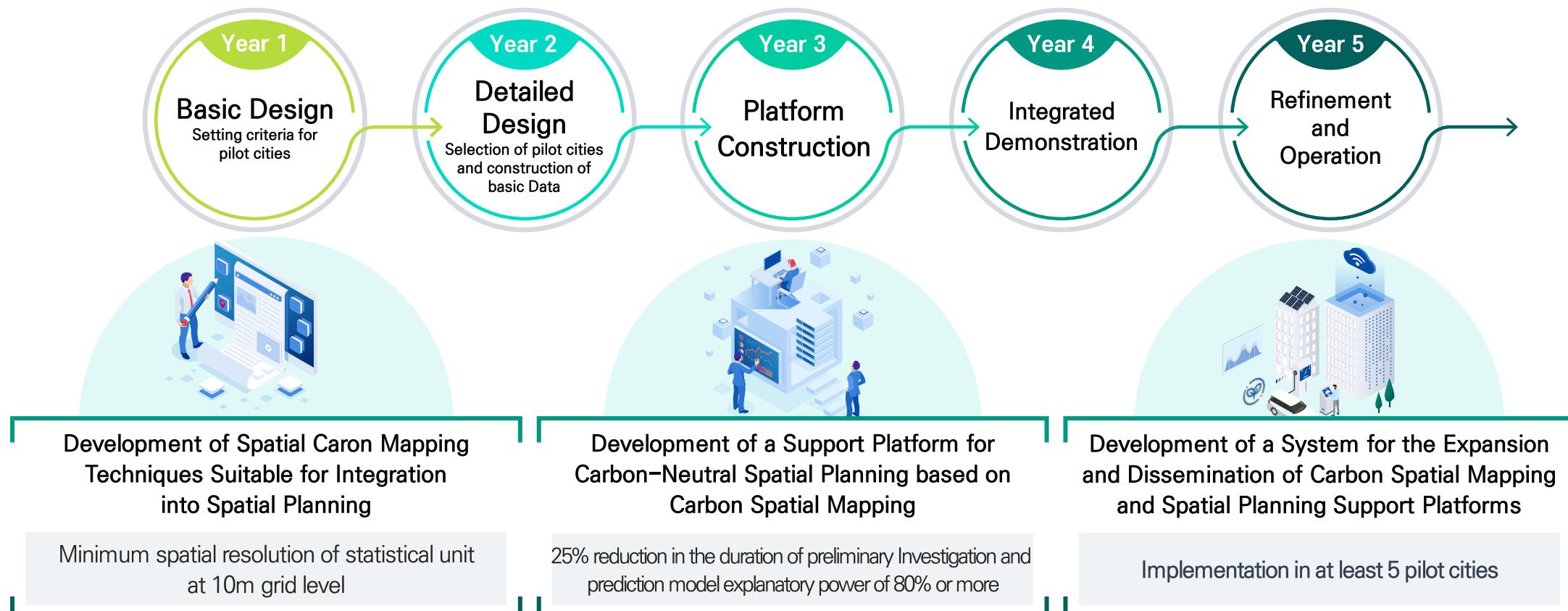
03 Research Implementation System

Research Institutes	Research content and role
KICT 한국건설기술연구원	Overall R&D Management, Development of Methodology for Constructing Carbon Spatial Maps in the Building Sector, Selection of Pilot Cities, and Formulation of Pilot Implementation Plans
KRIHS 국토연구원	Development of Legal and Policy Framework for Carbon-Neutral City Planning
한국교통연구원	Development of Methodology for Constructing Carbon Spatial Maps in the Transportation Sector
KEI 한국환경연구원 Korea Environment Institute	Development of Methodology for Calculating Carbon Sequestration Performance in the Carbon Sink Sector, Advancement of Carbon Spatial Mapping
한국국토정보공사	Research on the Operation and Management Strategies for Carbon Spatial Mapping and Carbon-Neutral City Spatial Planning Support Platform
SPTek	Overall Platform Construction, Establishment of Carbon-Neutral Data Lake
빅밸류	Development of Carbon Emission Reduction Simulation Model for Development Projects
SUNDOSOFT	Enhancement and Construction of Carbon Spatial Mapping System
JUNGDO UIT	Development of Planning Support Technologies including Urban Planning Basic Surveys
QBicware	Development of Technology for Establishing Carbon Emission Database in the Transportation Sector
서울대학교 산학협력단 And R&D Foundation	Development of Carbon Emission Simulation Technology Based on Spatial Structural Changes
한양대학교 산학협력단	Validation of Carbon-Neutral City Planning Pilot Results
SPACE N	Development of a Model for the Expansion of Carbon Spatial Mapping and Spatial Planning Support Platform



04 Final Objective

“ Development and Demonstration of Technological Support for Carbon-Neutral City Planning through Advanced Carbon Space Mapping Technology for Local Government's Carbon-Neutral Planning and Monitoring of Emission Reduction Measures ”



Application Strategy



01 Urban Planning

Guidelines for the establishment of city and county master plans

1-2-4. (Environmental Perspective) In order to pursue sustainable land management from an environmental perspective ... **formulate a spatial structure favorable for carbon reduction**. By restraining the use of fossil fuels and promoting the use of renewable energy, we strive for energy transition and enhance carbon sinks within the city ...

4-2-8. GHG Reduction Target

(1) Objective setting

② The presentation of GHG reduction targets is provided in 5-year increments until the target year of the city/county master plan ...

(2) Analysis of GHG emissions and absorption status

① In the baseline survey, it is necessary to collect sector-specific data on annual direct and indirect greenhouse gas emissions and uptake in the corresponding city/county, analyze the current status, and determine the recent five-year emissions and uptake based on the latest available data that can be established by the city/county, including identifying net emissions ...

4-3-1. Configuration of Spatial Structure

⑥ The urban spatial structure is established in alignment with the direction of achieving GHG reduction goals.

⑦ It presents directions for the restructuring of spatial structure that minimizes fossil fuel consumption and facilitates the adoption of renewable energy.

⑧ Expand GHG sinks such as urban forests, parks, green spaces, and green buildings in areas beyond conservation axes ...

4-4-1. Fundamental principles and analysis of land use

(7) ... By predicting the appropriate scale and land demand for achieving carbon neutrality ...

Establishment of Carbon-Neutral City/County Master Plan

- Establishing spatial plans based on mapping of emission and absorption status
- Utilizing grid or administrative unit-level statistical data as a basis for the baseline survey

Setting carbon neutrality policy application areas and managing quantitative targets

- Analysis of carbon neutrality vulnerability and classification of carbon neutrality vulnerability levels
- Establishment and management of carbon neutrality priority areas

Simulation of carbon neutrality contribution by implementation measures

- Development of a model for calculating the global contribution of carbon neutrality implementation measures
- Utilized for goal management towards achieving carbon-neutral cities

Prediction of the effectiveness of carbon-neutral planning methods

- Simulation of carbon emission changes based on changes in land use characteristics such as functionally intensive spatial structure, intensified land use, adjustment of density around commercial areas, and development of transit-oriented hubs
- Quantitatively estimating the changes in potential transportation demand based on land use changes and statistically analyzing the spatial distribution relationship with carbon emissions

02 Service Provision

Building/District Carbon Efficiency Rating

특정 건축물의 온실가스 사용량 그래프

Category	Energy Use	Tco2eq
전기	150,000,000	60,000,000
지역난방	20,000,000	10,000,000
가스	80,000,000	20,000,000

에너지원 사용량

에너지원	단위	사용량
전기	에너지사용량	133,425.37
전기	Tco2eq	60,348.91
지역난방	에너지사용량	24,433.33
지역난방	Tco2eq	29,664,674.28
가스	에너지사용량	75,428,289.59
가스	Tco2eq	4,241,785.74

Efficiency Rating

Even with high energy consumption, a higher proportion of renewable energy contributes to carbon emissions reduction

닫기

Example

Carbon Spatial Map Education/Promotion

Objectives

- Establishment of an education program for cultivating professionals in carbon-neutral cities
- The need for education targeting overseas personnel when expanding abroad

Target

- Department officials responsible for formulating carbon-neutral city policies
- Officials responsible for urban and municipal basic plans and urban management plans
- Specialists in utilizing spatial information and environmental information to create a database related to carbon emissions and absorption
- Practitioners in urban planning and design fields
- Researchers involved in carbon-neutral city studies (professors, students, researchers, etc.)

Contents

- Construction of the Carbon Spatial map database
- Utilization of planning support functions in the carbon-neutral city spatial planning support platform
- Maintenance of the carbon neutral city spatial planning support platform
- Plans for platform enhancement
- Education on service planning and utilization of the platform utilization

Example

Our Home Greenhouse Gas Calculator (In case of Gwangju)

» 우리집 온실가스 계산기

1단계 : 현황체크

아래를 체크하여 입력하세요

사용 요금 사용량 온실가스

전기	90,000	원
수도	7,000	원
도시가스	25,000	원
LPG(프로판가스)	0	원
지역난방	0	원

[계산하기]

2단계 : 목표설정

아래를 체크하여 입력하세요

사용 요금 사용량 온실가스

전기	30,000	원
수도	5,000	원
도시가스	20,000	원
LPG(프로판가스)	0	원
지역난방	0	원

[계산하기]

3단계 : 감축효과

68,000원을 절약할 수 있어요.

소나무 1그루를 심는 것과 같은 효과예요.

자동차 주행거리를 20km 줄인 효과예요.

* CO₂eq. 상세에 정묘한 소나무 식재 그루 수 = 7,161주
(출처: 주요 온실가스의 표준 단위수당 (국립환경과학원, 2012))
** LCO₂eq. 발생에 필요한 자동차 주행거리 = 150km
(출처: 자동차 온실가스 배출증 관리법 제5조 CA)

온실가스 배출량

240 kgCO₂eq.
자동차주행거리 46 km
소나무 2 그루

온실가스 배출량

135 kgCO₂eq. (▼44%)
자동차주행거리 26 km
소나무 1 그루

그래프 영역

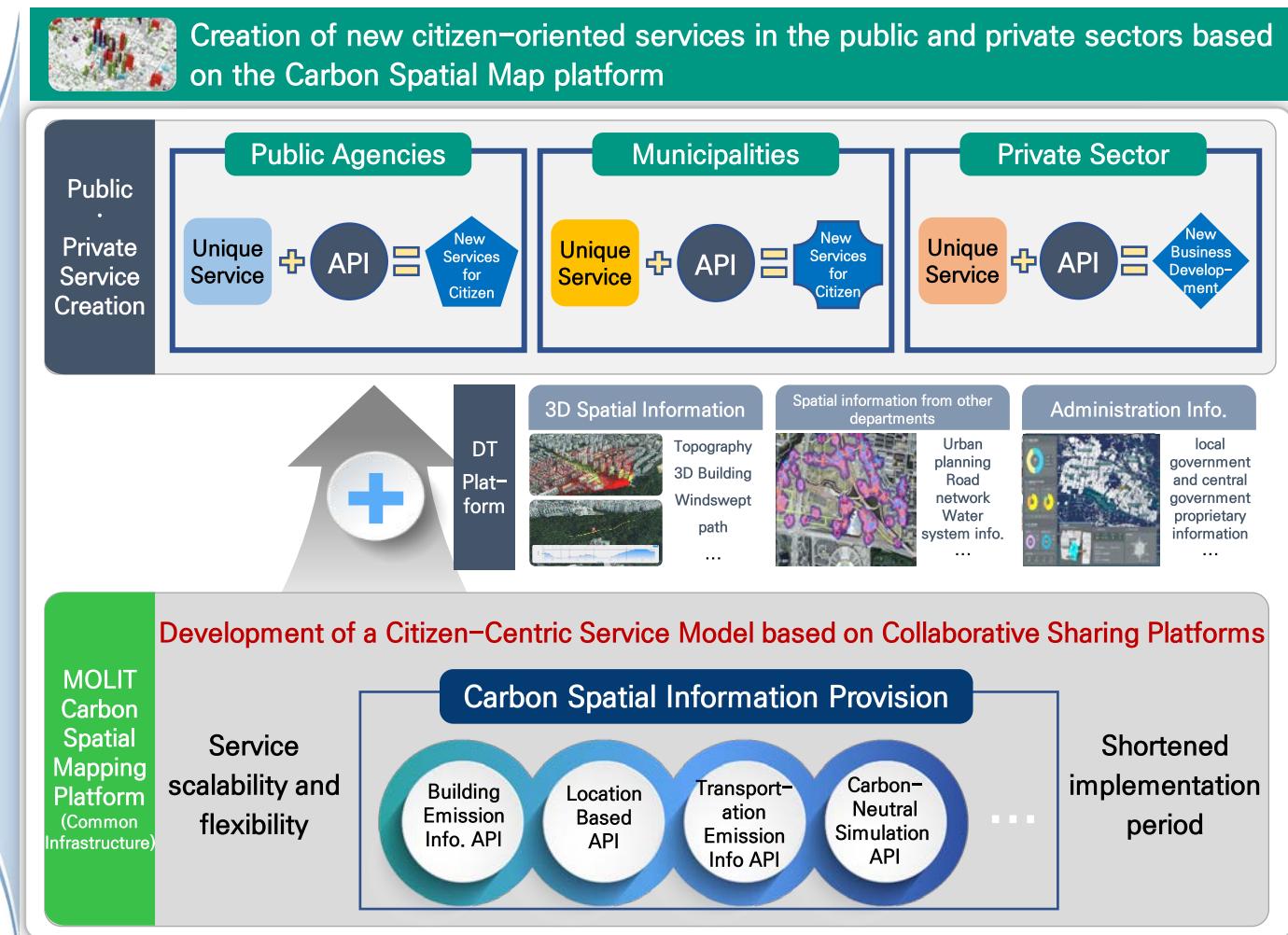
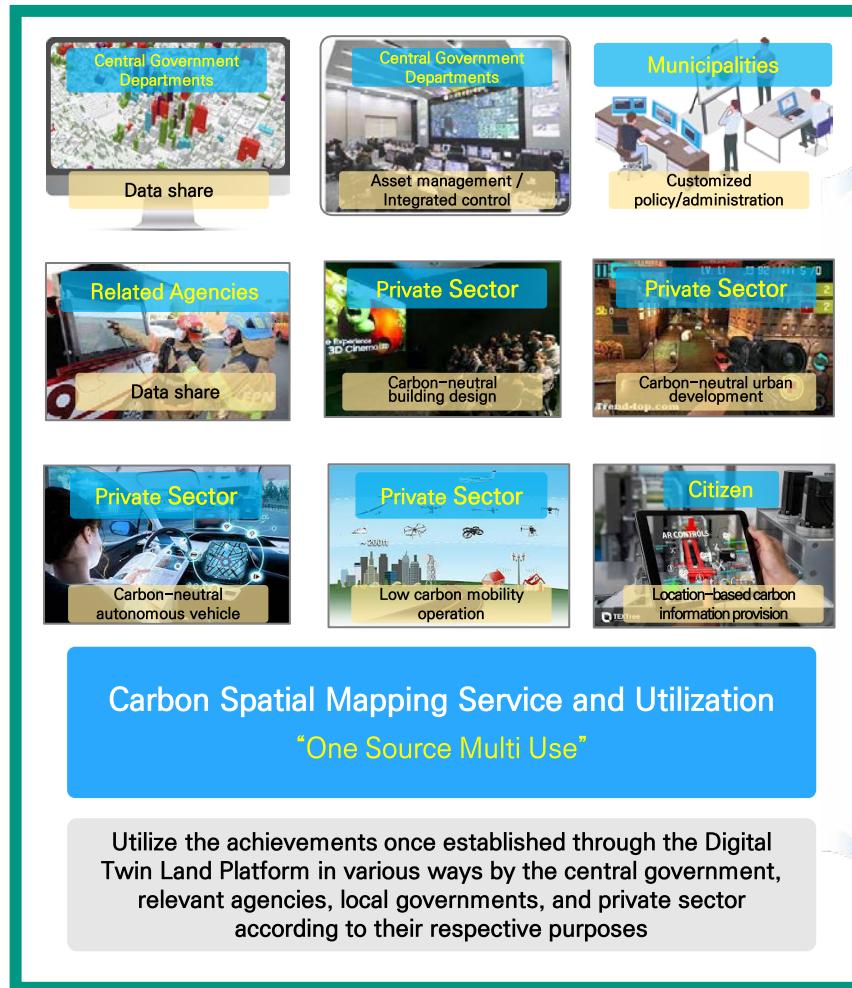
75.0%
24.0%

그래프 영역

전기
수도
도시가스
LPG(프로판)
지역난방
감축전
감축후

Example

03 Increased Application as Carbon-Neutral Industries



Thank You

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