

# Development of a global integrated assessment model for climate-air quality management focused on Northeast Asia (GUIDE-Global) : A Framework Design

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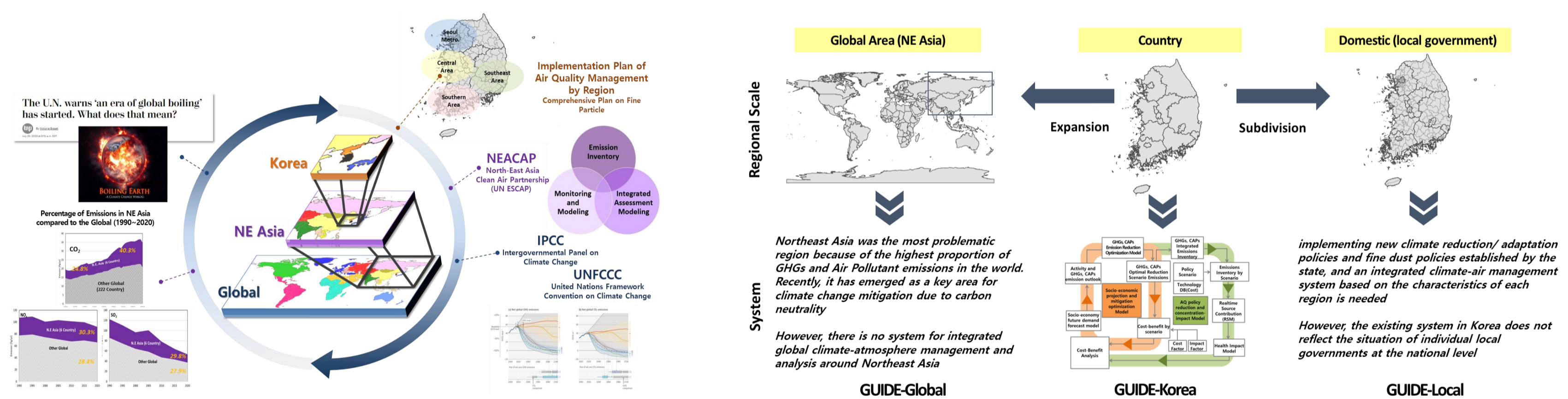
## I. Introduction & Objectives

### Background

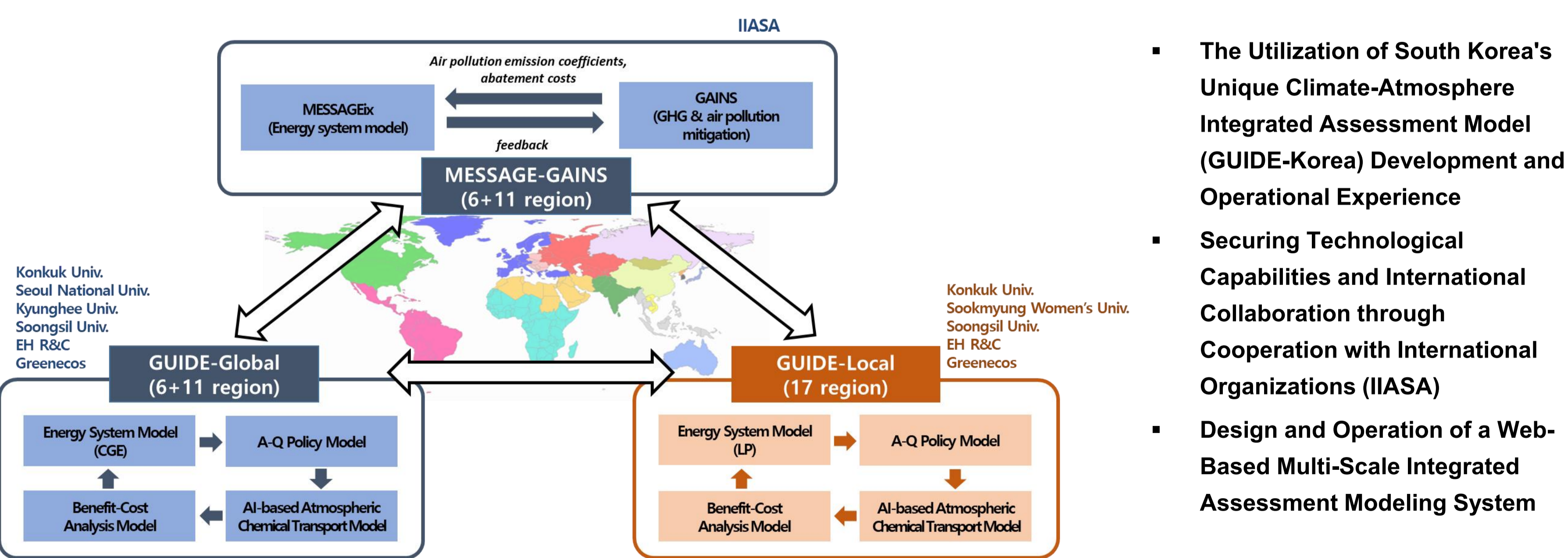
- With the adoption of the Paris Agreement, an international climate treaty, and the IPCC Special Report on Global Warming of 1.5°C, efforts to achieve the common goal of carbon neutrality have commenced worldwide.
- Northeast Asia, including South Korea, China, Japan, Mongolia, North Korea, and Russia, accounted for approximately 37.5% of global CO2 emissions (EDGARv7.0) and about 43.4% of global PM2.5 emissions based on 2018 data (EDGARv6.1). This region stands out as one of the largest emission sources globally.
- Consequently, Northeast Asia is a very important region for integrate regional air pollution management with global climate change mitigation efforts. Improvements in this region are expected to yield significant global benefits in addressing climate change.

### Objectives

- Development of Global Integrated Assessment Modeling Systems for Climate-Air Quality Management Focused on Northeast Asia (GUIDE-Global and MESSAGE-GAINS) and a Local IAM in support of National-Local Actions (GUIDE-Local)



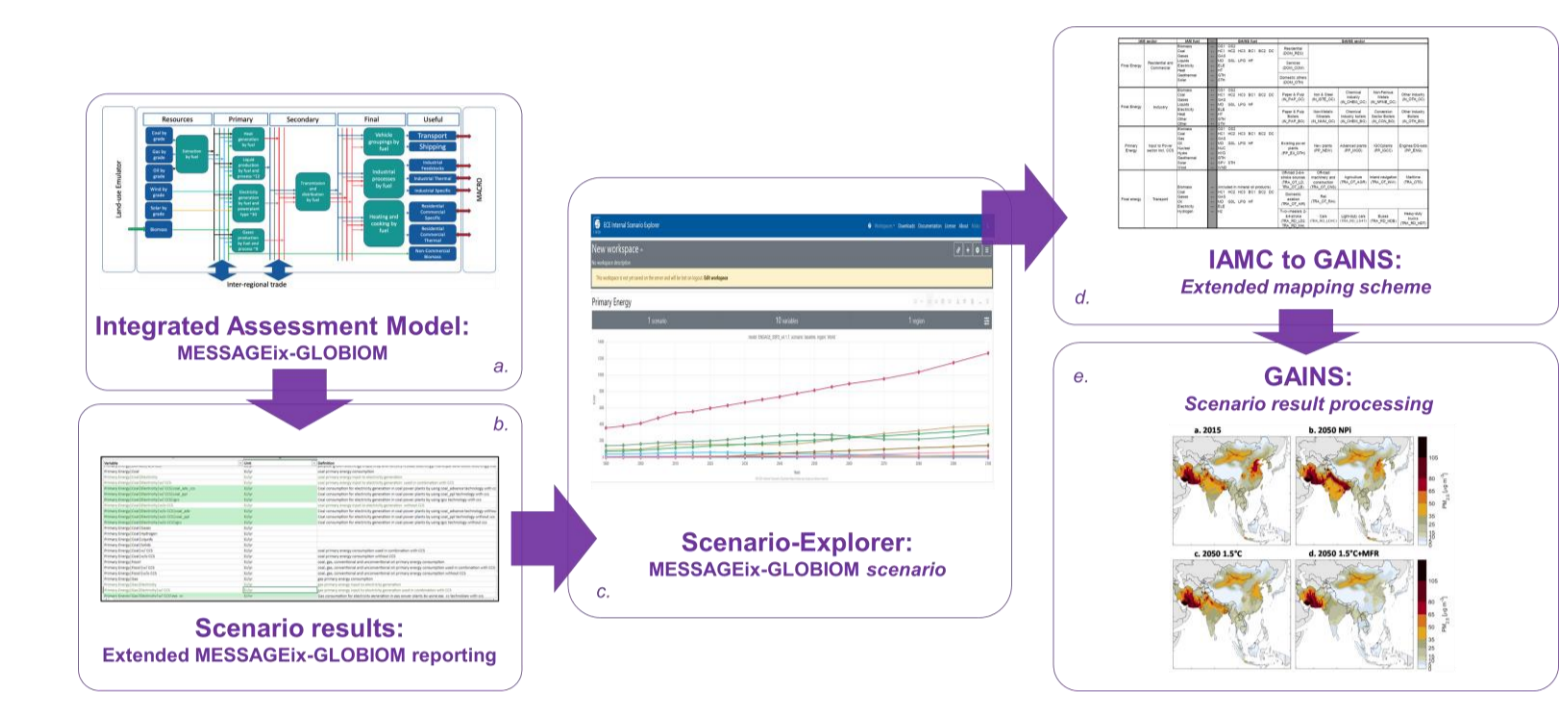
## II. Framework



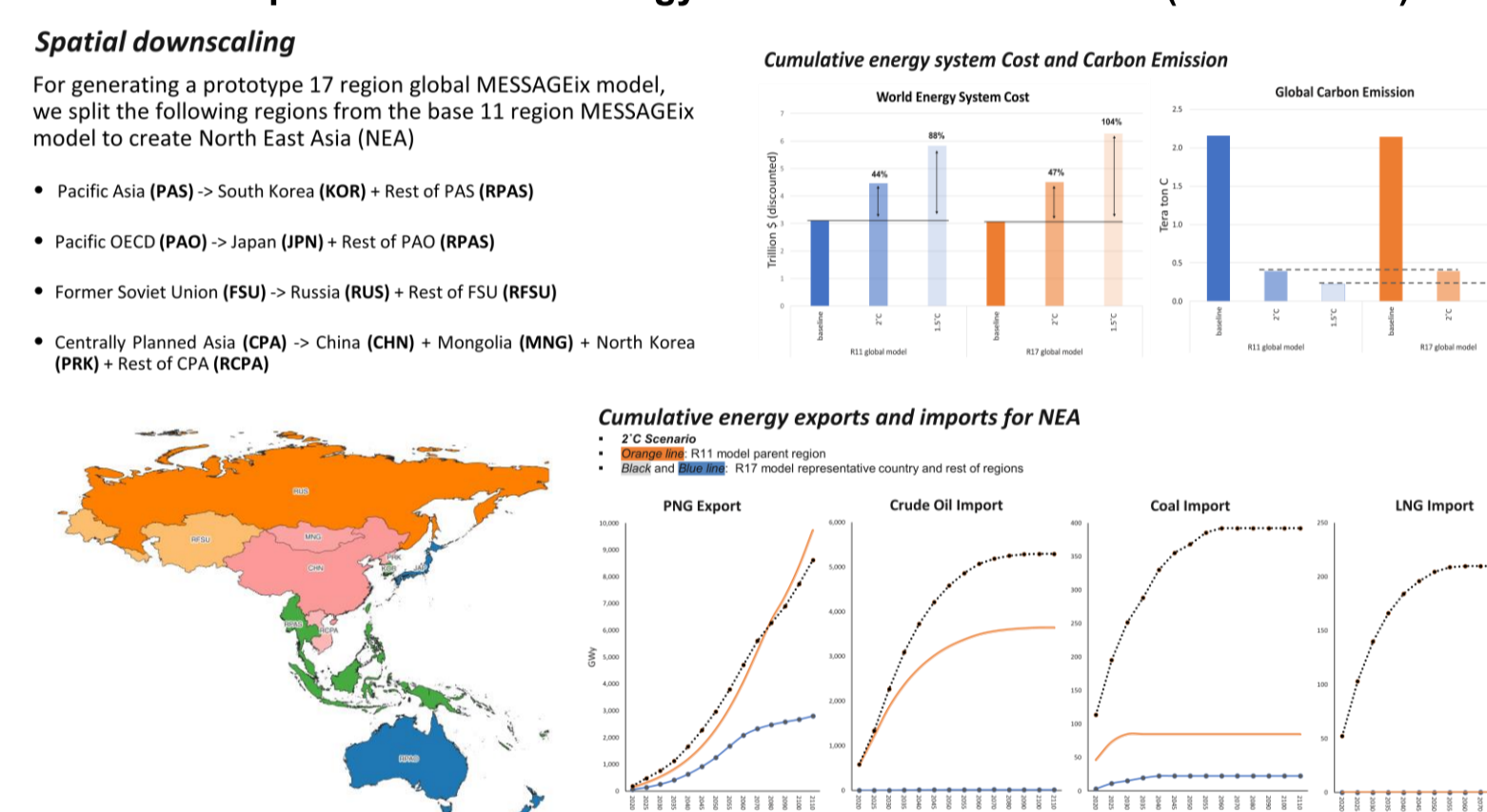
- The Utilization of South Korea's Unique Climate-Atmosphere Integrated Assessment Model (GUIDE-Korea) Development and Operational Experience
- Securing Technological Capabilities and International Collaboration through Cooperation with International Organizations (IIASA)
- Design and Operation of a Web-Based Multi-Scale Integrated Assessment Modeling System

## III. Results

### MESSAGE-GAINS



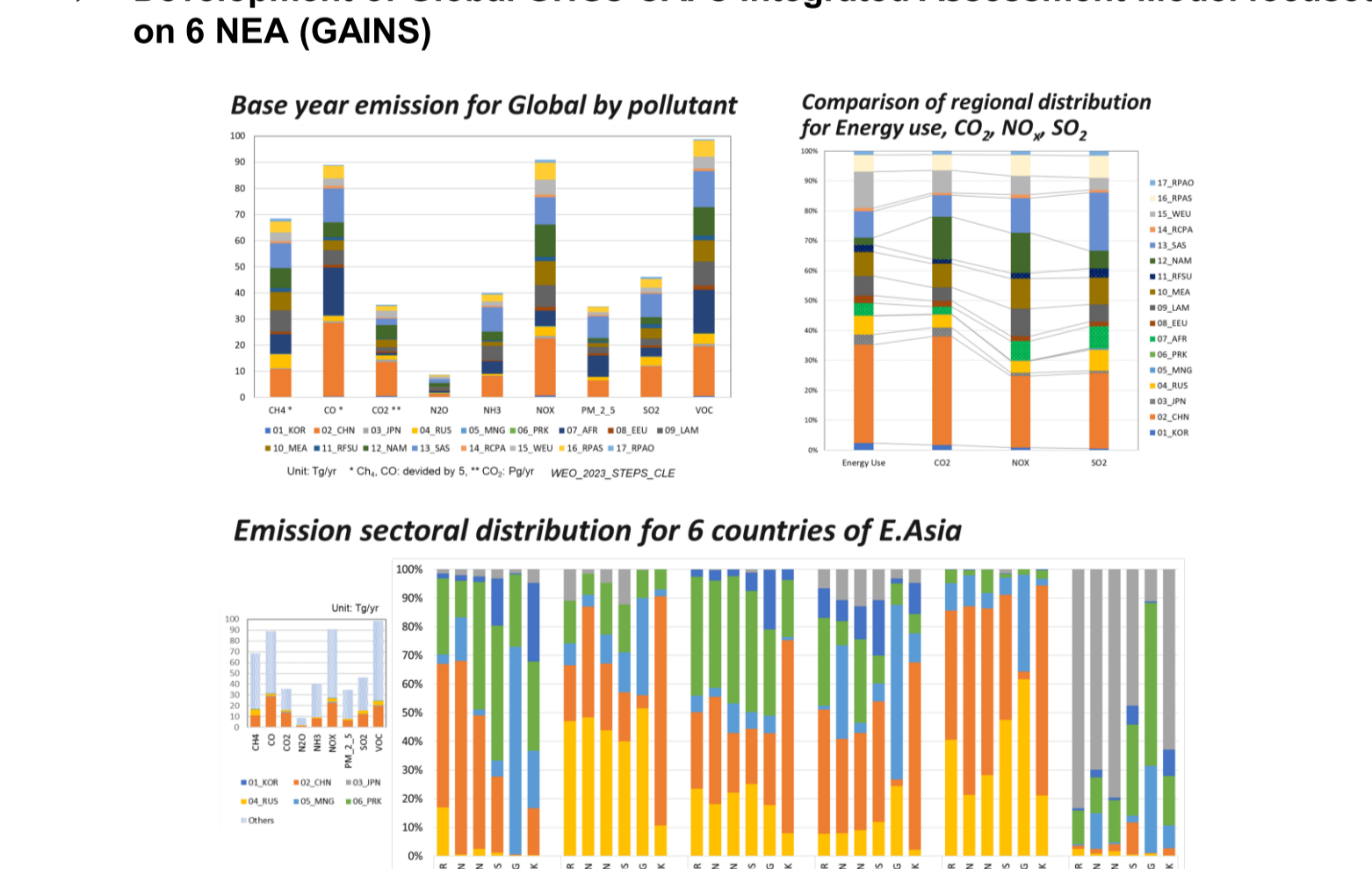
#### Development of Global Energy Model focused on 6 NEA (MESSAGEix)



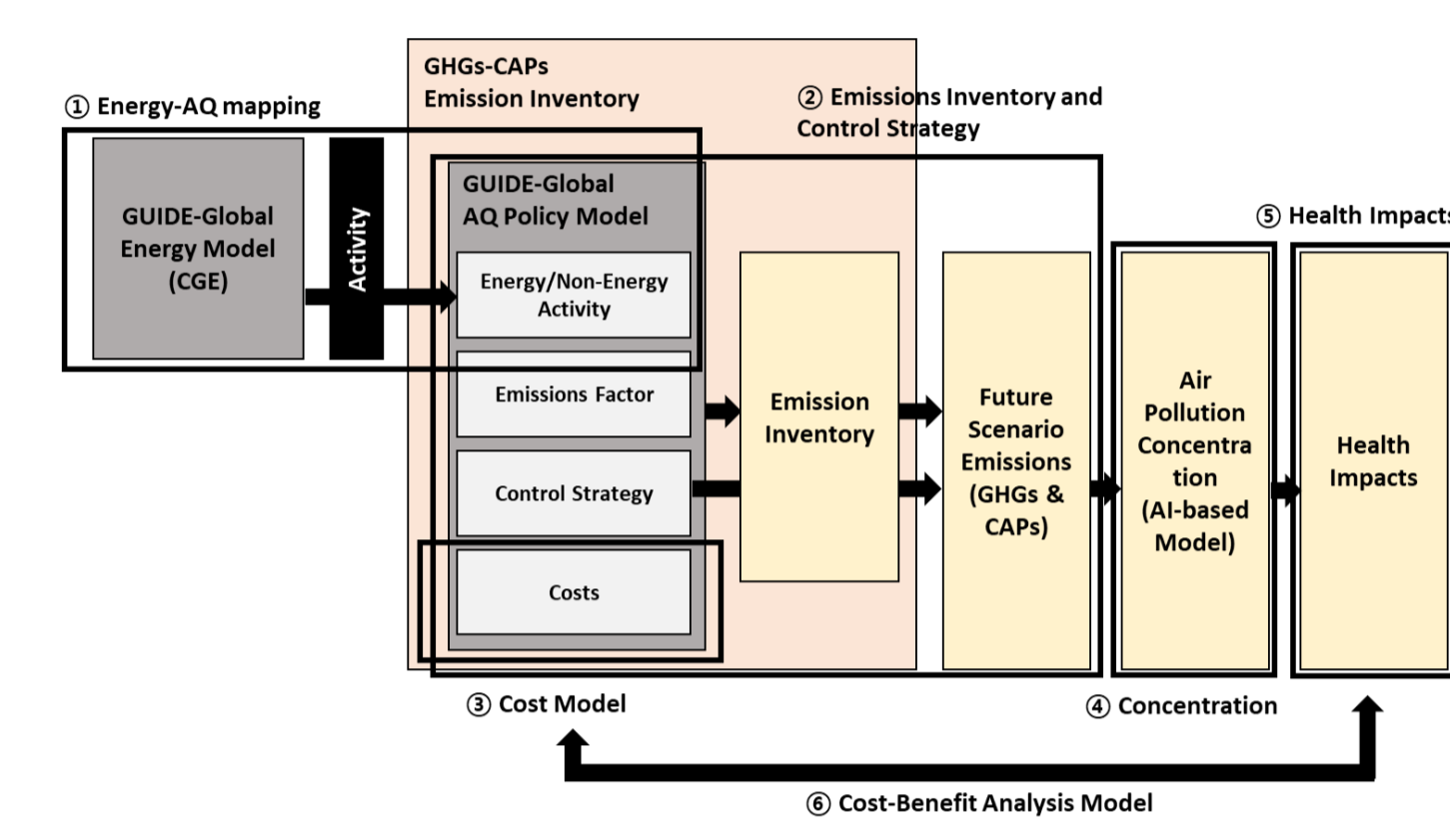
#### Region and Sector mapping between MESSAGE\_ix and GAINS

Region	Sector	Activity	
11 regions	6 regions	China	Electricity
		China	Manufacturing
		China	Transport
		China	Buildings
		China	International aviation and shipping
		China	Land use, land-use change, and forestry
6 regions	6 regions	China	Electricity
		China	Manufacturing
		China	Transport
		China	Buildings
		China	International aviation and shipping
		China	Land use, land-use change, and forestry

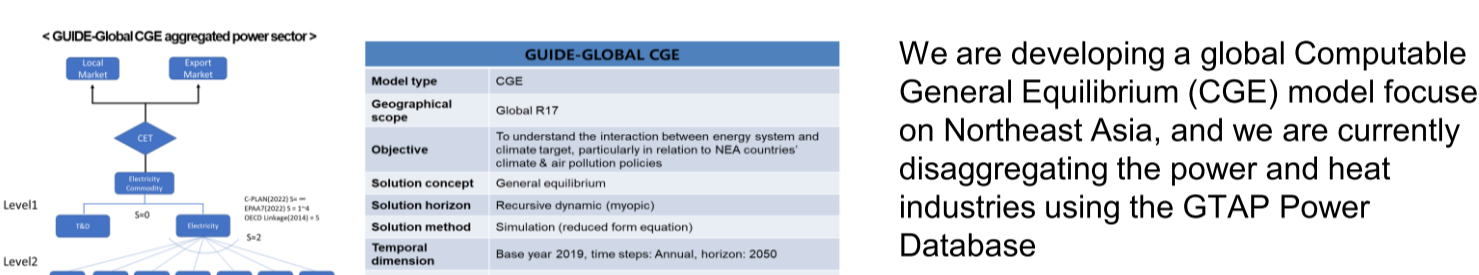
#### Development of Global GHGs-CAPs Integrated Assessment Model focused on 6 NEA (GAINS)



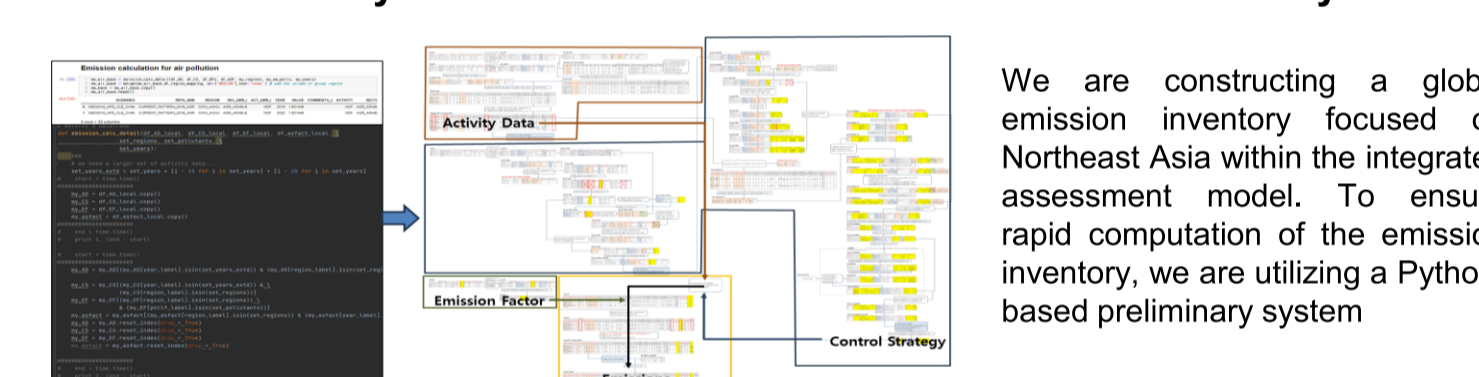
### GUIDE-Global



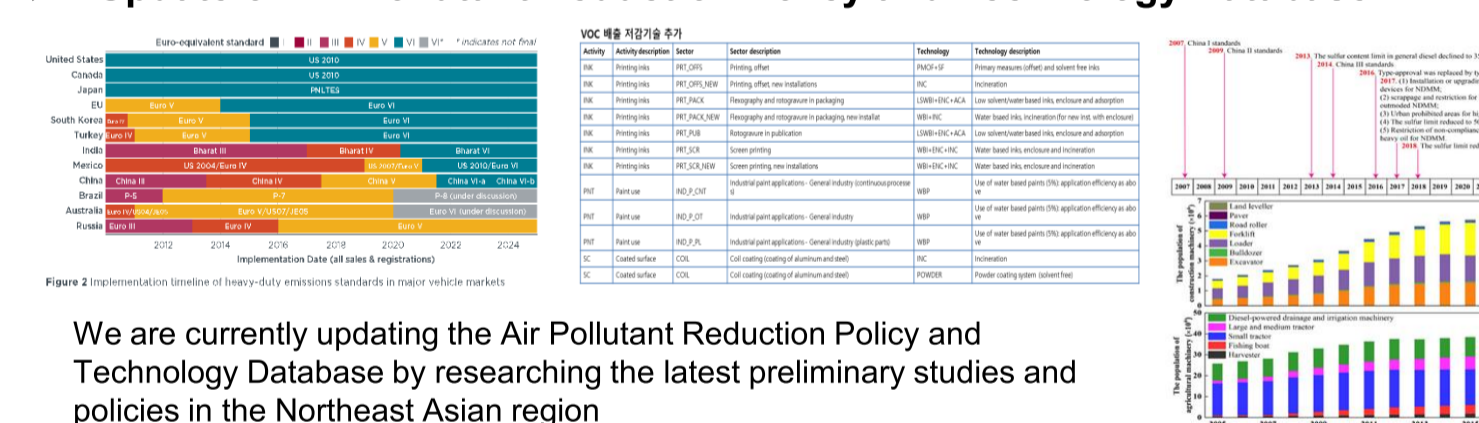
#### Development of Energy-Economic Models and Energy-Greenhouse Gas Scenarios with a Focus on Northeast Asia



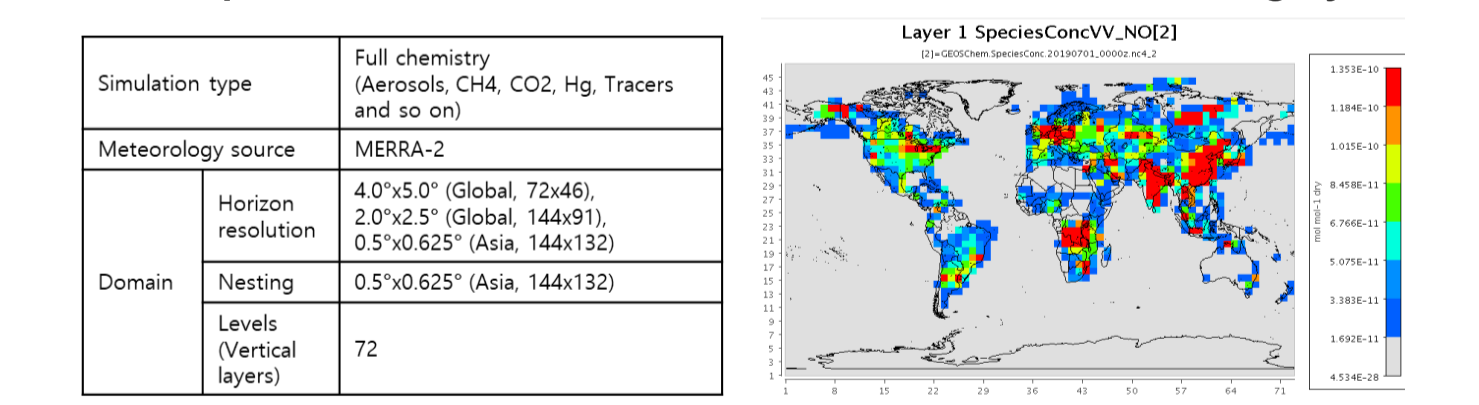
#### Utilization of Python-Based Air Pollutant Emission Calculation System



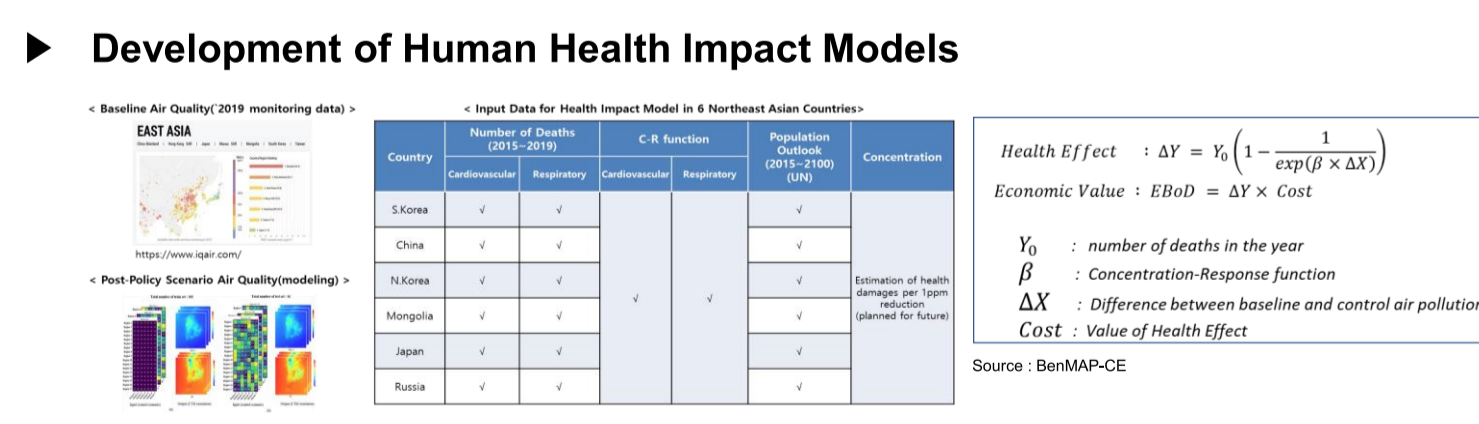
#### Update of Air Pollutant Reduction Policy and Technology Database



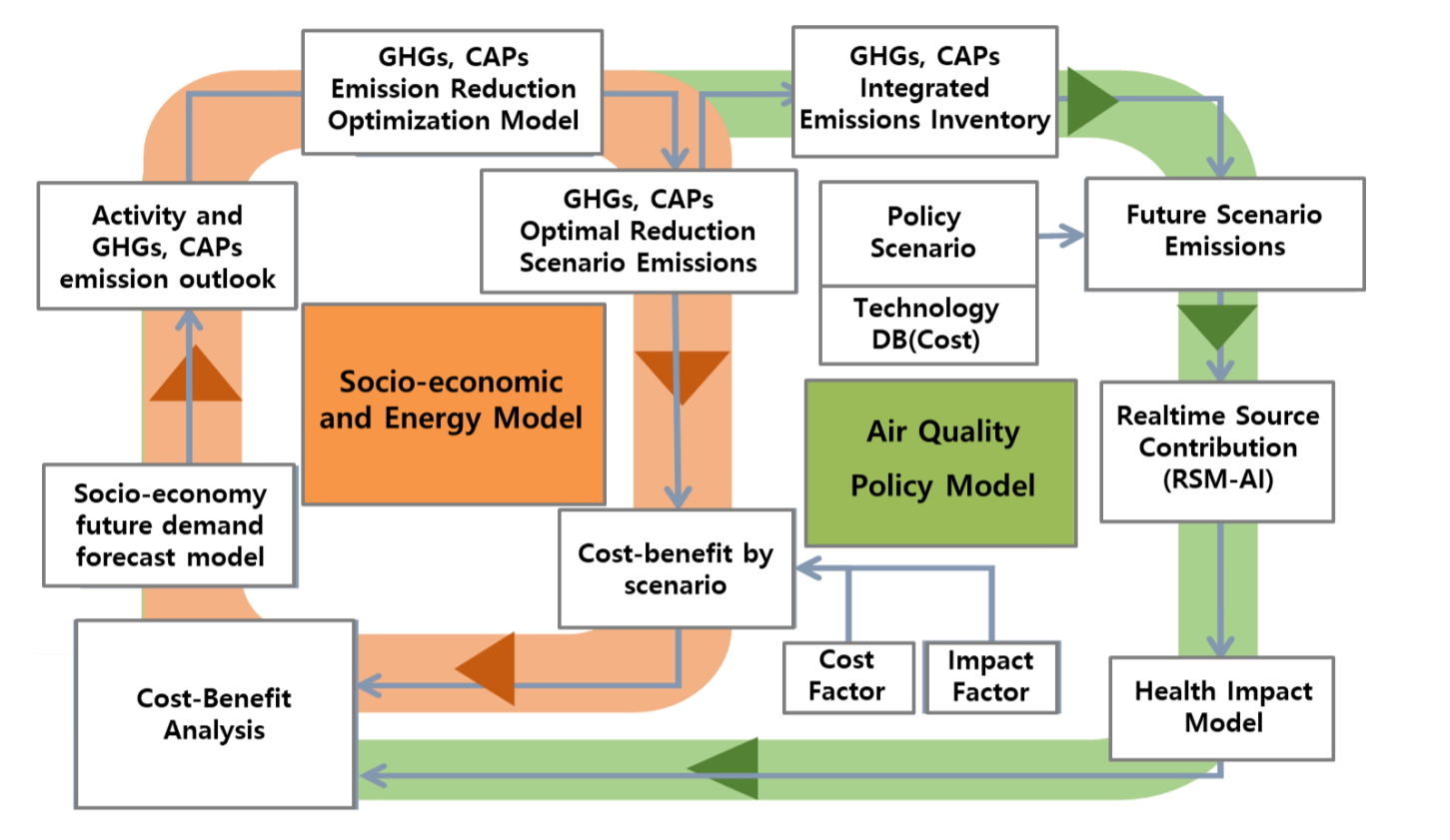
#### Development of AI-based Air Pollution Concentration Modeling System



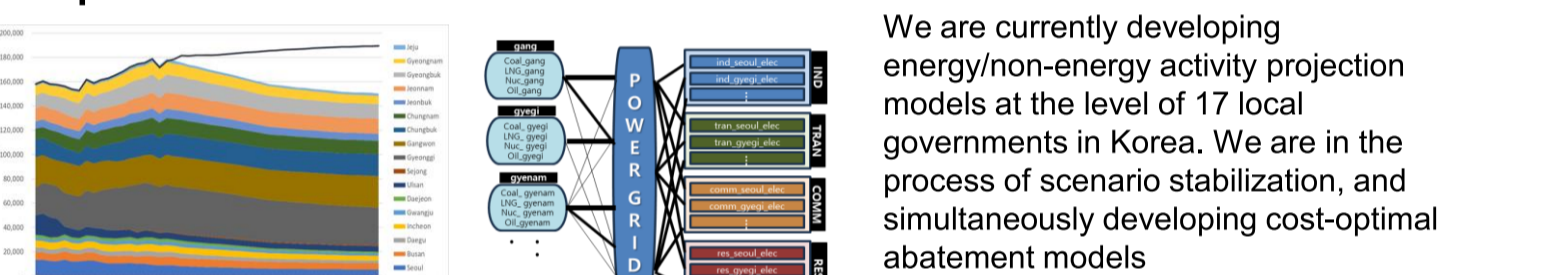
#### Development of Human Health Impact Models



### GUIDE-Local



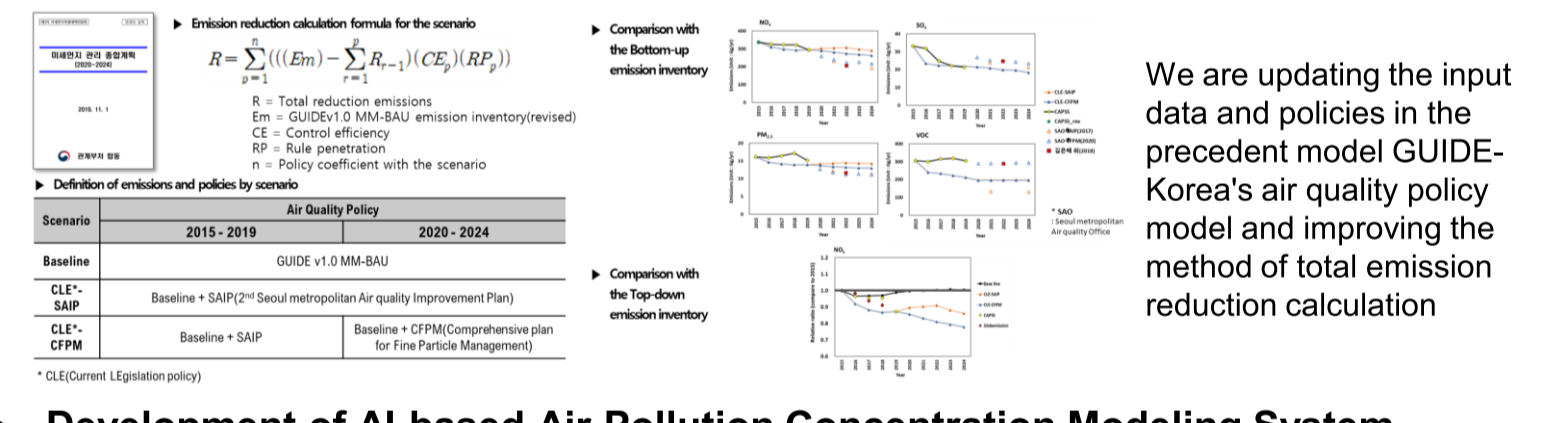
#### Development of Energy/Non-Energy Activity Projection Models and Cost-Optimal Abatement Models



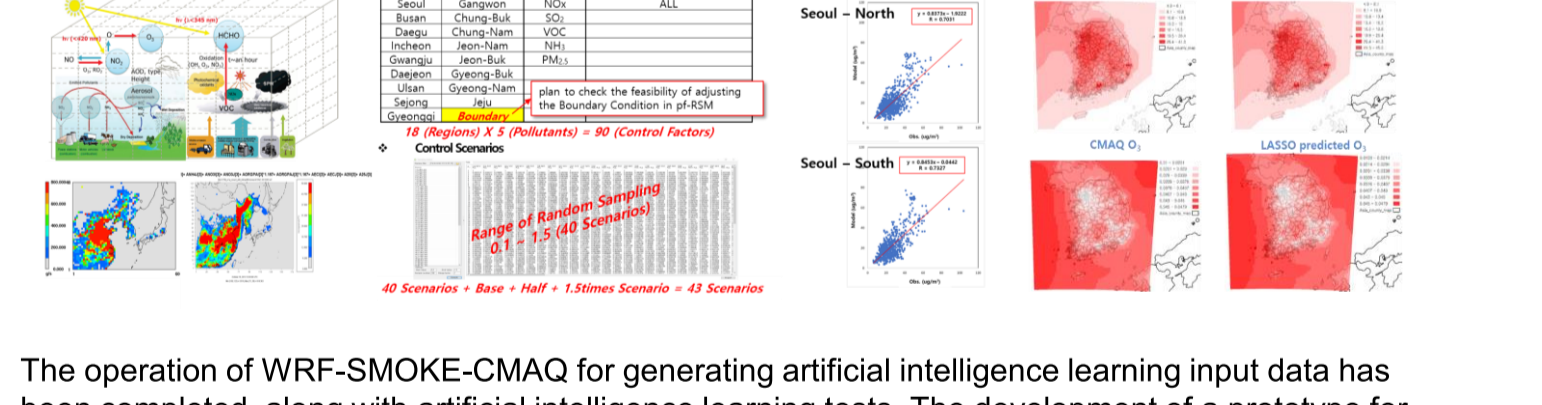
#### Development of Integrated Emission Inventory for Greenhouse Gases and Air Pollutants

Level	GHG	CO2	CH4	N2O	HFCs	PFCs	SF6	SO2	NOx	PM10	PM2.5	VOC	NH3	OC
Global	111,000	40,000	5,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Regional	10,000	3,000	400	100	100	100	100	100	100	100	100	100	100	100
National	1,000	300	40	10	10	10	10	10	10	10	10	10	10	10
Local	100	30	4	1	1	1	1	1	1	1	1	1	1	1

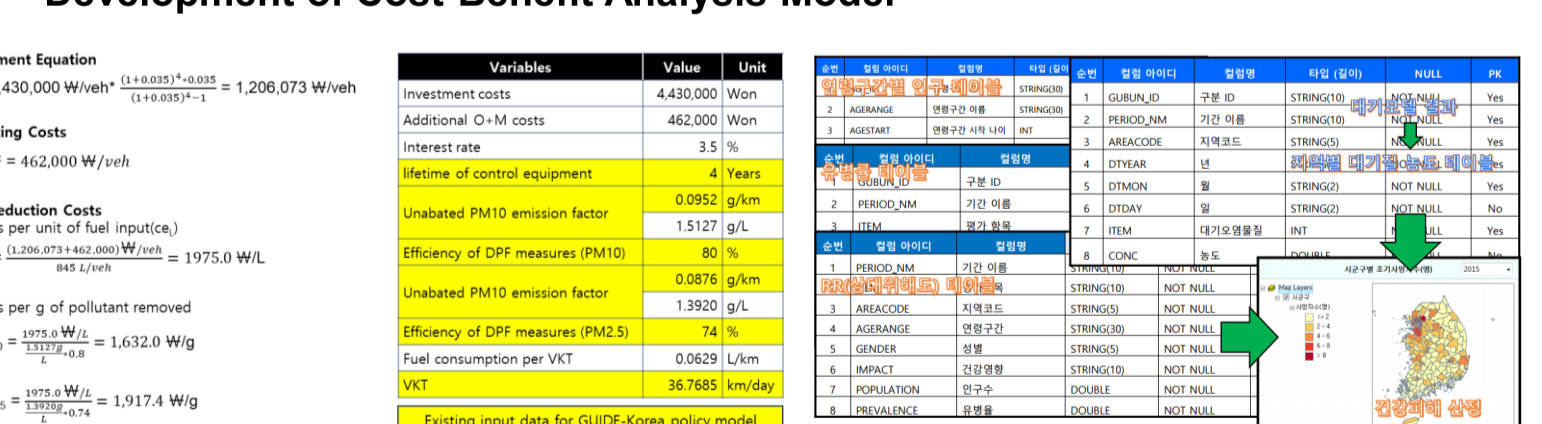
#### Development of Air Quality Policy Models and Update of Policies



#### Development of AI-based Air Pollution Concentration Modeling System



#### Development of Cost-Benefit Analysis Model



## IV. Summary & Future Work

- [MESSAGE-GAINS] We have been developing a fully calibrated MESSAGEix model for 17 regions. The developed model will be used to project energy/non-energy activities in the baseline scenario, then inputted into the GAINS model. Additionally, through the GAINS model, we will construct control pathways for future baseline scenarios and calculate air pollution concentrations and health impacts.
- [GUIDE-Global] For development of a global-scale integrated assessment model, we are in the process of developing a global CGE model and have calculated a draft of greenhouse gas emissions until 2100 for six Northeast Asian countries under the BAU scenario. For forecasting air pollutant emissions, we are updating the policy-technology database using the latest policies previous studies and developing Python-based air policy modeling system. Additionally, GEOS-Chem was set to calculate global-scale concentration fields for the development of real-time air pollution models based on artificial intelligence.
- [GUIDE-Local] We are developing integrated assessment models at the local government level to support Korea's climate-air action plans. Energy/non-energy activity forecasting models and air policy reduction models have been developed for 17 local governments. Furthermore, we have developed a prototype for real-time air pollution concentration models based on WRF-SMOKE-CMAQ and artificial intelligence.
- We plan to complete the development of the GUIDE-Global and GUIDE-Local integrated assessment models by 2025. By 2026, we aim to develop greenhouse gas and air pollutant emission scenarios focusing on Northeast Asia.
- Through this research, we expect to contribute to international climate change-air quality research communities with these new IAMs. We also anticipate that this work will help finding solutions for climate change and air pollution issues in multiple scales.

## VI. References

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