

# Future GHG and Air-pollutant emission range consistent with the SSP in East Asia region

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# 01 Project Overview

## Background

- Hot-spot area of climate change

Category	Area	Current (1986- 2005)	Mid term (2046- 2065)		Long term (2081- 2100)	
Average temperature (°C)	Korea peninsula	11.3	+2.3	(+3.3)	+3.0	(+5.9)
	East Asia	-	+1.9	-	+2.4	-
	Global	-	+1.4	(+2.0)	+1.8	(+3.7)
Precipitation	Korea peninsula	1144.5	+13%	+21%	+20%	(+18%)
	East Asia				+7%	

Source: CMIP5 results based on RCP4.5

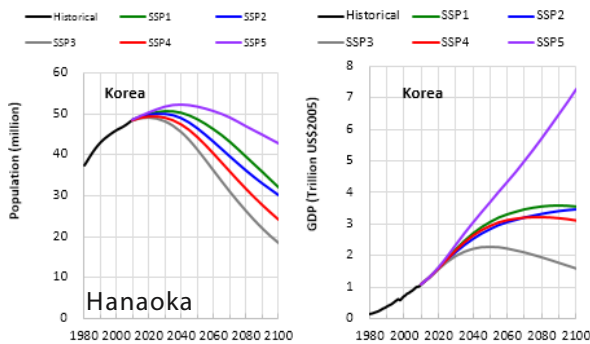
( ) means RCP8.5 result

- South Korea's climate change laws
  - Framework Act on Low Carbon Green Growth / 2010
  - Act on the allocation and trade of greenhouse gas emissions rights / 2012
  - Act on the Creation and Facilitation of Use of Smart Grids / 2011

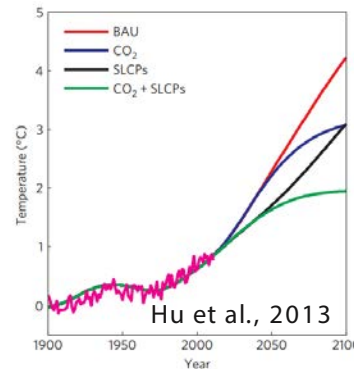
# 01 Project Overview

## Background

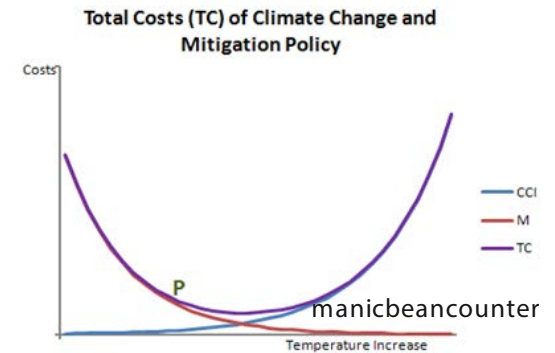
- "No Regrets" Approach to Decision-Making against climate change
  - Characterizing Uncertainty in Regional Climate Change and impact
  - Integrated assessment modelling coupled with Regional characteristic



Socio-economic scenario



Modelling (LLGHG, SLCP)

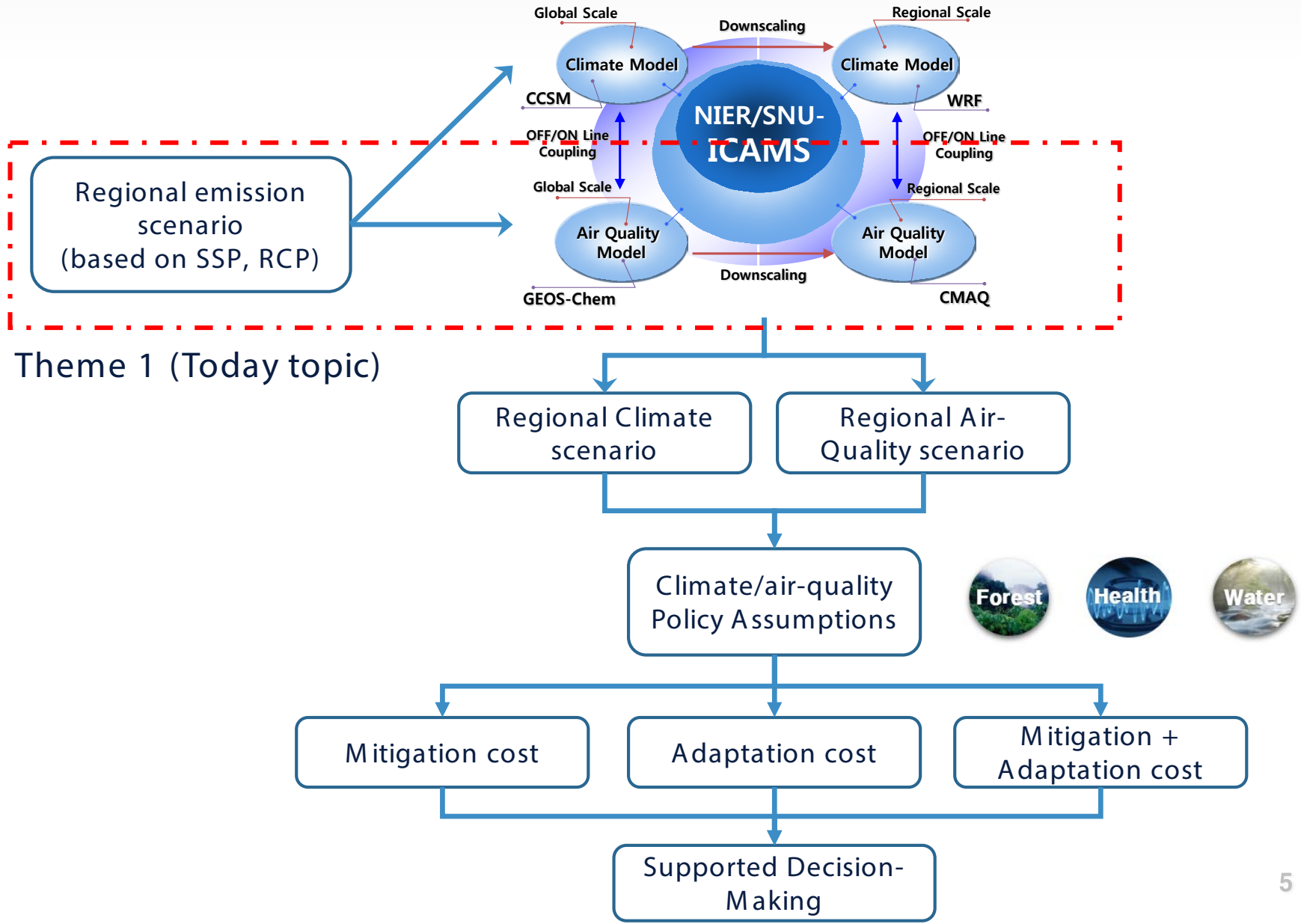


Cost

## Goal

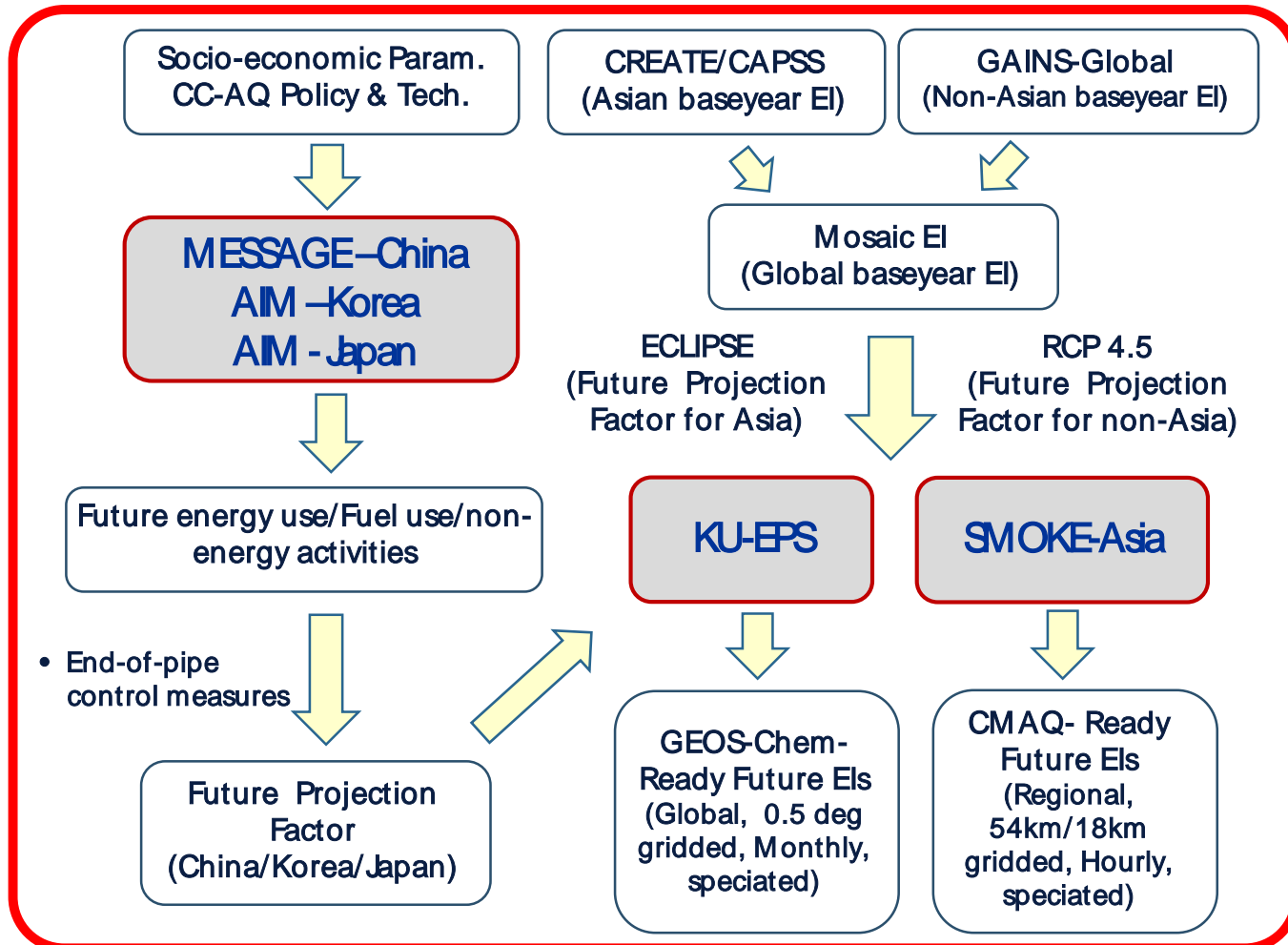
- To develop an integrated evaluation system for climate policy by interconnecting emission inventory, integrated assessment models (emission and impact), and climate models

# 01 Project Overview



## 02 Scope

- To Present emission scenarios of Long-lived GHG (LLGHG) and Short lived Climate Pollutant (SLCP) (East Asia region) for climate modeling



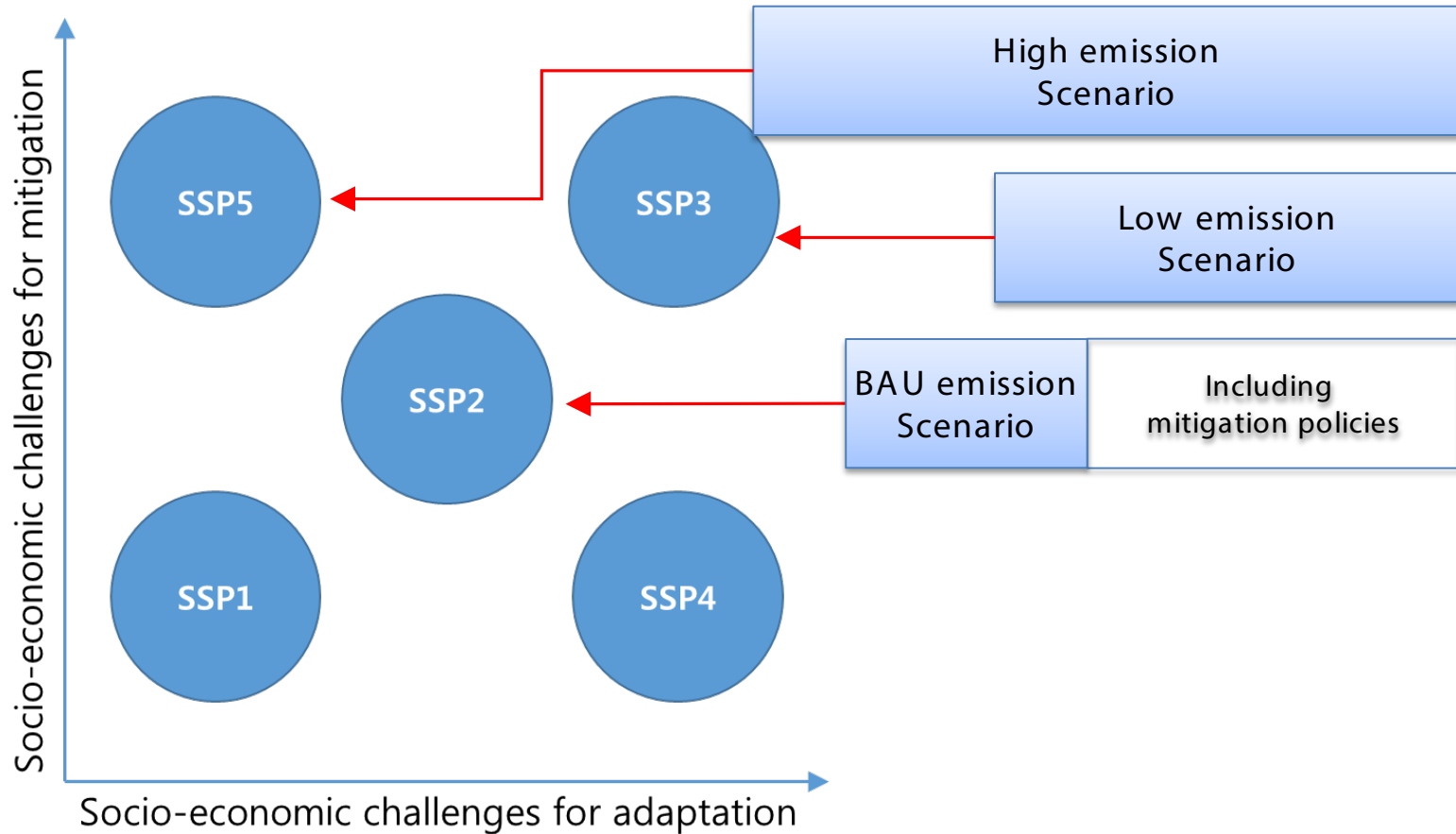
# 03 Method

## Emission modeling

- Time
  - 2010 - 2100
    - Base Year : 2010, Target Year : 2030, 2050, 2100
- Sectors
  - Fuel combustion (Residential sector, Commercial sector, Transport sector, Industry sector (Steel, Cement, Other industries))
  - Industrial process, Agriculture, Waste (Residential sector, Commercial sector, Industry sector), Fuel mining, Others
- Data
  - Population, GDP : OECD, IIASA, National Statistics
  - Mitigation policy : National policy, Suggested policy from research
  - Technology : AIM Enduse[GLOBAL], GAINS-China
  - Discount rate: 5%
  - Energy price: World Energy Outlook
  - Emission factor: IPCC guideline
  - Climate scenario : RCP8.5, RCP4.5

# 03 Method

## Emission scenario setting

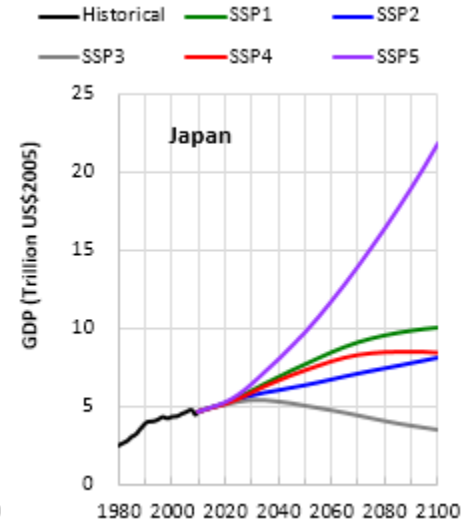
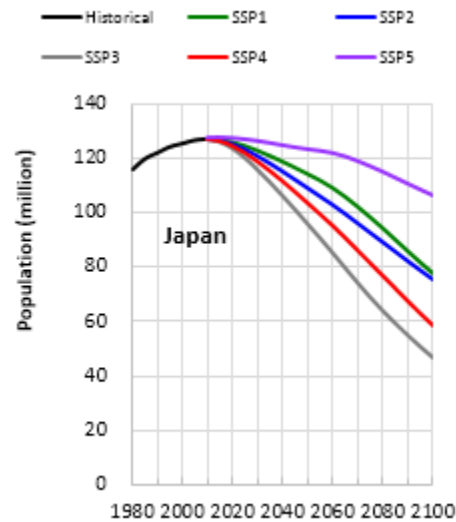
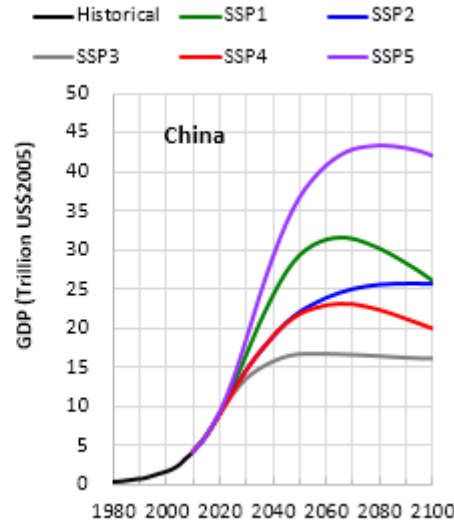
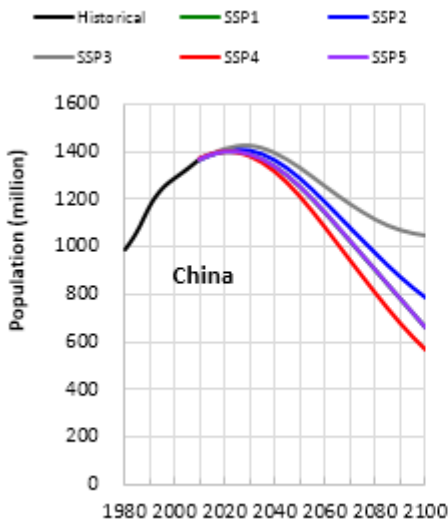
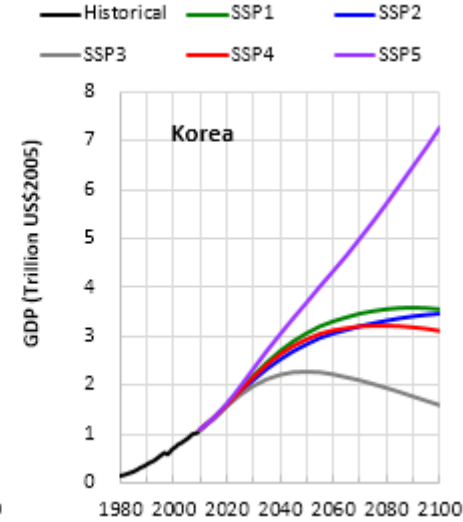
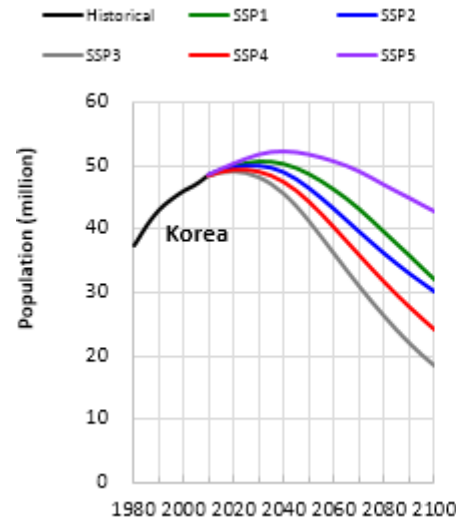




# 03 Method

## Socio-economic data

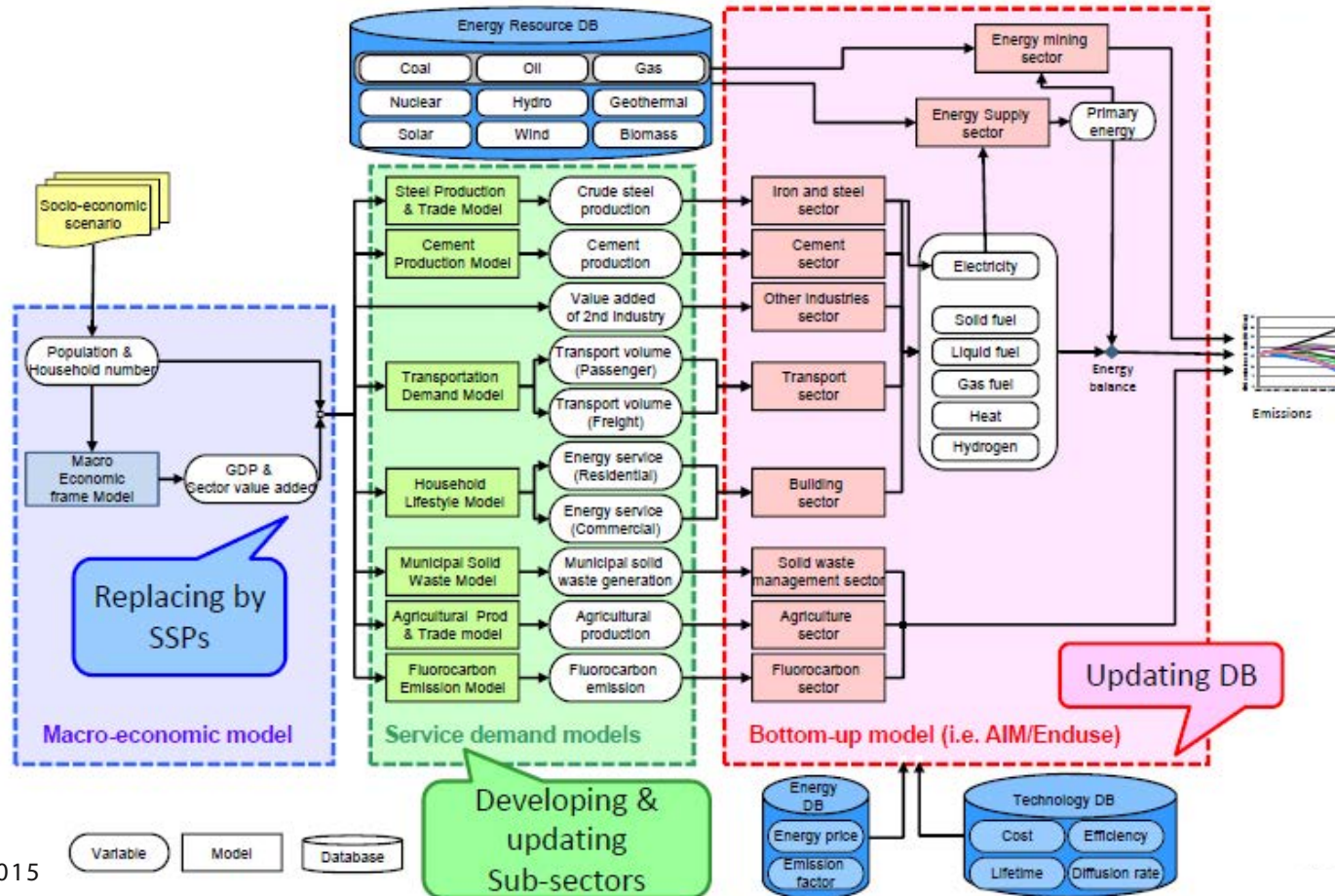
- Population
- GDP



# 03 Method

## Emission modeling (Korea, Japan)

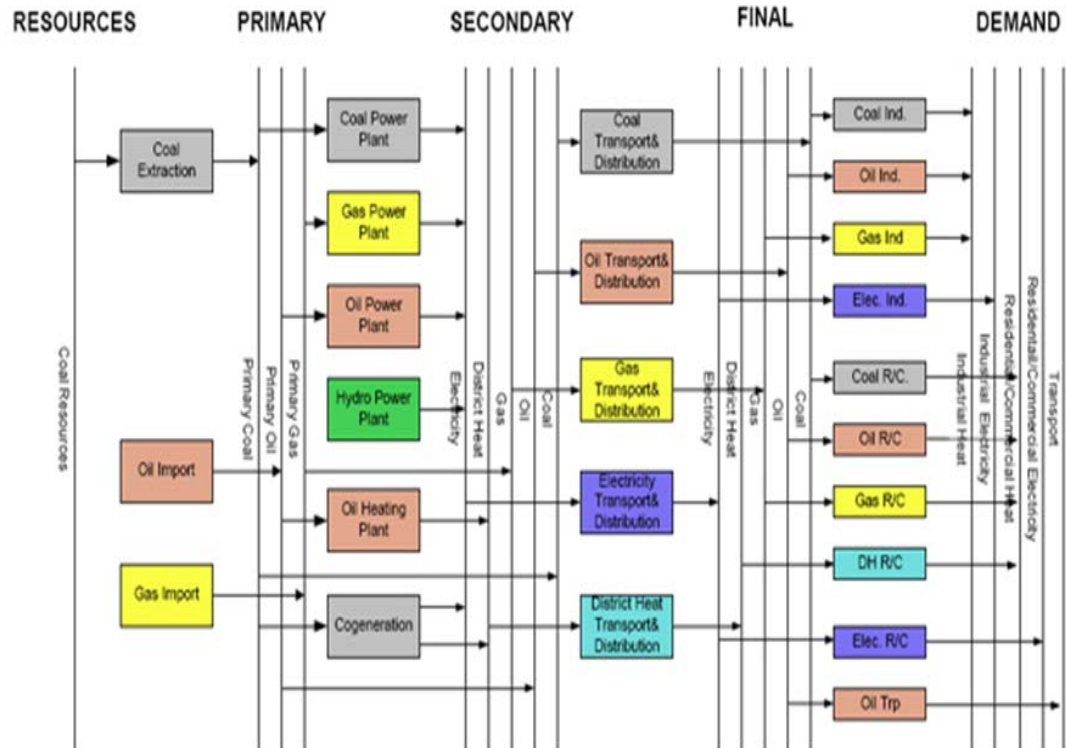
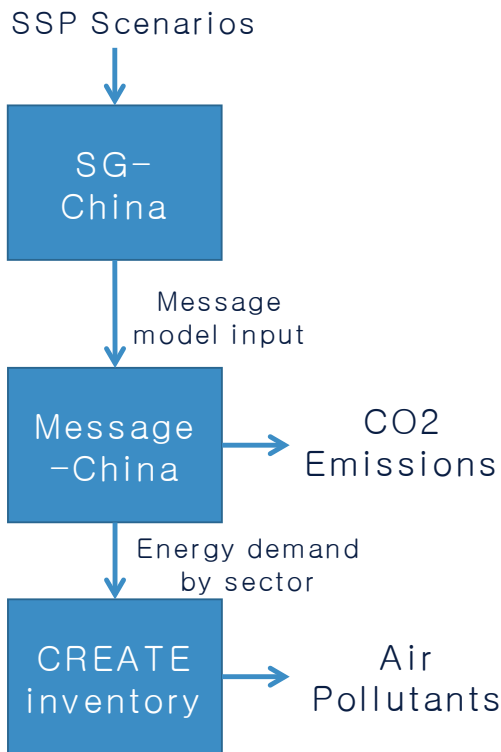
- Model: AIM Enduse Global



# 03 Method

## Emission modeling (China)

- Model: MESSAGE-China



# 03 Method

## Implementation of Control technology (China case)

Sector	Control Measures	Penetration year	Control Efficiency (%)	Technology
Power	- Nearly all coal-fired power plants to be equipped with high efficiency FGD facilities	2010	80%	FGD (SO2)
		2030	90%	
	- All new-built thermal power plants be equipped with low NOx combustion technologies and flue gas denitrification - Existing thermal power plants should be upgraded with low NOx combustion technologies, and flue gas denitrification is required for large units (≥300 MW).	2010	25%	LNB/SCR/SNCR (NOx)
		2030	85%	
	- Set a strict PM in-stack concentration standard: 30mgm-3 for the whole country (by installing ESP and wet-FGD simul-taneously) and 20mgm-3 for "key regions" (high efficiency deduster , including FF and electrostatic-fabric integrated precipitator).	2010	95%	CYC/WET/ESP/FAB (PM2.5)
		2030	99%	ESP/FAB (PM2.5)
- Denitration in natural gas power plants	2010	25%	LNB/SCR/SNCR (NOx)	
	2030	75%		

Sector	Control Measures	Penetration year	Control Efficiency (%)	Technology
In_Combustion	- Coal-fired boilers great than 20 t/h shall use desulfurization technologies (A)	2010	0%	SO2 FGD (SO2)
		2030	80%	
	- The NOx in-stack concentration of coal-fired boilers is limited at 300mgm-3 for newly built boilers (require LNB technologies). (B)	2010	0%	LNB (NOx)
		2030	30%	
- Existing de-dusting facilities of coal-fired boilers and industrial kilns shall be upgraded. (C)	2010	35%	CYC/WET (PM2.5)	
	2030	90%	WET/ESP/FAB (PM2.5)	
Residential	- Promote to use clean coal in rural areas./Promote to use advanced coal stove (D)	2010	0%	clean coal/ advanced coal stove (SO2, PM2.5, VOC)
		2030	65%	
	- Promote to use advanced biomass stove (E)	2010	0%	advanced biomass stove (SO2, PM2.5, VOC)
		2030	65%	
Agriculture	- to develop new varieties of slow-release fertilizers, and to reduce NH3 emissions from fertilizer application.	2010	0%	slow-release fertilizers (NH3)
		2030	70%	

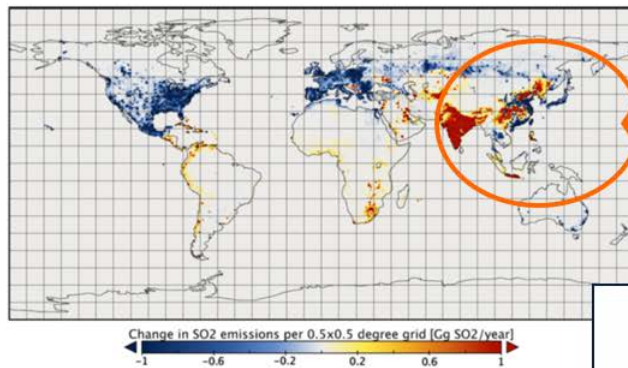
Industrial process_SO2	Control technology	2010	2020	2030
Sintering	FGD	10	30	40
Glass production (float process)	FGD	0	0	0
Sulfuric acid production	Ammonia acid desulfurization method	0	0	0
Other industrial process	PRSO2 (70% efficiency)	0	0	0
Industrial process_NOx	Control technology	2010	2020	2030
Sintering	SNCR	0	0	0
	SCR	0	0	0
	LNB	35	35	35
Precalcined cement kiln	LNB+SNCR	0	0	0
Nitric acid (dual pressure process)	ABSP	12	12	12
	SCR	18	18	18
Nitric acid (other process)	ABSP	63	66	66
	SCR	32	34	34
	ABSP+SCR	0	0	0
Other industrial process	PRNOX (40% efficiency)	0	0	0

Vehicle	Standard	Penetration			Control Efficiency			
		2010	2020	2030	CO_%	NOx_%	PM_%	VOC_%
HDT-D	NOC	1	0	0				VOC
	HDEUI	8	0	0	5	30.5	23.1	30
	HDEUII	22	0	0	16	26.3	58.58	49
	HDEUIII	70	7	0	55	36.2	66.12	57
	HDEUIV	0	19	0	64	63.3	93.31	60
	HDEUV	0	75	100	64	77.6	93.27	65
	HDEUVI	0	0	0	64	95.5	99.66	89.5
HDB-D	NOC	8	0	0				
	HDEUI	18	0	0	5	30.5	23.1	30
	HDEUII	24	3	0	16	26.3	58.58	49
	HDEUIII	51	20	0	55	36.2	66.12	57
	HDEUIV	0	18	2	64	63.3	93.31	60
	HDEUV	0	59	98	64	77.6	93.27	65
	HDEUVI	0	0	0	64	95.5	99.66	89.5

# 03 Method

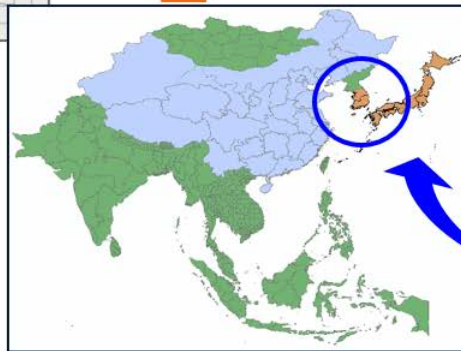
## Grid Emission Inventory

- Global : ECLIPSE version 5
- Regional : CREATE (NIER-KU)
- Korea : CAPSS (NIER)

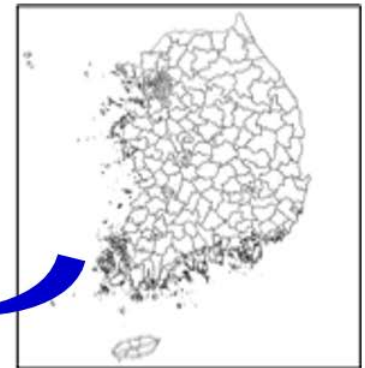


Global-scale emissions inventory – ECLIPSE v5

- Air-pollutant: PM2.5, PM10, SO2, NOx, VOC, CO, NH3
- GHG : CO2, CH4, N2O
- Database type: IIASA GAINS Model



Asia-scale emissions inventory – CREATE

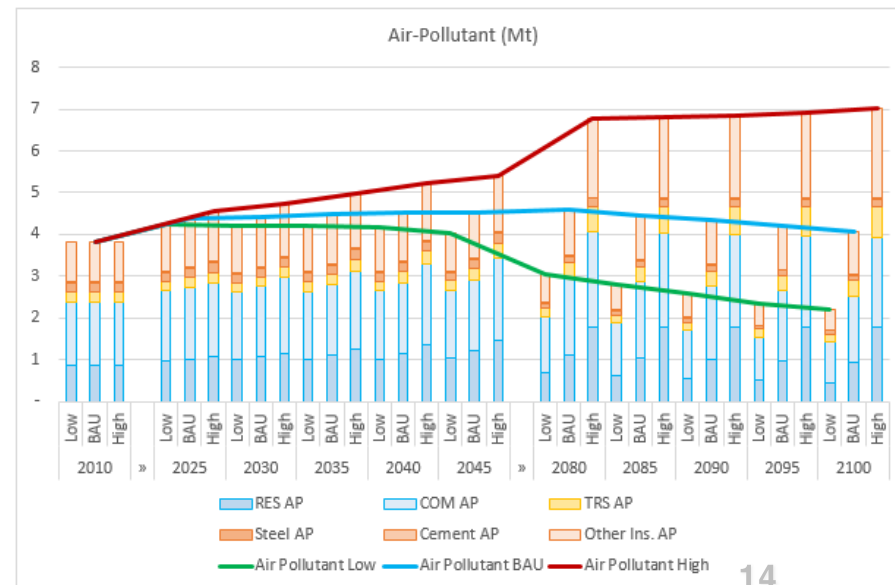
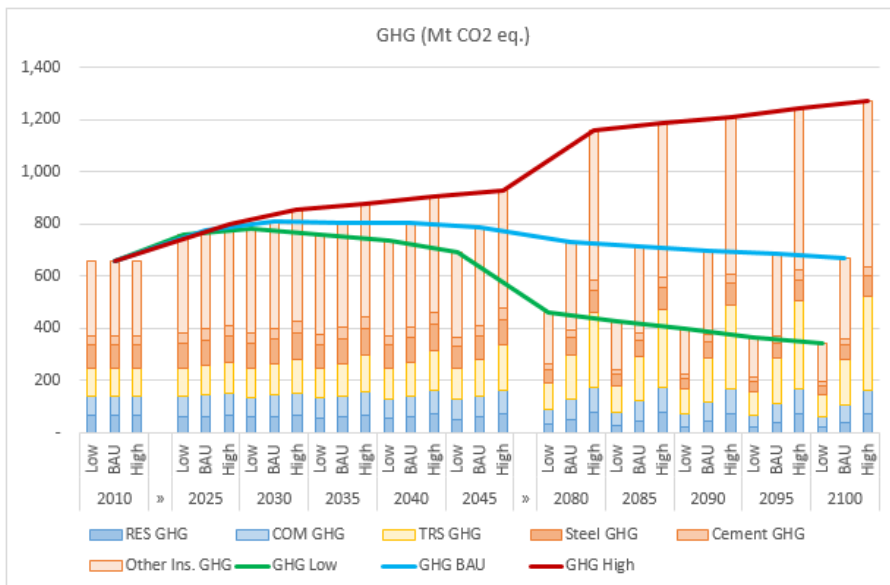


National inventory – CAPSS

# 04 Results

## Emission in Korea

- Emission inventory : GHG (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), Air-pollutant (SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>10</sub>, CO, BC, TSP, VOC, NH<sub>3</sub>)
- Sector's Contribution to GHG :  
 (2010) Building 21% , Transport 16% , Industry 63%  
 (2100) Building (13-18)% , Transport (26-28)% , Industry (56-59)%
- Sector's Contribution to Air-pollutant :  
 (2010) Building 6% , Transport 63% , Industry 31%  
 (2100) Building (8-11)% , Transport (55-66)% , Industry (26-33)%

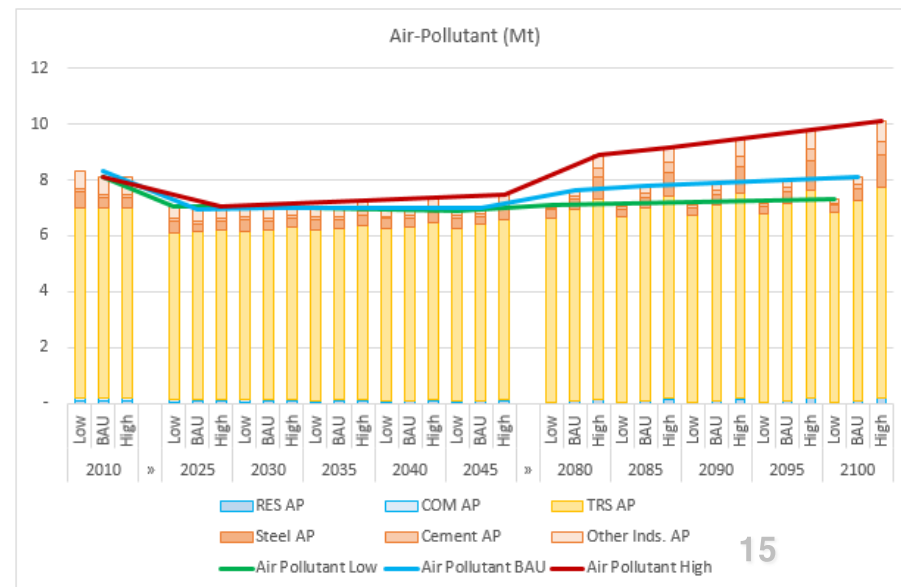
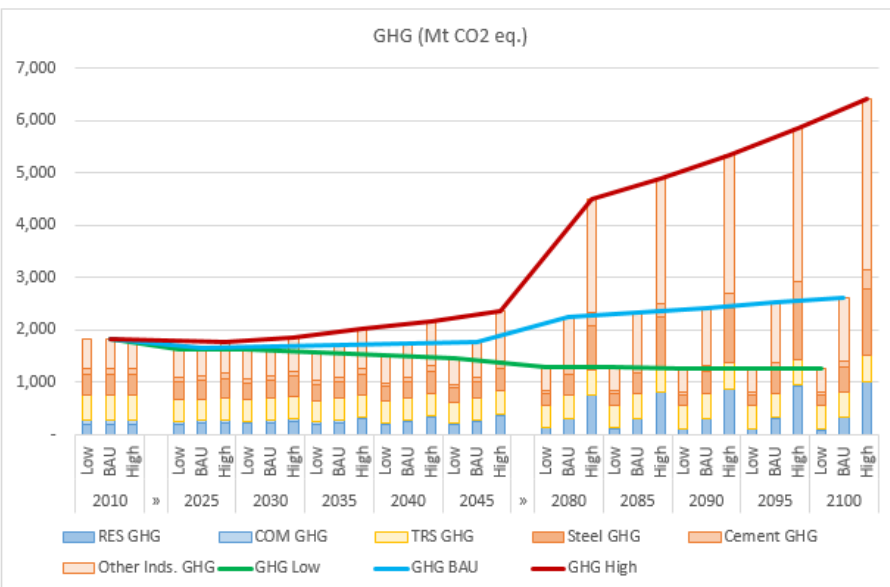




# 04 Results

## Emission in Japan

- Emission inventory : GHG (CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O), Air-pollutant (SO<sub>2</sub>, NO<sub>x</sub>, BC)
- Sector's Contribution to GHG :  
 (2010) Building 20% , Transport 24% , Industry 56%  
 (2100) Building (17-25)% , Transport (7-32)% , Industry (51-68)%
- Sector's Contribution to Air-pollutant :  
 (2010) Building 2% , Transport 82% , Industry 31%  
 (2100) Building (1-2)% , Transport (74-93)% , Industry (6-23)%

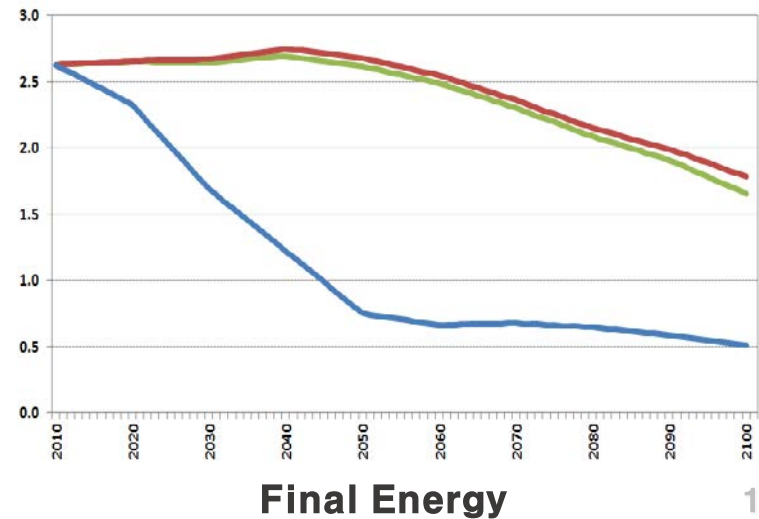
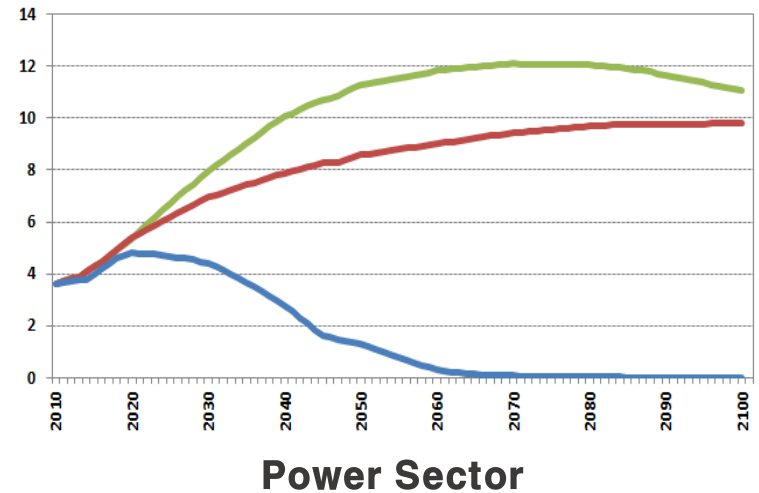
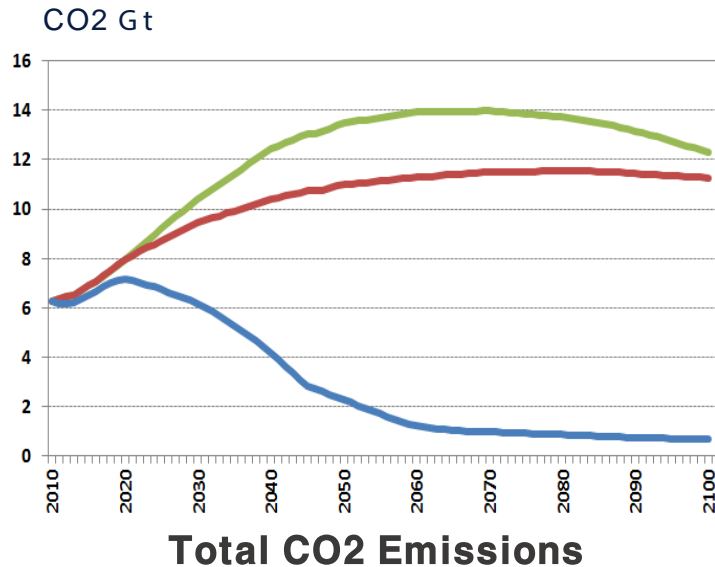


# 04 Results

## Emission in China (air-pollutant)

- Emission inventory :  
GHG(CO<sub>2</sub>, CH<sub>4</sub>),  
Air-pollutant (SO<sub>2</sub>, NO<sub>x</sub>, PM<sub>2.5</sub>, CO, BC)

High  
BaU  
Low

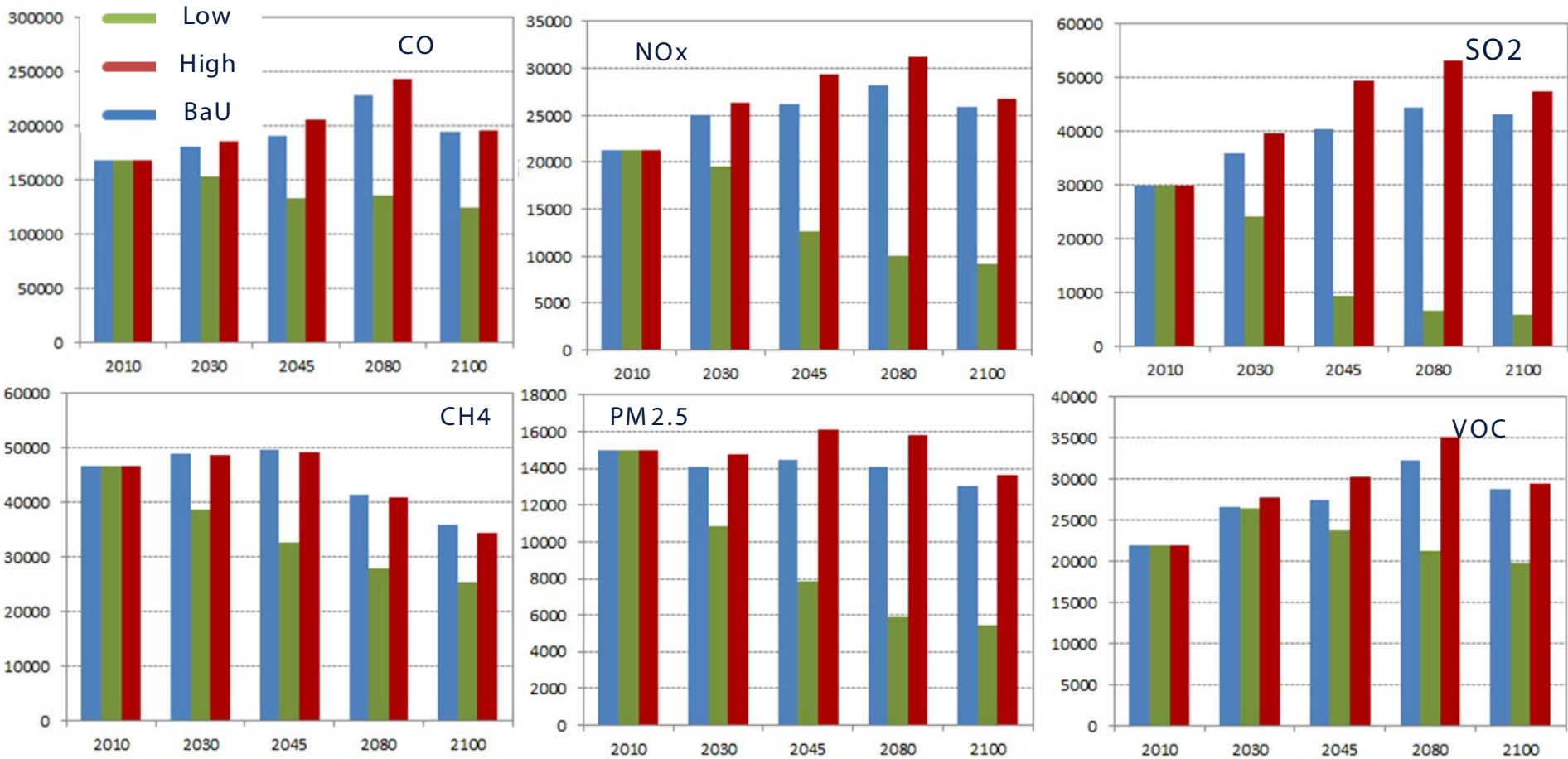




# 04 Results

## Emission modeling result in China (air-pollutant)

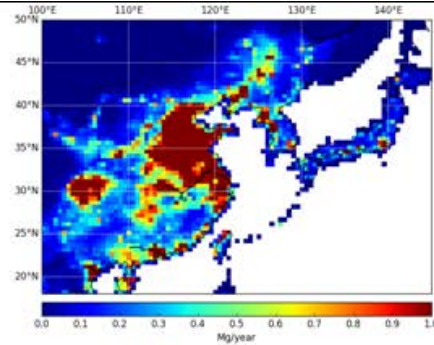
Gg/yr



# 04 Results

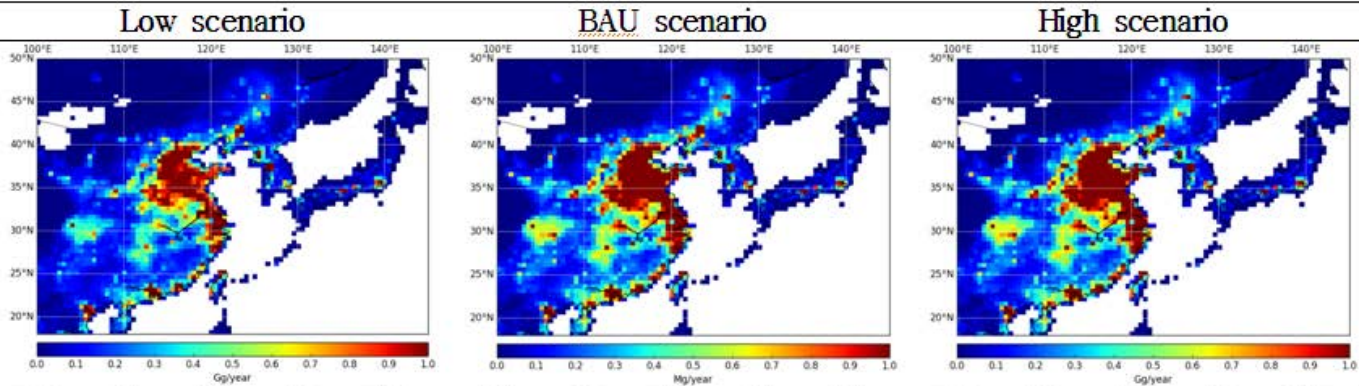
## Emission result in East Asia region

Present  
(2010)

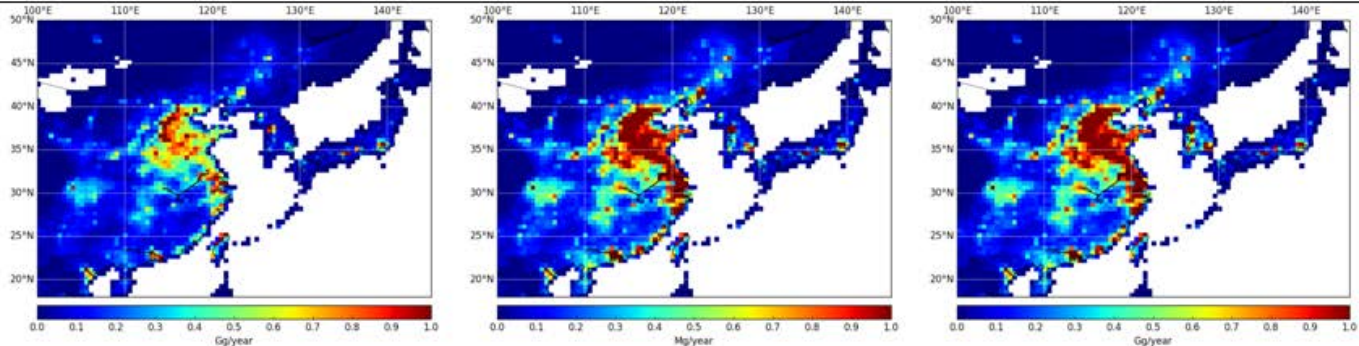


▪ BC

Middle term  
(2040)

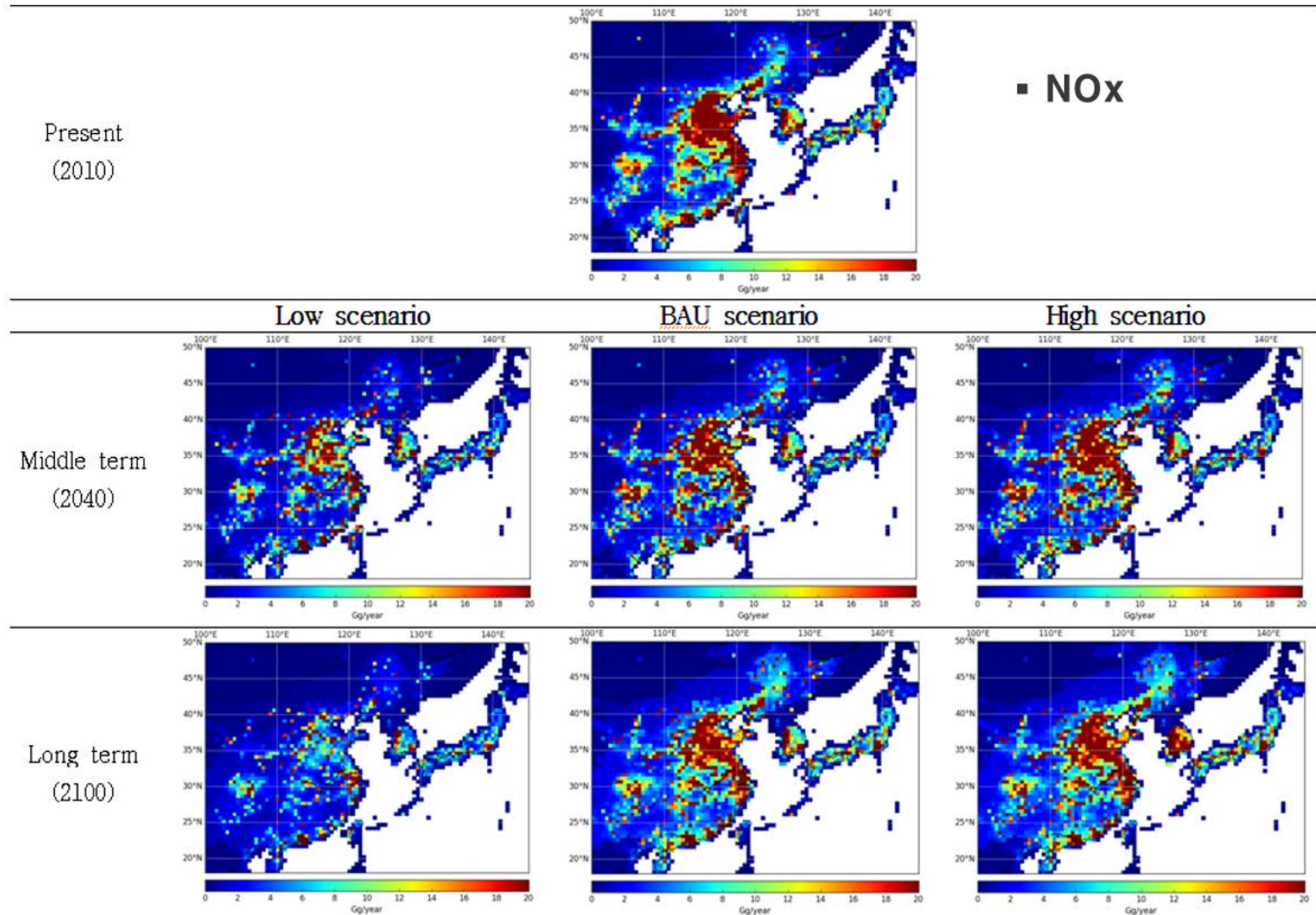


Long term  
(2100)



# 04 Results

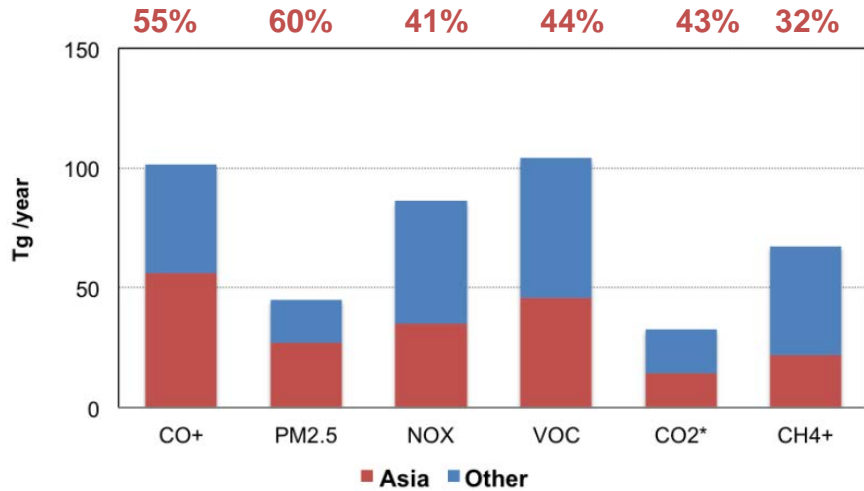
## Emission result in East Asia region



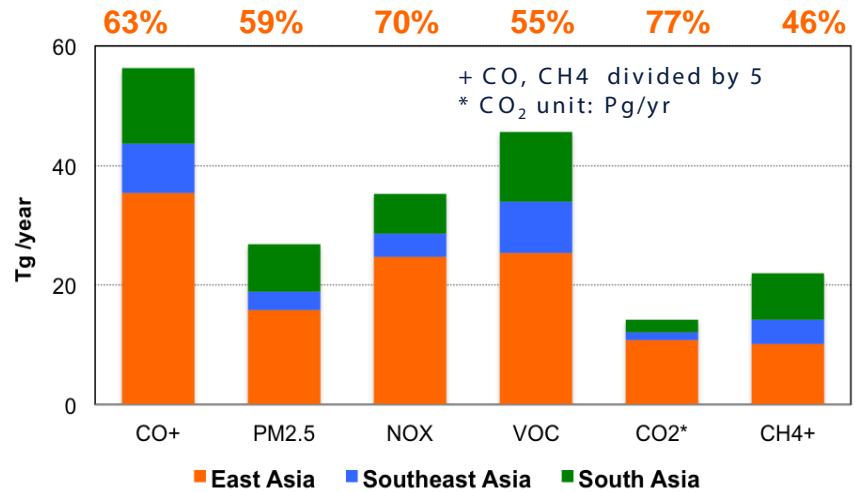
# 04 Results

## Emission contribution in 2010 and Emission Comparison

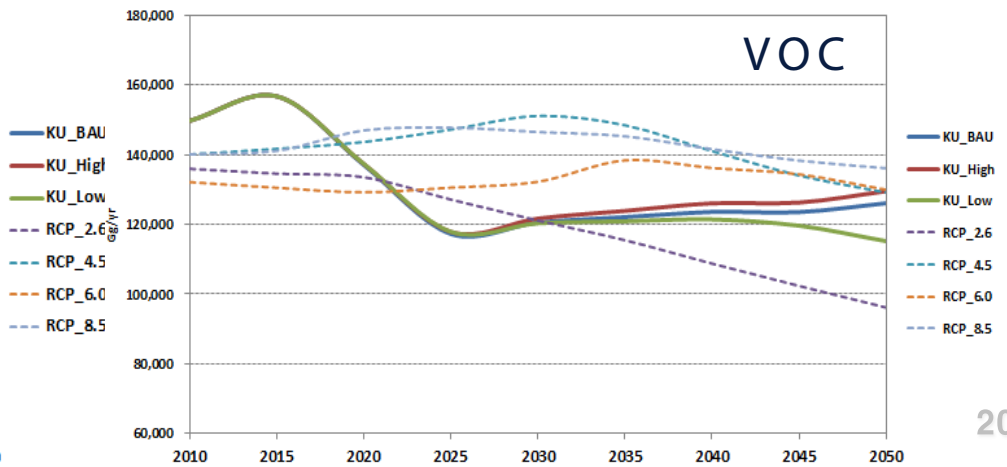
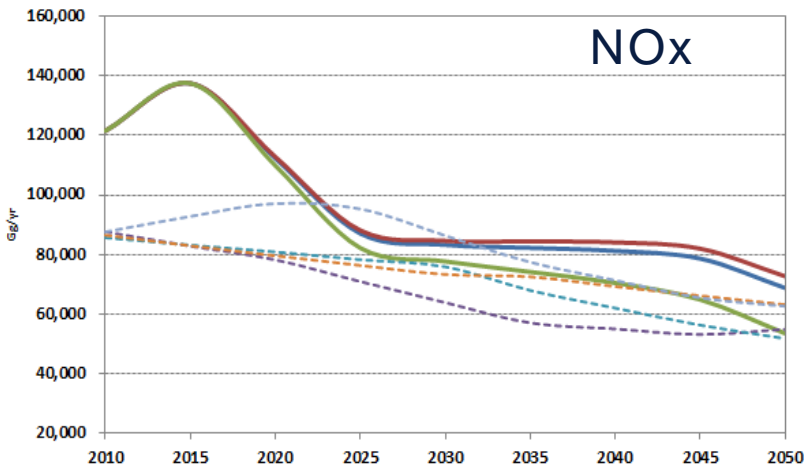
Emission Contribution of Asia in 2010



Emission Contribution of East Asia in 2010



Emission GAP



**Thank you**