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Scenarios of Energy and Air quality in Northeast Asia: data linkage and harmonization

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CMAS-Asia-Pacific

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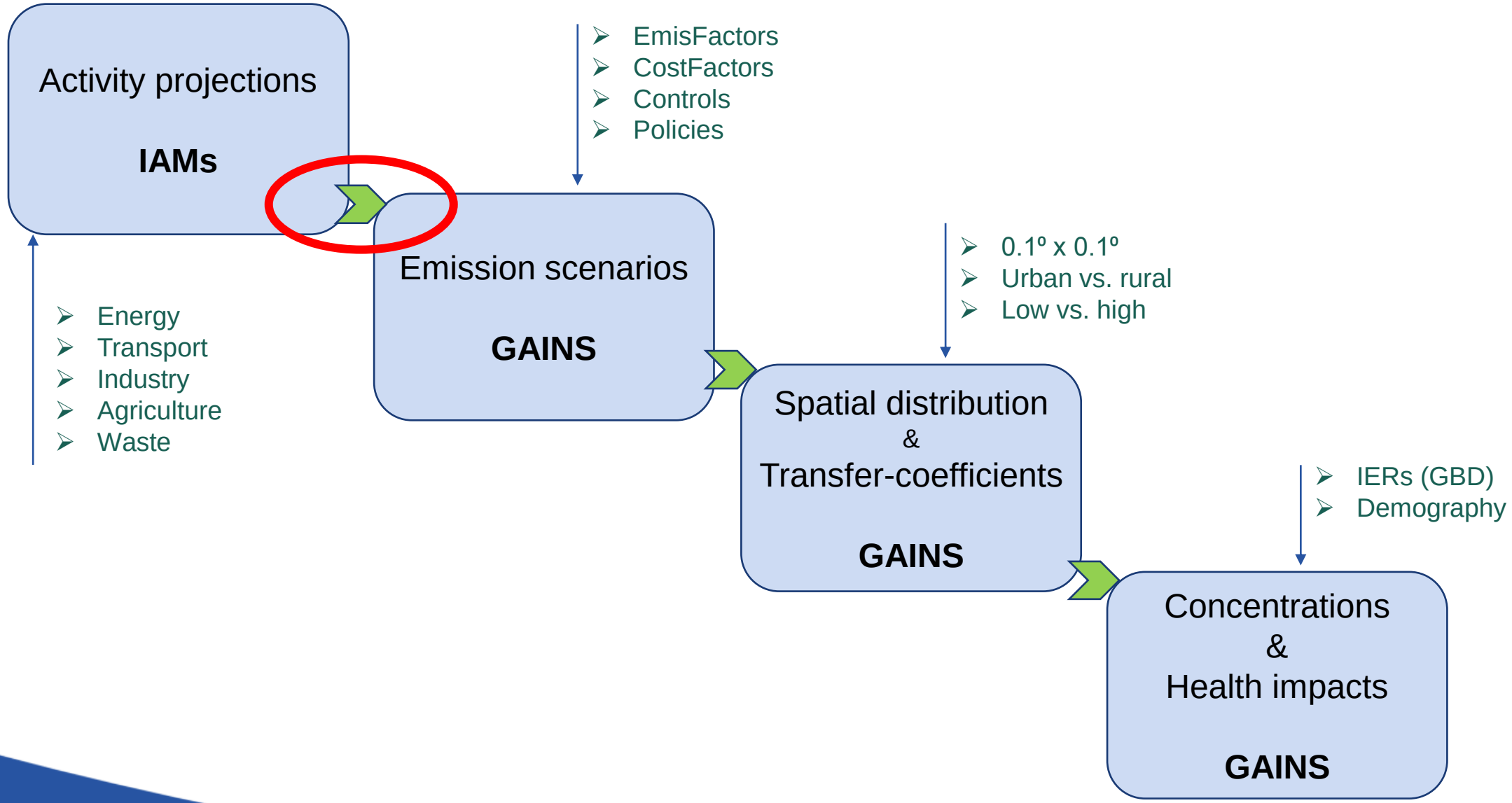
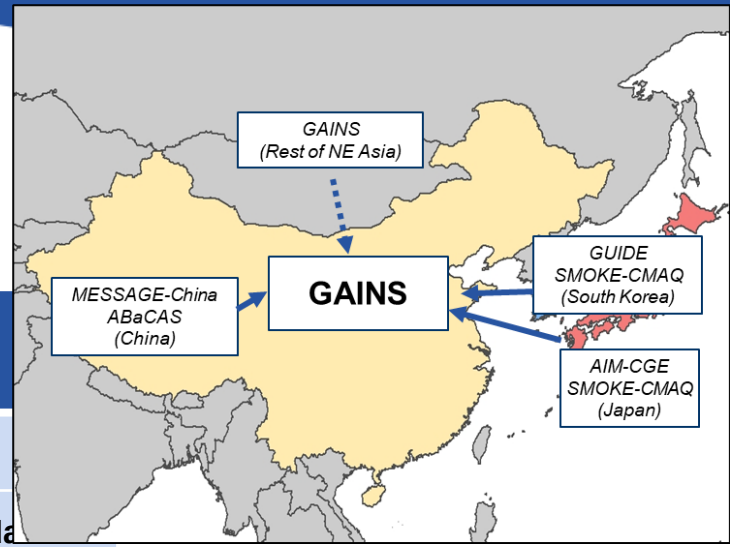
A process of converting energy IAM data to GAINS and further



AQNEA : A set of scenarios by countries and the source IAM



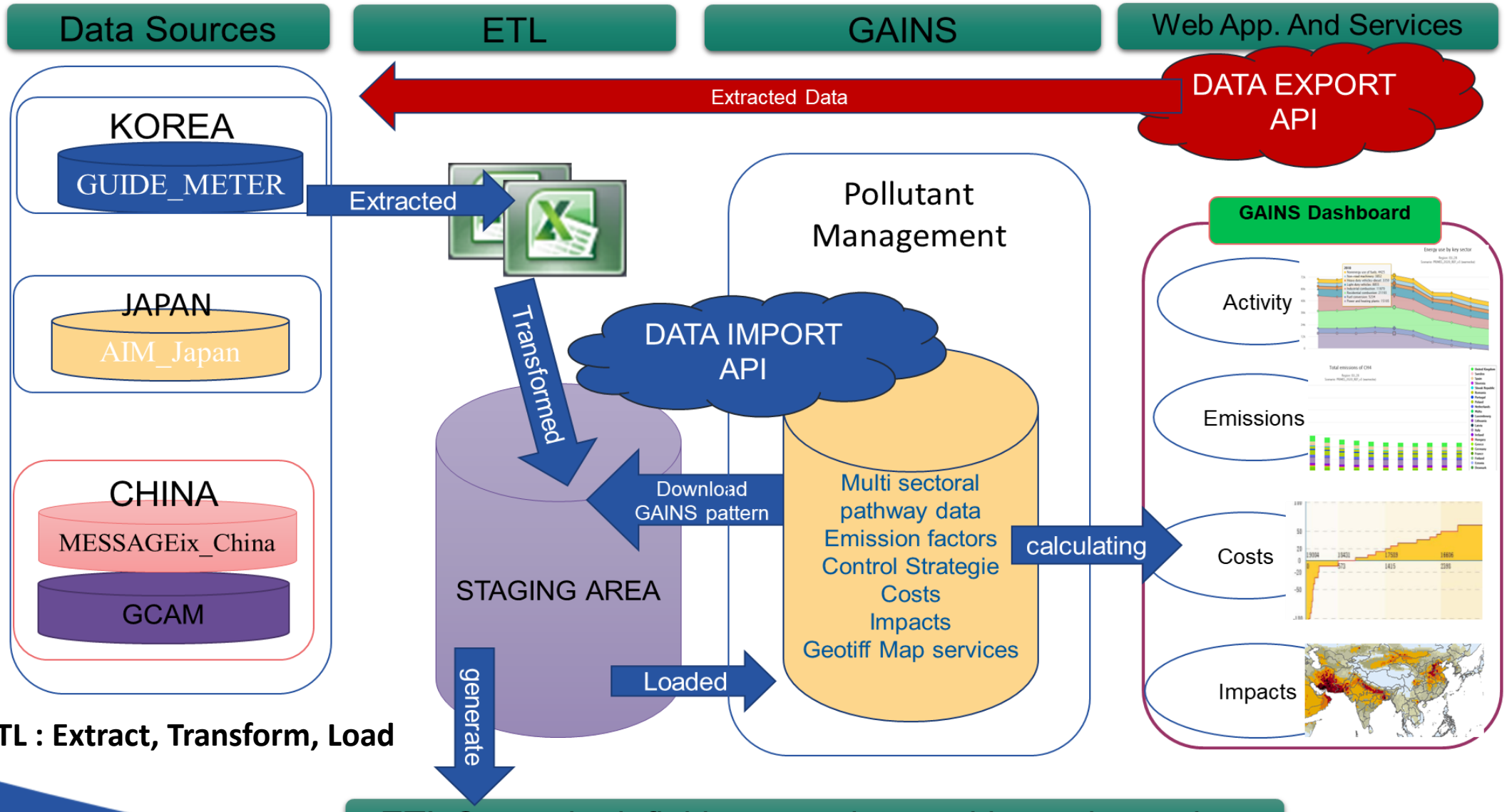
Country	IAM; Integrated Assessment Model Framework	Scenario group	Scenario in IAM
Korea	GUIDE-METER	Baseline	BAU
		Middle scenario	Stated Policies (Outda NDC)
		Net-Zero	Net Zero
Japan	AIM/Hub-Japan 2.4	Baseline	Baseline
		Middle scenario	26% by30 + 80% by50
		Net-Zero	46% by30 + 100% by50
China	MESSAGEix-GLOBIOM 1.1-M-R12	Baseline	Baseline
		Middle scenario	2-degree
		Net-Zero	Carbon neutrality
Rest of NE Asia	IIASA GAINS	Baseline	Baseline+Stated Policies
		Middle scenario	Proposed Pledges
		Net-Zero	Net Zero

Matrix system to set-up GAINS scenarios

	SSP1-1.9	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP3-LowNTCF	SSP3-LowNTCF-CH4	SSP5-8.5
Air pollution strategy	MFR	MFR	CLE	CLE	MFR	MFR	CLE
VOC pathway	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
Agriculture pathway	Healthy diet	Efficient N-use	Baseline	Baseline	Baseline	Baseline	Baseline
Forest fires	Mitigation	Mitigation	Baseline	Baseline	Mitigation	Mitigation	Baseline
Shipping pathway/controls	MFR	MFR	CLE	CLE	MFR	MFR	CLE
Emission factors	LowN	LowN	Base	Base	Low	Low	Base

GAINS Explorer

: Infrastructure to process global, regional, and national scenarios for further analysis and intercomparison in the GAINS model



ETL : Extract, Transform, Load

Processing of scenario data into the GAINS model structure for China, Japan, and S. Korea

- **IAMs**

AIM_Japan (national)
MESSAGE_China (national)
GUIDE_Korea (17 subregions)

- **Data exchange**

– a common format for all models
– compatible with the AR6/**IAMC reporting protocol** (template)
– completeness check

- **Regional mapping**

– IAMs (sub)regions / provinces to the GAINS regions
– model-specific regional matrixes

- **Sectoral mapping**

– IAMs variables to the GAINS sectors & fuels
– limited to energy projections
– one mapping matrix for all models

- **Proportional downscaling**

– based on existing patterns in GAINS
– missing projections derived from macroeconomic parameters
– or defaults are used (non-energy sectors)

	IAM_SOURCE_VARIABLE	SOURCE_UNIT	GAINS_SECTOR	GAINS_ACTIVITY
Power sector	Primary Energy|Gas|Electricity|w/ CCS	EJ/yr	PP_MOD_CCS	GAS
	Primary Energy|Gas|Electricity|w/o CCS	EJ/yr	PP_EX, PP_NEW, PP_MOD	GAS
	Primary Energy|Oil|Electricity|w/ CCS	EJ/yr	PP_MOD_CCS	MD, HF
	Primary Energy|Oil|Electricity|w/o CCS	EJ/yr	PP_EX, PP_NEW	MD, HF
	Primary Energy|Biomass|Electricity|w/ CCS	EJ/yr	PP_IGCC_CCS, PP_MOD_CCS	FWD, ARD
	Primary Energy|Biomass|Electricity|w/o CCS	EJ/yr	PP_EX, PP_NEW, PP_MOD, PP_IGCC	FWD, ARD
	Primary Energy|Coal|Electricity|w/ CCS	EJ/yr	PP_IGCC_CCS, PP_MOD_CCS	HC, BC, DC
	Primary Energy|Coal|Electricity|w/o CCS	EJ/yr	PP_EX, PP_NEW, PP_MOD, PP_IGCC	HC, BC, DC
	Primary Energy|Nuclear	EJ/yr	PP_TOTAL	NUC
	Primary Energy|Geothermal	EJ/yr	PP_TOTAL	GTH
	Primary Energy|Hydro	EJ/yr	PP_TOTAL	HYD
	Primary Energy|Solar	EJ/yr	PP_TOTAL	SPV
	Primary Energy|Wind	EJ/yr	PP_TOTAL	WND
Industry	Final Energy|Industry|Gases	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	GAS
	Final Energy|Industry|Liquids	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	MD, HF, LPG, GSL
	Final Energy|Industry|Solids|Biomass	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	FWD, ARD, CHCO, WST
	Final Energy|Industry|Solids|Coal	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	HC, BC, DC
	Final Energy|Industry|Electricity	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	ELE
	Final Energy|Industry|Heat	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	HT
	Final Energy|Industry|Hydrogen	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	H2
	Final Energy|Industry|Other	EJ/yr	IN_ISTE, IN_CHEM, IN_NMMI, IN_PAP, IN_OTH	GTH, SPV, STH
Domestic	Final Energy|Residential and Commercial|Gases	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	GAS
	Final Energy|Residential and Commercial|Liquids	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	MD, HF, LPG, GSL
	Final Energy|Residential and Commercial|Solids|Biomass	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	FWD, ARD
	Final Energy|Residential and Commercial|Solids|Coal	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	HC, BC, DC
	Final Energy|Residential and Commercial|Electricity	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	ELE
	Final Energy|Residential and Commercial|Heat	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	HT
	Final Energy|Residential and Commercial|Hydrogen	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	H2
	Final Energy|Residential and Commercial|Other	EJ/yr	DOM_URB, DOM_RUR, DOM_COM, DOM_OTH	GTH, SPV, STH
Transport	Final Energy|Transportation|Hydrogen	EJ/yr	TRA_RD_LD, TRA_RD_HD	H2
	Final Energy|Transportation|Electricity	EJ/yr	TRA_RD_LD, TRA_RD_HD, TRA_OT	ELE
	Final Energy|Transportation|Gases	EJ/yr	TRA_RD_LD, TRA_RD_HD, TRA_OT	GAS
	Final Energy|Transportation|Liquids|Oil	EJ/yr	TRA_RD_LD, TRA_RD_HD, TRA_OT	MD, GSL, LPG, HF
	Final Energy|Transportation|Liquids|Oil|Shipping	EJ/yr	TRA_OTS	HF, MD
Others	Primary Energy|Gas|Convert	EJ/yr	CON_COMB, CON_BO, CON_LOSS	GAS
	Primary Energy|Oil|Convert	EJ/yr	CON_COMB, CON_BO, CON_LOSS	MD, HF, LPG, GSL
	Primary Energy|Biomass|Convert	EJ/yr	CON_COMB, CON_BO, CON_LOSS	FWD, ARD
	Primary Energy|Coal|Convert	EJ/yr	CON_COMB, CON_BO, CON_LOSS	HC, BC
	Final Energy|Non-Energy Use|Coal	EJ/yr	NONEN	HC, BC, DC
	Final Energy|Non-Energy Use|Oil	EJ/yr	NONEN	HF, MD, LPG
	Final Energy|Non-Energy Use|Gas	EJ/yr	NONEN	GAS
	Final Energy|Non-Energy Use|Biomass	EJ/yr	NONEN	FWD, WST
	Primary Energy|Oil|Liquids	EJ/yr	PR_REF	NOF
	Resource|Extraction|Coal	EJ/yr	MINE_BC, MINE_HC	NOF
	Resource|Extraction|Gas	EJ/yr	PROD	GAS
	Resource|Extraction|Oil	EJ/yr	PROD	CRU
	GDP|MER	billion US$2010/yr	MACRO	GDP
	Population	Million	ANY	POP

Mapping of IAMC format to the GAINS structure

← sectors and fuels/activities

spatial split

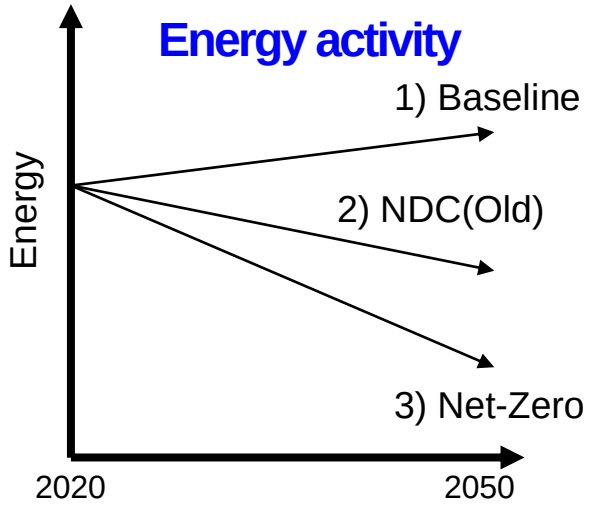
National

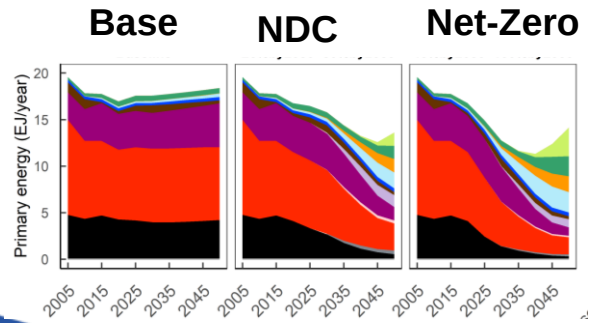
Provincial

From Energy IAM to GAINS
: Energy and AQ scenario pathways setup

Energy IAM data in GAINS format

Energy activity





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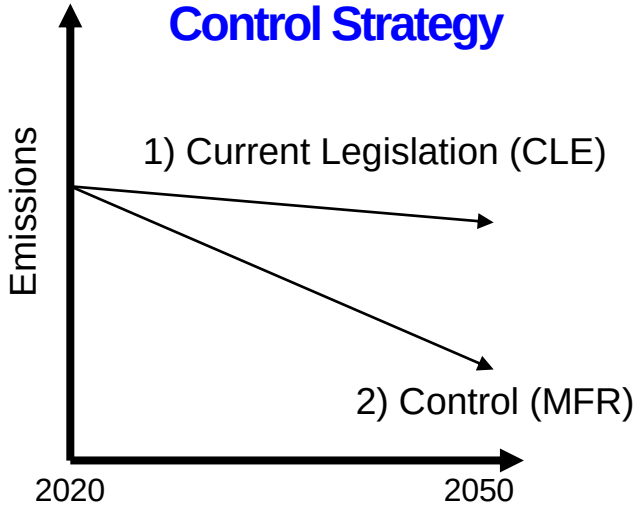
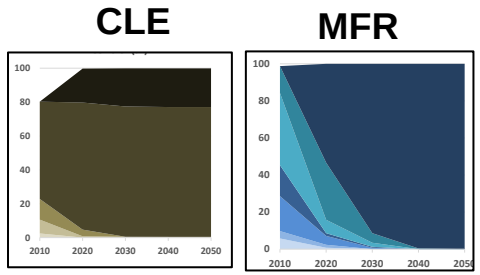
Policy-Technology in GAINS

Control Strategy





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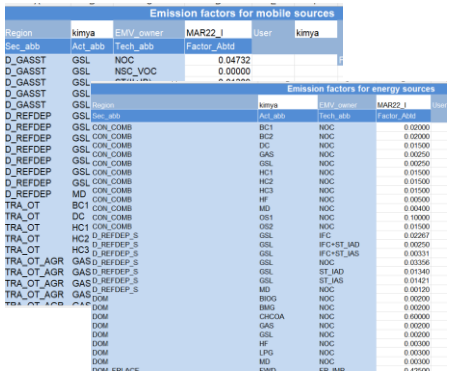
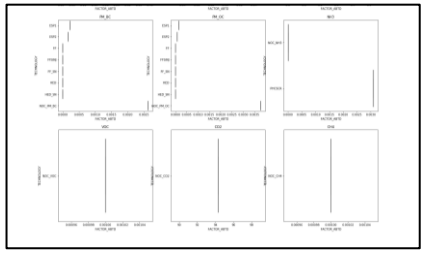
Data in GAINS

Emission Factor





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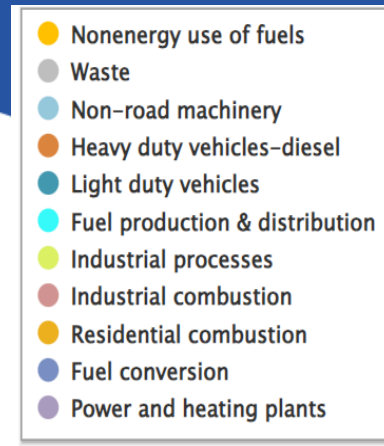
Future Scenario Pathways

6 Scenario Emissions

Base_CLE
Base_MFR
NDC_CLE
NDC_MFR
NetZero_CLE
NetZero_MFR

Result: AQNEA Future Energy Scenario Pathways and CO_2 emissions

China/S.Korea/Japan



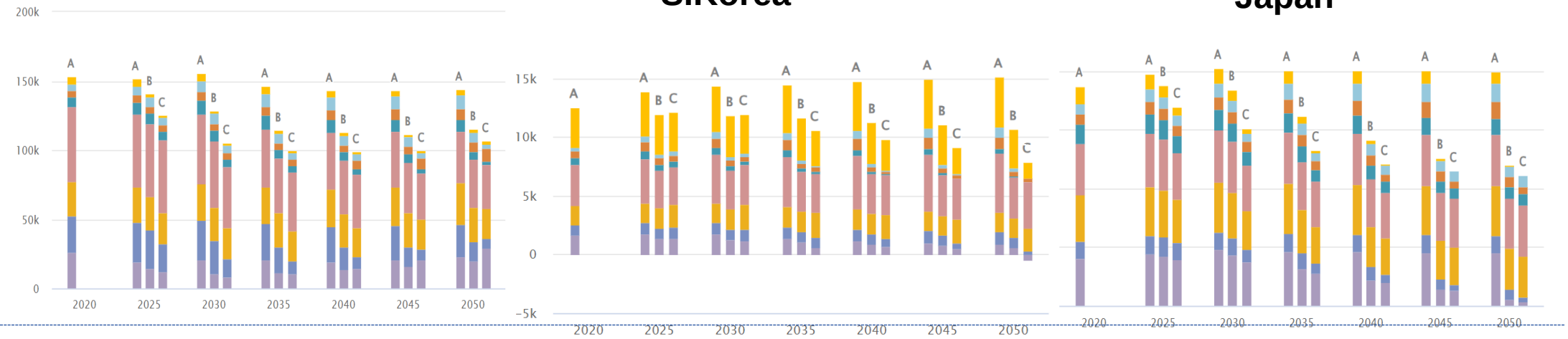
China

S.Korea

Japan

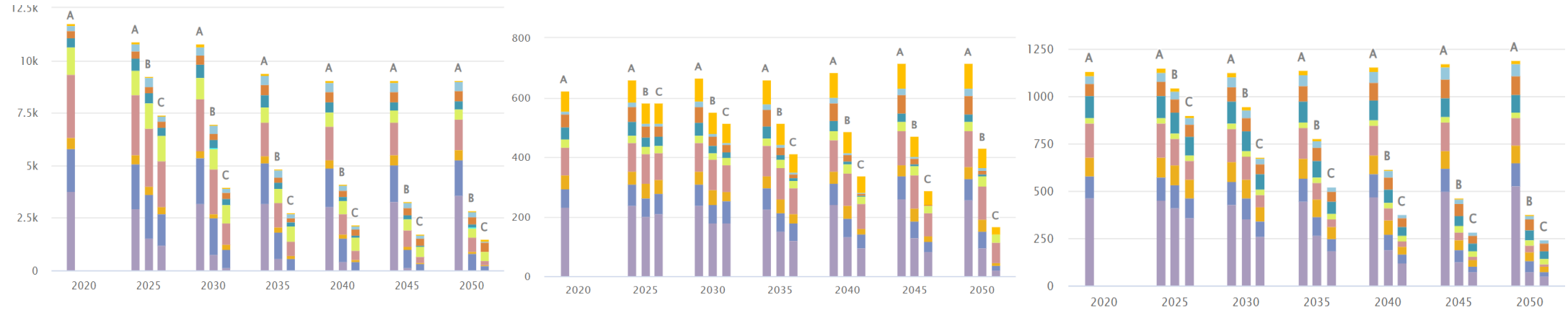
Energy

Unit: PJ/yr



Emissions

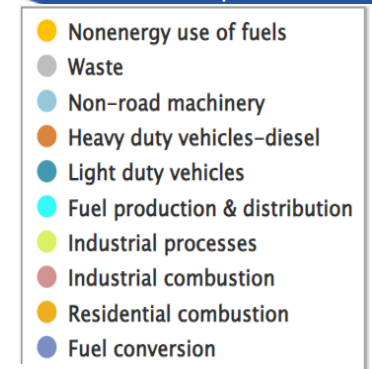
Unit: Mt CO_2



A: Baseline B: NDC C: Net-Zero

Result: AQNEA Future Energy Scenario Pathways and CO_2 emissions

N.Korea / Mongolia / A.Russia



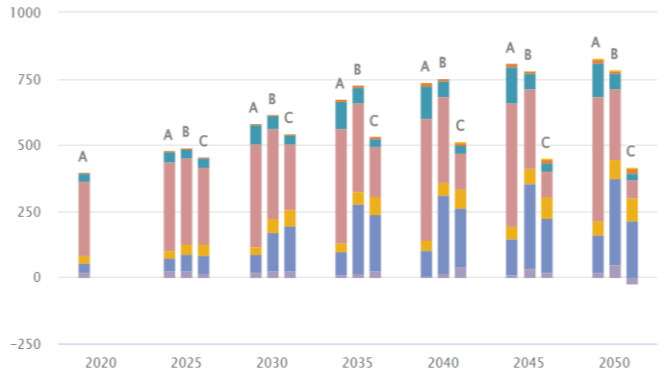
N.Korea

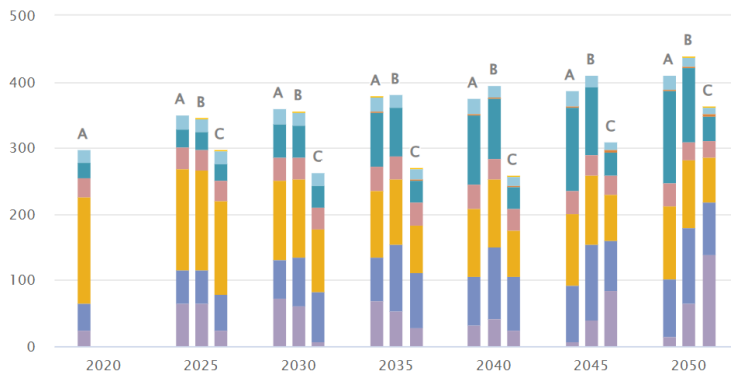
Mongolia

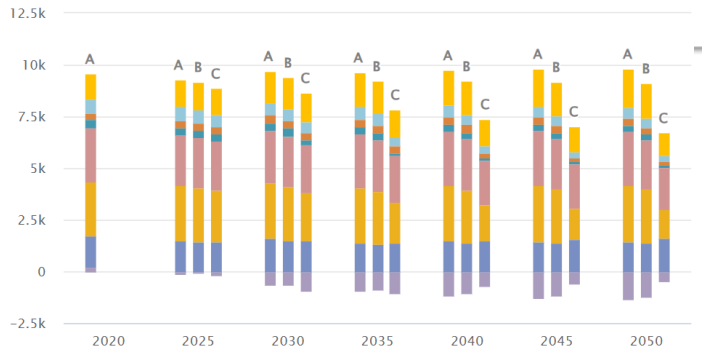
A.Russia

Energy

Unit: PJ/yr

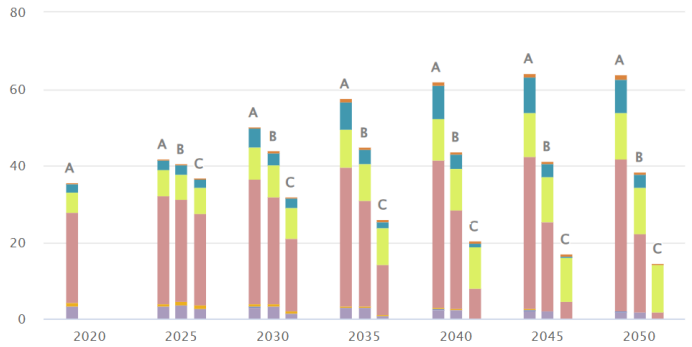


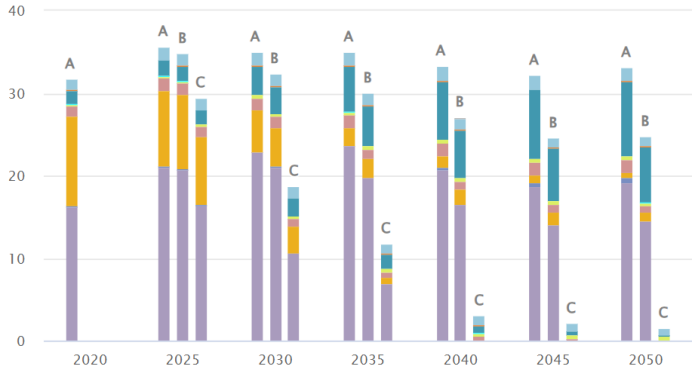


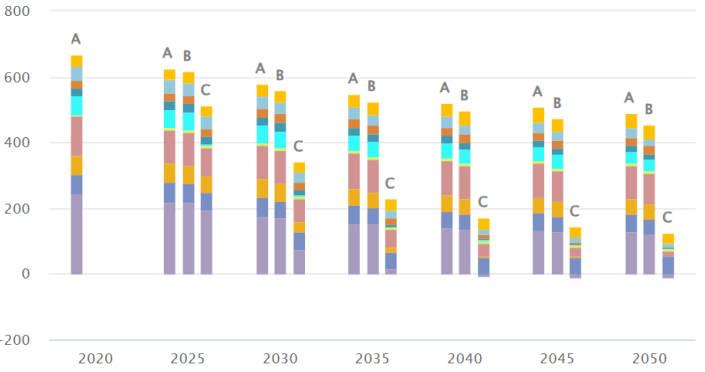


Emissions

Unit: Mt CO_2

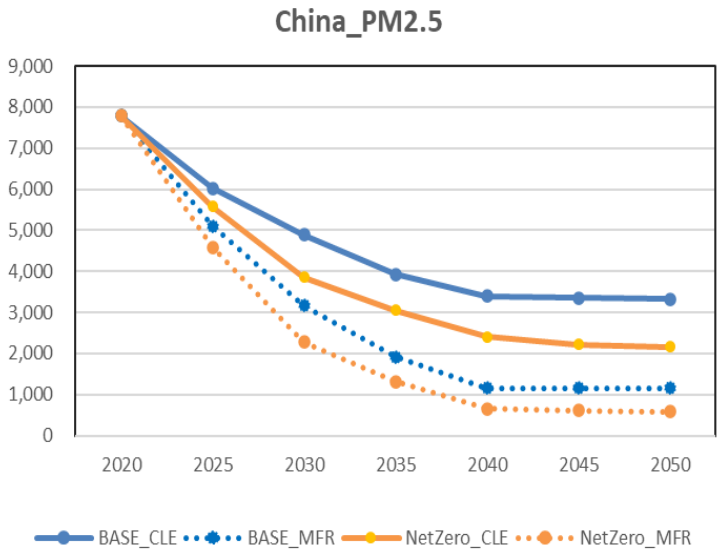


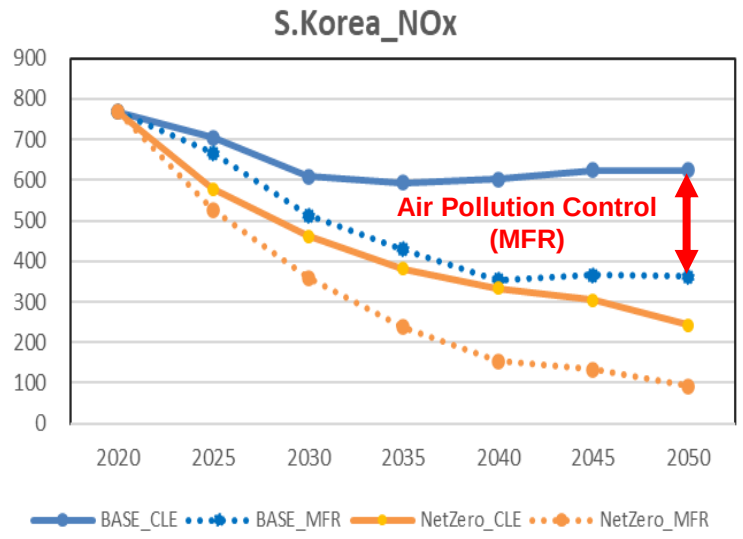


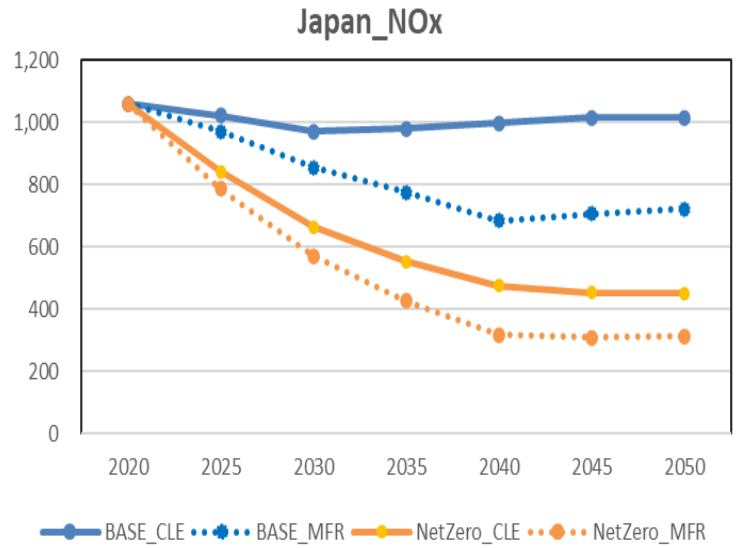


A: Baseline B: NDC C: Net-Zero

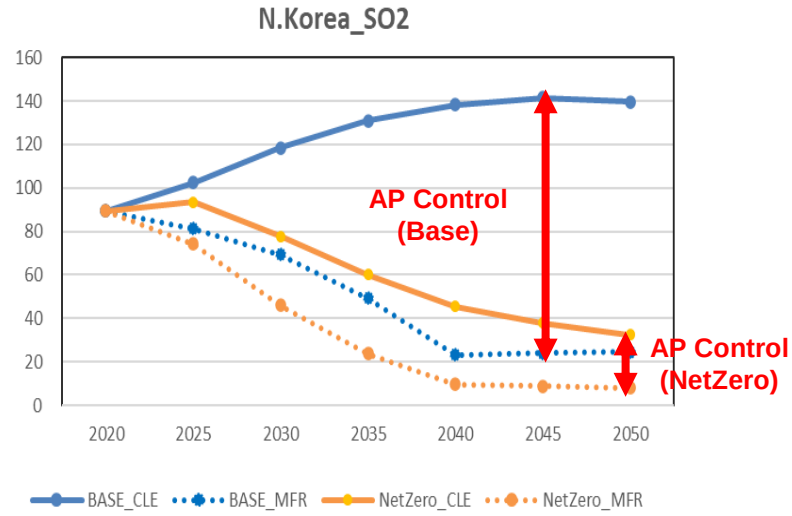
Result: Air Pollutant Abatement in AQNEA Countries

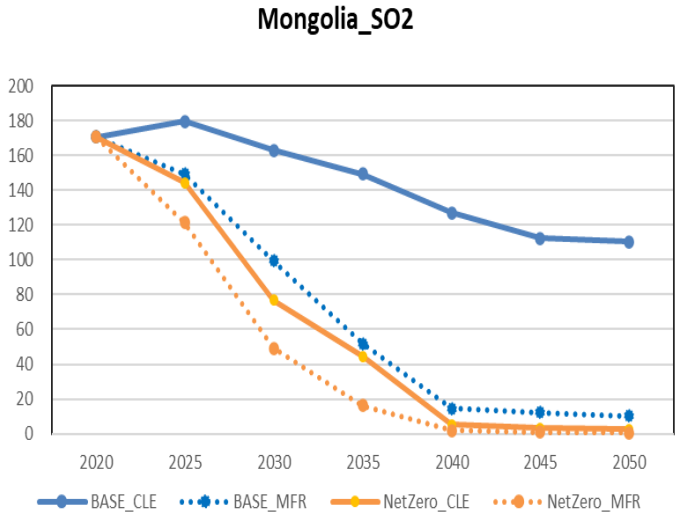






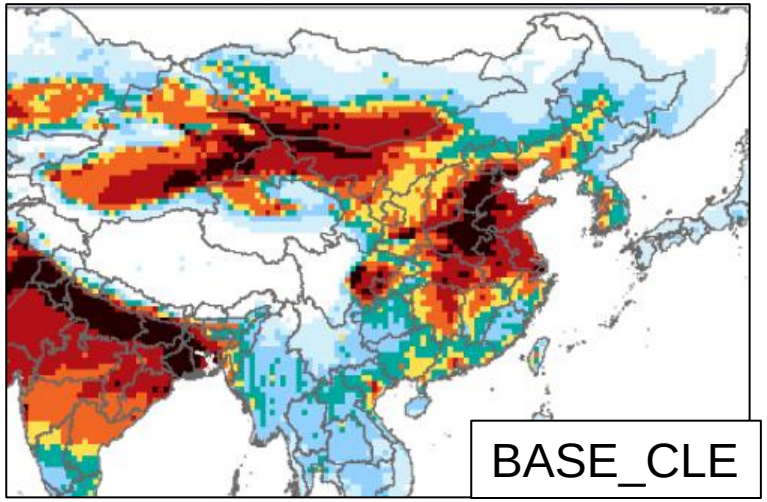
Unit :
kton/yr



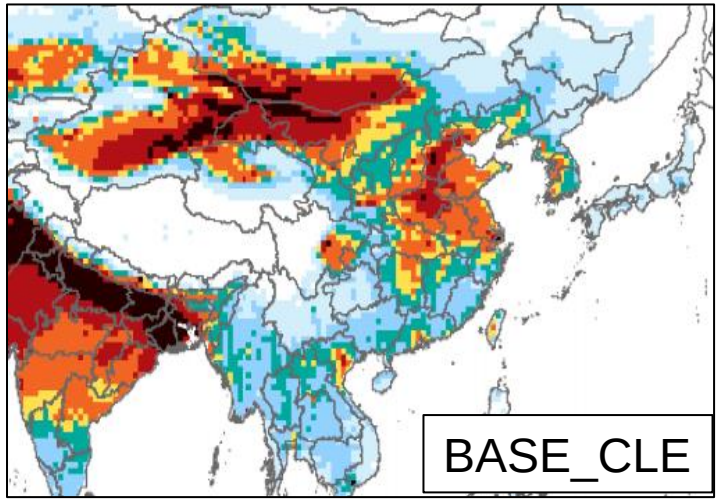


AQNEA: Ambient PM2.5 concentrations : Calculations by the GAINS model

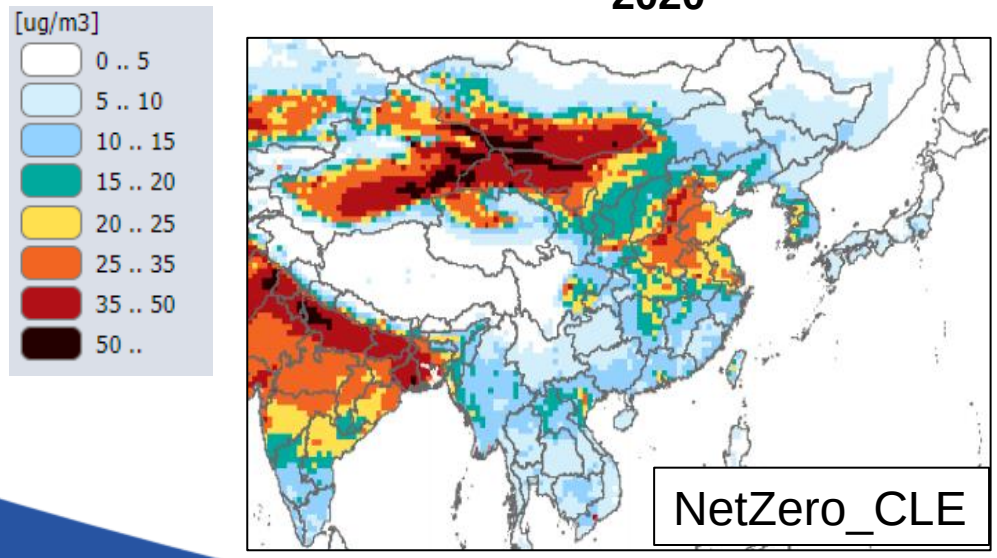
$PM_{2.5}$ [$\mu g\ m^{-3}$]



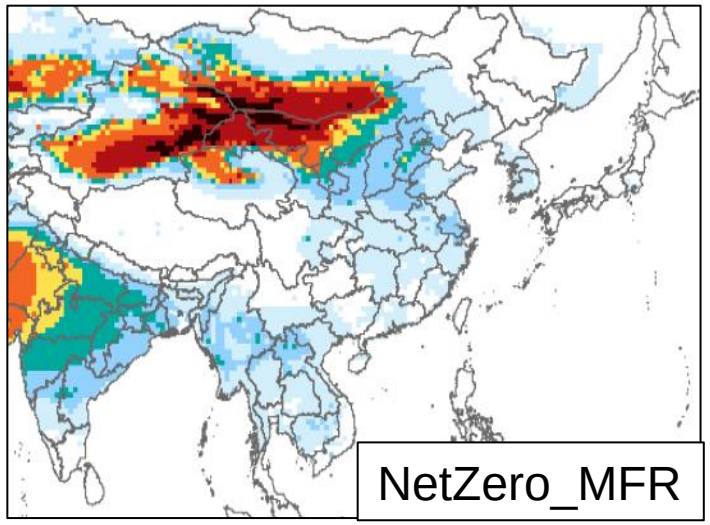
2020



2050



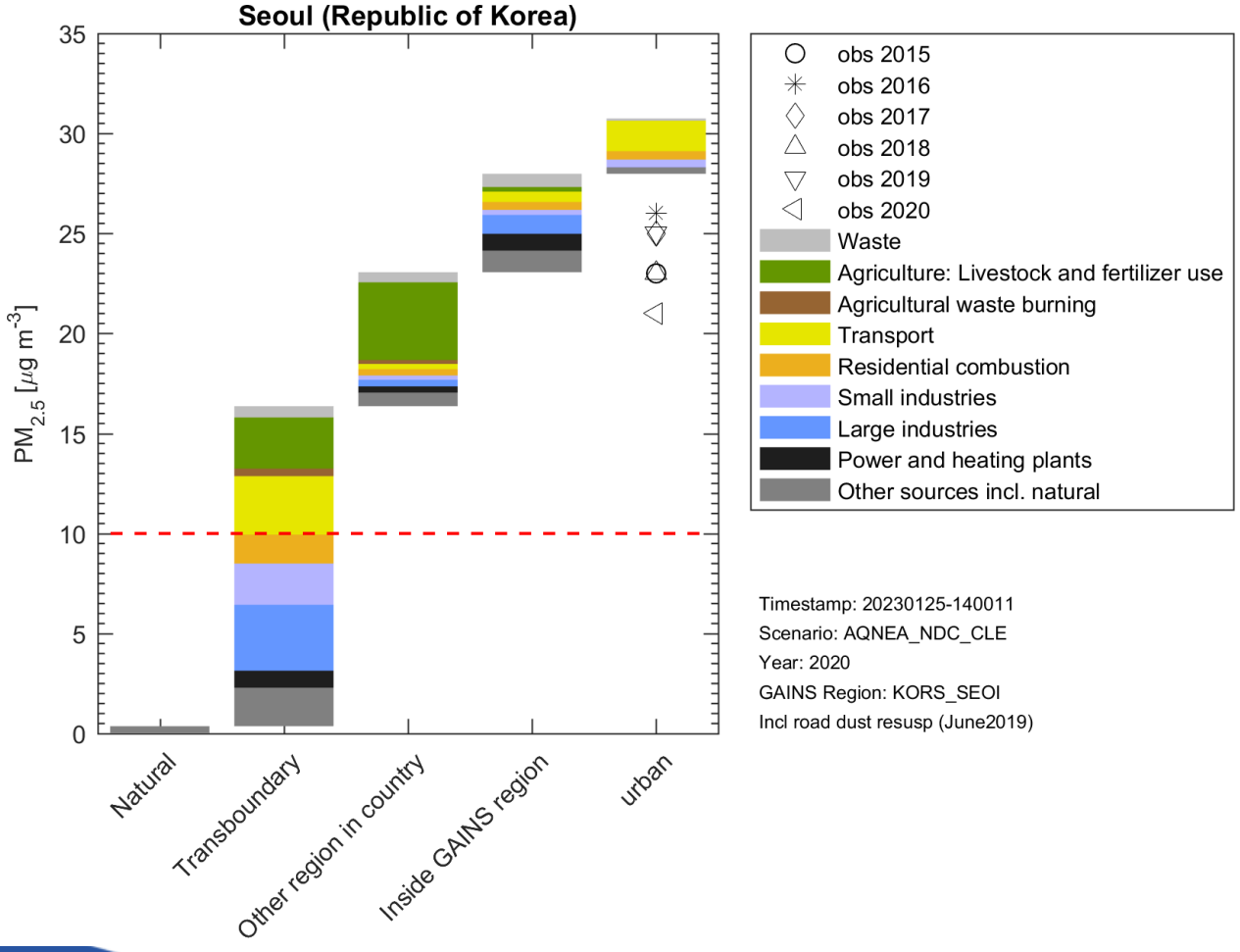
2050

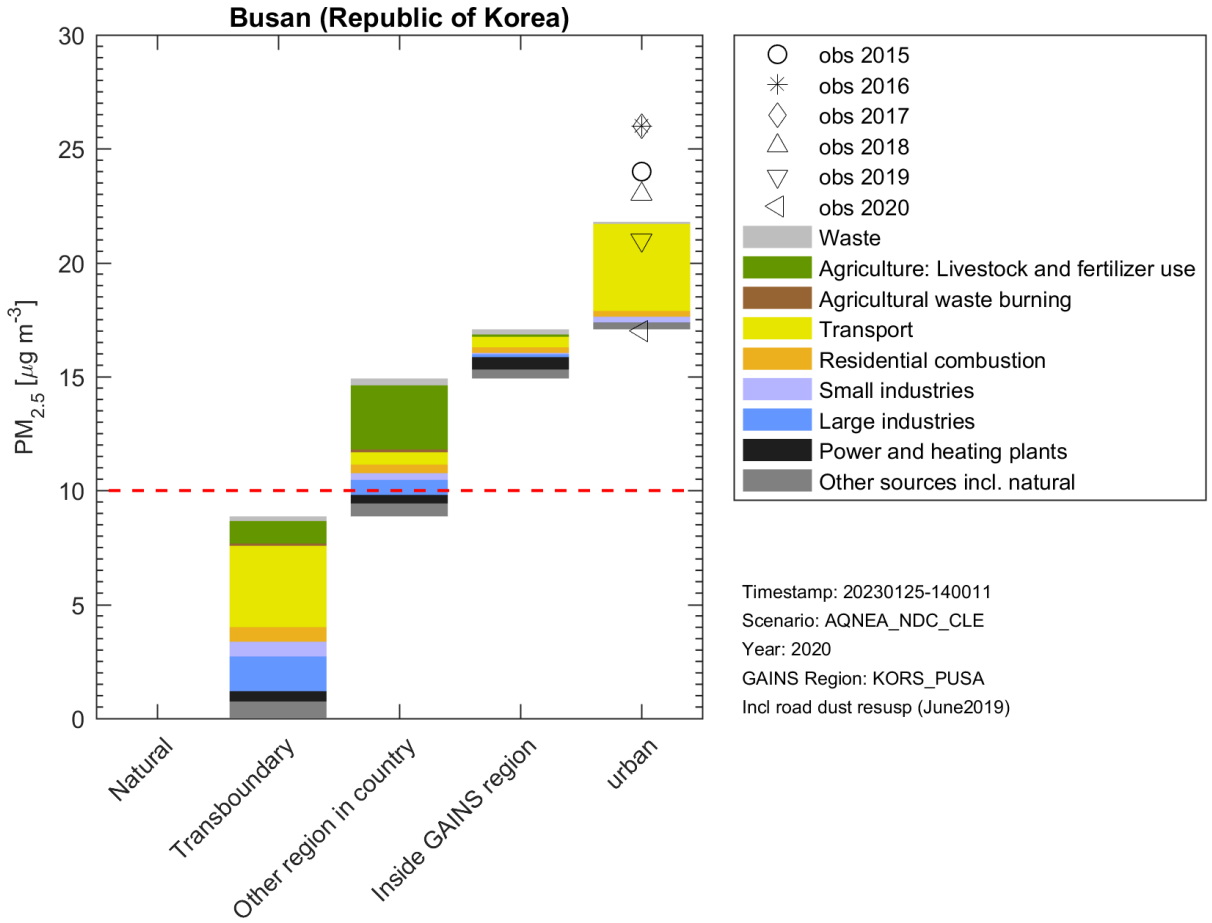


2050

- CLE would not resolve the remaining air quality problems by 2050.
- The remaining elevated concentrations under Net-Zero + MFR(Maximum Feasible Reduction) are largely of natural origin.

AQNEA: Source Contribution of Ambient PM2.5 concentrations : Calculations by the GAINS model





Summary

- Energy IAM exported data were converted GAINS activity data format for AQNEA countries
- Integrated analysis in GAINS, such as emissions, air quality, health impact could be conducted
- Stringent air pollution control scenario, MFR, show significant reductions, especially in baseline scenario of a developing country
- Ambient air quality with source contribution analysis show a reasonable agreement with monitoring data and could give some insight of domestic vs transboundary contribution
- Continue to improve harmonization and linkage for AQNEA stage2

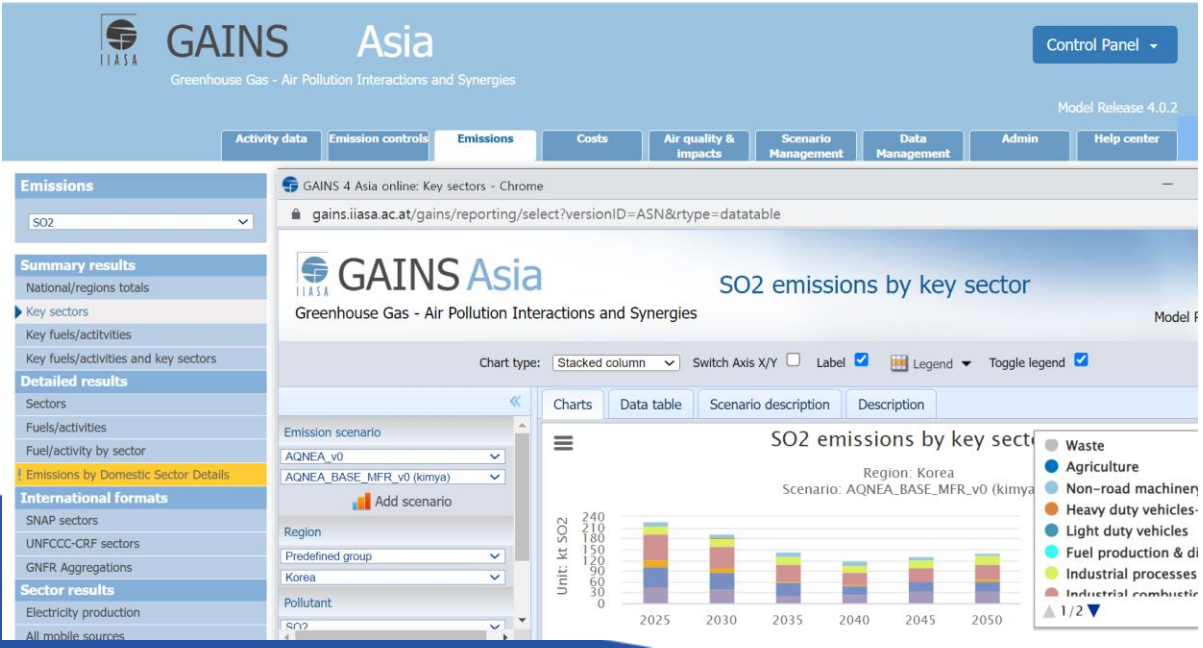
- **GAINS model**

Access to the model:

http://gains.iiasa.ac.at/models/index.html

Tutorial:

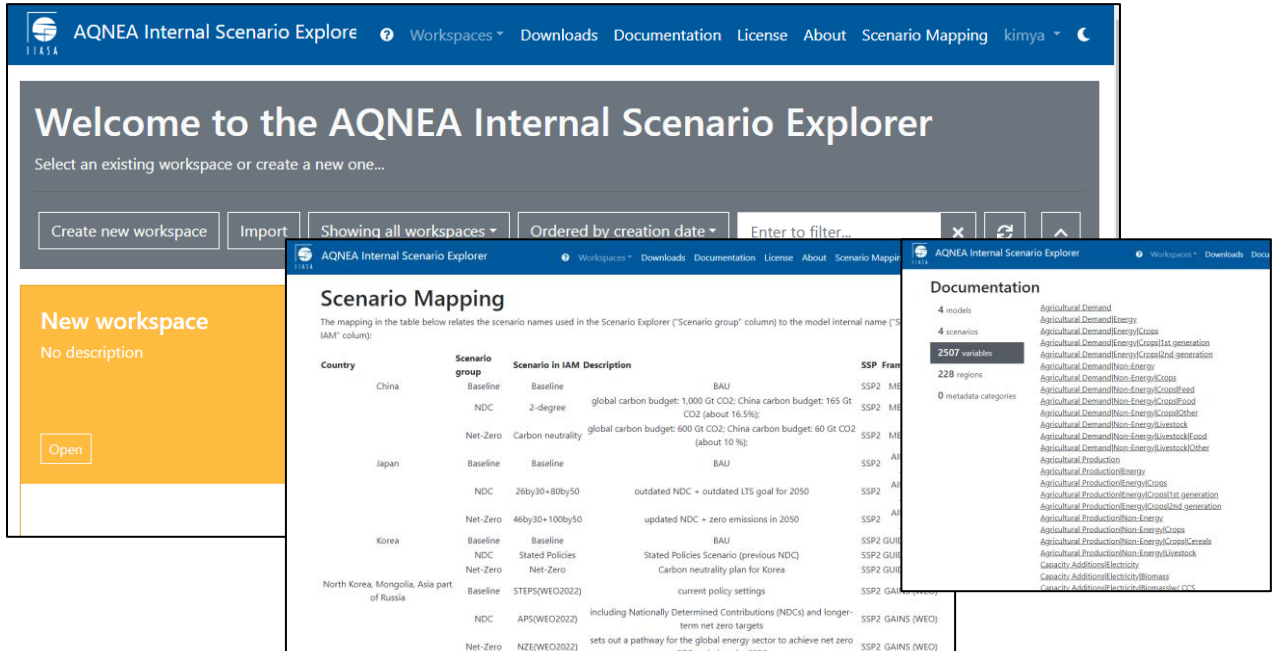
http://gains.iiasa.ac.at/gains/download/GAINS-tutorial.pdf



- **Scenario Explorer**

Access to the system:

https://data.ece.iiasa.ac.at/aqnea-internal/#/workspaces



Thank you for your time.