Overview of AIM/Enduse[Global] and Analysis on comparable efforts

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Objective of AIM/Enduse[Global]

1) **Estimation of marginal abatement costs and evaluate GHG mitigation potentials** in world regions.
   - Region-wise mitigation potentials and costs
   - Sector-wise mitigation potentials and costs

2) Analysis of the impact of policy instruments and consequent effects on GHG emission reductions.
   - possibility of achievement of required reduction under stabilization constraints

How much is technological mitigation potential by region & by sector?

Development of AIM/Enduse[Global]

Type : Bottom-up optimization model with detail technology selection framework in world regions.

Components:

Regional energy enduse module coupled with

- Regional energy resource module
- International energy, basic materials balance module
- Regional macro-economy and energy service demand module

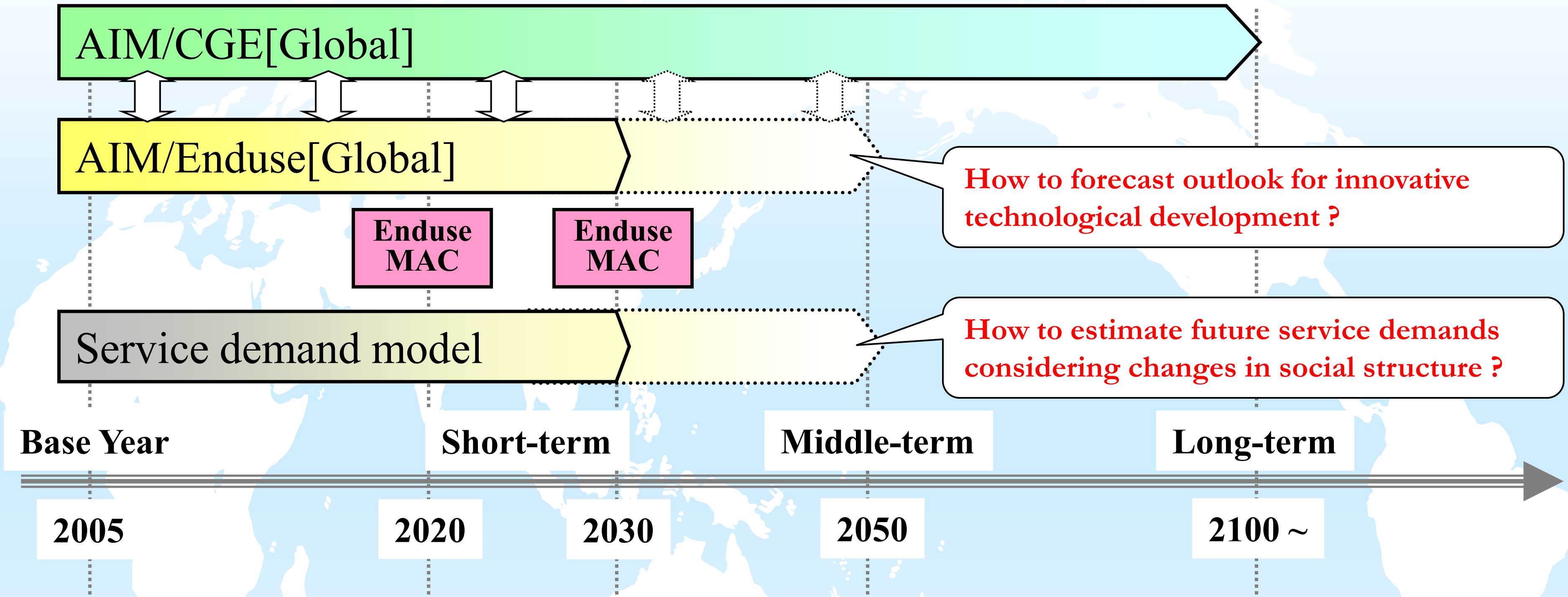
◆ Enduse[Global] model

- Recursive dynamic analysis: selection of technologies under several constraints
- Optimization in the global scale

◆ Enduse[Global]/MAC tool

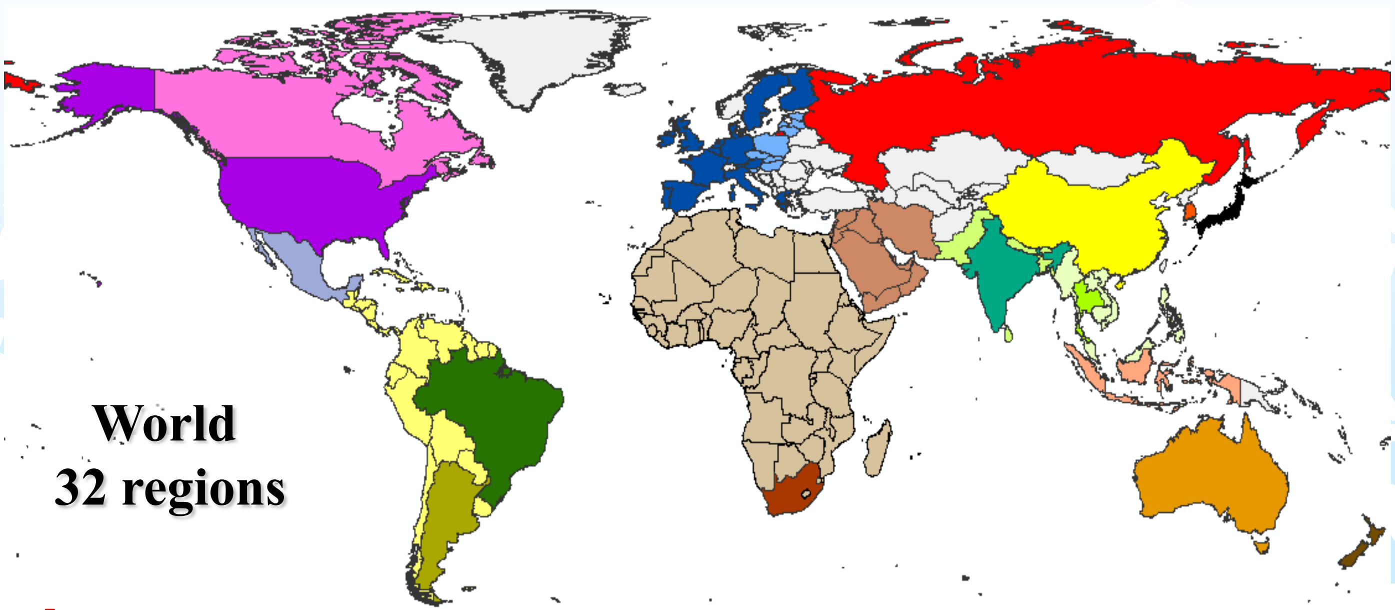
- Static analysis: mitigation options under a certain carbon price.
- Optimization by country/region

Temporal scale of mitigation analysis



- **Due to data constraints of future technology information and service demands, Enduse model analyzes scenarios with horizons of 2030, and up to 2050 at most.**
- **To utilize Enduse model for Low Carbon Society scenario study toward 2050, it is essential to discuss outlook for innovative technological development and future service demands considering changes in social structure.**

Regional classification



Annex I

OECD

JPN (Japan)	USA (United States)	CAN (Canada)	KOR (Korea)
AUS (Australia)	XE15 (Western EU-15)	TUR (Turkey)	MEX (Mexico)
NZL (New Zealand)	XE10 (Eastern EU-10)	XEWI (Other Western EU in Annex I)	BRA (Brazil)
RUS (Russia)	XE2 (Other EU-2)	XEEI (Other Eastern EU in Annex I)	ARG (Argentine)
CHN (China)	XSA (Other South Asia)	XENI (Other EU)	XLM (Other Latin America)
IND (India)	XEA (Other East Asia)	XCS (Central Asia)	ZAF (South Africa)
IDN (Indonesia)	XSE (Other South-East Asia)	XOC (Other Oceania)	XAF (Other Africa)
THA (Thailand)	MYS (Malaysia)	VNM (Viet Nam)	XME (Middle East)

ASEAN

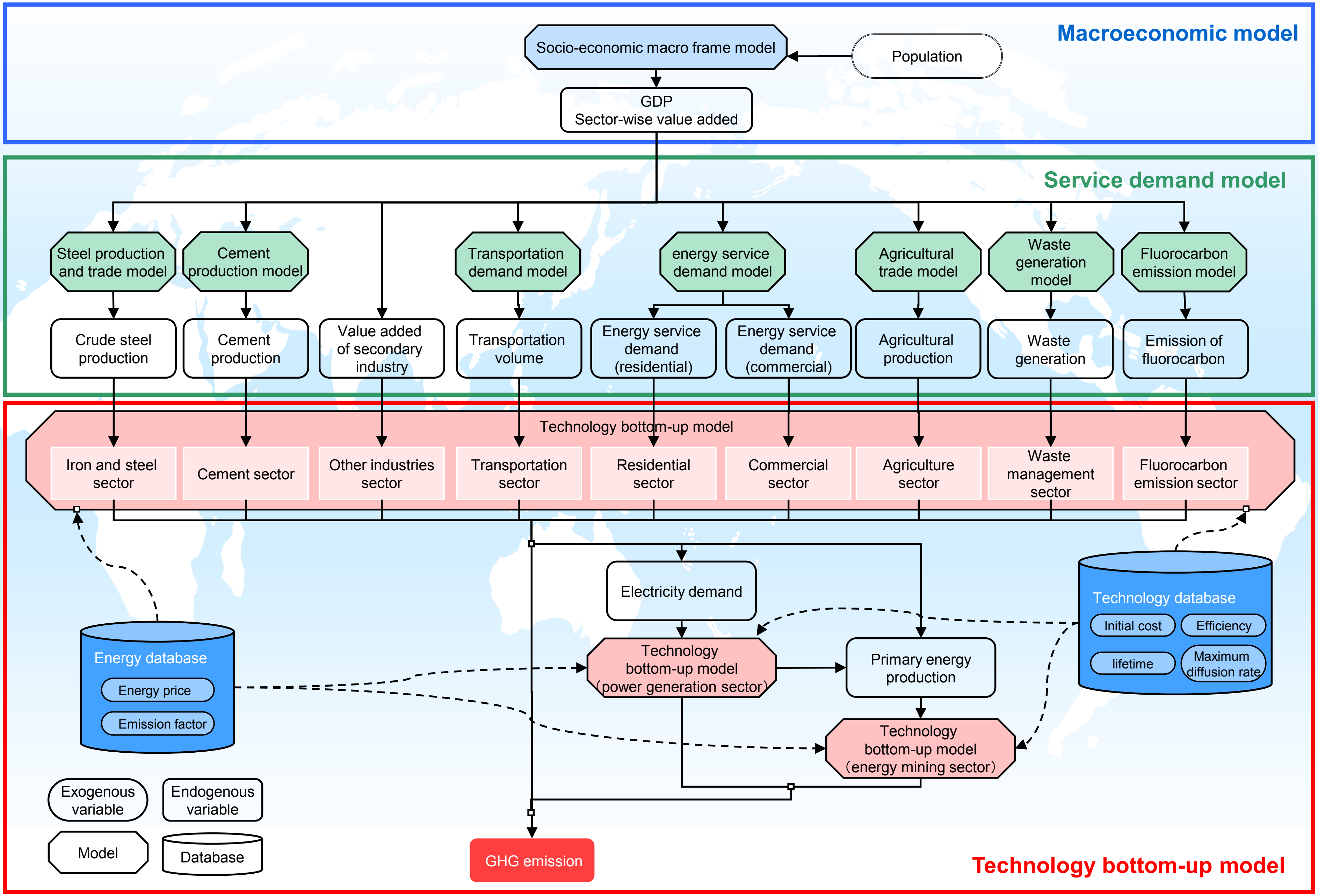
Target gas and sectors

GHG	Sector	Services
CO_2 CH_4 N_2O	Power generation	Coal power plant, Oil power plant, Gas power plant, Renewable (Wind, Biomass, PV)
	Industry	Iron and steel, Cement Other industries（Boiler, motor etc）
	Transportation	Passenger vehicle, Truck, Bus, Ship, Aircraft, Passenger train, Freight train (except for pipeline transport and international transport)
	Residential and & Commercial	Cooling, Heating, Hot-water, Cooking, Lighting, Refrigerator, TV
CH_4 N_2O	Agriculture	Livestock rumination, Manure management, Paddy field, Cropland
	MSW	Municipal solid waste
CH_4	Fugitive	Fugitive emission from fuel
HFCs, PFCs,SF_6	Fgas emissions	By-product of HCFC-22, Refrigerant, Aerosol, Foams, Solvent, Etching, Aluminum production, Insulation gas, others.

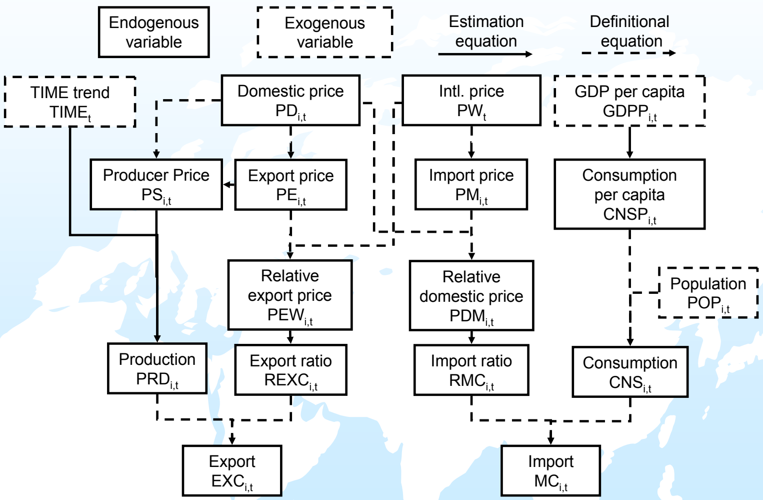
Note)

- Nuclear power, hydro power, and geothermal power generation are included in the baseline and they are not considered as mitigation options in this study.
- There are some mitigation options which are not able to be considered in this study due to the lack of data availability, for example, CO_2 mitigation options in petrochemical, N_2O mitigation options in waste water, CO_2 mitigation options in agriculture etc.

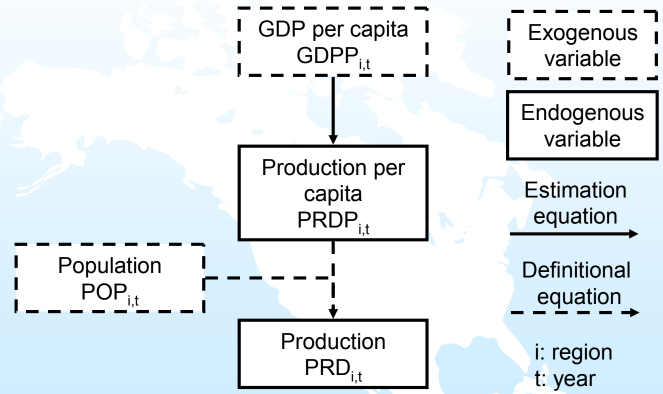
Overview of AIM/Enduse[Global]



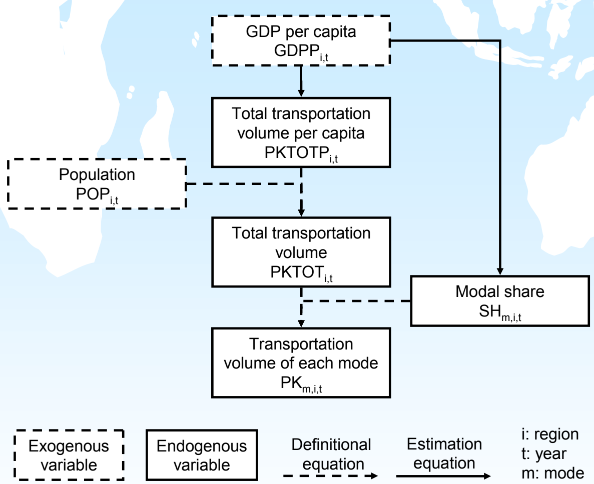
Service demand models



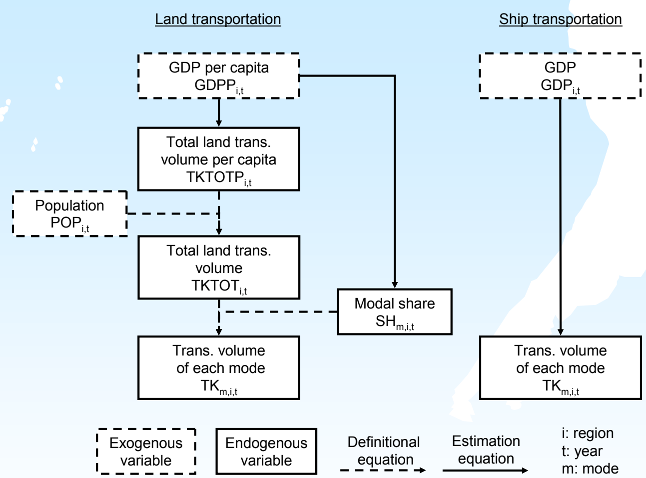
Steel production and trade model



Cement production model

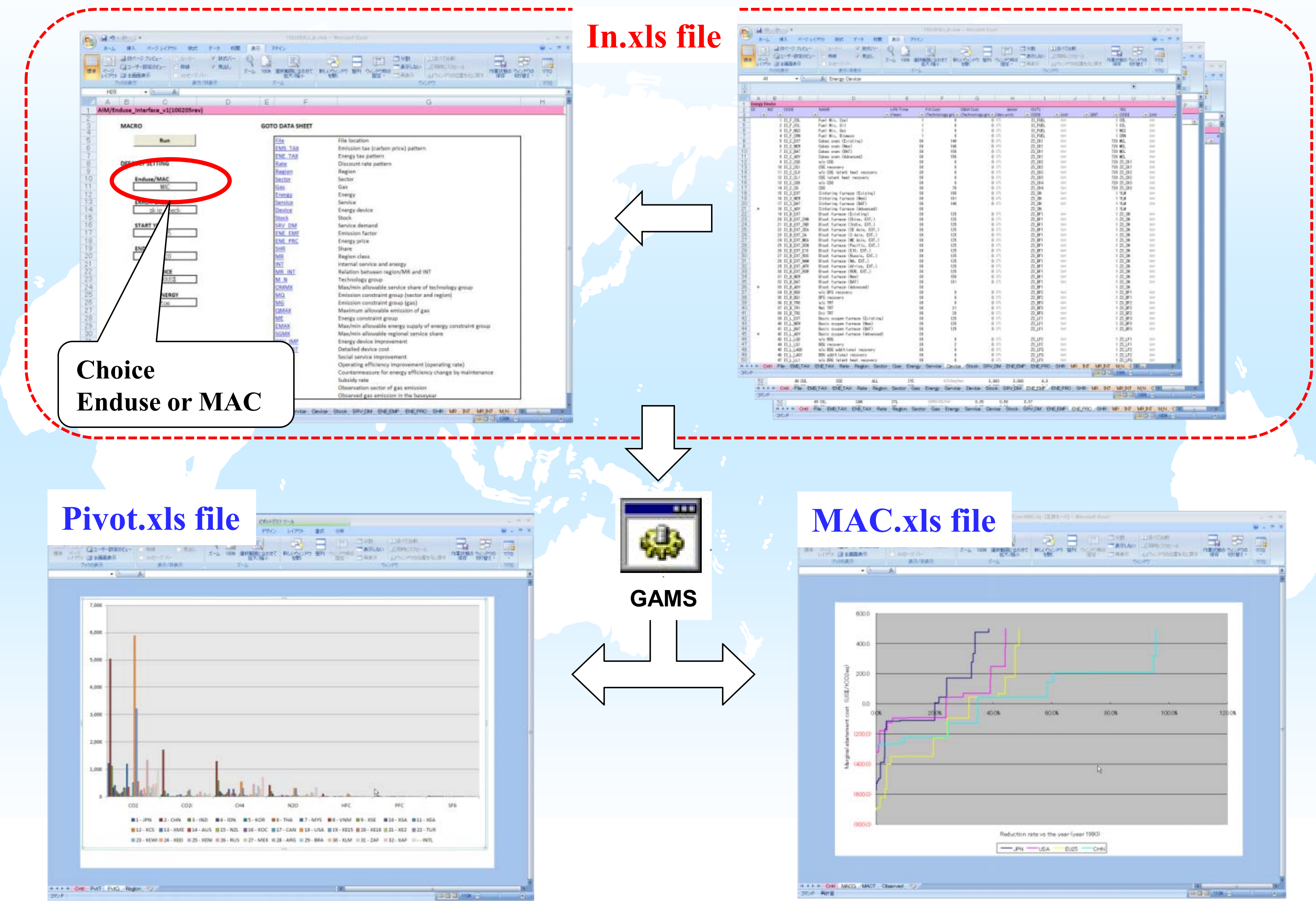


Passenger transport demand model



Freight transport demand model

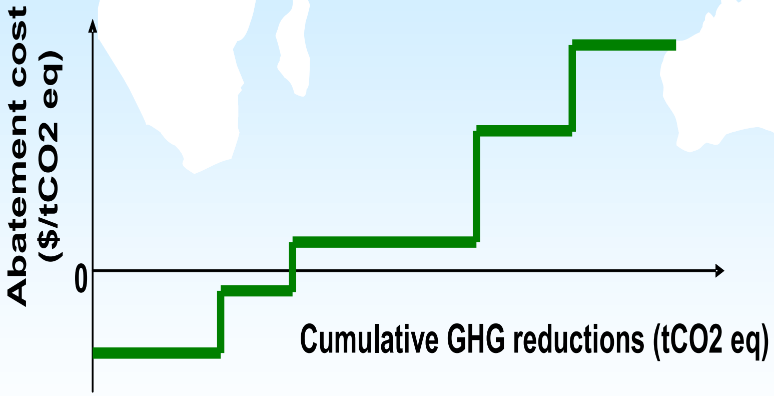
Database interface for Enduse[Global]



Analysis by AIM/Enduse[Global] MAC

- **Target Regions : 32 geographical world regions**
- **Time Horizon : 2000 – 2030**
- **Target Gas : CO_2, CH_4, N_2O, HFCs, PFCs, SF_6**
- **Target Sectors : Multiple sectors**

(Power generation / Industry / Residential and Commercial / Fugitive/ Transport / Agriculture / Waste / F-gas emissions sector)



Mitigation potentials and costs are estimated by using MAC tool in order to compare mitigation efforts across different countries/regions.

Baseline assumption & technologies

Baseline assumption

Baseline is set as a technology frozen case, i.e. when the future share and energy efficiency of standard technologies are fixed at the same level as in the base year.

Mitigation technologies

This study is based on realistic and currently existing technologies, and future innovative technologies expected in 2020 are not taken into account.

Note1）For example, CCS is one of expected future innovative technologies that is likely to have large effect on mitigation measures. due to the lack of data availability, CCS is not taken into account as a mitigation measure in this study.

Note2) Effects of mitigation measures such as additional policies promoting modal shift, public-enlightment actions are not considered in this study.

Key factors for comparing MAC

Results of mitigation potentials vary widely depending on data assumptions such as socio-economic characteristics

Coverage

1) Geographical coverage
2) Sectoral coverage
3) GHG coverage
4) Mitigation options coverage

Definition

1) Definition of "potential"
2) Definition of "cost"
3) Definition of "drivers"
4) Definition of any specific terms…

Data assumptions

1) Population
2) GDP and service demands
3) Energy price
4) Discount rate
5) Payback period
6) Composition of power sources
7) Baseline scenario

Detail information (which reflects key uncertainties)

1) The rate of technology development and diffusion
2) The cost of future technology
3) Climate and non-climate policy drivers

…. and so on

Overview of scenario

Energy efficient technology options are selected if energy saving cost benefits exceeds additional investment costs.

Additional investment cost
≦ energy savings ×（energy price＋emission factor × carbon price）× payback period

① Comparison of length of payback period

- **Scenario A**: short payback period
  around 3-years payback period in most of sectors.
  around 10-years payback period for large plants such in power generation and industry
- **Scenario B**: long payback period by policy intervention
  adequately payback periods corresponding to about 50~70% of the technology's lifetime.
  e.g.) Residential equipments: 7-10 years (when technology's lifetime is 10-15years）
  Car, truck, bus: 6-9 years (when automobile lifetime is 8-12 years)
  Large plant: 14-15 years (when plant lifetime is 30 years）

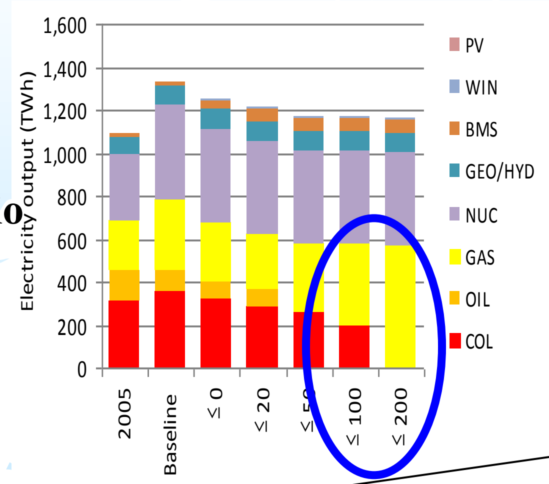
② Comparison of composition of power sources

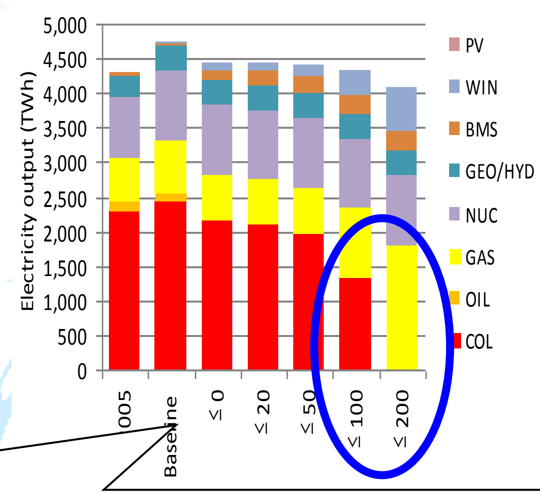
- **Scenario A**: composition under cost optimization without energy security restrictions
  A drastic energy shift is allowed. For example, if a gas power plant is more cost effective than a existing coal or oil power plant, then the coal or oil power plant is immediately stopped and replaced with a gas power plant.
- **Scenario B**: composition with energy security restrictions.
  Social barriers restrict to a certain extent any drastic energy shift from coal and oil power plants to efficient gas powers or renewable energies.

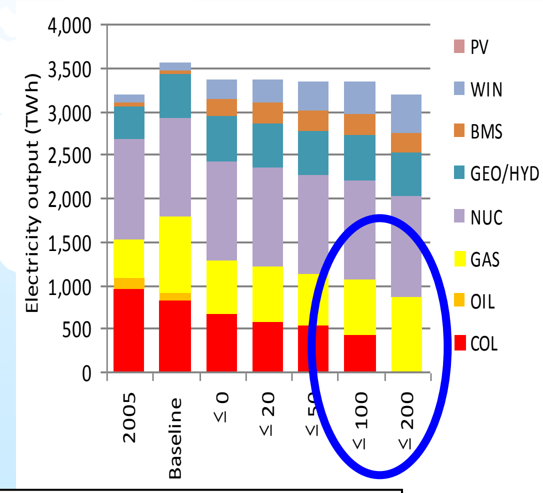
Example of composition of power sources

Japan | USA | EU25

Scenario A

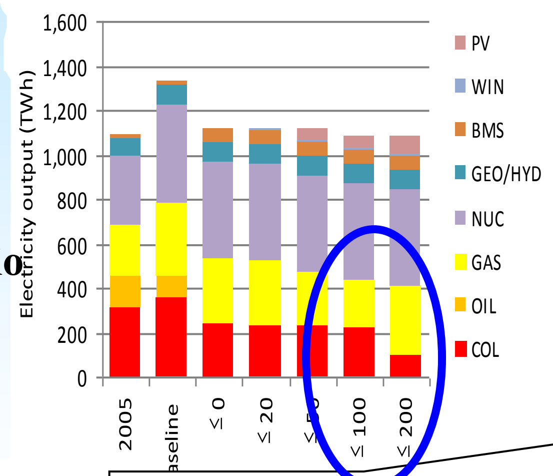


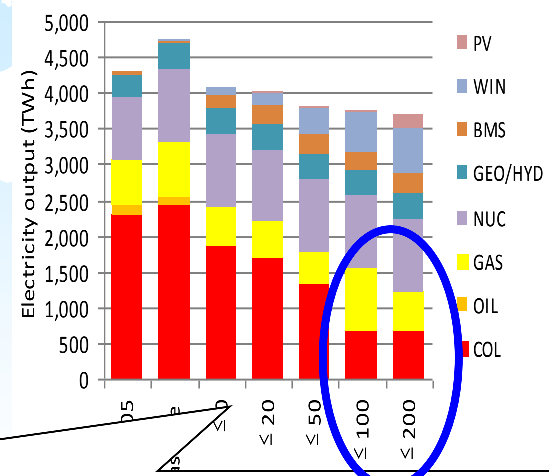


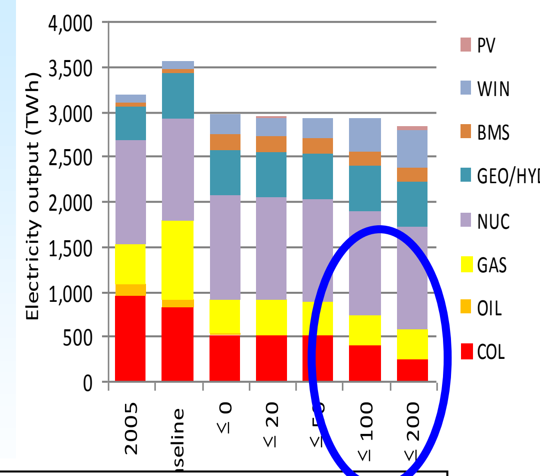


A drastic energy shift from coal and oil to gas is allowed if it is cost effective.

Scenario B



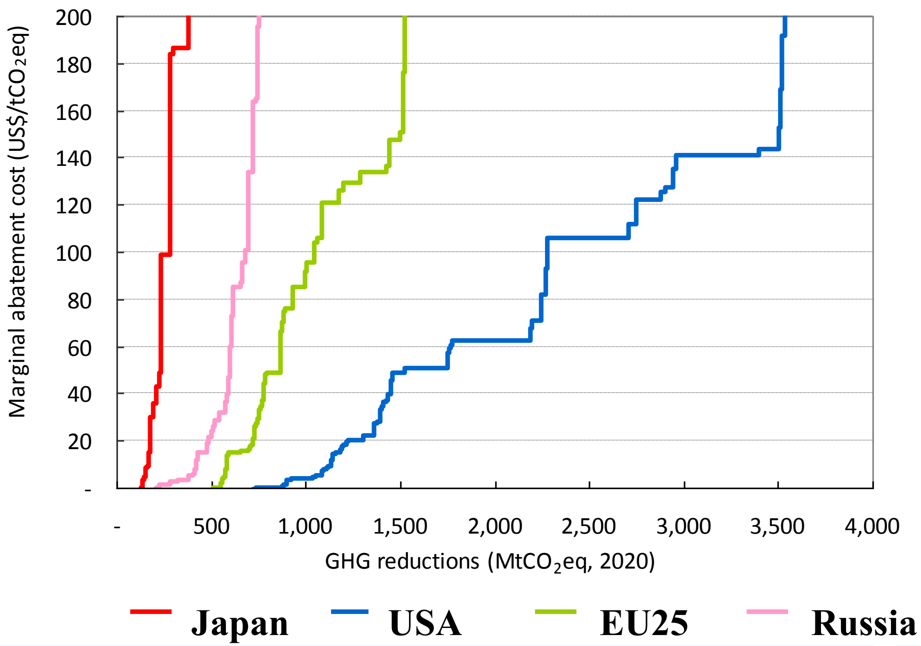




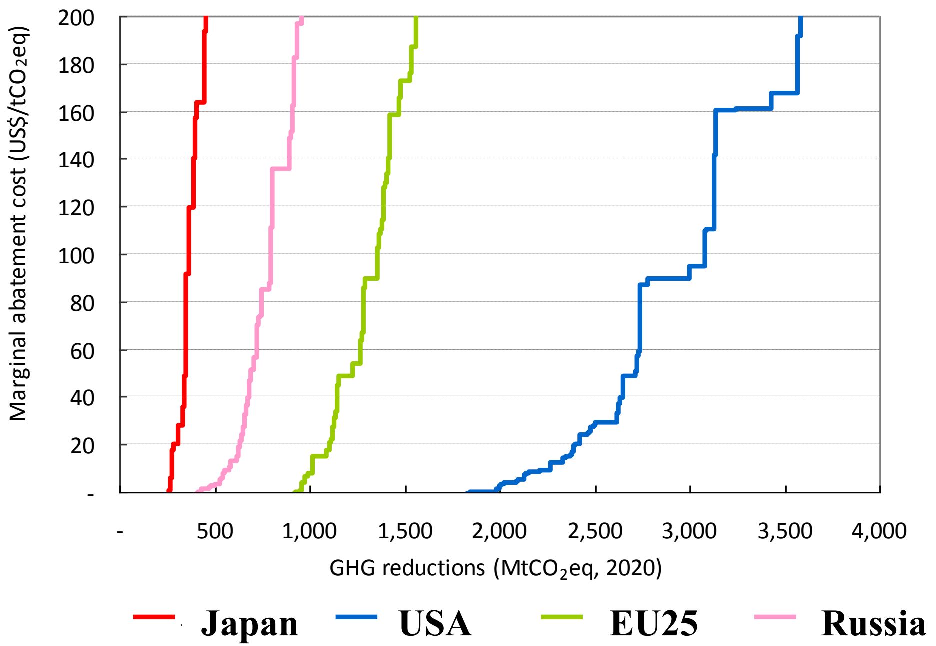
Social barriers restrict any drastic energy shift considering realistic state.

Example of difference of abatement cost curves in major developed countries

Scenario A
- short payback period
- cost optimization in power sector



Scenario B
- long payback period
- energy security restrictions in power sector



- **Under the long payback period, more reduction potentials at lower costs are estimated due to the effects of promoting high efficient technologies on the demand side.**
- **Under cost optimization without energy security restrictions in power generation, more mitigation potentials are estimated above 50 US$/t-CO2 eq due to the effects of a drastic energy shift from existing coal and oil power plants to new efficient gas power plants.**

Contribution of Enduse[Global] to Japan's mid-term target discussions

AIM/Enduse [Global]
Global bottom-up model

⇩

AIM/Enduse [Japan]
Japan bottom-up model

⇩

AIM/CGE [Japan]
Japan CGE model

AIM models

AIM/Enduse [Global]	GHG mitigation potentials comparisons across Annex I countries	⇔	RITE
AIM/Enduse [Japan]	Analysis of detailed mitigation options with policies in Japan	⇔	IEEJ
AIM/CGE [Japan]	Analysis of economic impact	⇔	JCER, KU

Criteria for Equitable Emission Allocation

A variety of criteria has been proposed by countries and experts.

Responsibility of emitting GHG

- Historical responsibility for temperature rise
- Emission per capita
- National emission at absolute level

Capacity (to pay)

- GDP or GDP per capita
- Combination with HDI (human development indicator) and GDP

Capability (emission reduction potential)

- Emission per unit of production
- Emission per GDP
- Marginal cost of reduction

Hybrid criteria

- Triptych
- Multi-stage Approach
- Multi-sector Convergence

EC Communication 28 Jan 2009 used four criteria to set emission targets for Annex I countries.

- GDP per capita

-Emission per unit of production

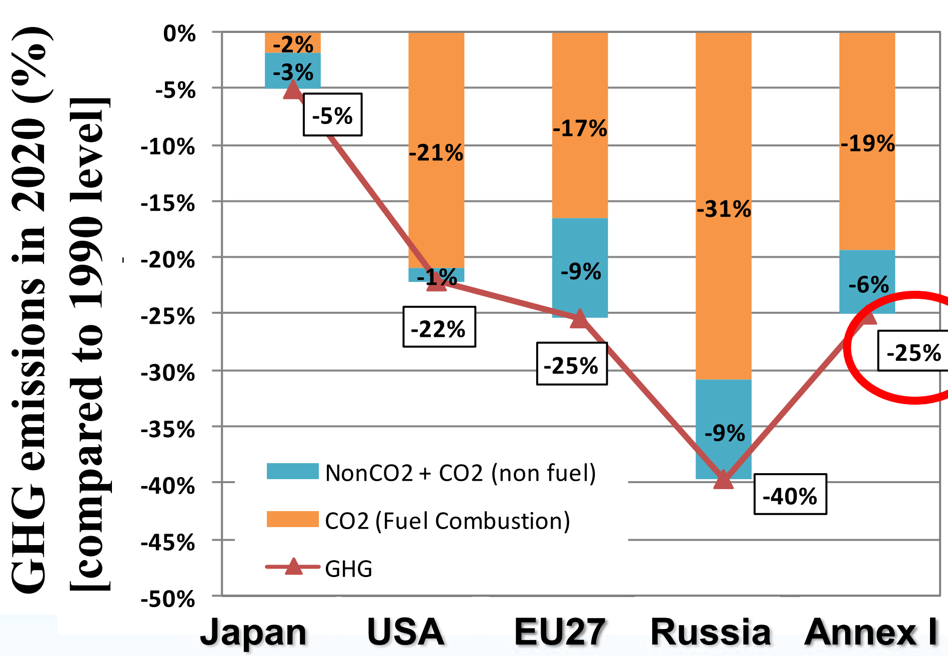
-Emission trend between 1990-2005

- Population trend between 1990-2005

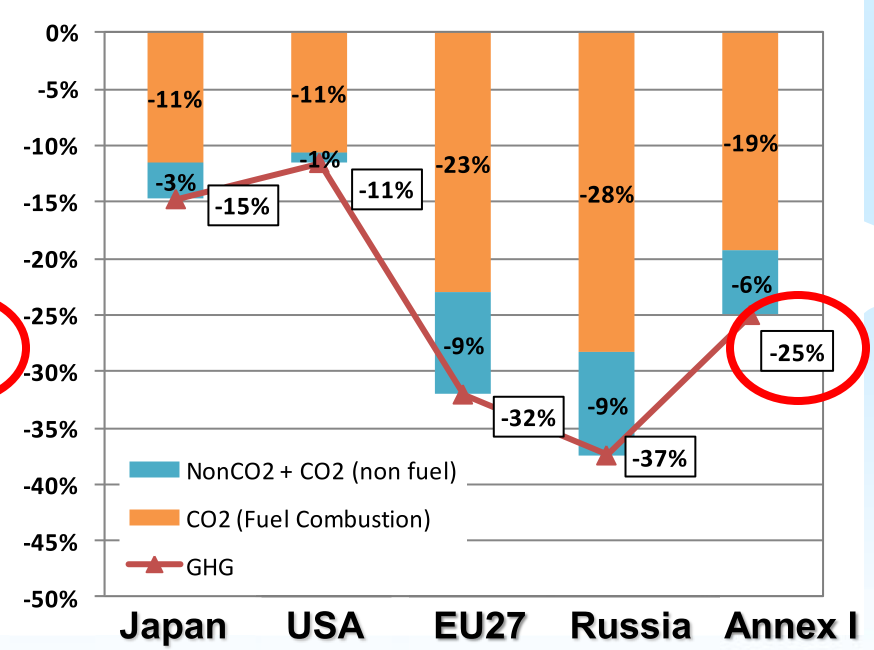
Example of equitable emission allocation to achieve 25% reductions in Annex I

Imposing equal marginal abatement cost (left figure) and equal total abatement costs per GDP (right figure) across Annex I countries to achieve a 25 % reduction target in Annex I countries.

Equal marginal abatement cost
MAC: 131 US$/tCO2 eq



Equal total abatement cost per GDP
Abatement cost per GDP: 0.74%



(Note: The latest updates in the case of Scenario A).

- It is important to compare reduction targets by using different indices.

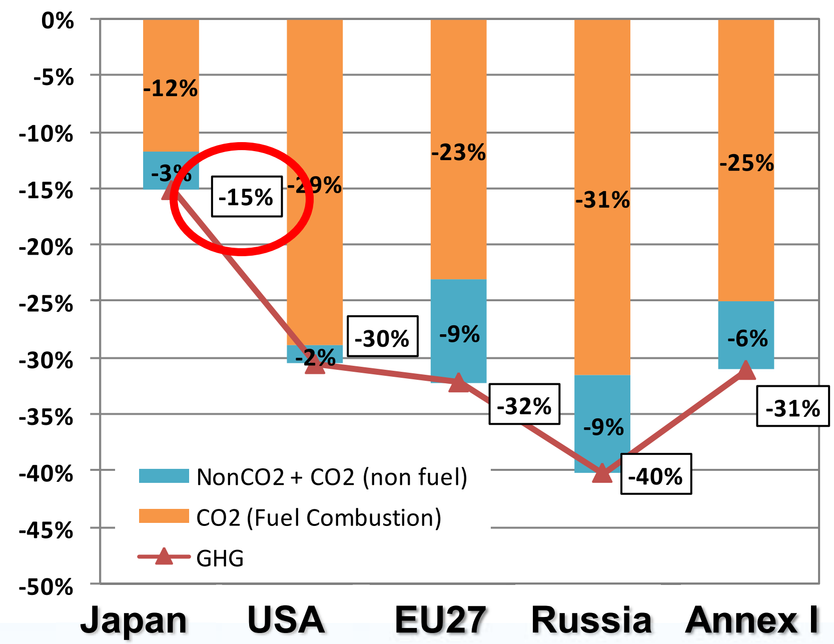
Example of equitable emission allocation
reduction target in Japan and comparable efforts in Annex I

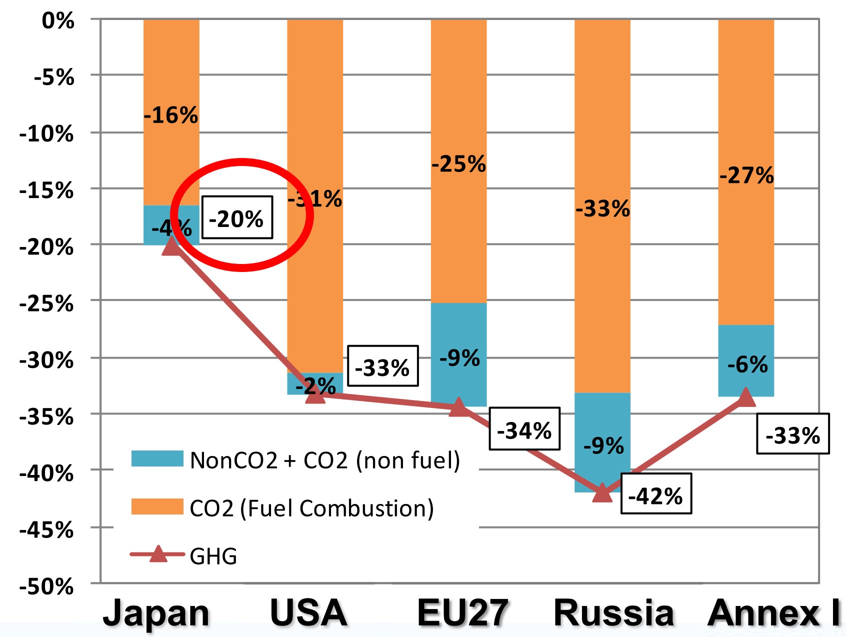
Imposing equal marginal abatement cost (to achieve 15% reduction target in left figure, 20% reduction target in right figure in Japan) across Annex I countries.

Equal marginal abatement cost
MAC: 270 US$/tCO2 eq

Equal marginal abatement cost
MAC: 544 US$/tCO2 eq

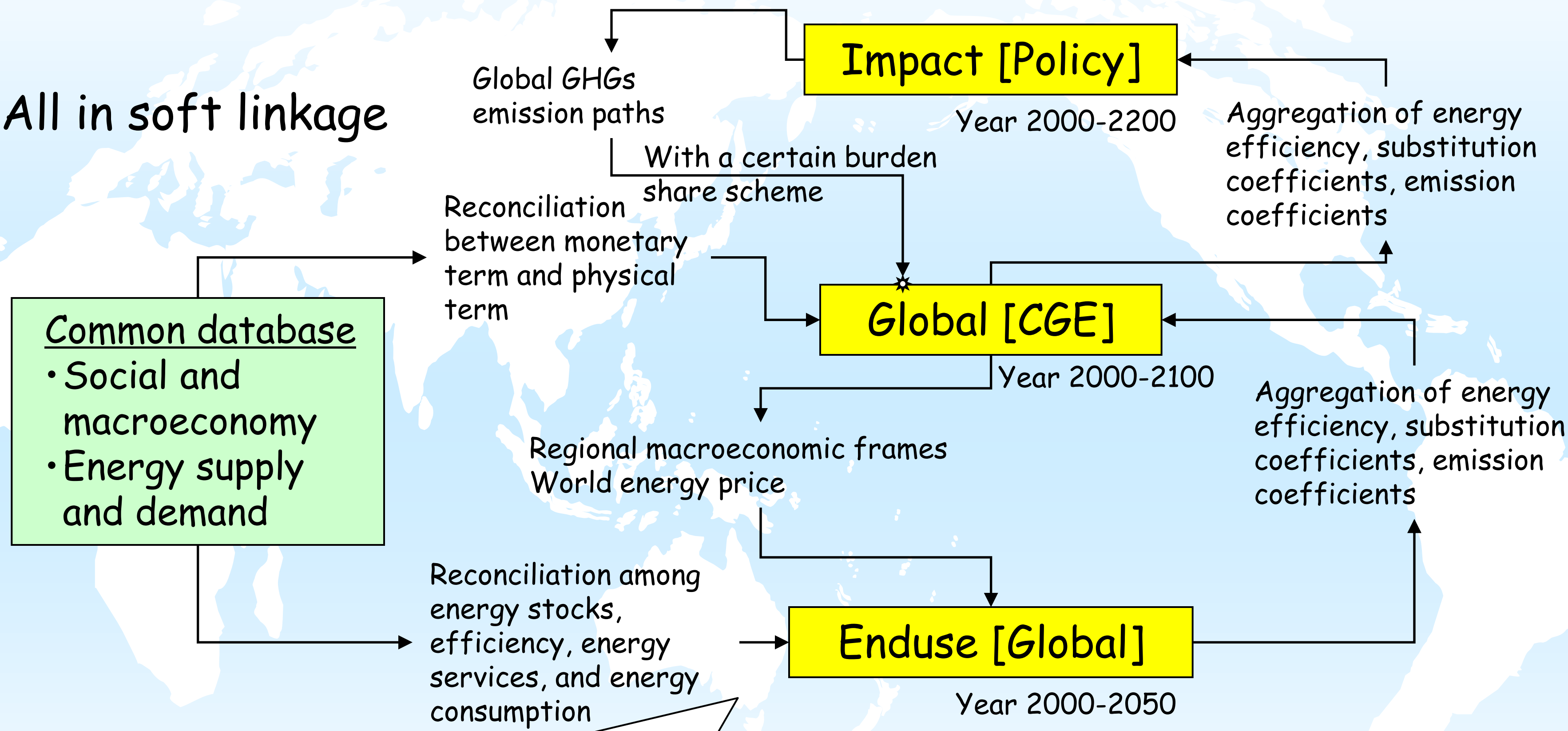
GHG emissions in 2020 (%) [compared to 1990 level]





(Note: The latest updates in the case of Scenario A).

Relation among three global models



The role of Enduse[Global] in the global model family are
-evaluation of technological feasibility of GHG mitigations in short- to middle-term.
-evaluation of energy service demands & transition toward the Low Carbon Society.