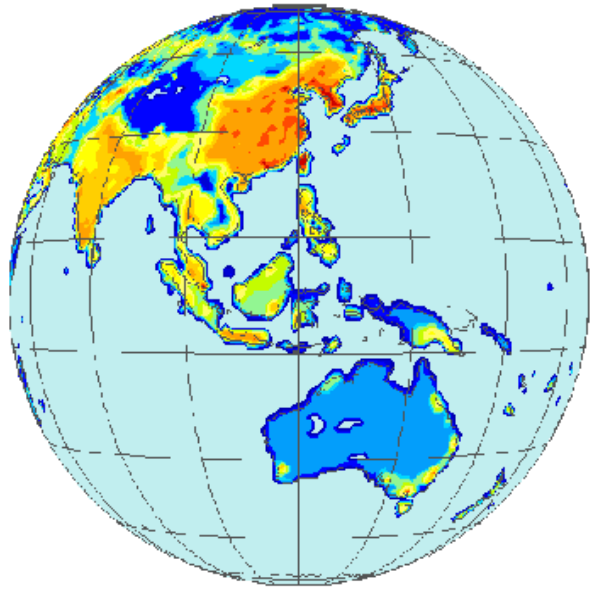
AIM/Enduse model: Features and applications



Mikiko KAINUMA

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(Integrated Environmental Assessment Group, APEIS)

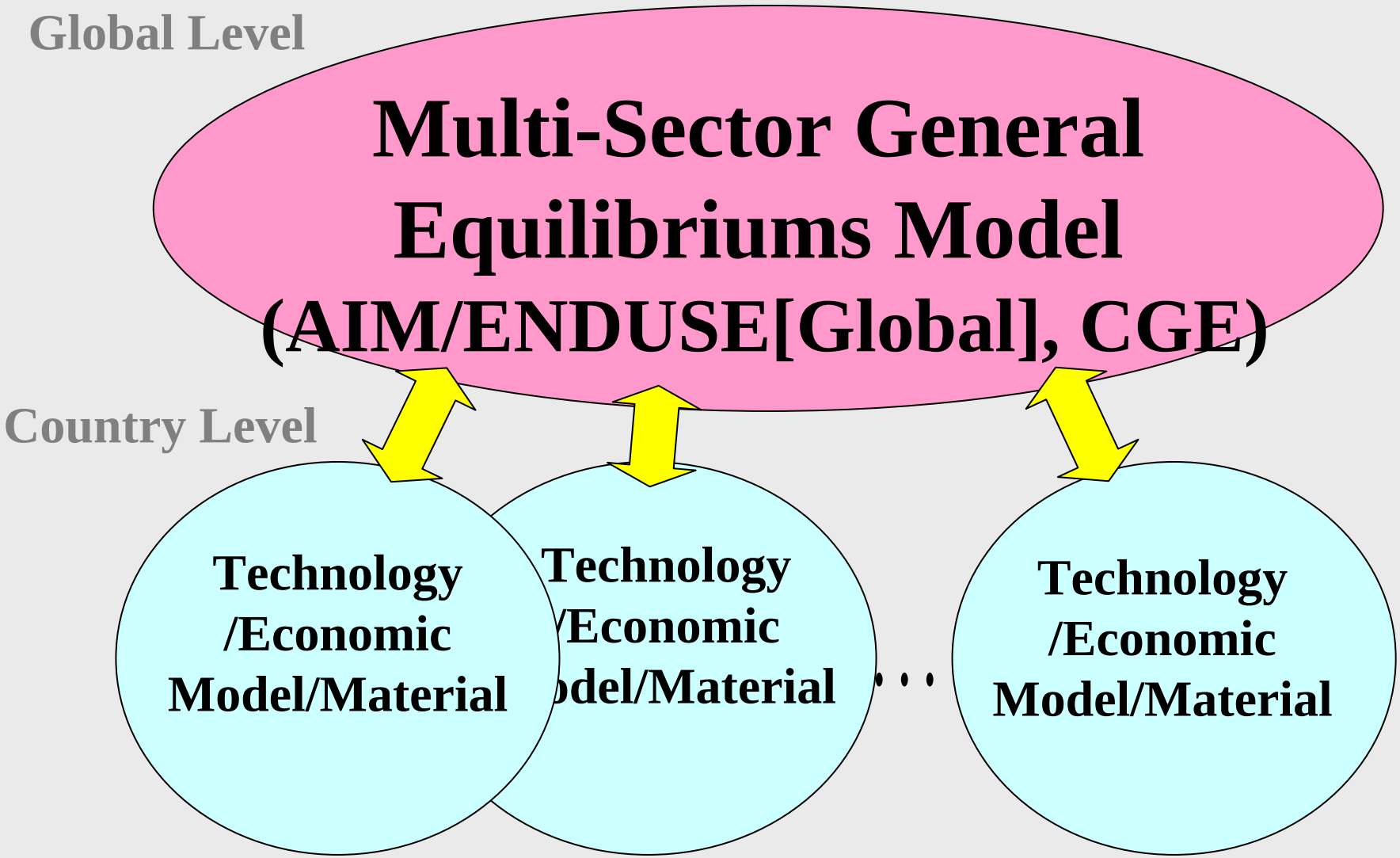
AIM/APEIS Workshop as a part of APEIS IEA activities

7-12 November 2005, NIES, Japan

Model analysis on CO2 reduction policy

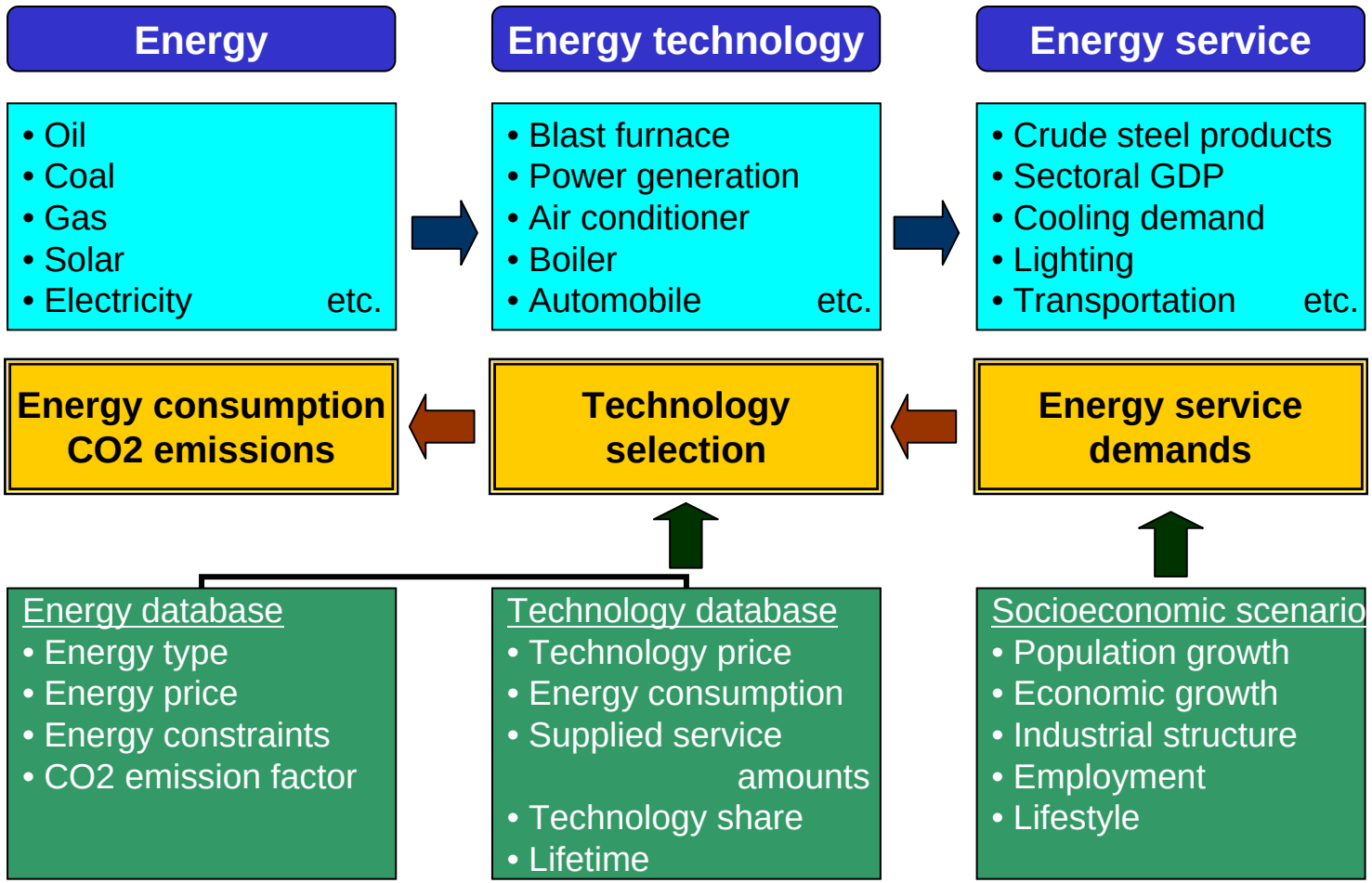
-Bottom-up model approach-

- **AIM/Enduse model**
  - **Based on socioeconomic scenario, energy devices and energy types are selected to minimize total cost.**
- **Marginal Abatement Cost Curve**



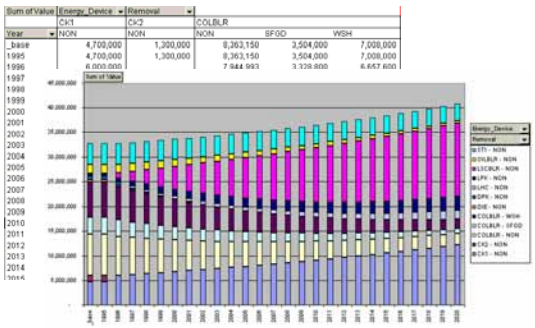
AIM/Emission

Model analysis on CO2 reduction policy -Bottom-up model approach-



Structure of AIM/Enduse model

Output



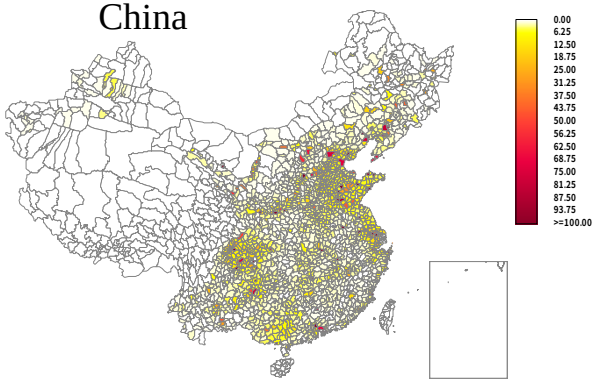
Change of technology share

AIM-Enduse, Local Database System

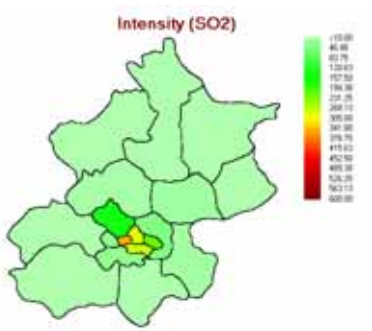
Model:
Search technology options
-Energy service technology
-Pollution removal technology
-Cost-benefit

GIS System

China



Beijing



SO2 emission intensity in 1995

Database + **End-use Model** (Local Pollution) + **GIS**

III. Input and Output

Input:

(1) Energy

- Fuel type
- Fuel price
- Emission factors by fuels and technologies(CO_2, SO_2, NO_X, SPM)
- Energy resource constraints

(2)Technology

- Initial cost
- Operating cost
- Energy consumption by fuels for a unit production
- Life-span
- Capacity
- Share
- Pollutants removal technologies and their combinations with major energy service technologies

(3) Service demand by regions and sectors

- Historical service data
- Future service demand forecast

  - Economic development plans from the local government
  - Development plans from the local industries

(4) Air pollutant emission constraints

- Current air pollutant emissions
- Local environmental protection policies

(3) Service output

- Service output by regions, sectors, technologies and years

(4) Energy balance table

- Energy balance table for the local region by years (with energy information for sectors, technologies and fuel types)

Output:

(1) Aggregated results

- Total energy consumption by years
- Total costs by years
- Total CO_2 emissions by years
- Total air pollutant emissions by years

(2) Technology options

- CO_2 emissions by technologies and years
- Air pollutant emissions by technologies and years
- Energy consumption by technologies and years

Model analysis on CO2 reduction policy

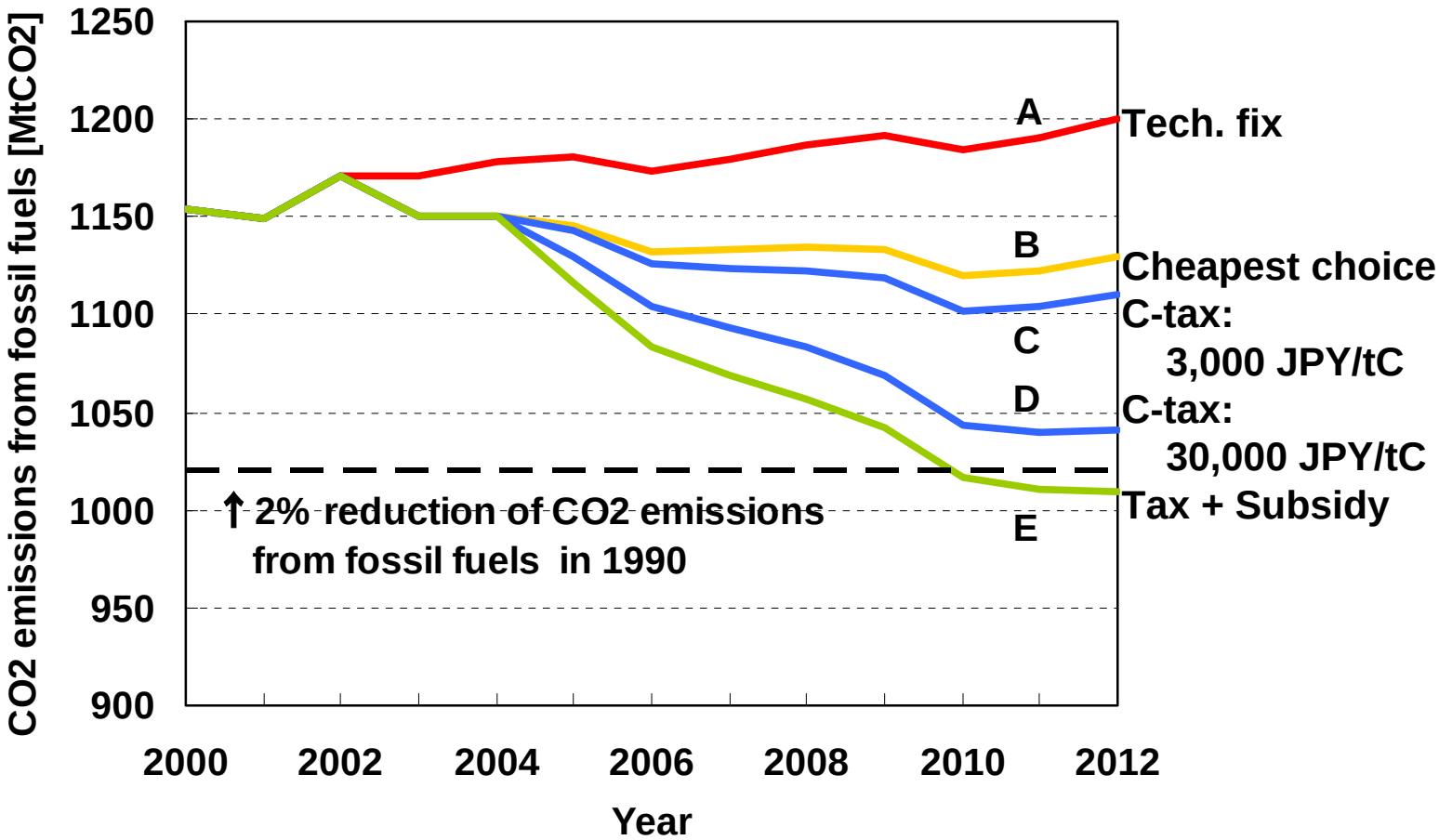
-Bottom-up model approach in Japan -

Examples of socioeconomic scenarios

			2000	2010	2012
Real GDP growth rate		%/year	0.9	1.9	1.9
Raw material production	Crude steel	mil. ton	106.9	95.9	94.8
	Cement	mil. ton	79.3	70.3	69.8
	Ethylene	mil. ton	7.6	6.7	6.7
	Paper & board	mil. ton	31.8	36.0	36.7
Number of households		mil.	46.8	49.1	49.2
Floor space in com. sector		mil. m^2	1,655	1,793	1,844
Passenger transportation		tri.*person*km	1.42	1.51	1.53
Freight transportation		tri.*ton*km	0.56	0.57	0.57
Nuclear power generation (new construction after 2002)		Plants	—	8	8

Model analysis on CO2 reduction policy

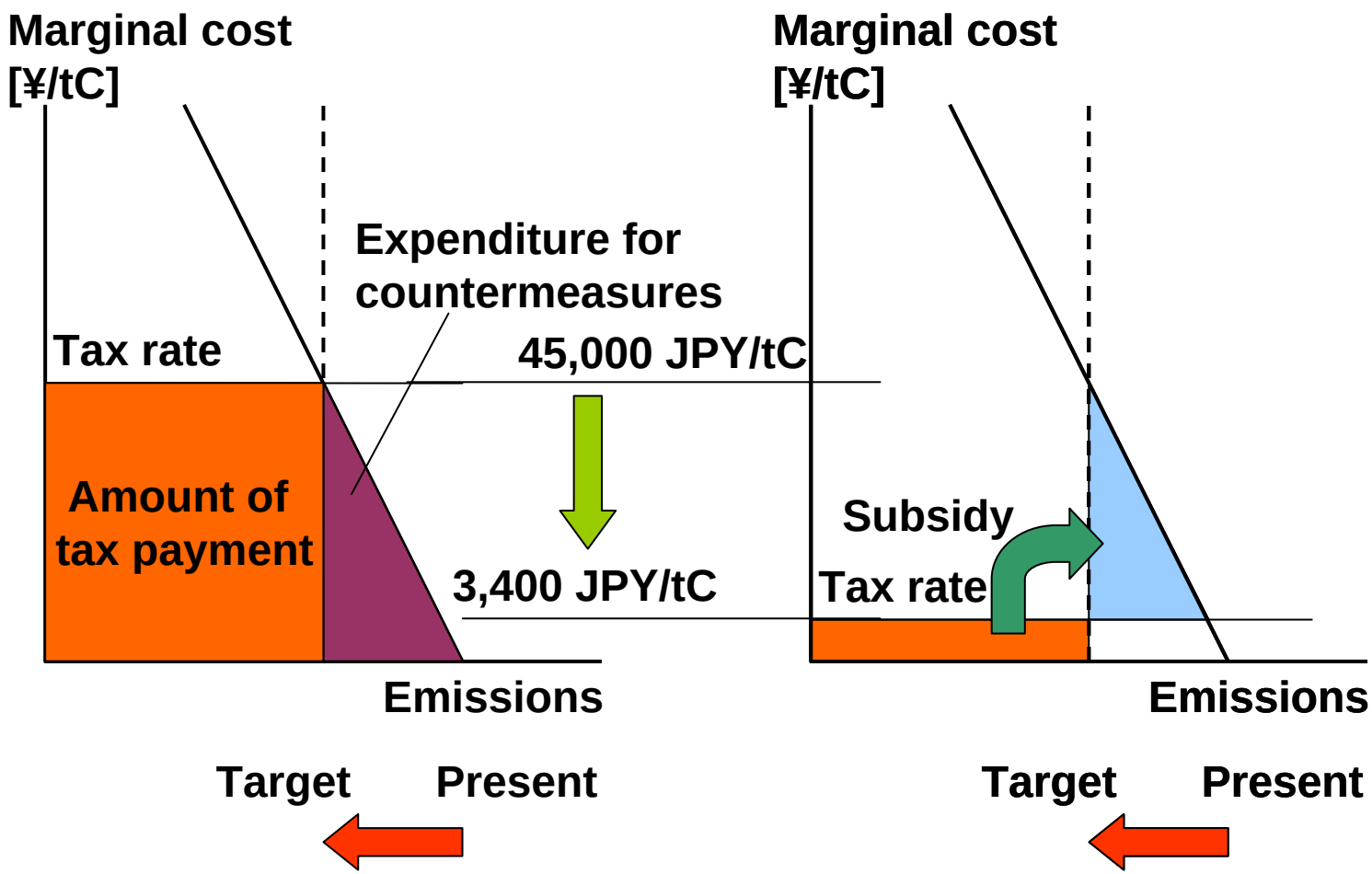
-Bottom-up model approach-



CO2 emissions trajectories by scenarios

Model analysis on CO2 reduction policy

-Bottom-up model approach-



Model analysis on CO2 reduction policy

-Bottom-up model approach-

Carbon tax rate and required additional investments for reducing CO2 emissions in Japan

sector	Subsidized measures and devices	Add. investment
Industrial sector	Boiler conversion control, High performance motor, High performance industrial furnace, Waste plastic injection blast furnace, LDF with closed LDG recovery, High efficiency continuous annealing, Diffuser bleaching device, High efficiency clinker cooler, Biomass power generation	101.3
Residential sector	High efficiency air conditioner, High efficiency gas stove, Solar water heater, High efficiency gas cooking device, High efficiency television, High efficiency VTR, Latent heat recovery type water heater, High efficiency illuminator, High efficiency refrigerator, Standby electricity saving, Insulation	353.9
Commercial sector	High efficiency electric refrigerator, High efficiency air conditioner, High efficiency gas absorption heat pump, High efficiency gas boiler, Latent heat recovery type boiler, Solar water heater, High efficiency gas cooking device, High frequency inverter lighting with timer, High efficiency vending machine, Amorphous transformer, Standby electricity saving, Heat pump, Insulation	194.5

bil. JPY / year

Model analysis on CO2 reduction policy

-Bottom-up model approach-

Carbon tax rate and required additional investments for reducing CO2 emissions in Japan (continued)

sector	Subsidized measures and devices	Add. investment
Transportation sector	High efficiency gasoline private car, High efficiency diesel car, Hybrid commercial car, High efficiency diesel bus, High efficiency small-sized truck, High efficiency standard-sized track	106.6
Forest management	Plantation, Weeding, Tree thinning, Multilayered thinning, Improvement of natural forest	195.7
Total		952.0

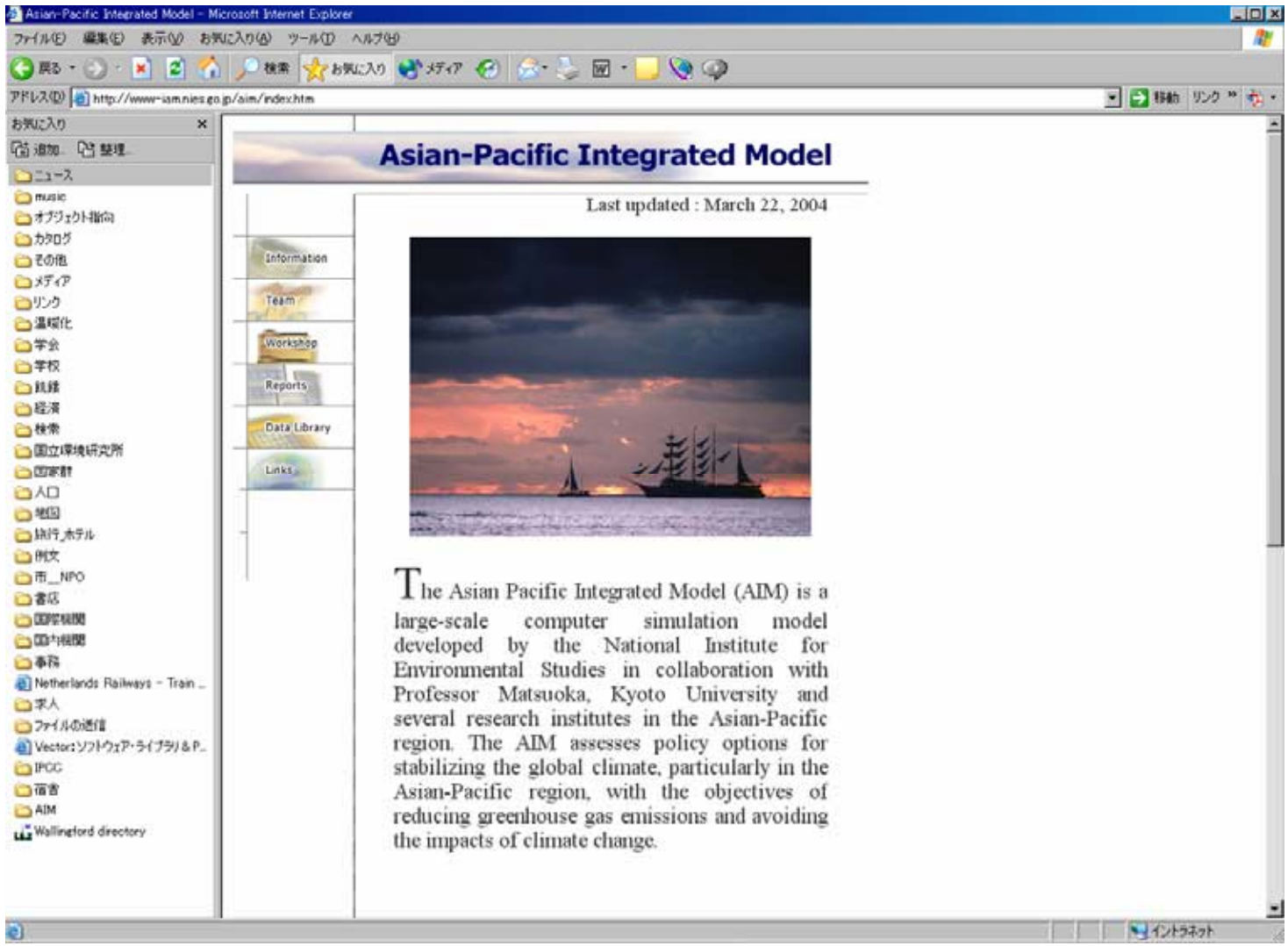
bil. JPY / year

Tax rate to appropriate required subsidiary payments (JPY/tC)	3,433

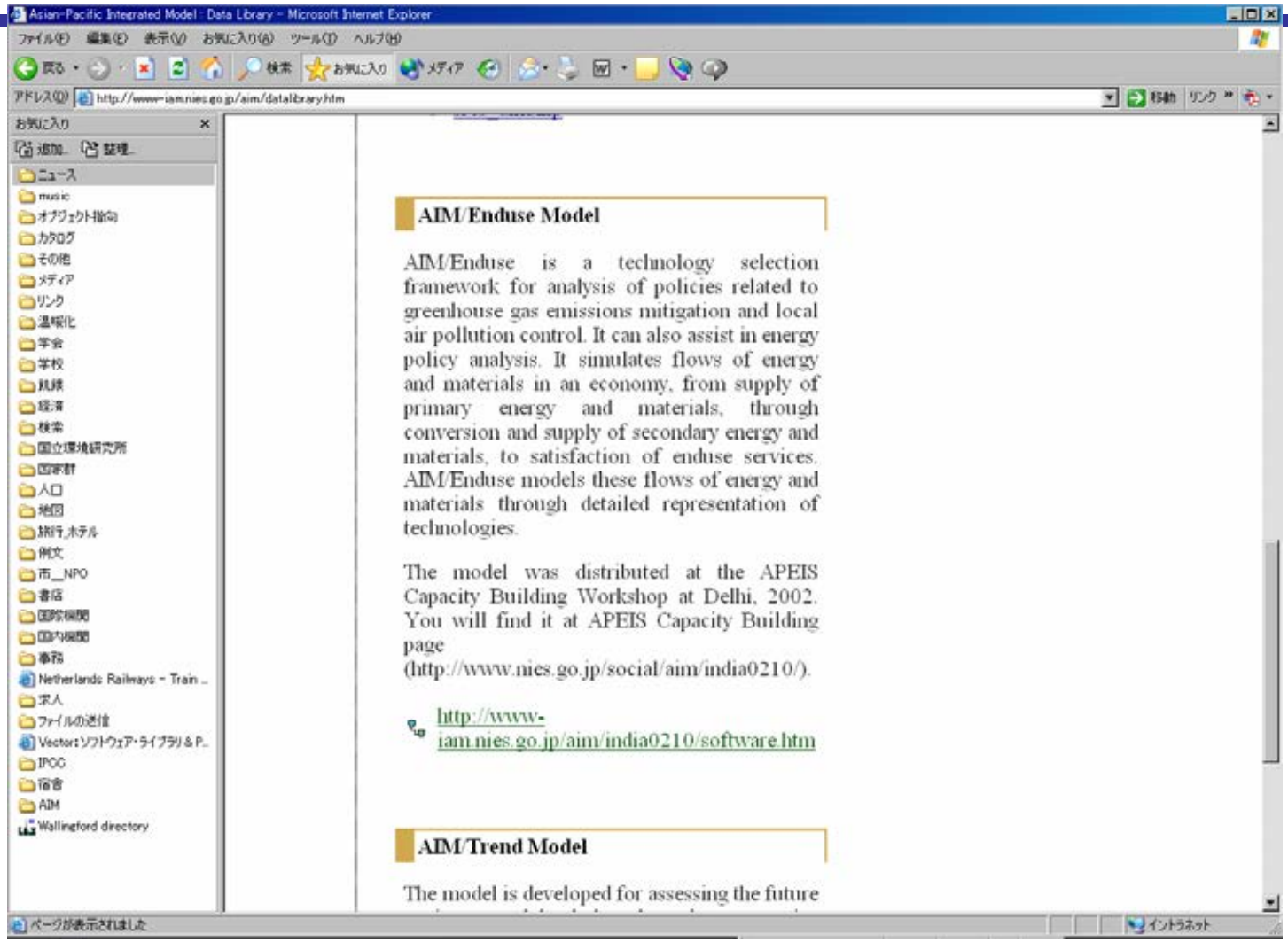
AIM/Enduse Software

AIM Home Page

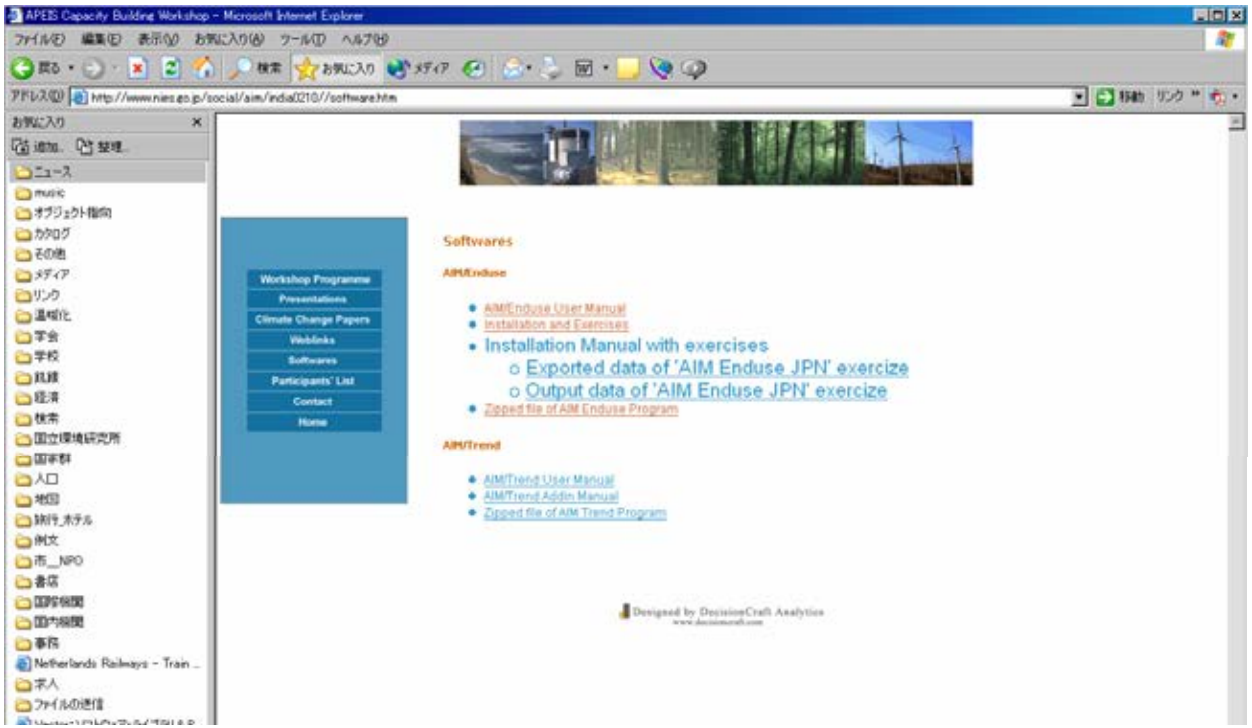
http://www-iam.nies.go.jp/aim/



AIM Home Page

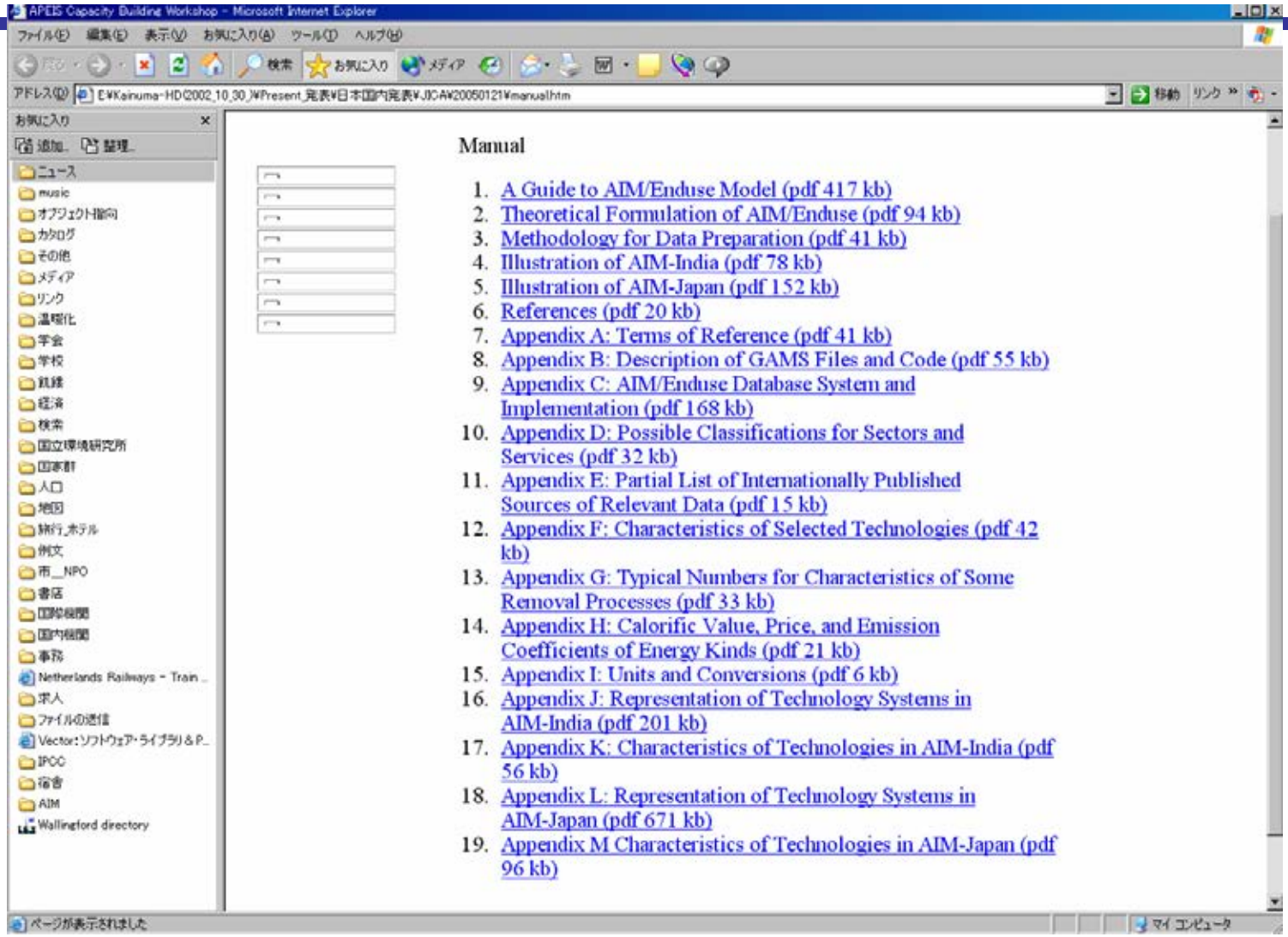


AIM Home Page



http://www-iam.nies.go.jp/aim/india0210/software.htm

Structure of Manual



Example of Marginal Abatement Cost Analysis

Siftware: Enduse_MAC_050119.mdb

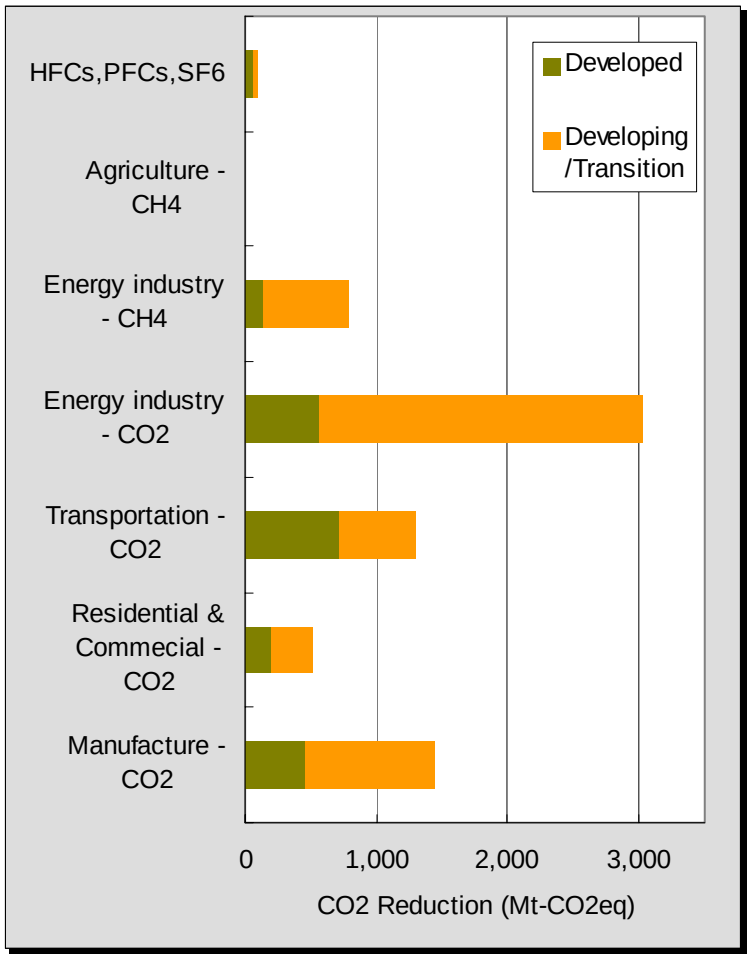
Is there enough potential in 2020?

Mt-CO2

Discount rate		5%			33%(Private), 10%(Public)		
Marginal abatement cost 2000US$		< 0	< 100	< 300	< 0	< 100	< 300
CO2	Steel	395	571	642	338	486	546
	Other manufacture	1,045	1,850	1,855	196	1,195	1,898
	Indutry total	1,440	2,421	2,496	533	1,682	2,444
	Residential	210	330	351	22	110	281
	Commercial	307	474	483	56	275	373
	Transportation	1,298	1,826	2,481	448	542	1,233
	Agriculture	0	0	0	0	0	0
	Others	0	0	0	0	0	0
	Power generation	3,026	3,366	3,526	3,010	3,082	3,463
	Total	6,282	8,417	9,337	4,069	5,690	7,795
CH4	Agriculture	0	42	330	0	32	152
	Energy	797	2,005	2,005	478	2,001	2,005
	Total	797	2,048	2,335	478	2,033	2,158
N2O		-	-	-	-	-	-
HFCs,PFCs,SF6 (4%)		84	796	859	-	-	-
Total		7,163	11,260	12,531	4,548	7,723	12,953

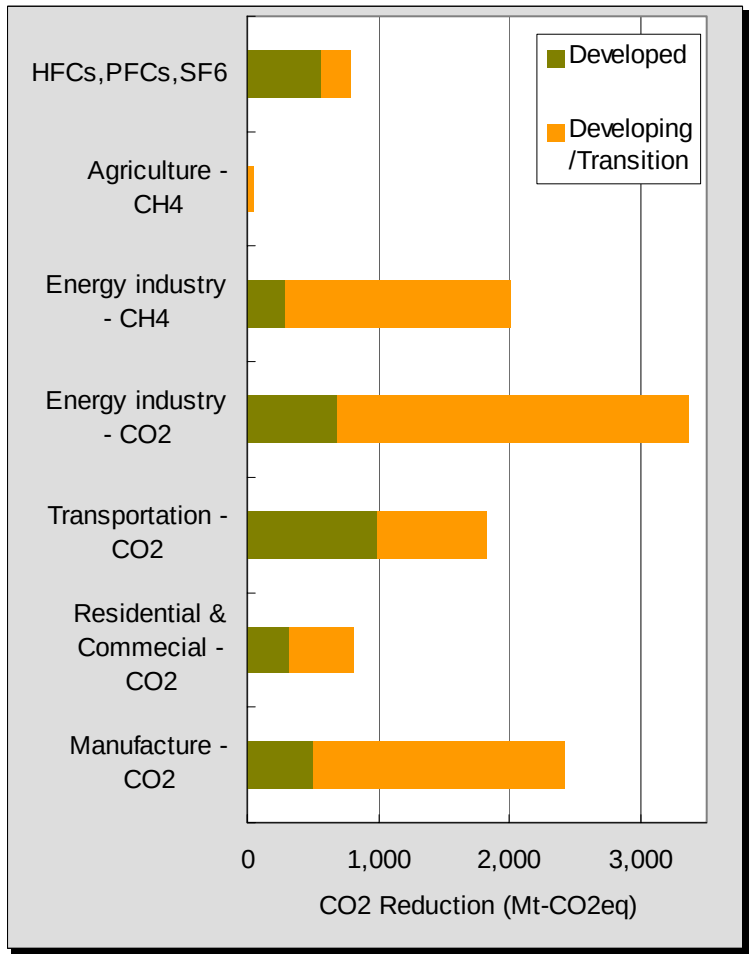
Reduction potential in Developed and Developing/Transition Economies

Developed



< US$ 0, 2020

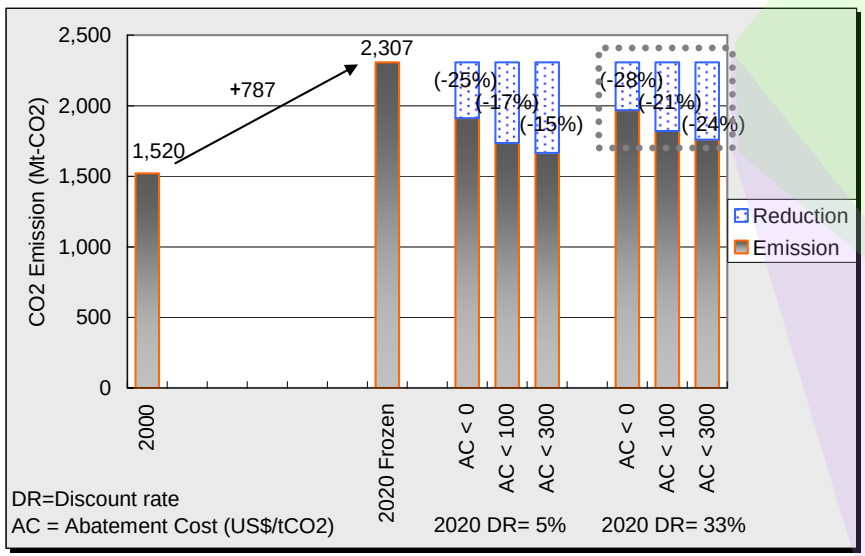
Developing/Transition



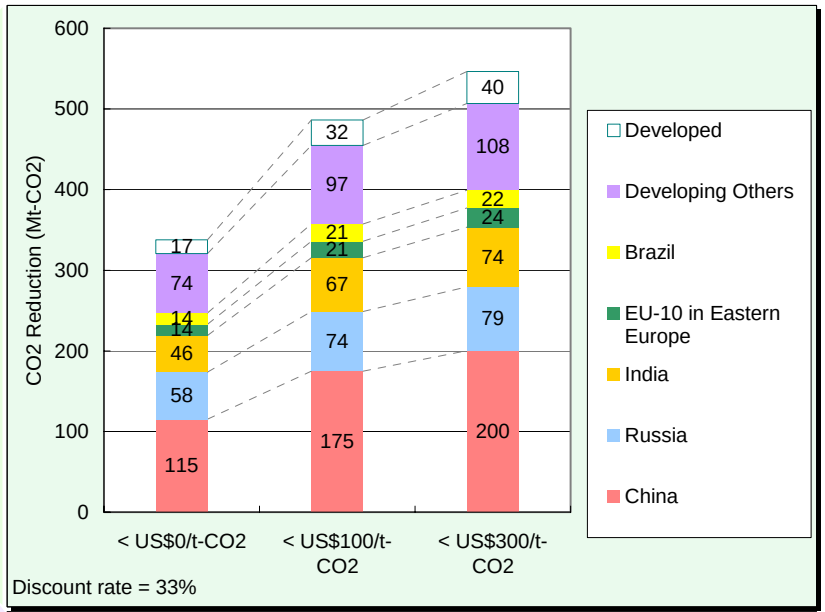
< US$ 100, 2020

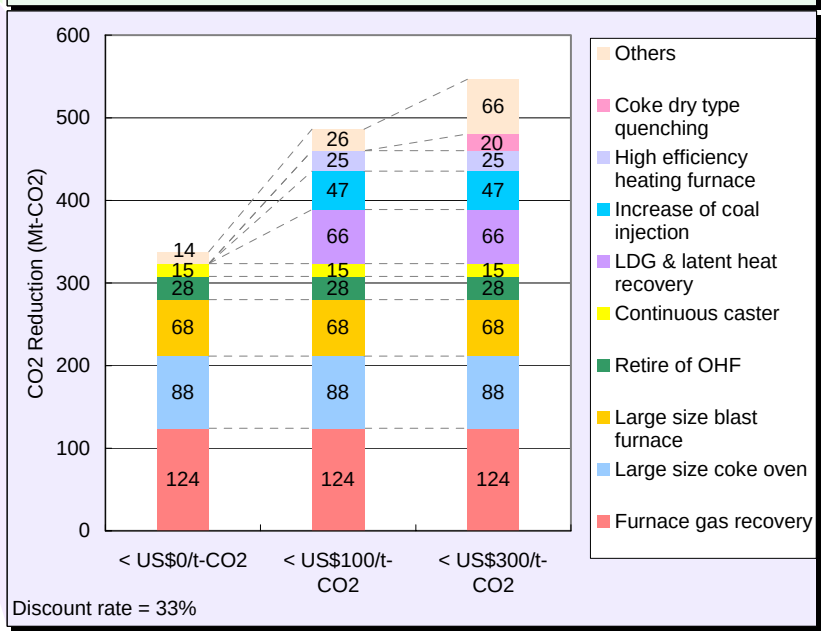
Discount rate = 5% (Private & Public)

Reduction potential from steel sector in 2020

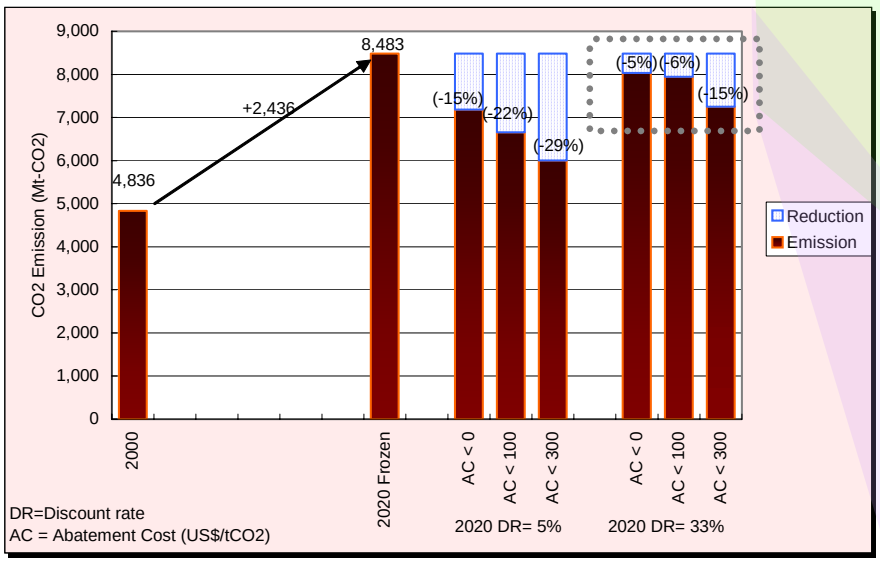


Discount Rate	Abatement Cost US$/tCO2	CO2 Reduction	
		Mt-CO2	vs frozen
33%	less than 0	338	15%
	less than 100	486	21%
	less than 300	546	24%
5%	less than 0	395	17%
	less than 100	571	25%
	less than 300	642	28%

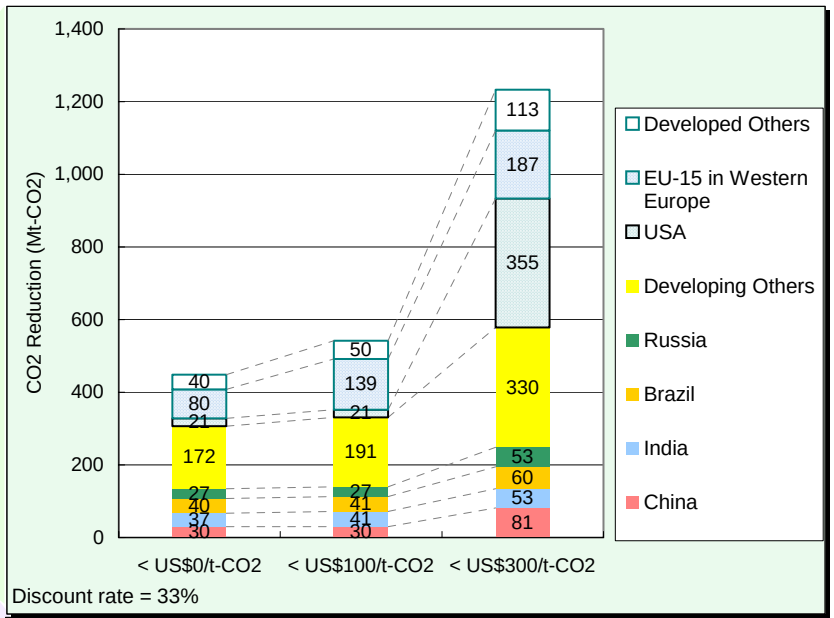


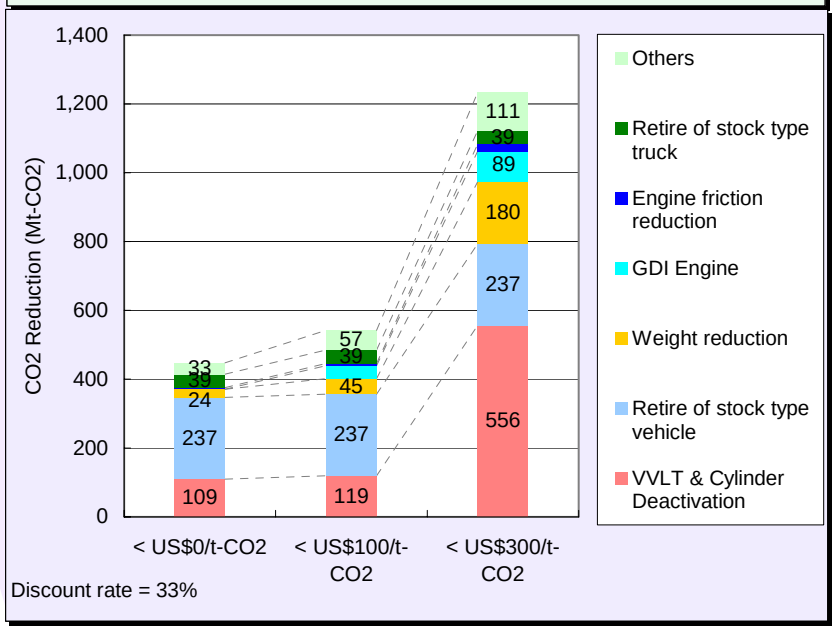


Reduction potential from transportation sector in 2020

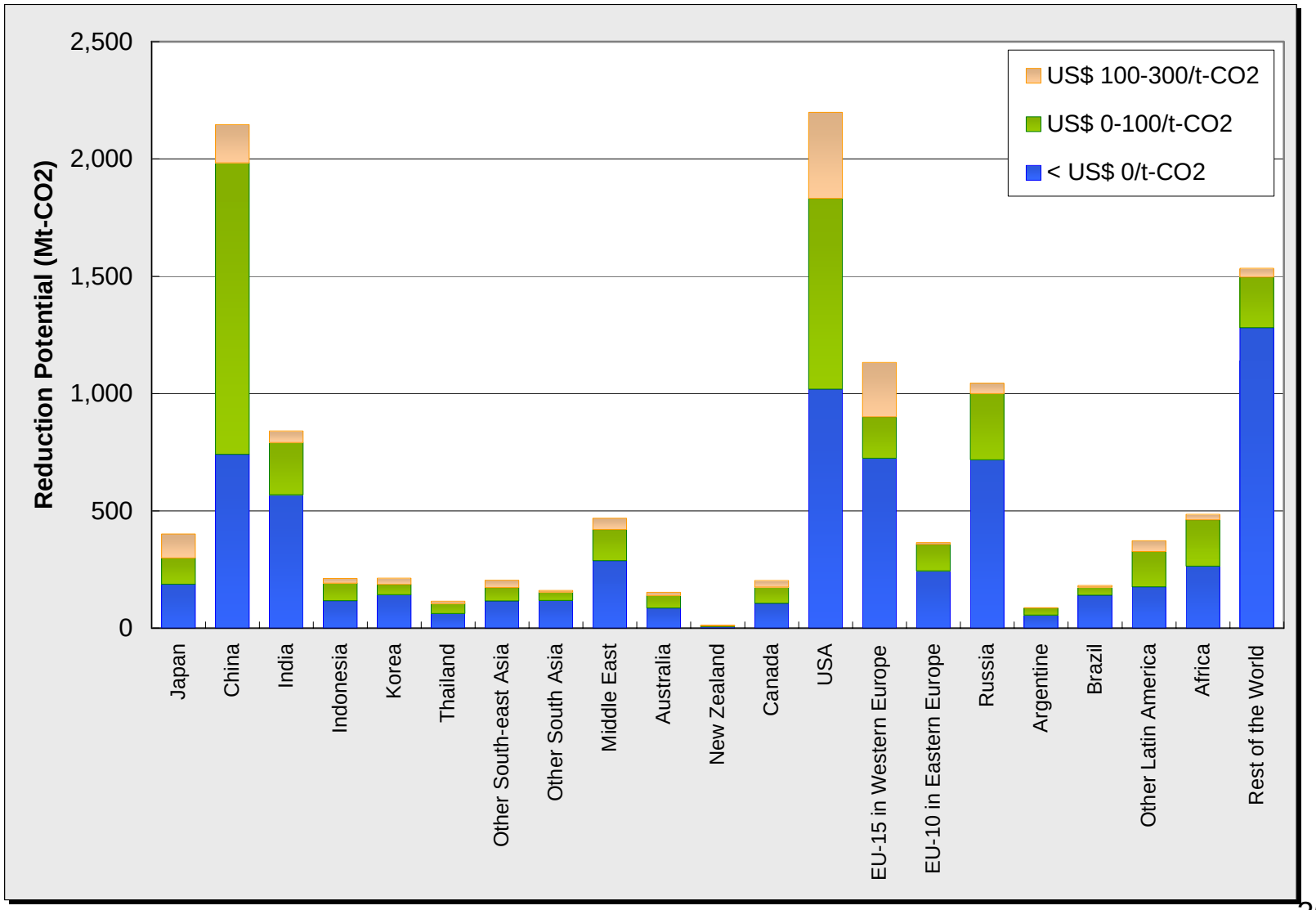


Discount Rate	Abatement Cost US$/tCO2	CO2 Reduction	
		Mt-CO2	vs frozen
33%	less than 0	448	5%
	less than 100	542	6%
	less than 300	1,233	15%
5%	less than 0	1,298	15%
	less than 100	1,826	22%
	less than 300	2,481	29%





Region-wise reduction potential in 2020



Discount rate = 5%

Technology with large reduction potential

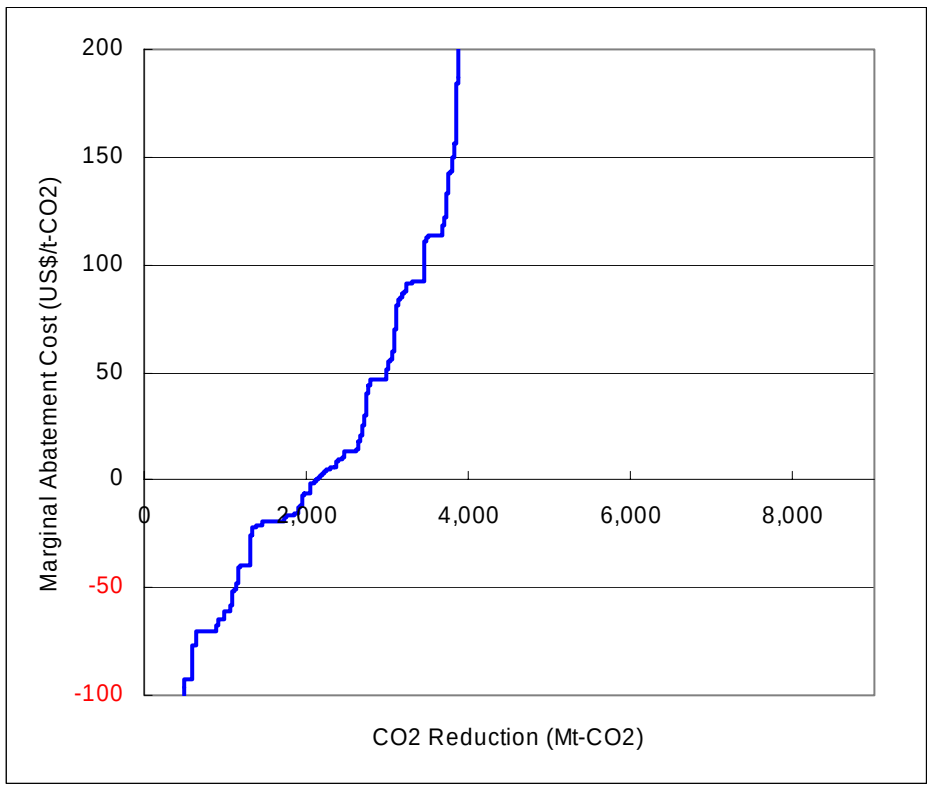
under 100 US$ marginal abatement costs in 2020

Developed	(MtCO2)	Developing/Transition	(MtCO2)
High efficiency gasoline engine (VVLT, GDI etc)	632	Existing type of power plant (coal ,gas)	2,462
Existing type of power plant (coal ,gas)	546	Use of instrument air, low bleed pneumatic devices*	676
Inverter control for motor	216	Gas high efficiency industrial furnace	449
Fluorescent of incandescent type	143	Inverter control for motor	431
Domestic refrigeration: recovery	129	Coal bed methane ventilation oxidizer for heat**	232

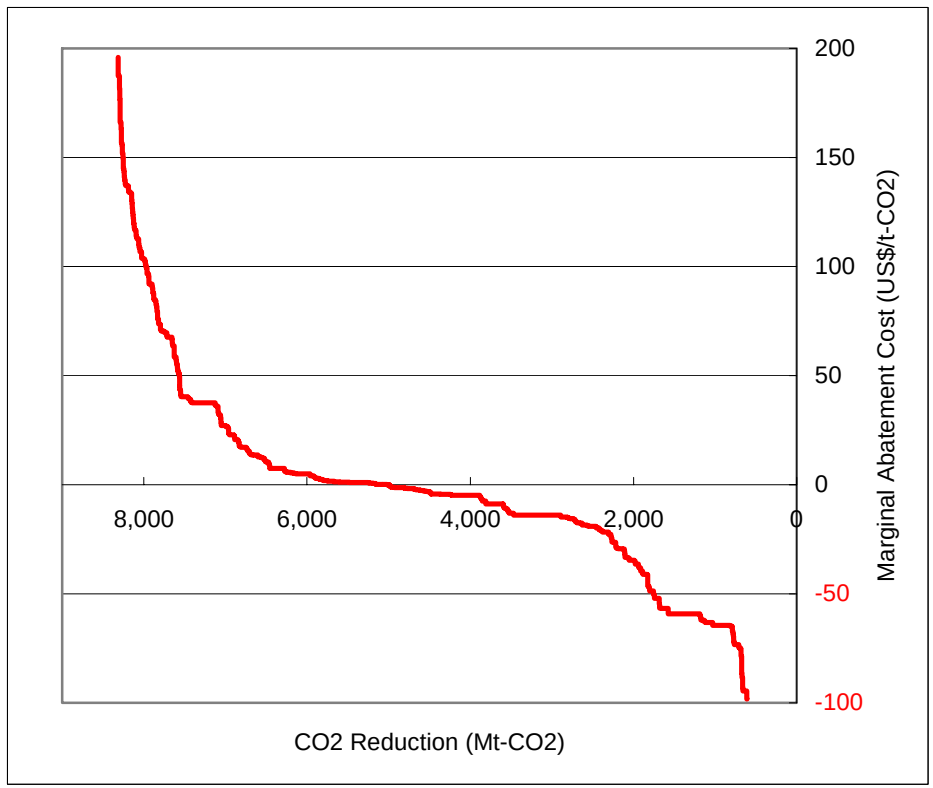
* Recovery of CH4 leakage from natural gas pipeline and well
** Recovery of CH4 in coal mine

Discount rate = 5%

Marginal abatement cost of developed and developing/transition economies

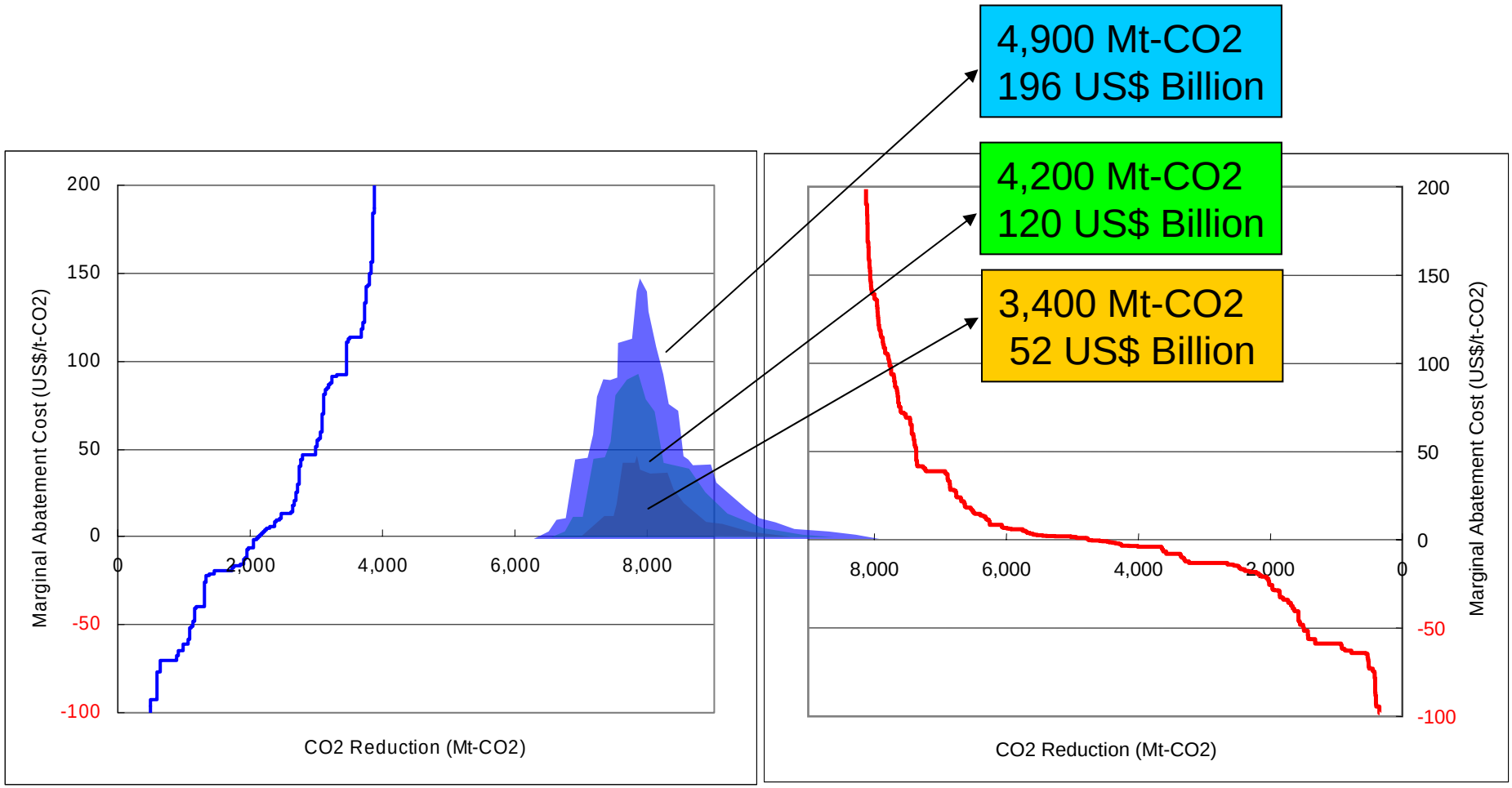


Developed



Developing/Transition

Discount rate = 5%, 2020



Developed

Developing/Transition

Discount rate = 5%, 2020

Summary

- **Tool to evaluate policy options to mitigate climate change and its impacts, and to analyze other environmental issues such as air pollution control, water resources management, land use management, environmental industry encouragement.**
- **Could be applied at global, regional and country level.**
- **Effect of policies such as regulation (constraint) on energy or emission, tax on emission (CO_2, SO_2, NO_x) or energy, subsidy on energy devices or removal process, etc. can be analyzed.**
- **Can analyze the effect of a single or combination of policies on technology mix, fuel mix, emission mix, total cost, etc.**