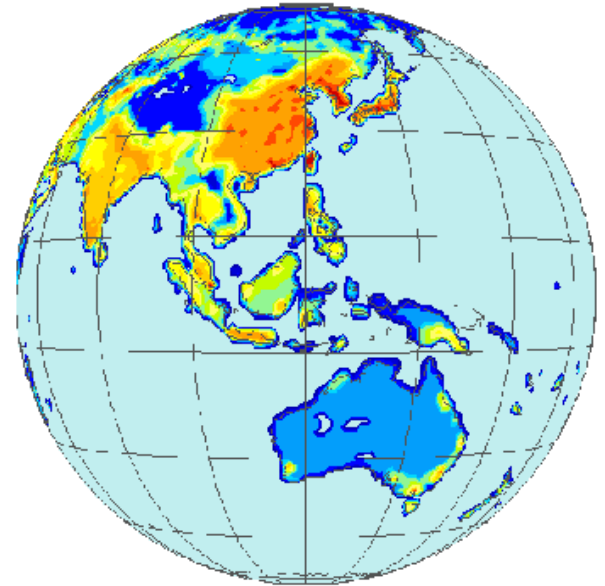


AIM/Enduse model: Features and applications



Mikiko KAINUMA

**AIM Team, National Institute for Environmental Studies
(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-

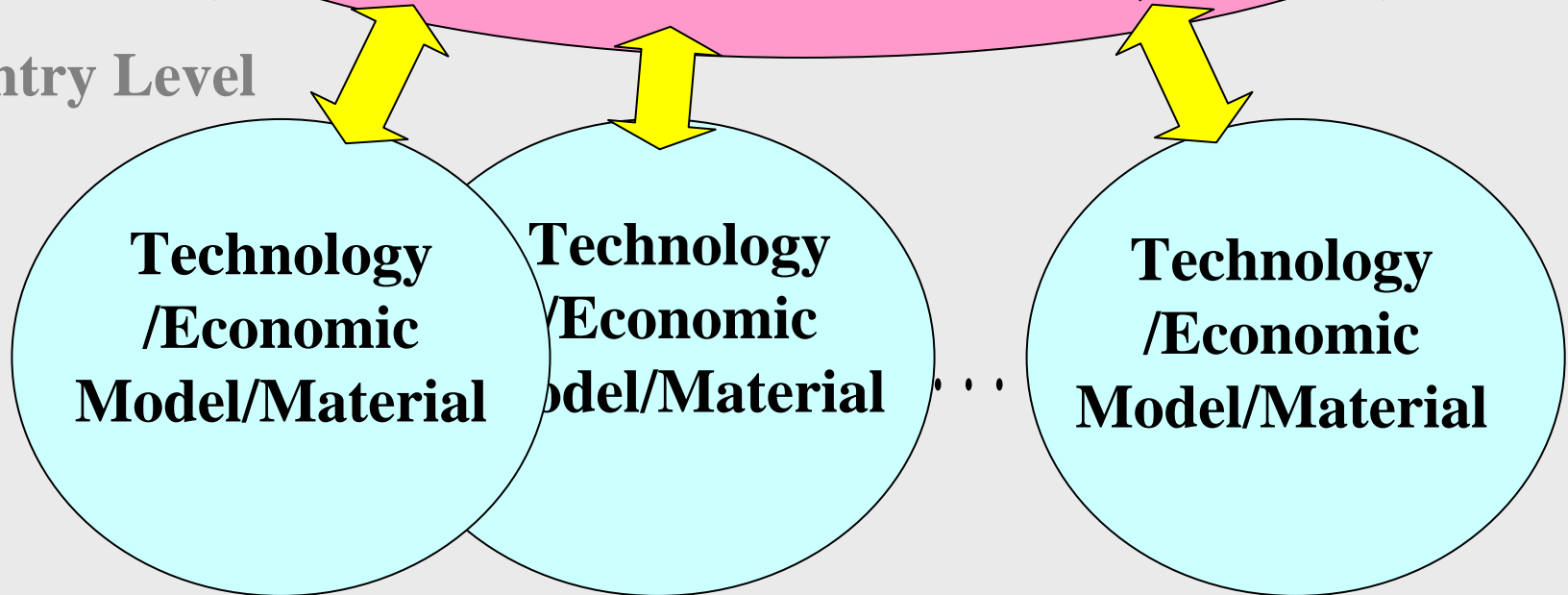
- **AIM/Enduse model**
 - Based on socioeconomic scenario, energy devices and energy types are selected to minimize total cost.
- **Marginal Abatement Cost Curve**



Global Level

**Multi-Sector General
Equilibriums Model
(AIM/ENDUSE[Global], CGE)**

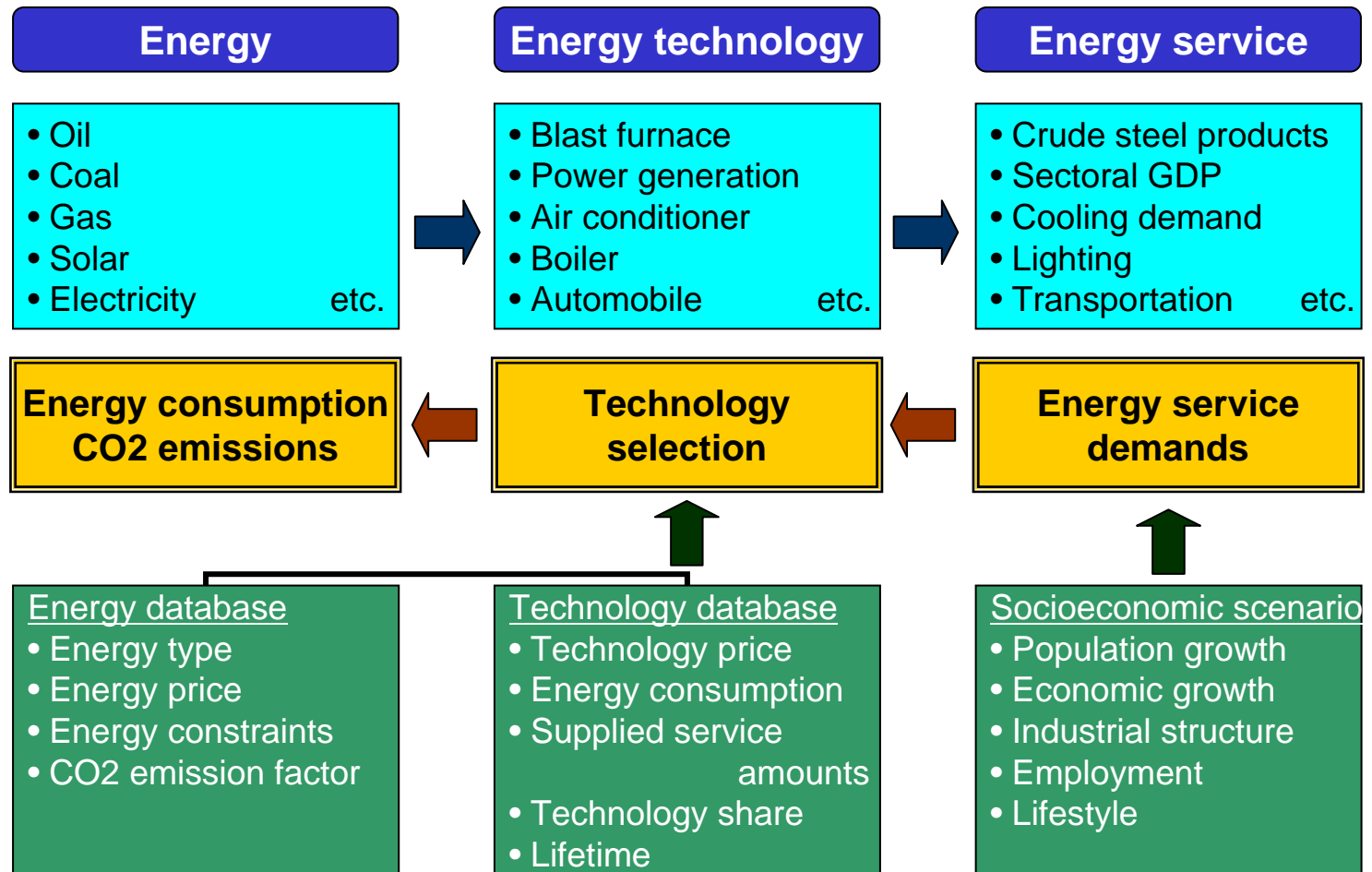
Country Level



AIM/Emission

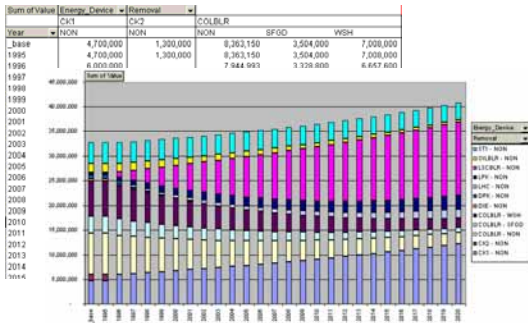
Model analysis on CO2 reduction policy

-Bottom-up model approach-

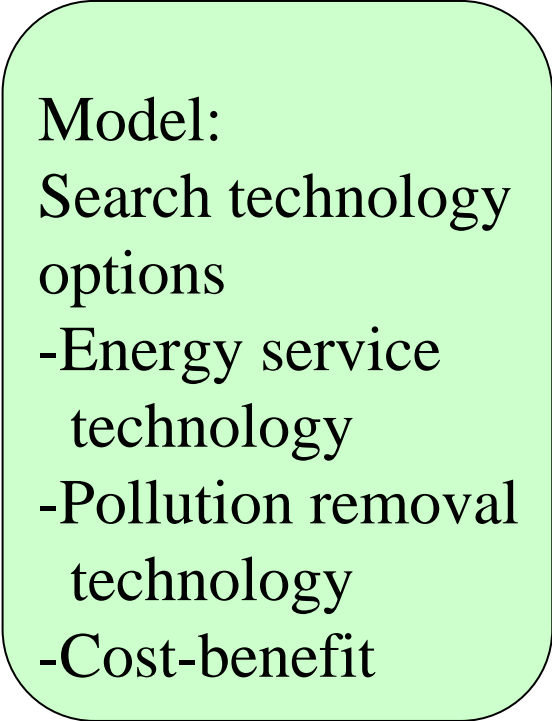
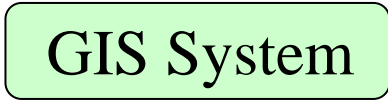
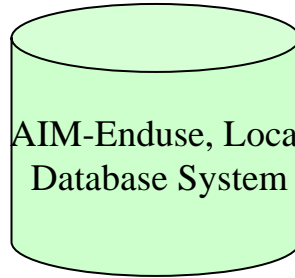


Structure of AIM/Enduse model

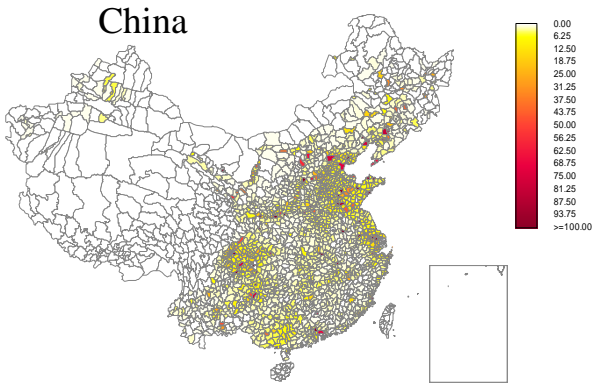
Output



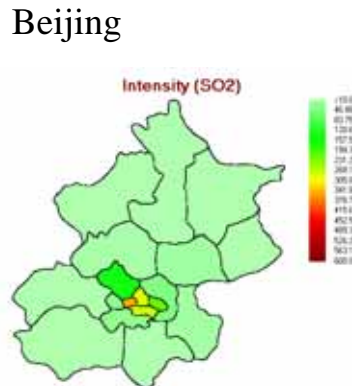
Change of technology share



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



SO2 emission intensity in 1995



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 CO₂ emissions by years
- Total air pollutant emissions by years

(2) Technology options

- CO₂ emissions by technologies and years
- Air pollutant emissions by technologies and years
- Energy consumption by technologies and years

Model analysis on CO2 reduction policy

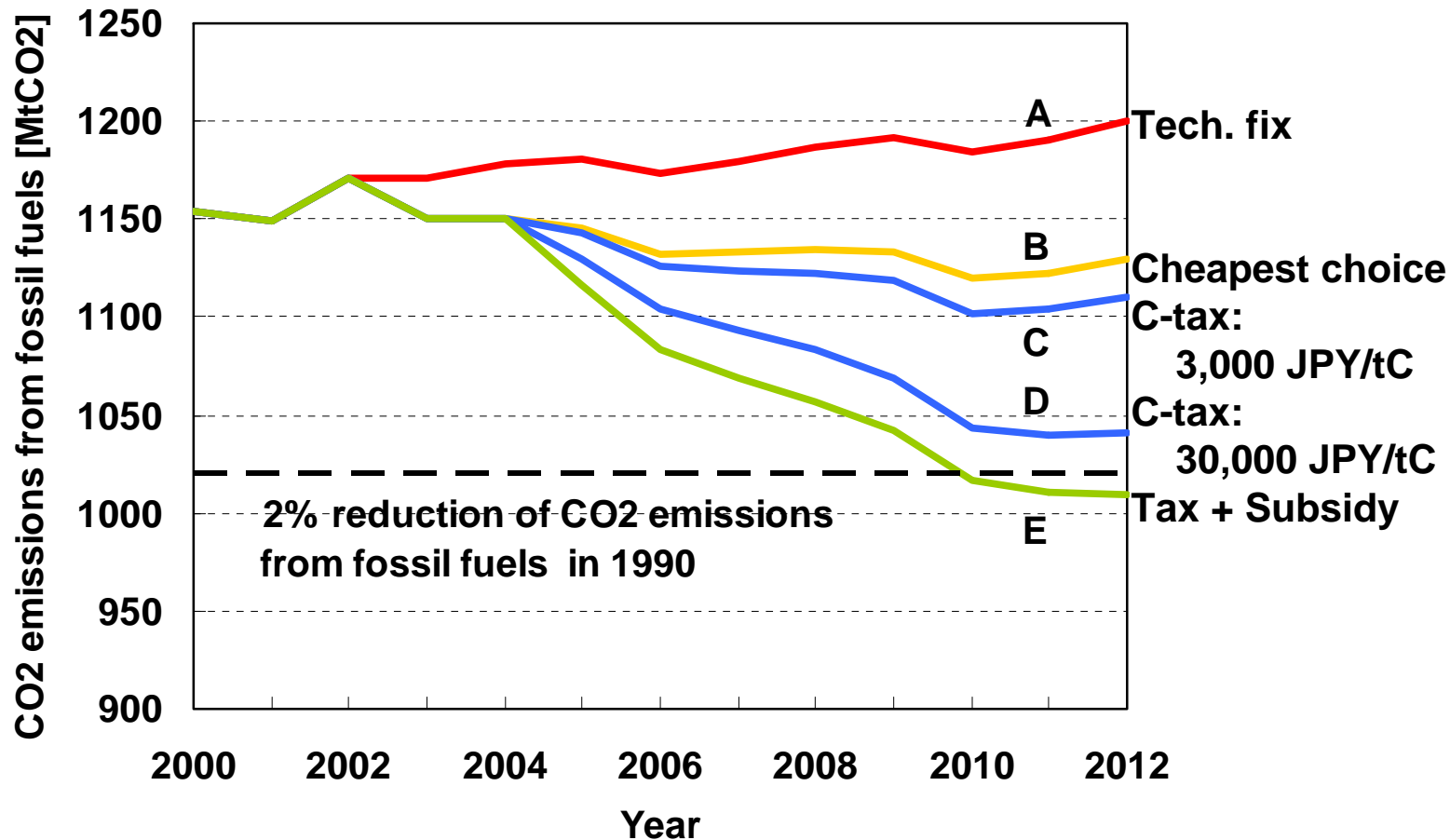
-Bottom-up model approach in Japan -

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-



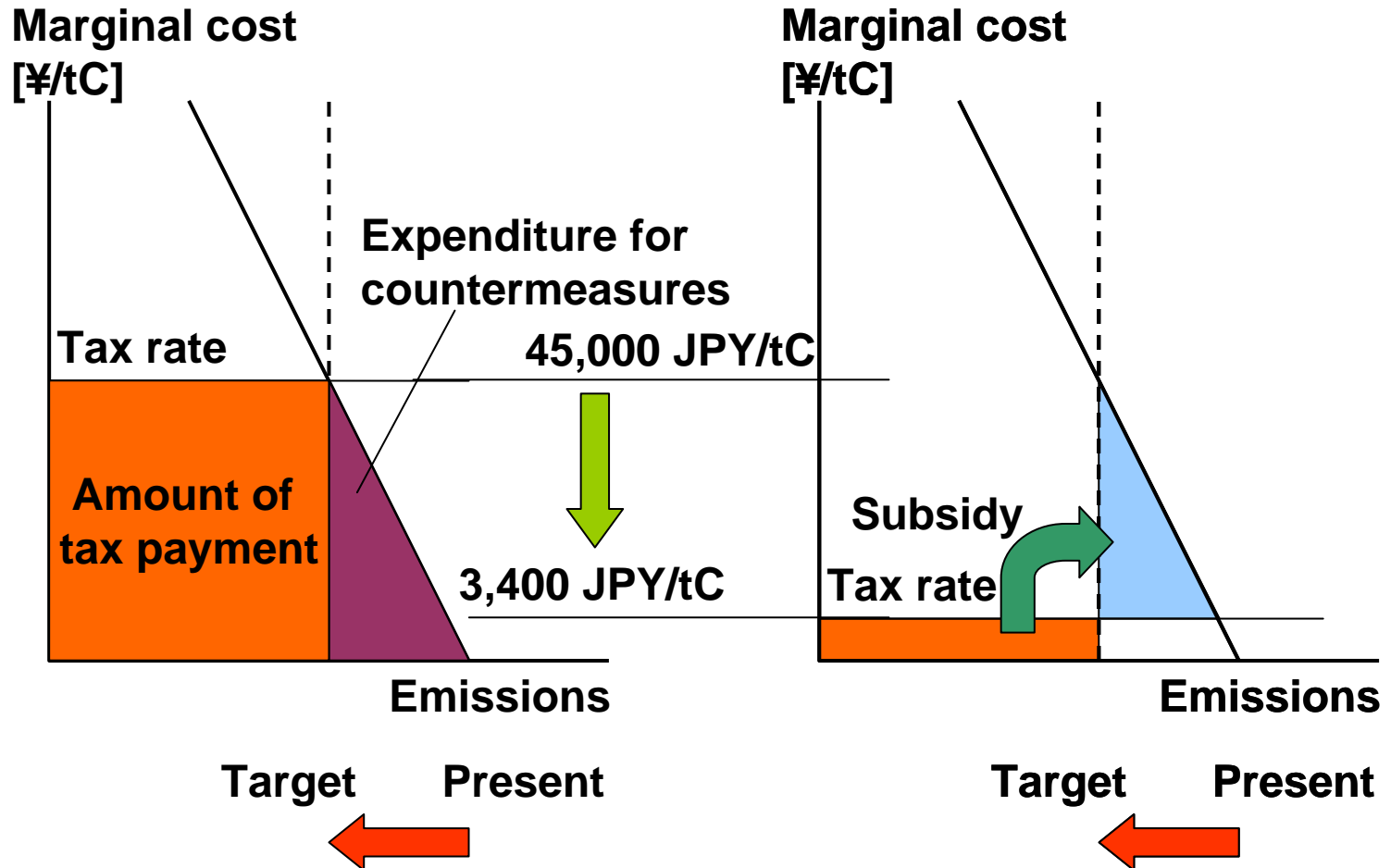
CO2 emissions trajectories by scenarios



Model analysis on CO2 reduction policy

-Bottom-up model approach-

CO2 reduction
in Japan
Model analysis
AIM/Enduse
AIM/Top-down
AIM/Material
Conclusion



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 truck	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/>

The screenshot shows a Microsoft Internet Explorer browser window displaying the homepage of the Asian-Pacific Integrated Model (AIM). The browser's address bar shows the URL <http://www-iam.nies.go.jp/aim/index.htm>. The page title is "Asian-Pacific Integrated Model". Below the title, it states "Last updated : March 22, 2004". A navigation menu on the left side includes links for Information, Team, Workshop, Reports, Data Library, and Links. A large image of a sunset over the ocean with a sailboat is featured. Below the image, a paragraph describes the AIM as a large-scale computer simulation model developed by the National Institute for Environmental Studies in collaboration with Professor Matsuoka, Kyoto University and several research institutes in the Asian-Pacific region. The AIM assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and avoiding the impacts of climate change.

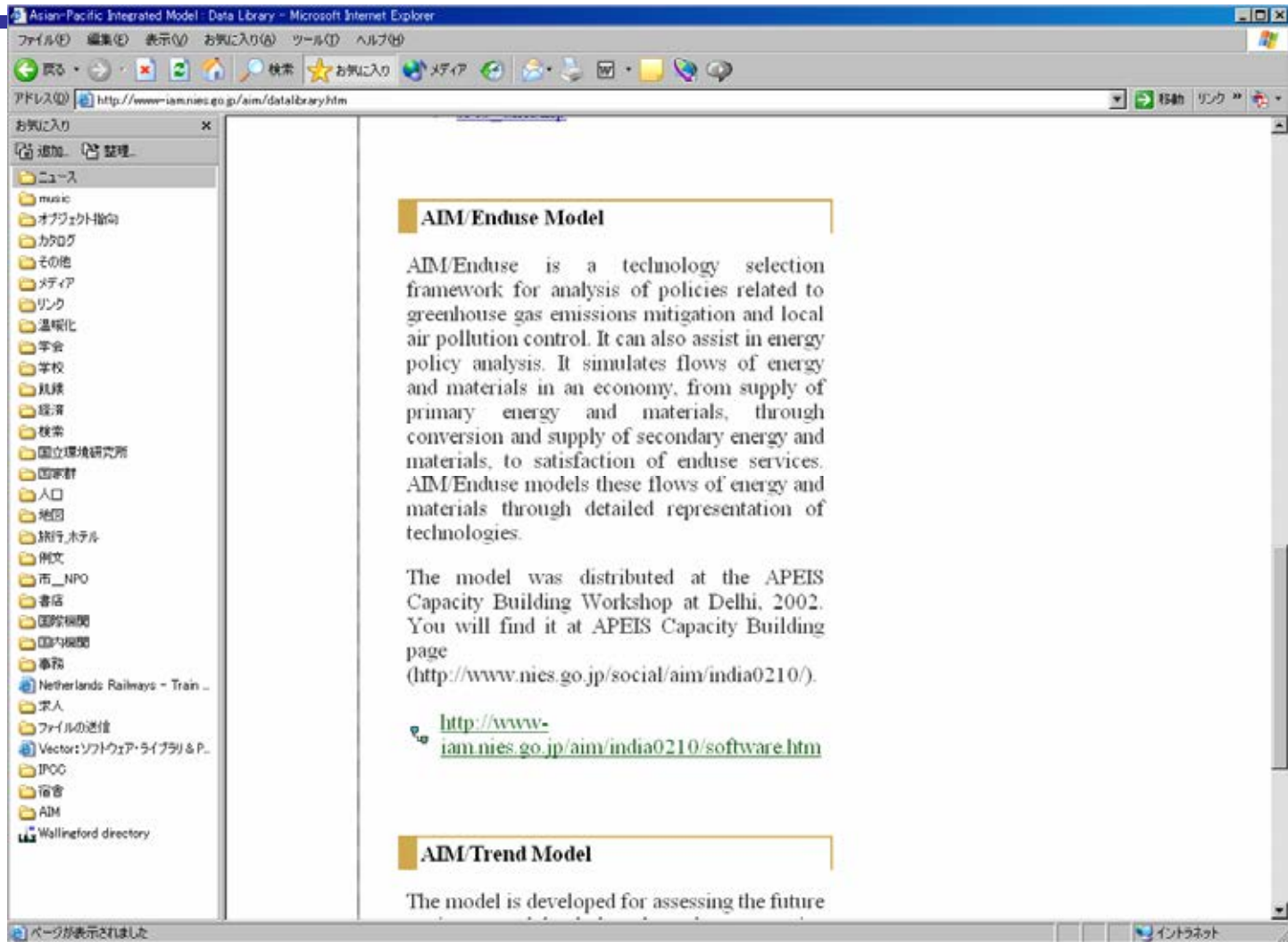
Asian-Pacific Integrated Model

Last updated : March 22, 2004

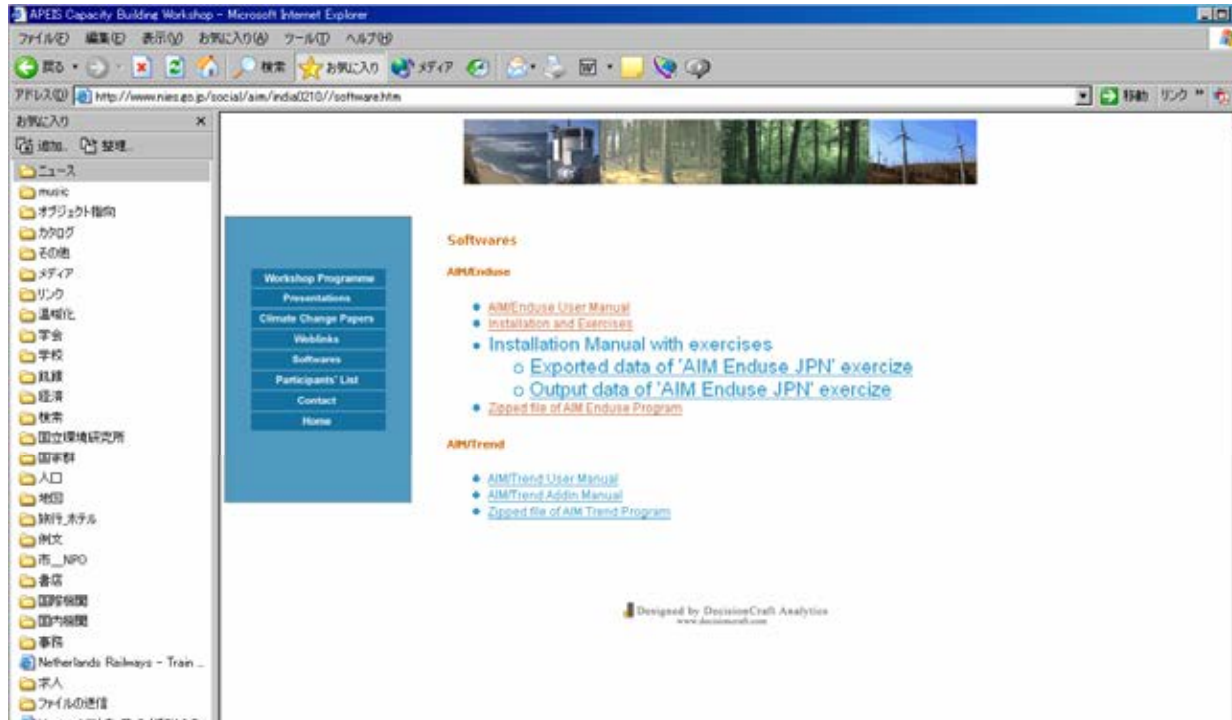
Information
Team
Workshop
Reports
Data Library
Links

The Asian Pacific Integrated Model (AIM) is a large-scale computer simulation model developed by the National Institute for Environmental Studies in collaboration with Professor Matsuoka, Kyoto University and several research institutes in the Asian-Pacific region. The AIM assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and avoiding the impacts of climate change.

AIM Home Page



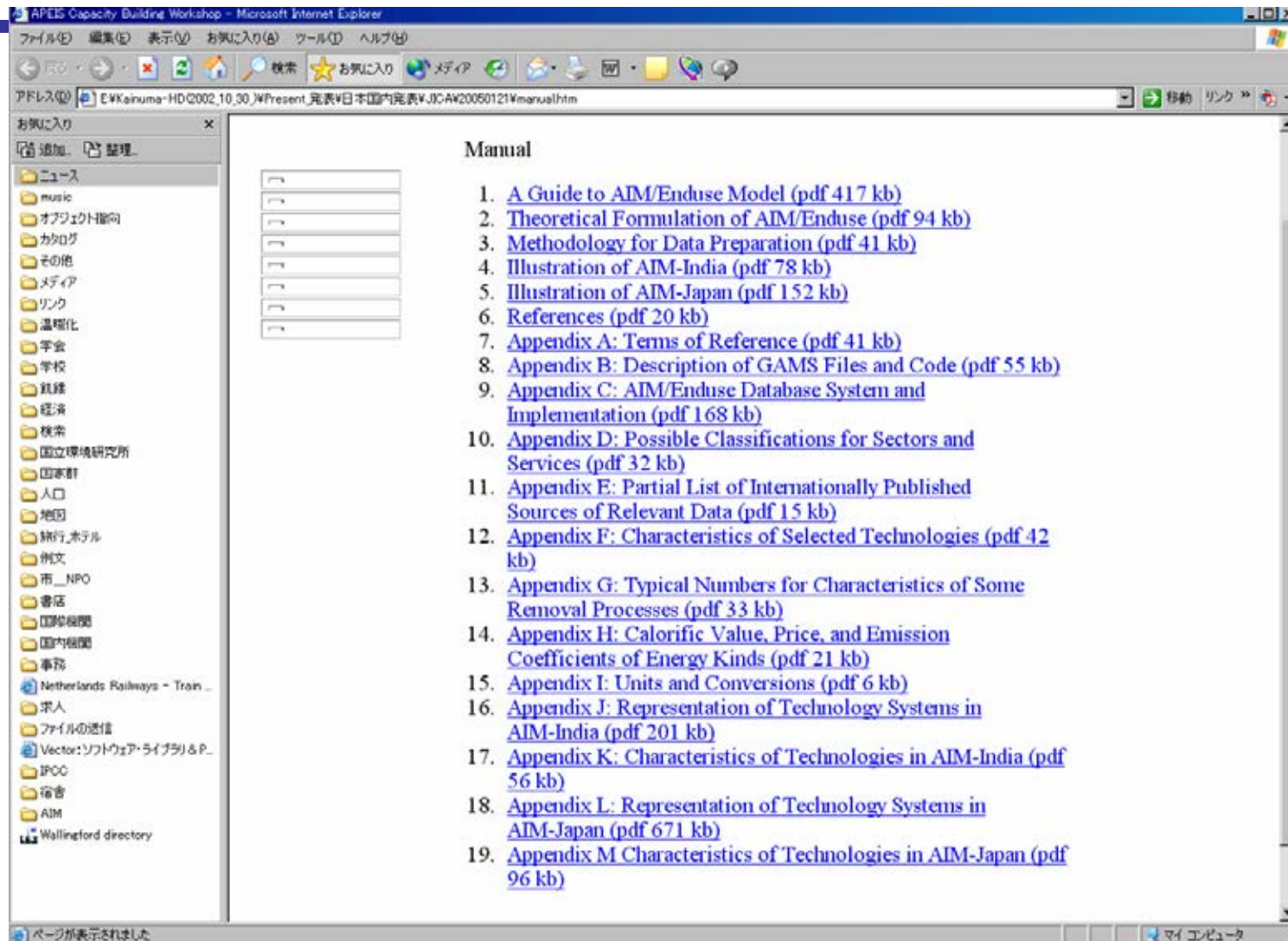
AIM Home Page



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



Structure of Manual



The screenshot shows a Microsoft Internet Explorer browser window with the title "APEIS Capacity Building Workshop - Microsoft Internet Explorer". The address bar shows the URL "E:\Kainuma-HD\2002_10_30_WPresent_発表4日本国内発表V.JGAW20050121Vmanual.htm". The browser interface is in Japanese. The main content area is titled "Manual" and contains a list of 19 items, each with a blue underlined link and a file size in parentheses. To the left of the list is a vertical sidebar with several empty rectangular boxes. The browser's left-hand pane shows a file explorer view with various folders and files, including "ニュース", "music", "オブジェクト指向", "カタログ", "その他", "メディア", "リンク", "温帯化", "学会", "学校", "直録", "経済", "検索", "国立環境研究所", "国策研", "人口", "地図", "旅行モデル", "例文", "市_NPO", "書店", "国研機関", "国内機関", "事務", "Netherlands Railways - Tran...", "求人", "ファイルの送信", "Vector:ソフトウェアライブラリ&P...", "IPCC", "宿舎", "AIM", and "Wallingford directory". The status bar at the bottom indicates "ページが表示されました" and "マイコンピュータ".

Manual

1. [A Guide to AIM/Enduse Model \(pdf 417 kb\)](#)
2. [Theoretical Formulation of AIM/Enduse \(pdf 94 kb\)](#)
3. [Methodology for Data Preparation \(pdf 41 kb\)](#)
4. [Illustration of AIM-India \(pdf 78 kb\)](#)
5. [Illustration of AIM-Japan \(pdf 152 kb\)](#)
6. [References \(pdf 20 kb\)](#)
7. [Appendix A: Terms of Reference \(pdf 41 kb\)](#)
8. [Appendix B: Description of GAMS Files and Code \(pdf 55 kb\)](#)
9. [Appendix C: AIM/Enduse Database System and Implementation \(pdf 168 kb\)](#)
10. [Appendix D: Possible Classifications for Sectors and Services \(pdf 32 kb\)](#)
11. [Appendix E: Partial List of Internationally Published Sources of Relevant Data \(pdf 15 kb\)](#)
12. [Appendix F: Characteristics of Selected Technologies \(pdf 42 kb\)](#)
13. [Appendix G: Typical Numbers for Characteristics of Some Removal Processes \(pdf 33 kb\)](#)
14. [Appendix H: Calorific Value, Price, and Emission Coefficients of Energy Kinds \(pdf 21 kb\)](#)
15. [Appendix I: Units and Conversions \(pdf 6 kb\)](#)
16. [Appendix J: Representation of Technology Systems in AIM-India \(pdf 201 kb\)](#)
17. [Appendix K: Characteristics of Technologies in AIM-India \(pdf 56 kb\)](#)
18. [Appendix L: Representation of Technology Systems in AIM-Japan \(pdf 671 kb\)](#)
19. [Appendix M Characteristics of Technologies in AIM-Japan \(pdf 96 kb\)](#)



Example of Marginal Abatement Cost Analysis

Software: Enduse_MAC_050119.mdb

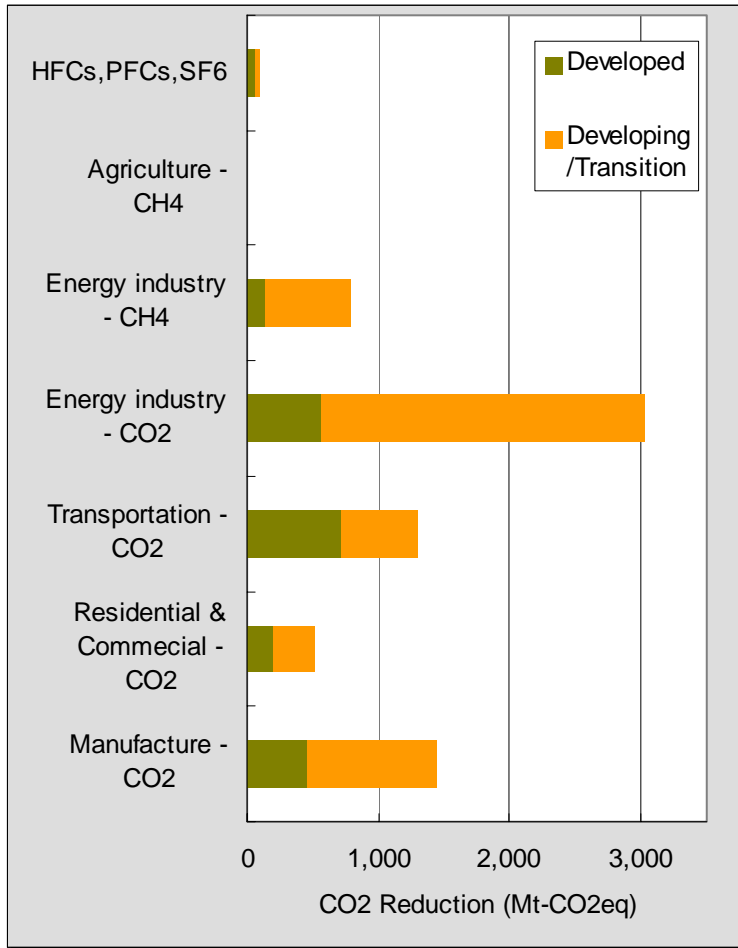
Is there enough potential in 2020?

Mt-CO2

Discount rate		5%			33%(Private), 10%(Public)		
		< 0	< 100	< 300	< 0	< 100	< 300
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	22 53

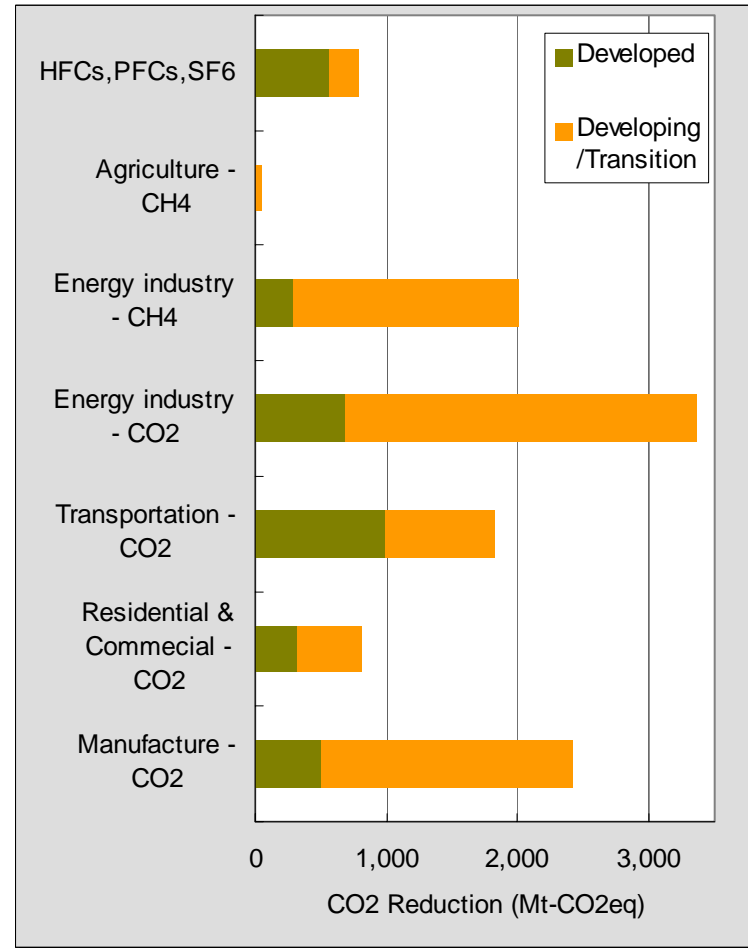
Reduction potential in Developed and Developing/Transition Economies

Developed



< US\$ 0, 2020

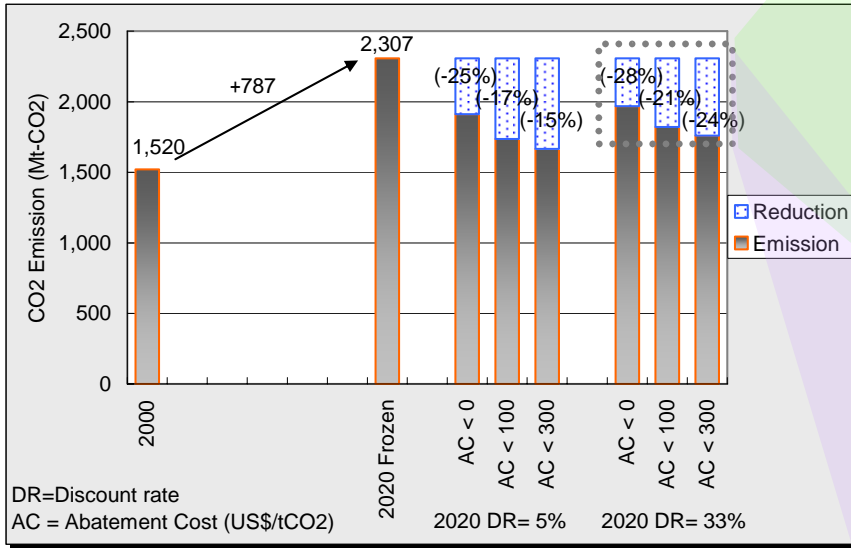
Developing/Transition



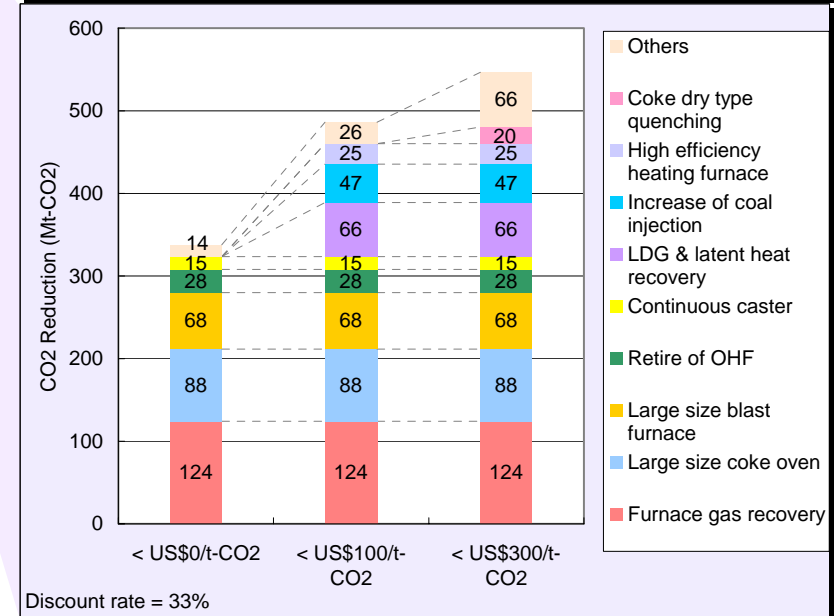
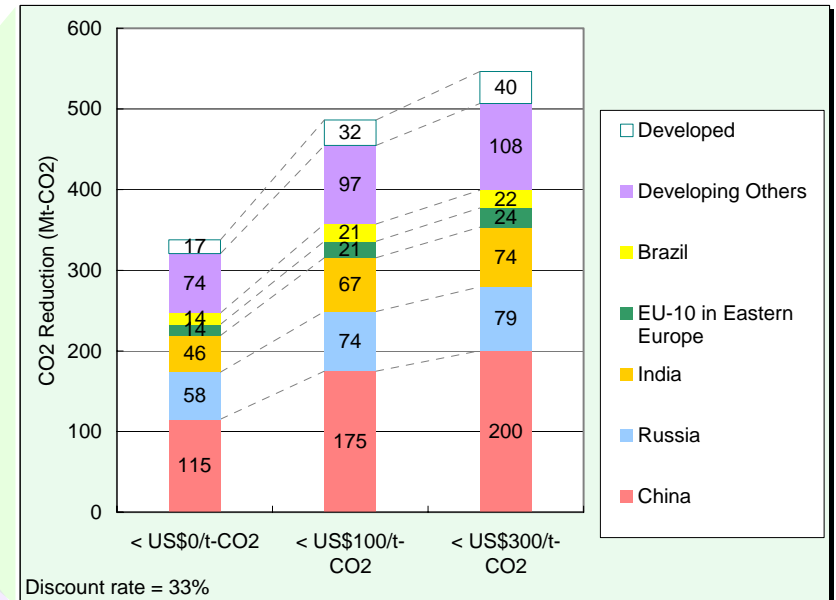
< US\$ 100, 2020

Discount rate = 5% (Private & Public)

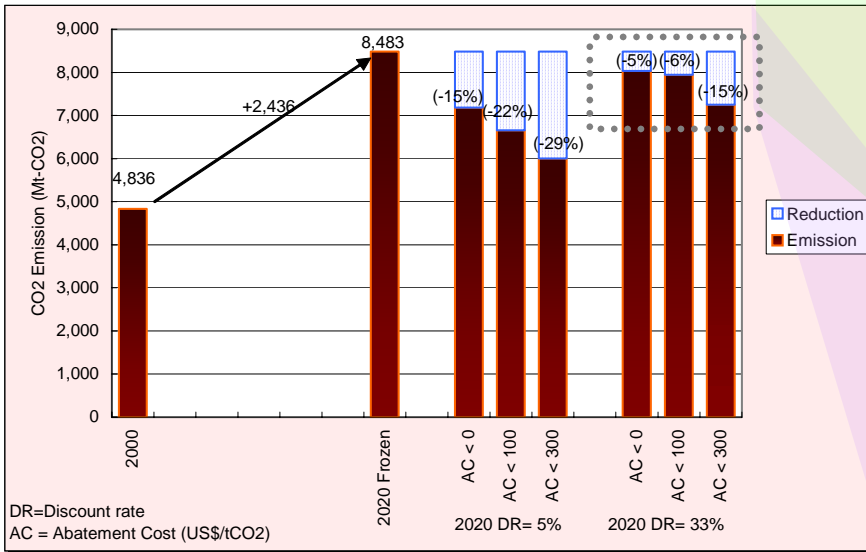
Reduction potential from steel sector in 2020



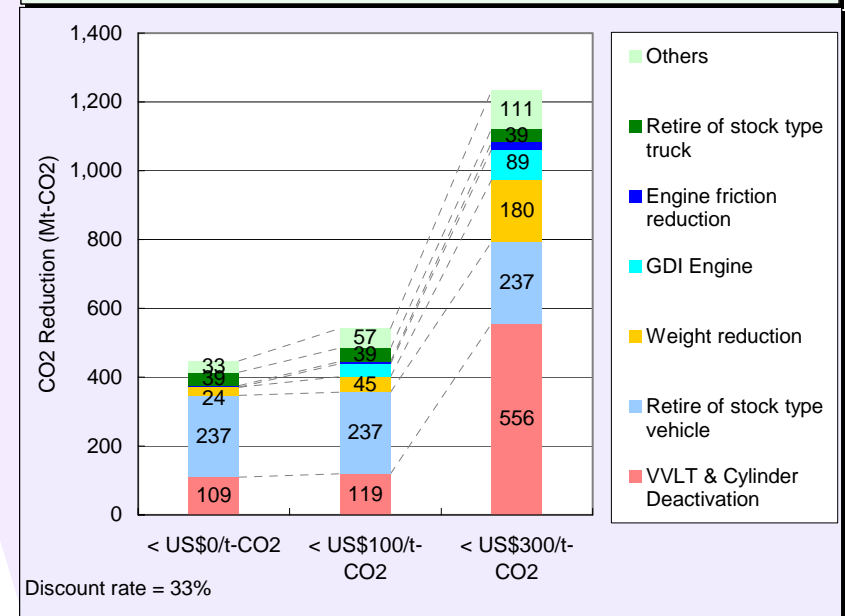
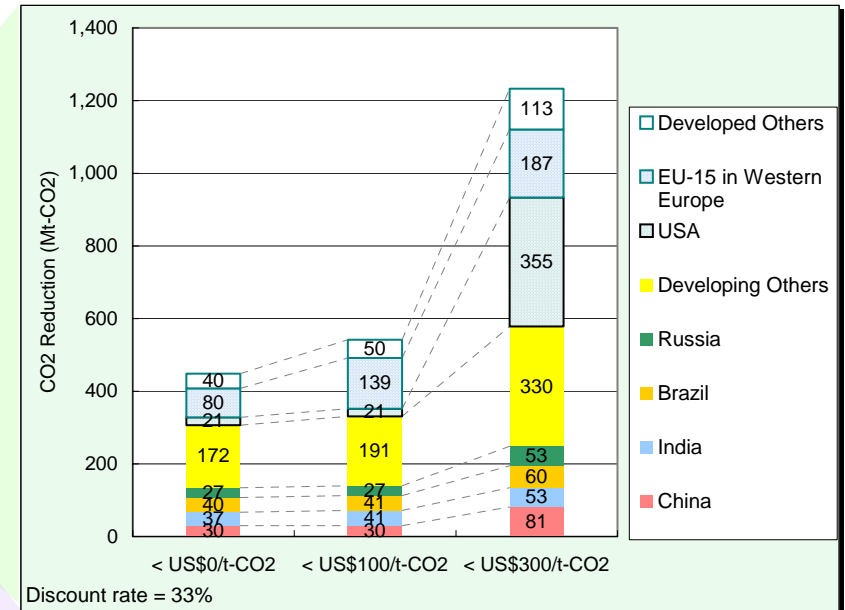
Discount Rate	Abatement Cost US\$/tCO2	CO2 Reduction	
		Mt-CO2	vs frozen
33%	less than 0	338	15%
	less than 100	486	21%
	less than 300	546	24%
5%	less than 0	395	17%
	less than 100	571	25%
	less than 300	642	28%



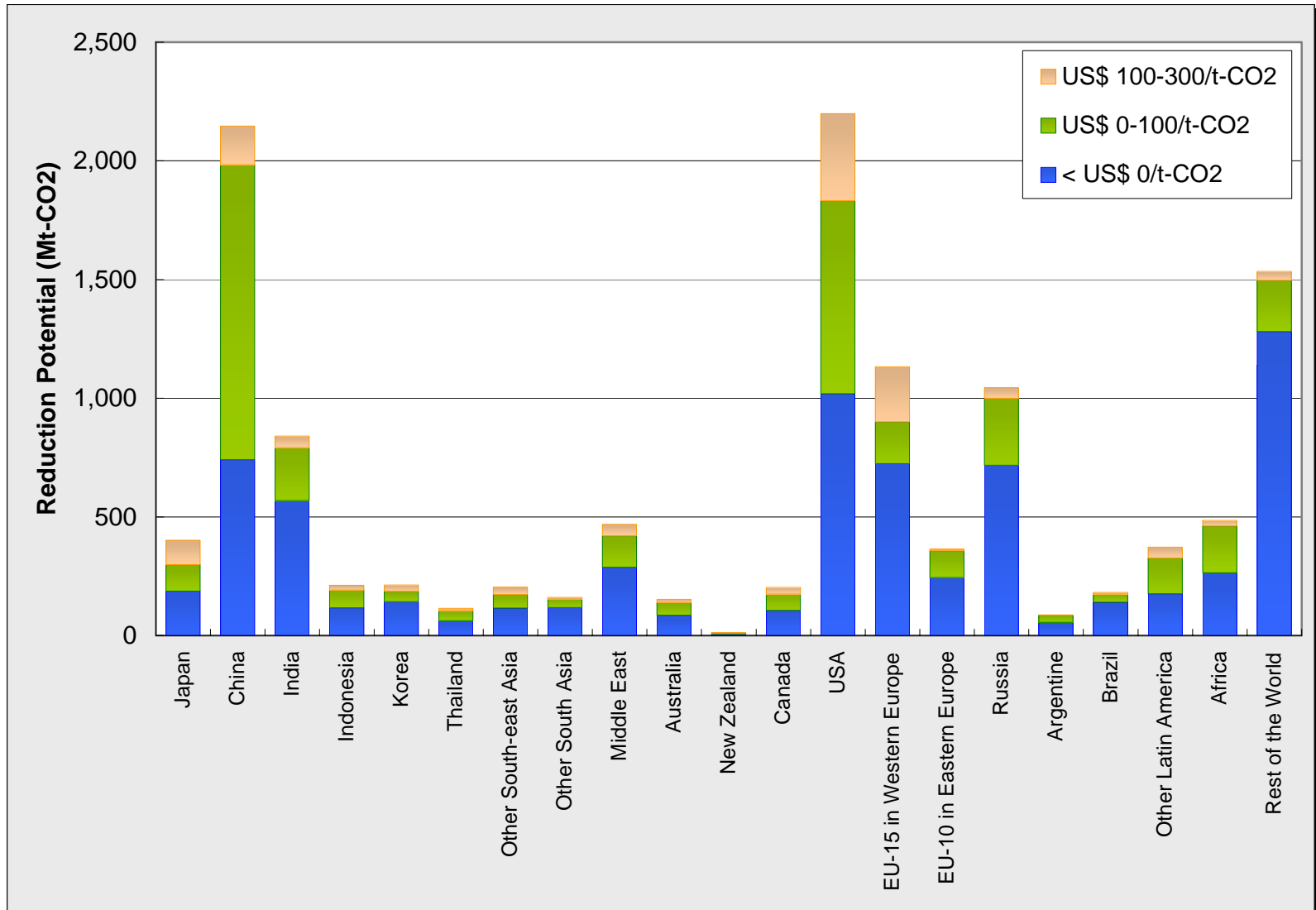
Reduction potential from transportation sector in 2020



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

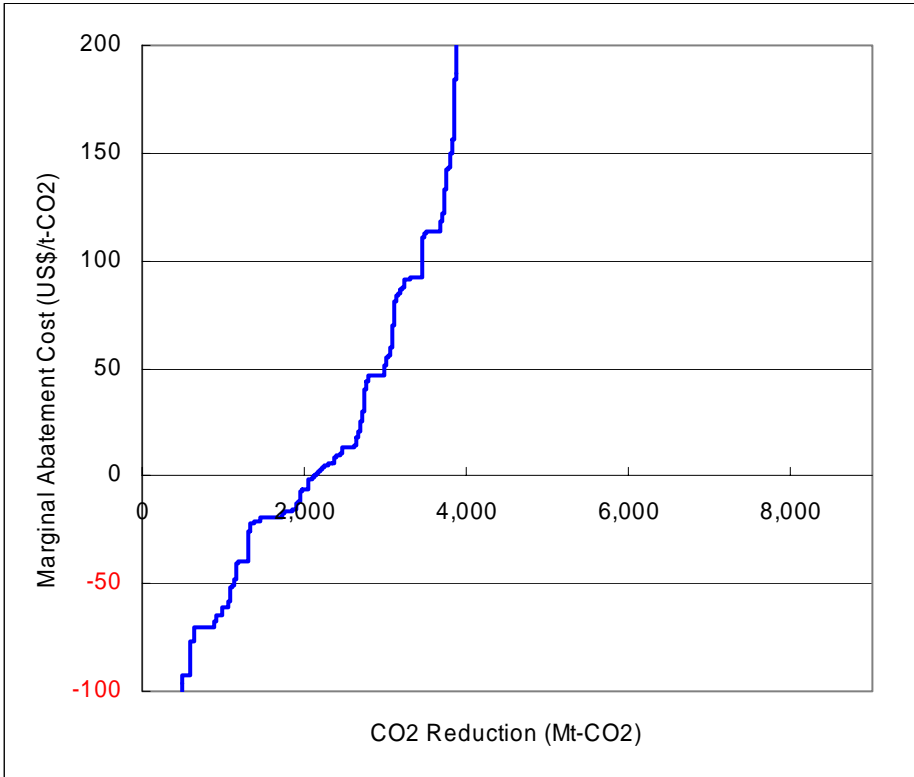
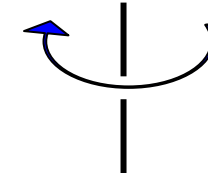
Developed	(MtCO ₂)	Developing/Transition	(MtCO ₂)
High efficiency gasoline engine (VVL, GDI etc)	632	Existing type of power plant (coal ,gas)	2,462
Existing type of power plant (coal ,gas)	546	Use of instrument air, low bleed pneumatic devices*	676
Inverter control for motor	216	Gas high efficiency industrial 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

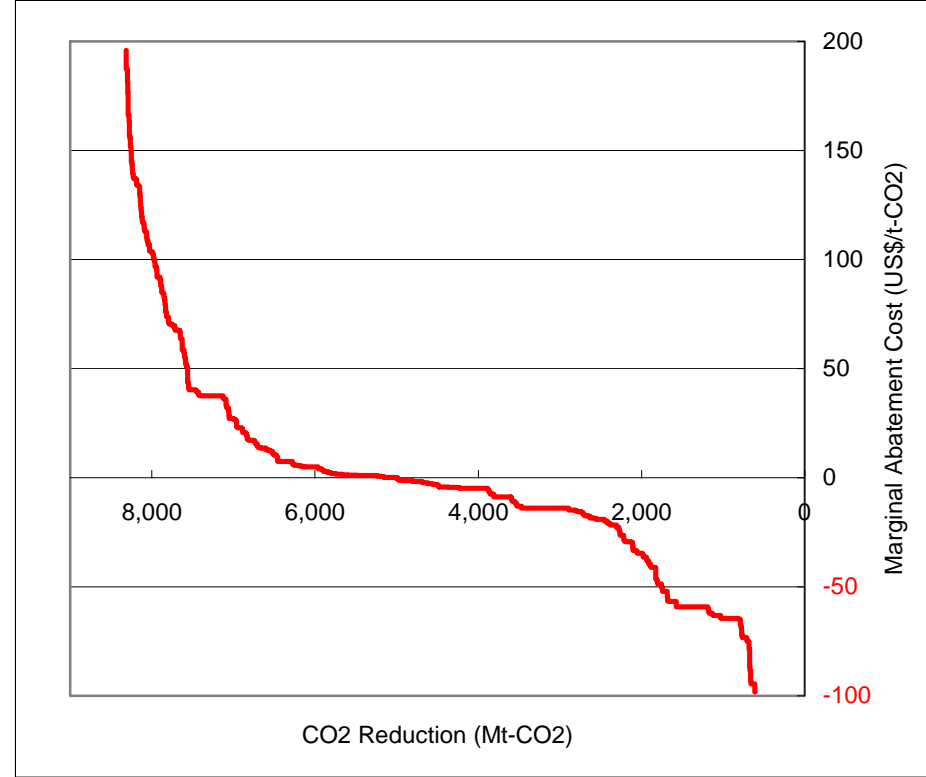
** Recovery of CH₄ in coal mine

Discount rate = 5%

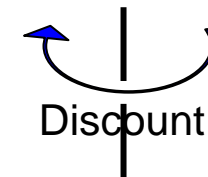
Marginal abatement cost of developed and developing/transition economies



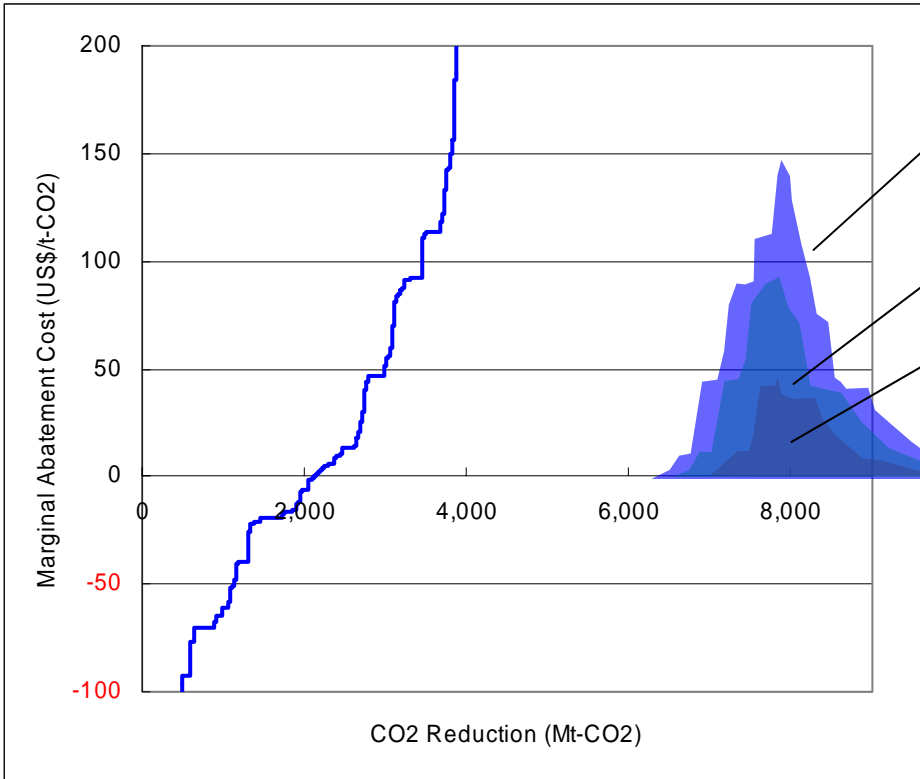
Developed



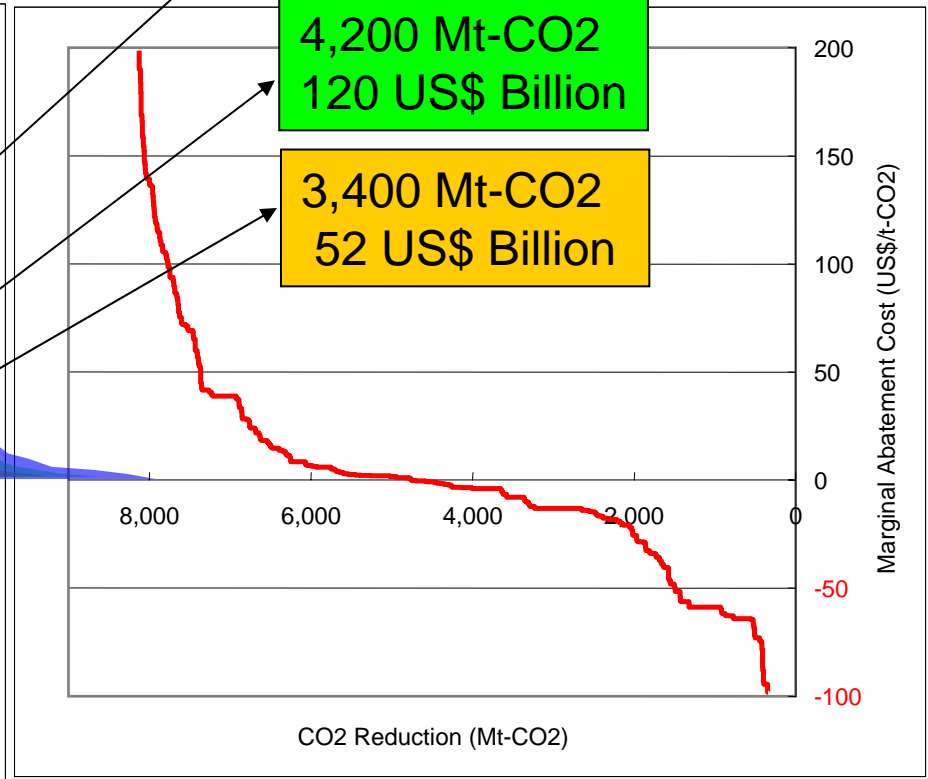
Developing/Transition



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 (CO₂, SO₂, 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.**

