

東京大学教養学部

2008年度冬学期

## 地球温暖化と経済学

### 第19—20回 地球温暖化（その8 中長期目標とポスト京都の枠組み）

山口 光恒

#### 1、温暖化の究極目標

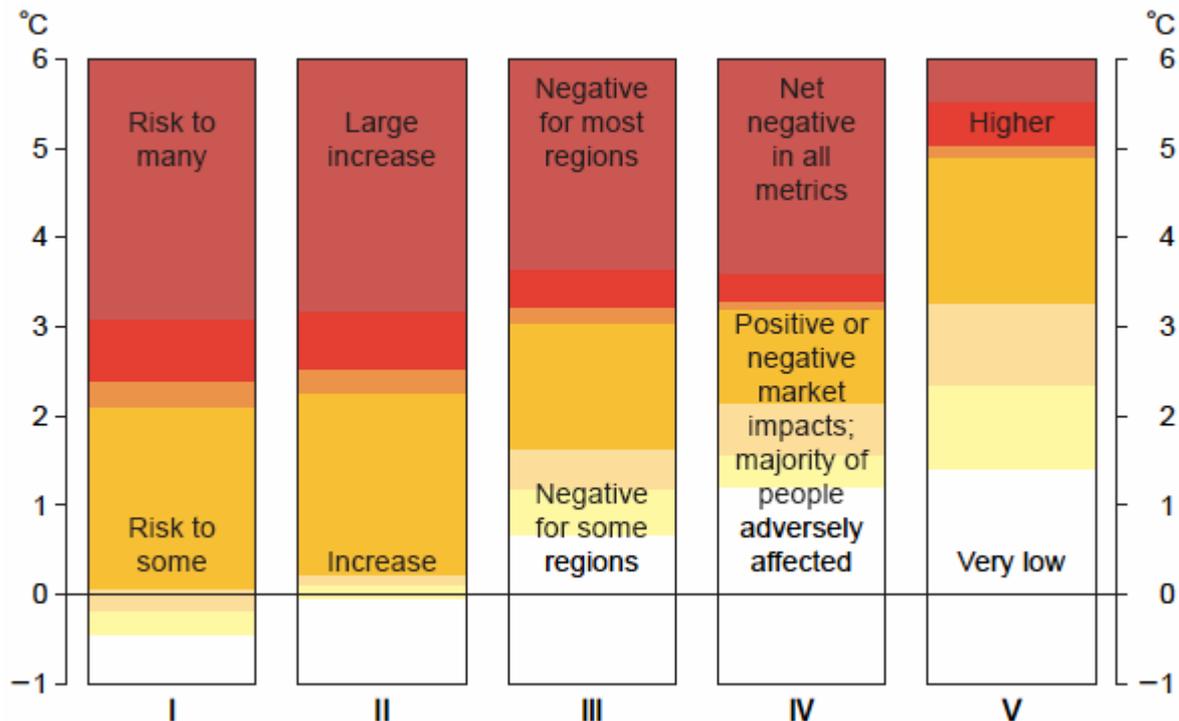
気候変動枠組み条約の目的

The ultimate objective of this Convention -- is to achieve -- stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

危険な人為的干渉（Dangerous Anthropogenic Interference）とは何か

危険とは何か、誰にとっての危険か、どの程度の危険か

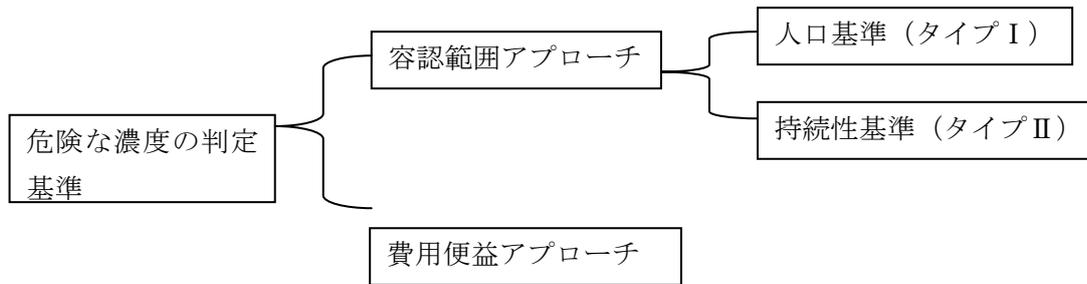
第1図 気温上昇とその影響（影響カテゴリー別）



(出所) IPCC (2001), p. 11.

Iは「種の多様性や自然システムに対するリスク」、IIは「極端な気候現象によるリスク（洪水、干ばつなど）」、IIIは「影響の地理的範囲（衡平性関連）」、IVは「損害の総和」、Vは「大規模かつ不連続な事象発生リスク」。前者（II、III、IV）をタイプI、後者（I、V）をタイプIIと呼ぶ。

#### 1) DAI 定義の試み



容認範囲アプローチ tolerable windows approach、以下TWA

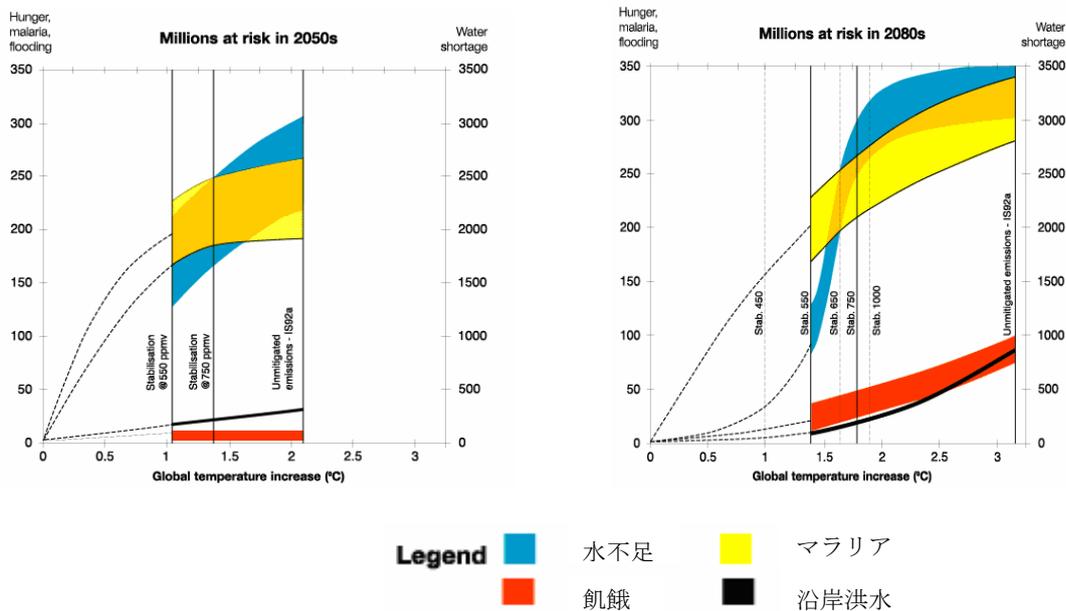
影響を受ける人の数を基準とする (タイプ I のリスク)

Millions at risk, But ---

濃度・気温上昇により新たにリスクにさらされる人口 (単位百万人)

(図 2-1) 2050 年代

(図 2-2) 2080 年代



”Millions at risk, defining critical climate change threats and targets”, Parry et al. Global Environmental Change 11 (2001) より。横軸は気温上昇 (1961-1990 年平均対比)、縦軸は人口、単位百万人 (それぞれの図の右側の単位は水不足、左側はマラリア・沿岸洪水・飢餓に新たにさらされる人口)。図中の縦線は濃度安定化水準、縦線が横軸と接する場所の気温は当該濃度安定化の場合の気温上昇。実線の幅はモデル計算による上限と下限、点線は推測。基礎となる (特段の対策をとらない場合の) シナリオは IS92a。

### 持続性基準 Sustainable Approach

大規模かつ不連続な事象 (熱塩循環停止、西部南極氷床崩壊など) のように、持続可能性を危うくするリスクに着目 (タイプ II のリスク)

費用便益分析 (講義 17 レジюме参照)

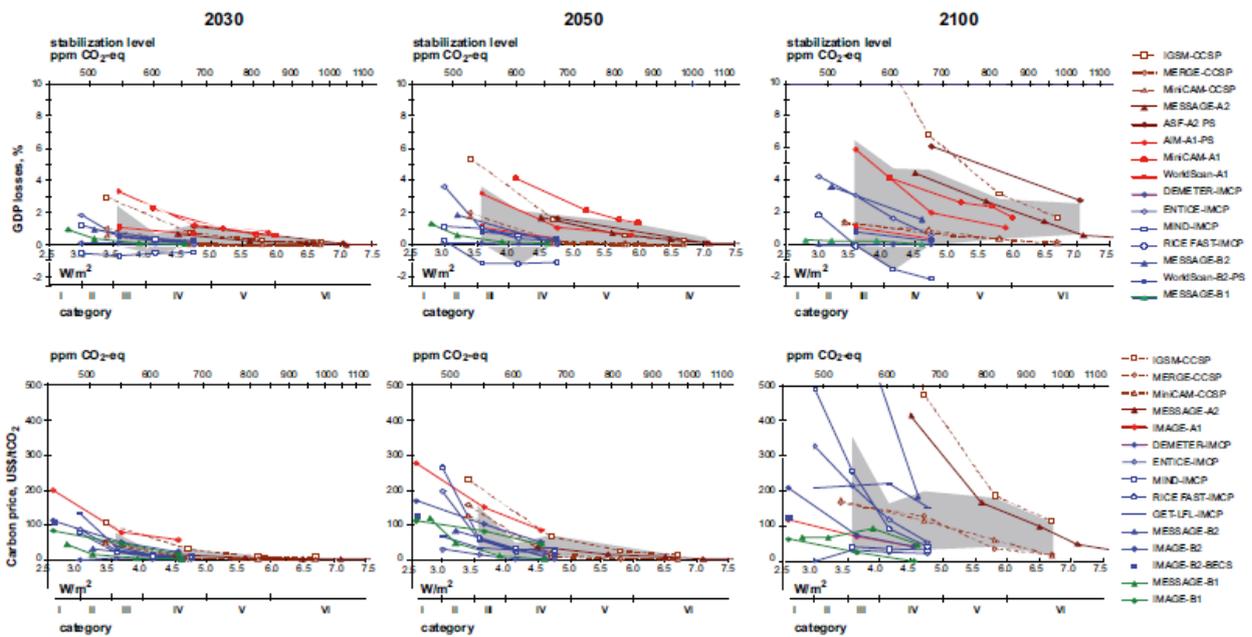
2) EUの2℃目標とその意味

Given the serious risk of such an increase and particularly the very high rate of change, the Council believes that the global average temperatures should not exceed 2 degrees above pre-industrial level and that therefore concentration levels lower than 550 ppm CO<sub>2</sub> should guide global limitation and reduction efforts. This means that the concentrations of all greenhouse gases should also be stabilized. (EU Council 1996)

REAFFIRMS that, with a view to meeting the ultimate objective of the United Nations Framework Convention on Climate Change ("the Convention") to prevent dangerous anthropogenic interference with the climate system, overall global annual mean surface temperature increase should not exceed 2oC above pre-industrial levels in order to limit high risks, including irreversible impacts of climate change; RECOGNISES that 2°C would already imply significant impacts on ecosystems and water resources; (EU Council, Oct. 14, 2004) コストの概念無し

Climate change adversely affects sustainable development. Conversely costly mitigation measures could have adverse effects on economic development (IPCC 2007a, 2007b)

安定化濃度とコスト



3) 究極目標の考え方

CO <sub>2</sub> 濃度 (ppm)	GHG濃度 (ppm)	気温上昇幅 (工業化後、℃)	CO <sub>2</sub> 排出ピーク年	CO <sub>2</sub> 削減率 2050/2000 (%)	削減コスト 対GDP (%)	損害	シナリオ数
350-400	445-490	2.0-2.4	2000-2015	-85~-50	5.5未満		6
400-440	490-535	2.4-2.8	2000-2020	-60~-30			18
440-485	535-590	2.8-3.2	2010-2030	-30~+5			21
485-570	590-710	3.2-4.0	2020-2060	+10~+60	0.5(-1~2)	GDPの1~5%	118
570-660	710-855	4.0-4.9	2050-2080	+25~+85	—		9
660-790	855-1130	4.9-6.1	2060-2090	+90~+140	—		5

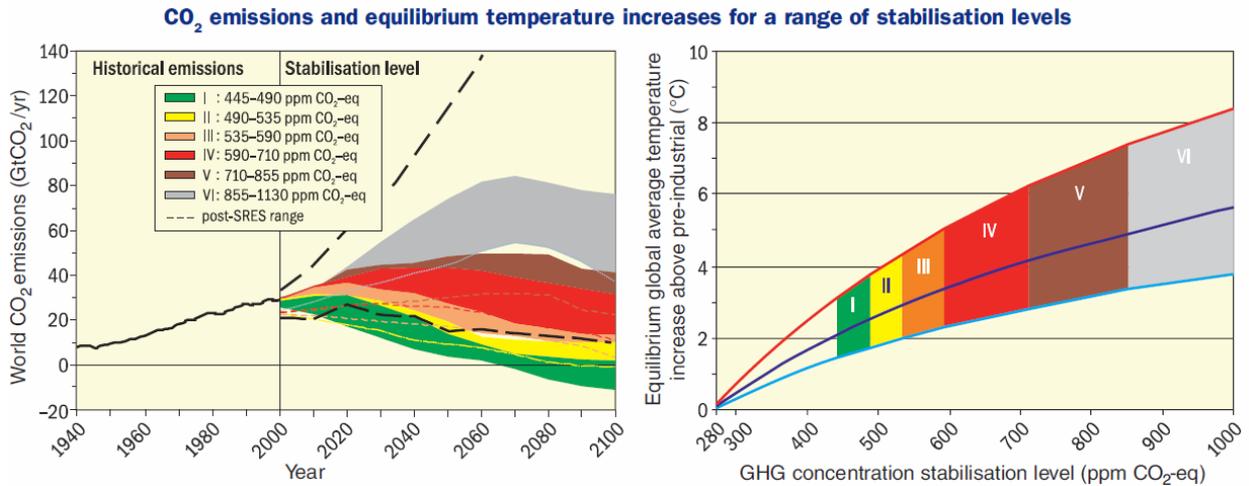
IPCC AR4 WG2 SPM P.20 及び WG3 SMP Table 5 及び 6 から作成

4) 日本としての考え方の確立

フェニックスプロジェクトでは550ppmCO<sub>2</sub>only  
<http://www.rcast.u-tokyo.ac.jp/ja/news/2008/0708/pdf/05.pdf>

## 2、2050年半減の意味（長期目標）

### 1）安定化に向けた大幅削減の必要性



IPCC (2007c) p.21

### 2）日本の半減目標の根拠（後に取り下げ） 2007年5月安倍首相

現時点で排出が吸収の2倍、従って排出を半減する

日本学術会議のスタンス

気候変動枠組条約に規定されている究極目標を達成するためには、長期的に大幅な排出削減を行わなくてはならず、最終的には50%を大幅に上回る削減が必要である。G8サミット等において2050年までに温室効果ガスを50%削減する目標が提起されているが、このような大幅な削減を実現するには、技術的にも社会経済的にも多くの難しい課題がある。

<http://www.sci.go.jp/ja/info/iinkai/chikyuu/summary.pdf>

### 3）洞爺湖サミットでの半減目標の扱い

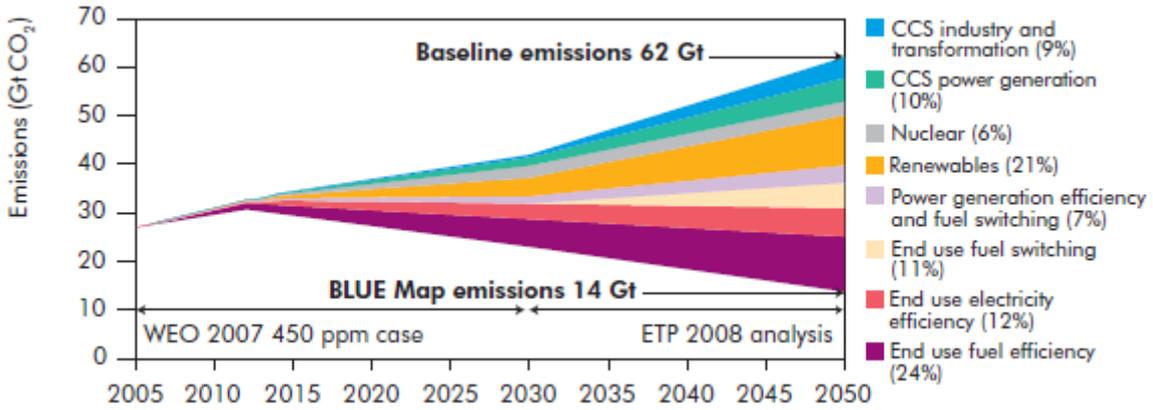
<http://premium.nikkeibp.co.jp/em/column/yamaguchi/32/05.shtml#top>

### 4）半減目標の意味（RITE DNA21+モデルによる）

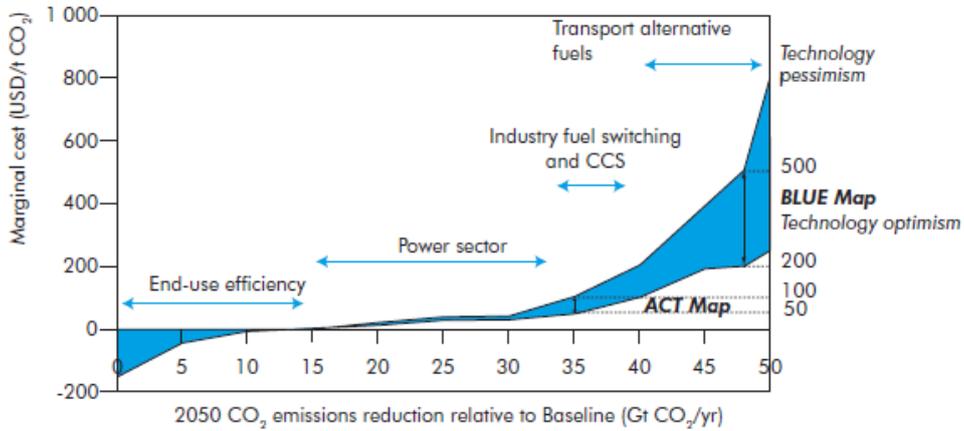
	2000 Actual E (MtCO <sub>2</sub> )	2050 BAU		50% reduction in 2050 Case 1 (Zero E. for Annex I)			50% reduction in 2050 Case 2 (20% E. for Annex I)		
		Emission (MtCO <sub>2</sub> )	Ratio (%)	Emission (MtCO <sub>2</sub> )	Ratio to 2000 (%)	Ratio to BAU (%)	Emission (MtCO <sub>2</sub> )	Ratio to 2000 (%)	Ratio to BAU (%)
	A	B	B/A	C	C/A	C/B	D	D/A	D/B
Annex I	13507	17391	128.8	0	—	—	2701	20.0	15.5
Non A. I	9151	30928	348.9	11329	123.8	36.6	8628	94.3	27.9
Total	22658	48319	213.3	11329	50.0	23.4	11329	50.0	23.4

2005年の排出実績値は27658Mt（2000年比22%増）

IEAの研究 (IEA 2008) 削減技術 p.41



IEAの研究 (IEA 2008) 削減コスト p.39



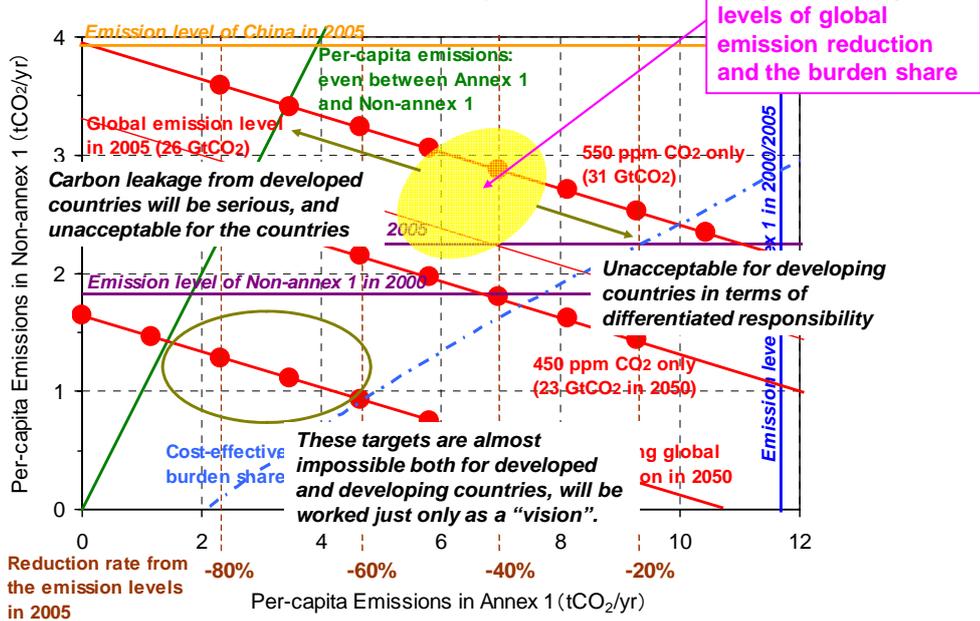
ACT Scenario: 2050年排出量が現状に等しくなる。Blue Scenario: 2050年半減

RITE秋元氏の提案 (2008.6.30-7.1東大における中長期対策国際会議)

## Emission Reduction Targets in Reality in Terms of Global Agreement in 2050



### Per-capita Emissions for Global Targets



### 3、中期目標

2020年の先進国の排出量を1990年対し30%削減（EUのみなら20%削減） 2007.3  
 バリ島（COP13）で突然浮上した先進国大幅削減案

Scenario category	Region	2020	2050
A-450 ppm CO <sub>2</sub> -eq <sup>1</sup>	Annex I	-25% to -40%	-80% to -95%
	Non-Annex I	Substantial deviation from baseline in Latin America, Middle East, East Asia and Centrally-Planned Asia	Substantial deviation from baseline in all regions
B-550 ppm CO <sub>2</sub> -eq	Annex I	-10% to -30%	-40% to -90%
	Non-Annex I	Deviation from baseline in Latin America and Middle East, East Asia	Deviation from baseline in most regions, especially in Latin America and Middle East
C-650 ppm CO <sub>2</sub> -eq	Annex I	0% to -25%	-30% to -80%
	Non-Annex I	Baseline	Deviation from baseline in Latin America and Middle East, East Asia

IPCC (2007b) p. 776

京都議定書AWG採択文書と政府、民主党の誤解

--- the AWG recognized that the contribution of Working Group III to the AR4 indicates that achieving the lowest levels assessed by the IPCC to date and its corresponding potential damage limitation would require Annex I Parties as a group to reduce emissions in a range of 25–40 per cent below 1990 levels by 2020, ---

民主党福山議員宛メール 2008.5.29

添付文書の5頁目の黄色のマーカーの箇所をご覧頂きたいのですが、

1、はじめのところはAWGがIPCCのシナリオレンジが有用と認識し、IPCC報告書がIPCC評価シナリオの最低水準で安定化するには、10-15年後にピークアウトし、2050年までに2000年の排出量を5割以上削減する必要があることを示唆している（示唆の主語はIPCC報告書です）

2、AWGは評価シナリオの最低水準を実現するにはAnnex 1諸国が2020年に1990年対比25-40%削減の必要があると示唆しているIPCC第4次報告の貢献を認識する（recognize）

と言う内容に合意しているだけです。

バリアクションプラン こちらはUNFCCC（アメリカが参加）

*Recognizing that deep cuts in global emissions will be required to achieve the ultimate objective of the Convention and emphasizing the urgency<sup>1</sup> to address climate change*

日本の中期目標は2009年のいずれかの時期に公表

EU：2020年に90年比20% (unilateral) or 30% (in case of treaty) 削減

アメリカは2025年にピークアウト（2008.4.16 President Bush's speech）

<sup>1</sup> Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Technical Summary, pages 39 and 90, and Chapter 13, page 776.

この場合、世界が2030年にピークアウトするために必要な先進国・途上国の削減分担組み合わせ（ベースライン比。ただし括弧内は2005年比）RITE秋元氏による試算

先進国 (附属書I国)	▲23% (1%)	▲28% (▲5%)	▲32% (▲11%)	▲36% (▲17%)
途上国 (非附属書I国)	▲46% (▲2%)	▲40% (9%)	▲34% (20%)	▲28% (31%)

注) 2030年のピーク排出量が約33GtCO<sub>2</sub>の場合。様々なピーク排出量が行われるためあくまで目安と考えるべきである。

米国以外の附属書 I国	▲37% (▲10%)	▲44% (▲20%)	▲51% (▲30%)	▲58% (▲40%)
米国	▲12% (16%)	▲12% (16%)	▲12% (16%)	▲12% (16%)

#### 4、ポスト京都の枠組み

日本（安倍3原則）

主要排出国全ての参加、各国固有の事情の尊重、環境と経済の両立

#### IPCCの評価

Table 13.3: Assessment of international agreements on climate change.<sup>45</sup>

Approach	Environmental effectiveness	Cost-effectiveness	Meets distributional considerations	Institutional feasibility
National emission targets and international emission trading (including offsets)	Depends on participation and compliance.	Decreases with limited participation and reduced gas and sector coverage.	Depends on initial allocation.	Depends on capacity to prepare inventories and compliance. Defections weaken regime stability.
Sectoral agreements	Not all sectors amenable to such agreements, thereby limiting overall effectiveness. Effectiveness depends on whether agreement is binding or non-binding.	Lack of trading across sectors increases overall costs, although they may be cost-effective within individual sectors. Competitive concerns reduced within each sector.	Depends on participation. Within-sector competitiveness concerns are alleviated if treated equally at global level.	Requires many separate decisions and technical capacity. Each sector may require cross-country institutions to manage agreements.
Coordinated policies and measures	Individual measures can be effective; emission levels may be uncertain; success will be a function of compliance.	Depends on policy design.	Extent of coordination could limit national flexibility, but may increase equity.	Depends on the number of countries (easier among smaller groups of countries than at the global level).
Cooperation on Technology RD&D <sup>a</sup>	Depends on funding, when technologies are developed and policies for diffusion.	Varies with degree of R&D risk. Cooperation reduces individual national risk.	Intellectual property concerns may negate the benefits of cooperation.	Requires many separate decisions. Depends on research capacity and long-term funding.
Development-oriented actions	Depends on national policies and design to create synergies.	Depends on the extent of synergies with other development objectives.	Depends on distributional effects of development policies.	Depends on priority given to sustainable development in national policies and goals of national institutions.
Financial mechanisms	Depends on funding selection criteria.	Depends on country and project type.	Depends on project and country.	Depends on national institutions.
Capacity building	Varies over time and depends on critical mass.	Depends on programme design.	Depends on selection of recipient group.	Depends on country and institutional frameworks.

1) 京都体制維持の可能性

利点

環境効果、効率性、議定書の実績

制度的問題点

絶対値目標（結果責任）とコスト、初期配分、  
資金の国家間移転、ホットエアーの発生不可避

実現可能性

途上国（及びアメリカ）の不参加→環境効果低下

エネルギー起源 CO<sub>2</sub> 排出量の見直し（単位：MtC/yr） 山口光恒・関根豪政（2005）

	1990年	2010年	2020年		2050年	
		BAU	BAU	締結国のみ (2010年より20%削減)	BAU	締結国のみ (1990年より60%削減)
世界合計	5,613.51	7,828.81	9,635.54	8,894.29 (-7.7%)◆	15,093.87	13,009.63 (-13.8%)◆
先進国	3,727.39	4,114.26	4,912.26	4,171.01	5,868.76	3,784.52
(議定書締結国)	(2,332.92)	(2,069.87)	(2,397.15)	(1,655.90) (-20%)★	(3,017.41)	(933.17) (-60%)★★
(アメリカ・豪州)	(1,394.47)	(2,044.39)	(2,515.11)	(2,515.11)	(2,851.35)	(2,851.35)
途上国	1,886.12	3,714.55	4,723.28	4,723.28	9,225.11	9,225.11

RITE,DNE21+のデータを基に筆者計算

◆ 同年の対BAU比 ★ 議定書締結国のみが2010年対比20%削減をした場合 \*\*同1990年対比60%削減した場合

結論：困難

2) Pledge and Reviewと環境効果

Pledge and Review Case 1

	Assumed Pledges
Japan	30% improvement of energy efficiency by 2030 (base year 2005)
EU27	20% reduction in 2020 (base year 1990) then linear 60% reduction in 2050
USA	20% reduction of gasoline consumption by 2017, 30% improvement of energy efficiency by 2015 then linearly toward 50% reduction in 2050
APEC	25% improvement of energy efficiency by 2030 (base year 2005)
China	Same as above
India	Same as above
Other Major Emitters	Same as above

Pledge and Review Case 2

日本のみMarginal Abatement Cost (MAC) をEUのプレッジと等しくした。

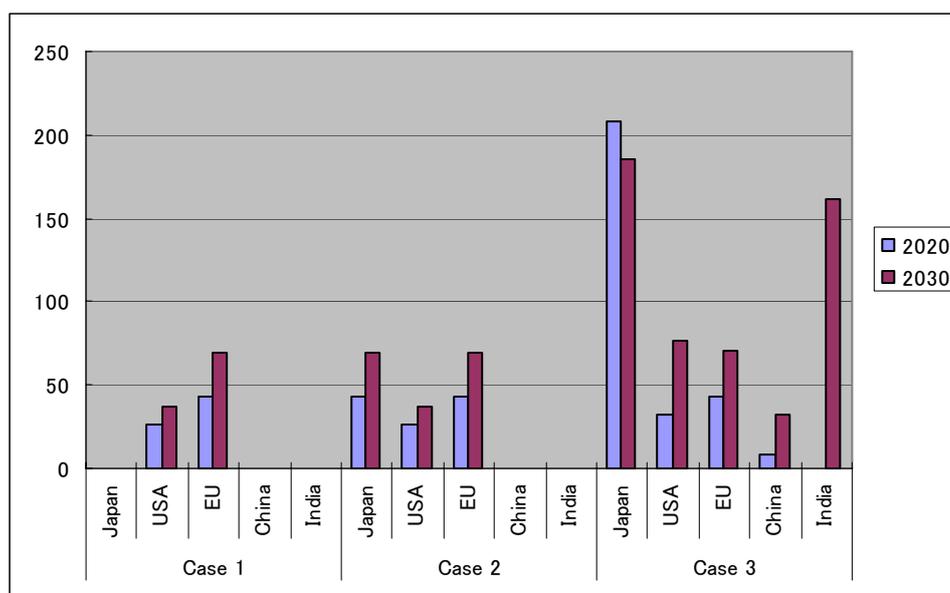
### Pledge and Review Case 3

	Assumed Pledges
Japan	MAC is same as EU's pledge, also subject to APEC's pledge
EU27	20% reduction in 2020 (base year 1990) then linearly 60% in 2050
USA	Same pledge as proposed in the Lieberman/Warner Bill (15% reduction in 2020 and 33% reduction in 2030, base year 2005)
APEC	30% improvement of energy efficiency by 2020 (base year 2005), 40% by 2030 (same as above)
China	20% improvement of energy efficiency by 2010 (base year 2005) 40% by 2020 (same as above), 60% by 2030 (same as above)
India	30% improvement of energy efficiency by 2020 (base year 2005) 50% by 2030 (same as above)
Other Major Emitters	Same as APEC Countries

### Emissions reduction volume, Comparison of 3 cases

	Reduction volume from BAU GtCO <sub>2</sub>	
	2020	2030
Pledge & Review Case 1	4.0	6.0
Pledge & Review Case 2	4.2	6.4
Pledge & Review Case 3	5.6	8.9

### Comparison of marginal abatement cost by region/country, by Case (\$/CO<sub>2</sub>)

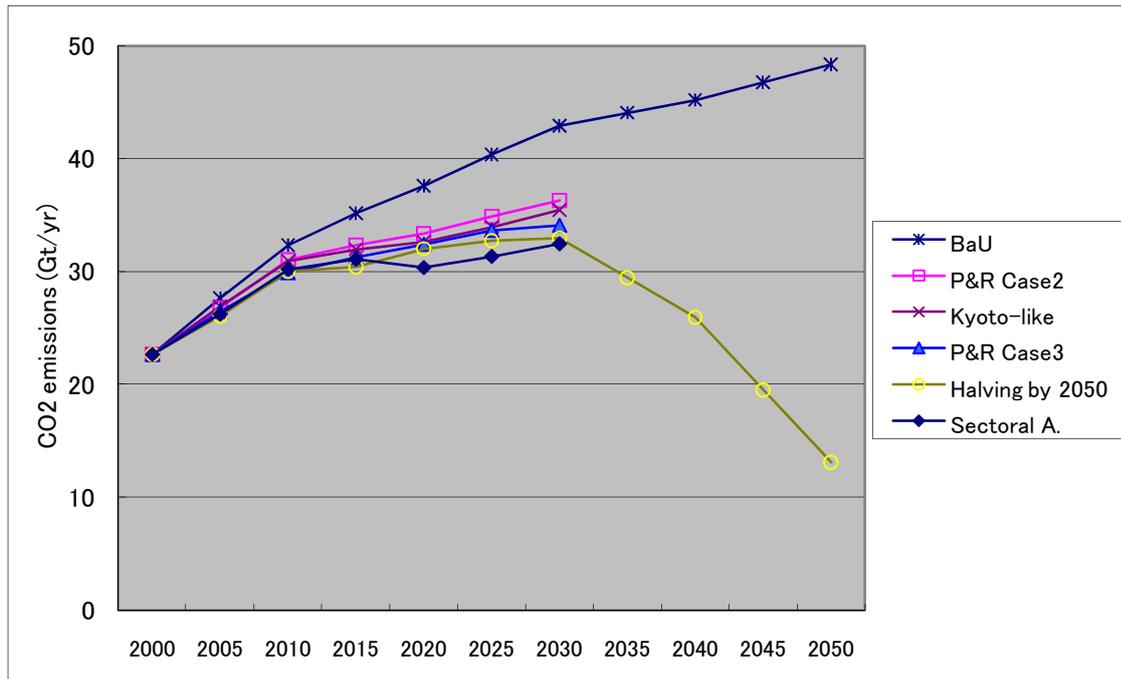


MAC for Japan (for Case 1 in 2030 and for Case 3 both in 2020 and 2030), China and India are calculated using marginal energy saving cost as explained in the text (This figure was compiled based on data provided by RITE)

**Total Abatement Cost vs. GDP in Case 3 (China and India) Unit B\$**

	China		India	
	2020	2030	2020	2030
Total Abatement Cost (A)	3.8	-2.4	-6.7	21.4
GDP (2000 price, MER) (B)	5367.3	9109.1	1609.7	2346.7
(A)/(B)*100	0.07%	-0.03%	-0.42%	0.91%

**Figure 3 Comparison of Global Emissions by Pledge and Review Cases 1-3 and Kyoto-like approach**



効率性、衡平性、実現可能性、技術促進効果

Pledge and Reviewで始める。可能な範囲でセクトラルアプローチを組み合わせる。

**6、温暖化問題の優先順位と効率追求の必要性**

1) Millennium Development Goalとの関係

貧困対策、清浄な飲料水、エイズ・マラリア対策、初等教育普及など

MDGとの関係 (Trade off か否か)

[Goal 1: Eradicate extreme poverty and hunger](#)

[Goal 2: Achieve universal primary education](#)

[Goal 3: Promote gender equality and empower women](#)

[Goal 4: Reduce child mortality](#)

[Goal 5: Improve maternal health](#)

[Goal 6: Combat HIV/AIDS, malaria and other diseases](#)

[Goal 7: Ensure environmental sustainability](#)

[Goal 8: Develop a Global Partnership for Development](#)

## 2) Copenhagen Consensus 2004年5月、2008年5月 Based on CBA

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