地球温暖化リスクへの基本戦略
Principles of a Response Strategy to the Climate Risk

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Recent Development of Climate Policy in Japan

Long-term Energy Supply and Demand Outlook (July 2015, METI)

↓

Submission of INDC for COP21 (GHG reduction target in 2030)

↘

Paris Agreement (Dec. 2015)

5th Science and Technology Basic Plan (Jan. 2016)

↓

NESTI 2050

(National Energy and Environment Strategy for Technological Innovation towards 2050 (April 2016)

Proceedings of Power/Gas System Reform

Plan for Global Warming Countermeasures (May 2016)

Status of Paris Agreement

Dec. 2015: Adoption of Paris Agreement at COP21

Nov. 4, 2016: Paris Agreement made effective

Nov. 7, 2016: COP22 started in Marrakech

Nov. 8, 2016: D. Trump elected for next President of USA

2018: IPCC special report on 1.5 degree C Scenario

2018: CMA1 will be concluded

2020: Framework of Paris Agreement starts;
Submission of long term low carbon strategy

Climate Goals in Paris Agreement

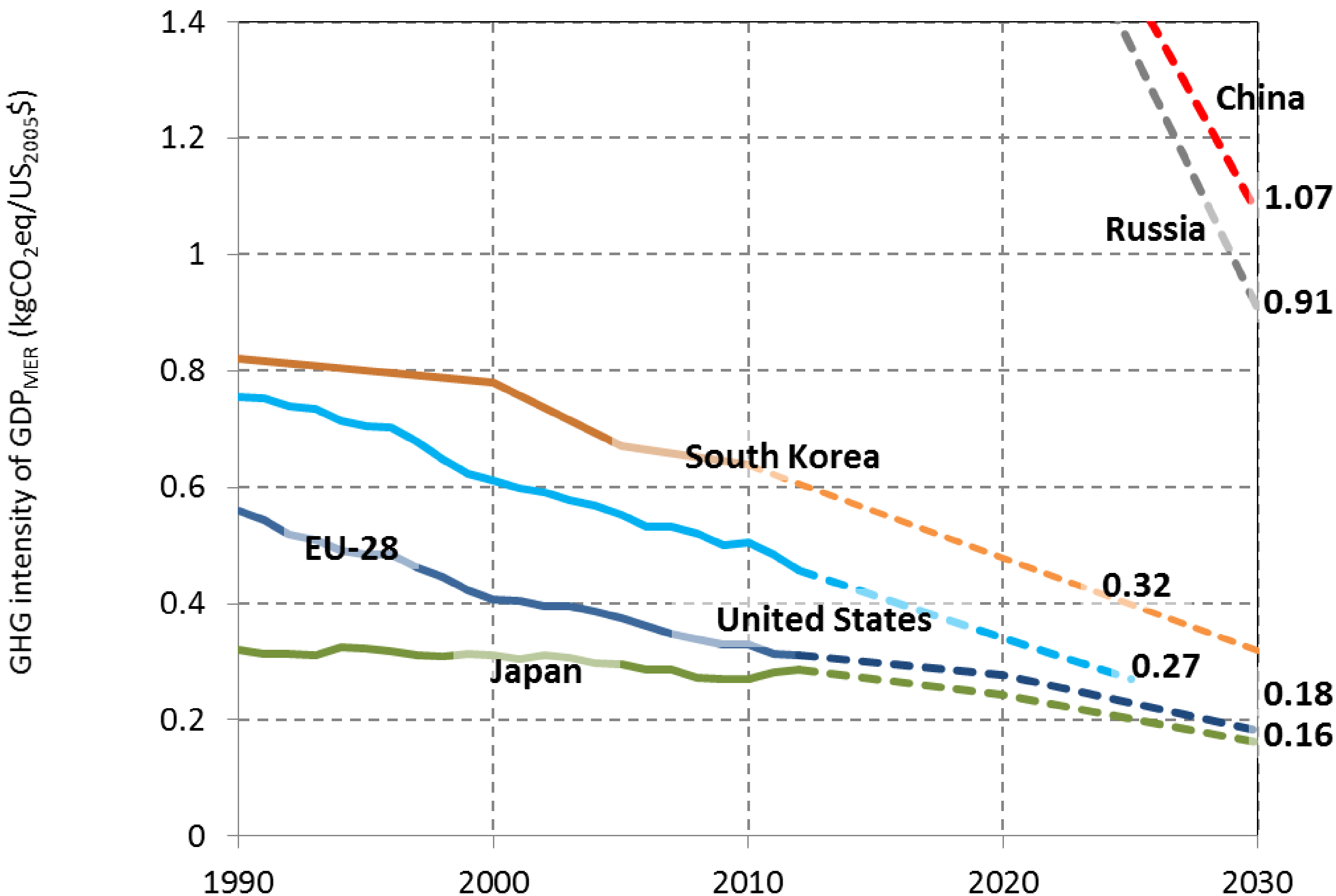
- **Regarding the long term targets, the Paris Agreement contains: "To hold the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels."**
- **To achieve the targets, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century**
- **Under the Paris Agreement, almost all nations tackle greenhouse gas (GHG) emission reductions for the post-2020 terms with legally binding processes. (Reduction targets are not legally bound)**
- **All of the member nations are required to submit their emission targets as the Nationally Determined Contribution (NDC), which are to be internationally and comparatively reviewed and evaluated from the viewpoint of meeting long-term targets constituting a form of "global stocktaking."**

Emissions reduction ratio from base year of NDCs for Japan and other major countries

	Emissions reduction ratio from base year		
	From 1990	From 2005	From 2013
Japan: in 2030, -26% from 2013 levels	-18.0%	-25.4%	**-26.0%**
US: in 2025, about -26 to -28% from 2005 levels	-14 to -16%	**-26 to -28%**	-18 to -21%
EU28: in 2030, -40% from 1990 levels	**-40%**	-35%	-24%
Russia: in 2030, -25% to 30% from 1990 levels	**-25 to -30%**	+10 to +18%	—
China: in 2030, CO_2 intensity of -60% to -65% from 2005 levels	+379 to +329%	**+129 to +105%**	—

If we take 2013 as the base year, the Japan's emission reduction target is more ambitious in the emissions reduction ratio than the US's or the EU's.

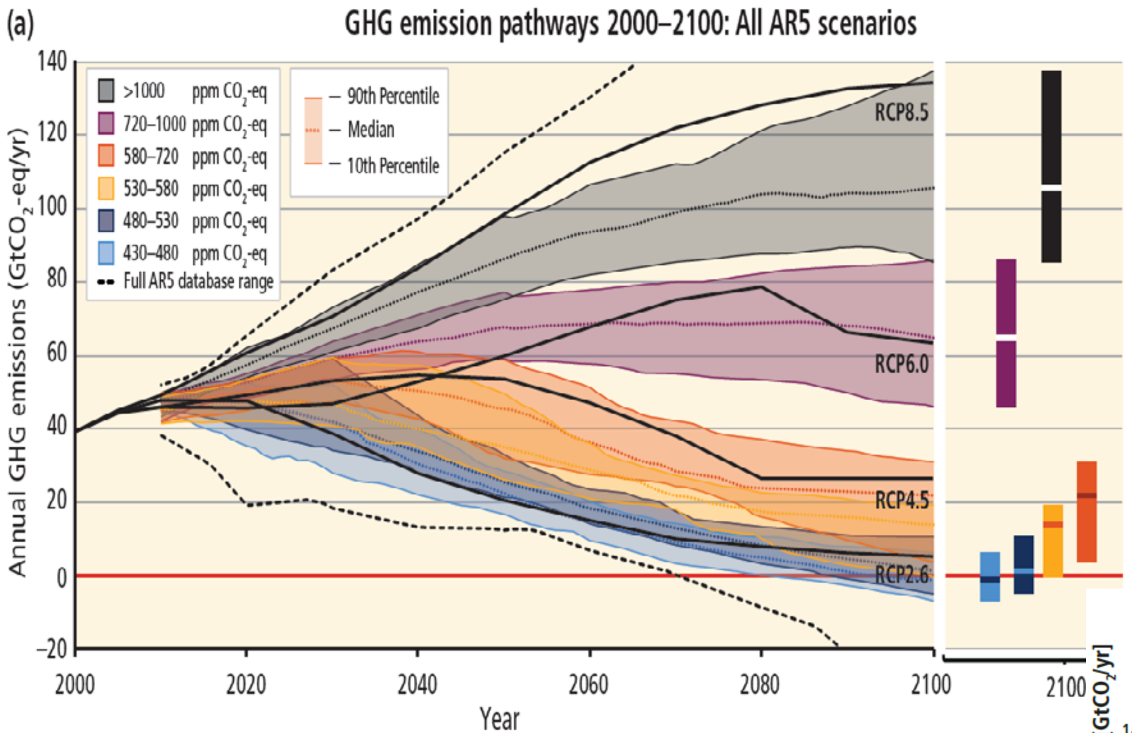
GHG intensity of GDP (MER)



Note) The lower range of emission targets are shown for the countries submitting their INDCs with ranges.

Even from the GHG intensity, the Japan's NDC sets a more demanding target than the US or the EU.

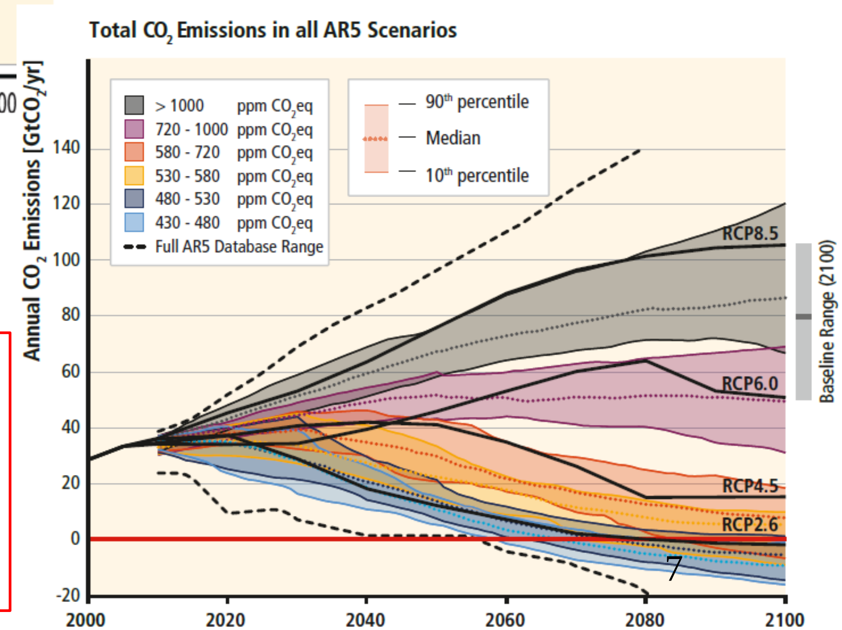
GHG Emission Pathways in IPCC WG3 AR5 Scenarios



+2℃（>66%）≒450 ppm CO2eq
+2℃（>50%）≒500 ppm CO2eq

(temperature in 2100, with equilibrium climate sensitivity of 2.0 - 4.5C (3.0C) likely range (“best estimate” or “most likely value”)

source）IPCC WG3 AR5



CO_2 emissions are negative, GHG emissions are around zero in 2100 for 450 ppm CO2eq (430-480) - 500 ppm CO2eq (480-520) scenarios.
Even for 550 ppm CO2eq (520-580) scenarios, CO2 emissions are nearly zero in 2100.

地球温暖化リスクの構造：Structure of the Climate Risk

・地球温暖化懐疑論：Skepticism on Climate Change
科学（e.g. 太陽活動論）から政治（e.g.トランプ政権)まで
：from science (e.g. solar activity) to political arena (e.g. Trump Administration)

・2℃目標(地球温暖化の損害)：2 Degree C Goal/Target(Damage of Climate Change)

・気候安定化への排出経路：Pathways of Emission Reduction to Climate Stability
e.g.気候感度の影響：e.g. effects of climate sensitivity

・排出削減コスト：Cost of GHG Emissions Reduction
e.g. イノベーションの効果：e.g. effects of innovations

・国際枠組みの有効性と安定性：Functions and Stability of International Framework
e.g.炭素漏洩と囚人のジレンマ：e.g. carbon leakage and prisoners' dilemma

・リスクの選択：Risk Trade-Off
e.g.持続可能な発展における温暖化リスク：e.g. climate risk in 17 SDGs

・気候正義：Climate Justice

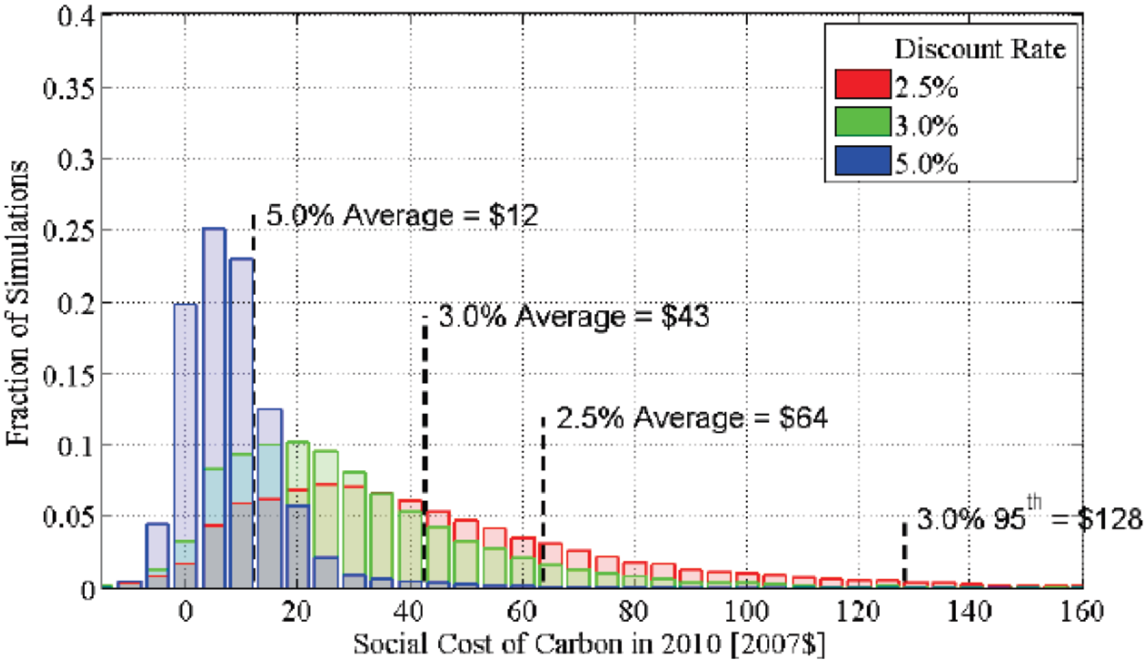
Social Cost of Carbon (SCC): 米国政府(USG)

年 (year)	割引率 (discount rate)			
	5% (3モデル平均)	3% (3モデル平均)	2.5% (3モデル平均)	3% (95パーセンタイル値)
2010	$11	$32	$51	$89
2015	$11	$37	$57	$109
2020	$12	$43	$64	$128
2025	$14	$47	$69	$143
2030	$16	$52	$75	$159
2035	$19	$56	$80	$175
2040	$21	$61	$86	$191
2045	$24	$66	$92	$206
2050	$26	$71	$97	$220

USG(2013)による世界のSCC推計値(2007年$価格、$/tCO2)

温暖化影響被害費用(SCC)の推計には大きな幅がある。

- **DICE、PAGE、FUNDの3つのモデルを利用**
- **経済成長、気候感度、割引 率について複数のシナリオを想定して計算(150,000シナリオを推計)**
- **EPAの既設火力発電規制の費用便益評価では、3%の割引率ケースが標準で利用されている。(ただし2011年価格に換算したものを利用)**



出典）Interagency working group on social cost of carbon

History of climate sensitivity judgment by IPCC and the sensitivity employed in the scenario assessments of the IPCC WG3 AR5

	Equilibrium climate sensitivity Likely range ("best estimate" or "most likely value")
Before IPCC WG1 AR4	**1.5–4.5°C (2.5°C)**
IPCC WG1 AR4	**2.0–4.5°C (3.0°C)**
Global mean temperature estimations for the long-term scenarios in the IPCC WG3 AR4 (employing MAGICC)	**No estimates with probability (3.0°C)**
IPCC WG1 AR5	**1.5–4.5°C (no consensus)**
Global mean temperature estimations for the long-term scenarios in the IPCC WG3 AR5 (employing MAGICC)	**2.0–4.5°C（3.0°C）** **[Based on the AR4]**

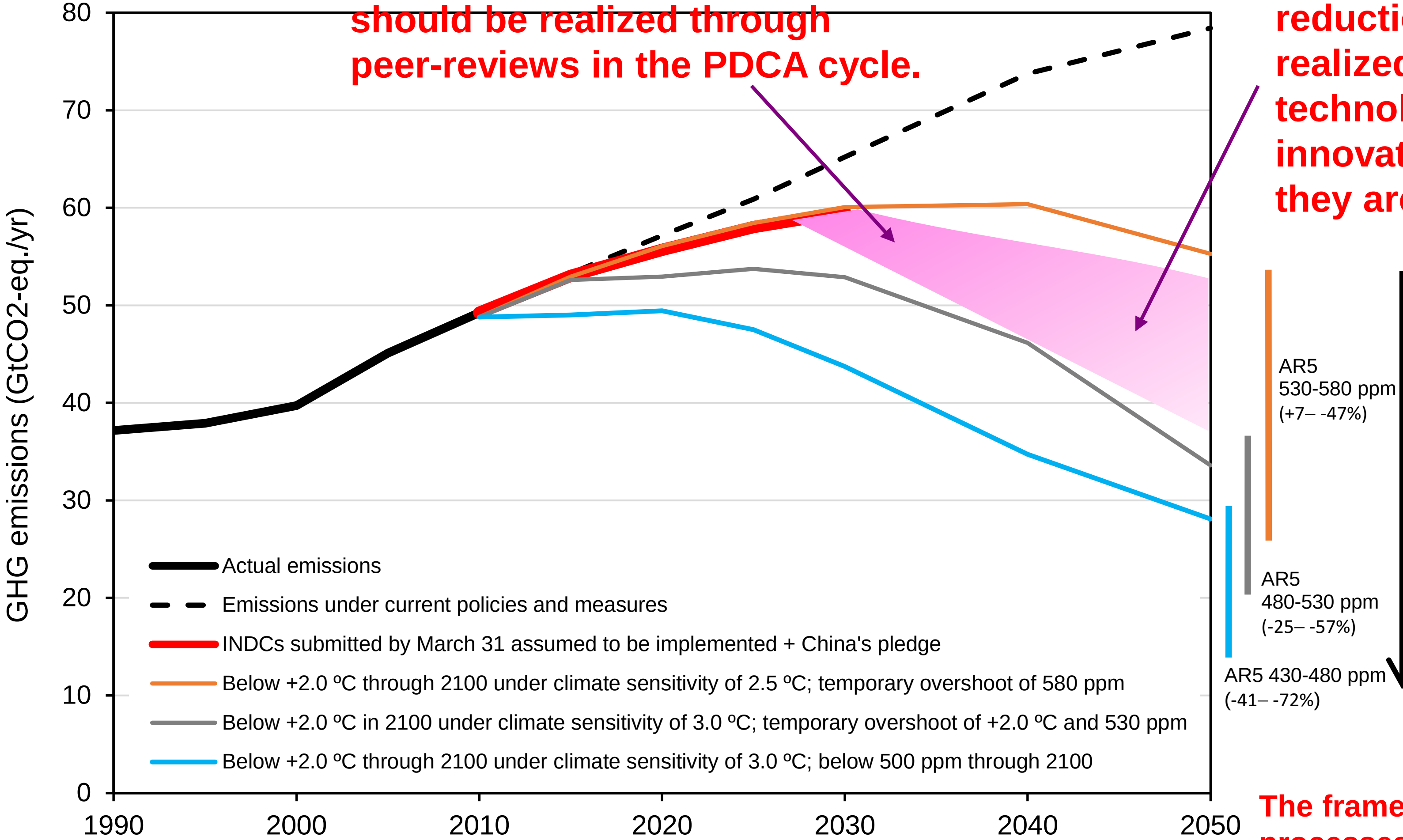
[The related descriptions of the SPM of WG1 AR5]
Likely in the range 1.5 °C to 4.5 °C (high confidence)
Extremely unlikely less than 1 °C (high confidence)
Very unlikely greater than 6 °C (medium confidence)
No best estimate for equilibrium climate sensitivity can now be given because of a lack of agreement on values across assessed lines of evidence and studies.

- The equilibrium climate sensitivity, which corresponds to global mean temperature increase in equilibrium when GHG concentration doubles, is still greatly uncertain.
- AR5 WG1 judged the likely range of climate sensitivity to be 1.5–4.5 °C, in which the bottom range was changed to a smaller number than that in the AR4, based not only on CIMP5 (AOGCM) results but also other study results.
- However, AR5 WG3 adopted the climate sensitivity of AR4, which has the likely range of 2.0–4.5 °C with the best estimate of 3.0 °C, for temperature rise estimates of long-term emission scenarios.

Relationship between climate sensitivity and global emission pathways for 2°C target, and outlook on INDCs

Larger emission reductions should be realized through peer-reviews in the PDCA cycle.

Deeper emission reductions should be realized through technology innovations although they are uncertain.



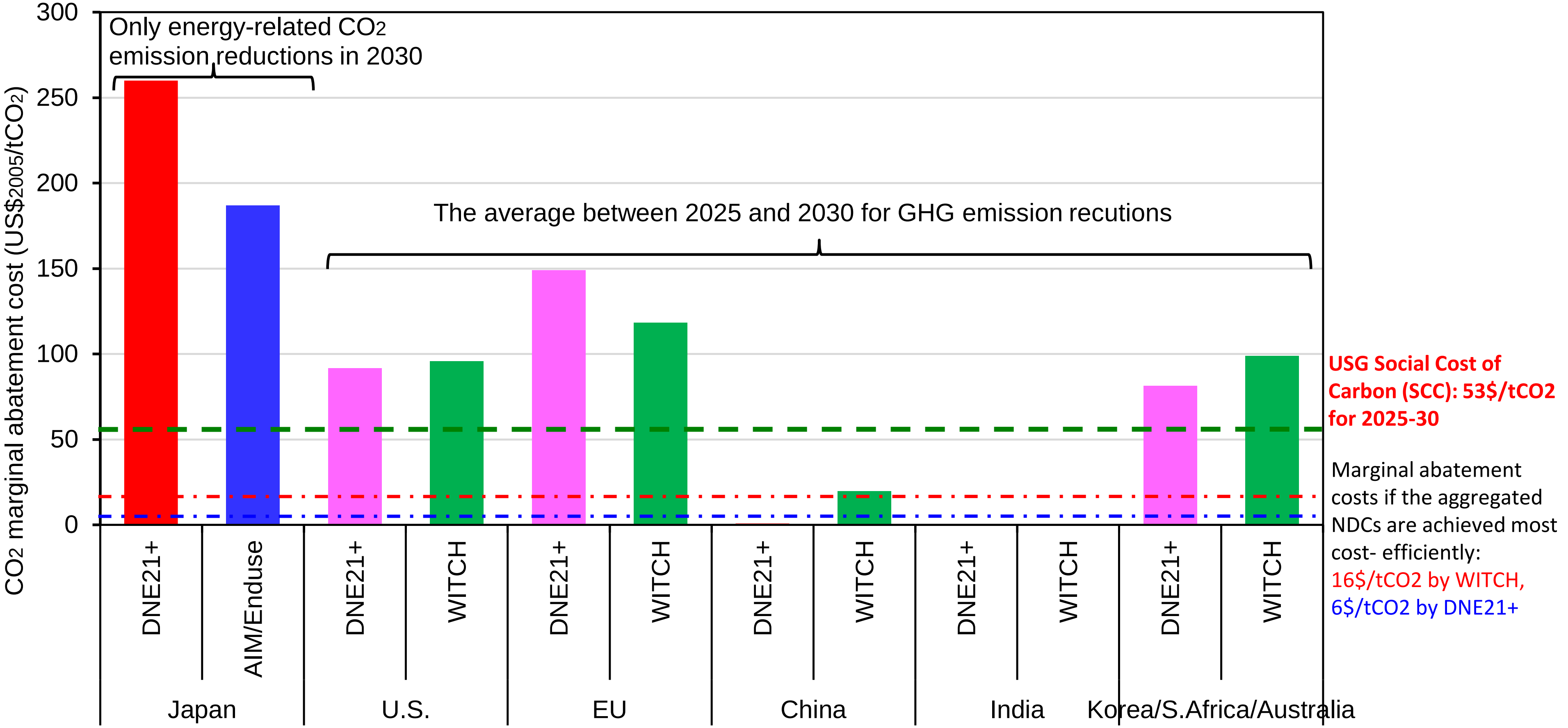
Estimated by RITE

The probability achieving below +2°C increases. On the other hand, measures with unrealistically high costs have to be adopted.

There are large gaps between the expected global emission under current INDCs and the emission pathway to 2°C target under climate sensitivity of 3.0°C. However, the INDCs are consistent with 2°C target if climate sensitivity is 2.5°C.

The framework of the processes to induce future emission reductions are more important than the levels of INDCs decided in COP21.

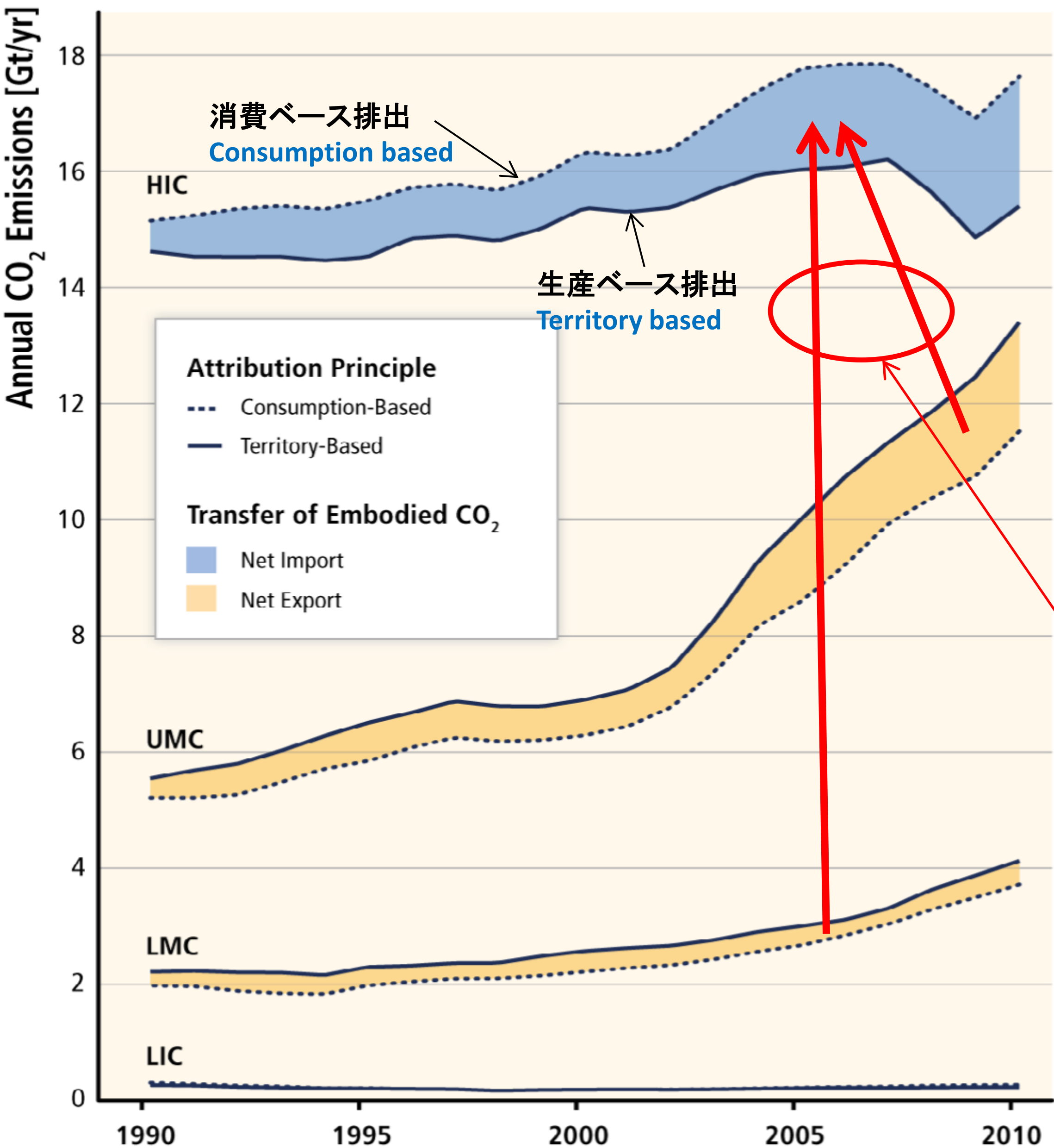
Marginal abatement costs estimations across models (RITE DNE21+, FEEM WITCH and NIES AIM)



Source: B. Pizer, J. Aldy, R. Kopp, K. Akimoto, F. Sano, M. Tavoni, COP21 side-event; MILES project report for Japan

- The marginal abatement costs vary across models for some countries, but can be comparable for many countries/regions.
- The CO_2 marginal abatement costs of the NDCs of OECD countries are much higher than the marginal cost for the case that the total reductions are achieved most cost-efficiently (globally uniform marginal abatement cost).

製品に体化されたCO_2排出量の国際移動：Transfer of Embodied CO_2



Source: IPCC WG3 AR5, Figure TS.5

高所得国 (HIC)
(more than $12,616)

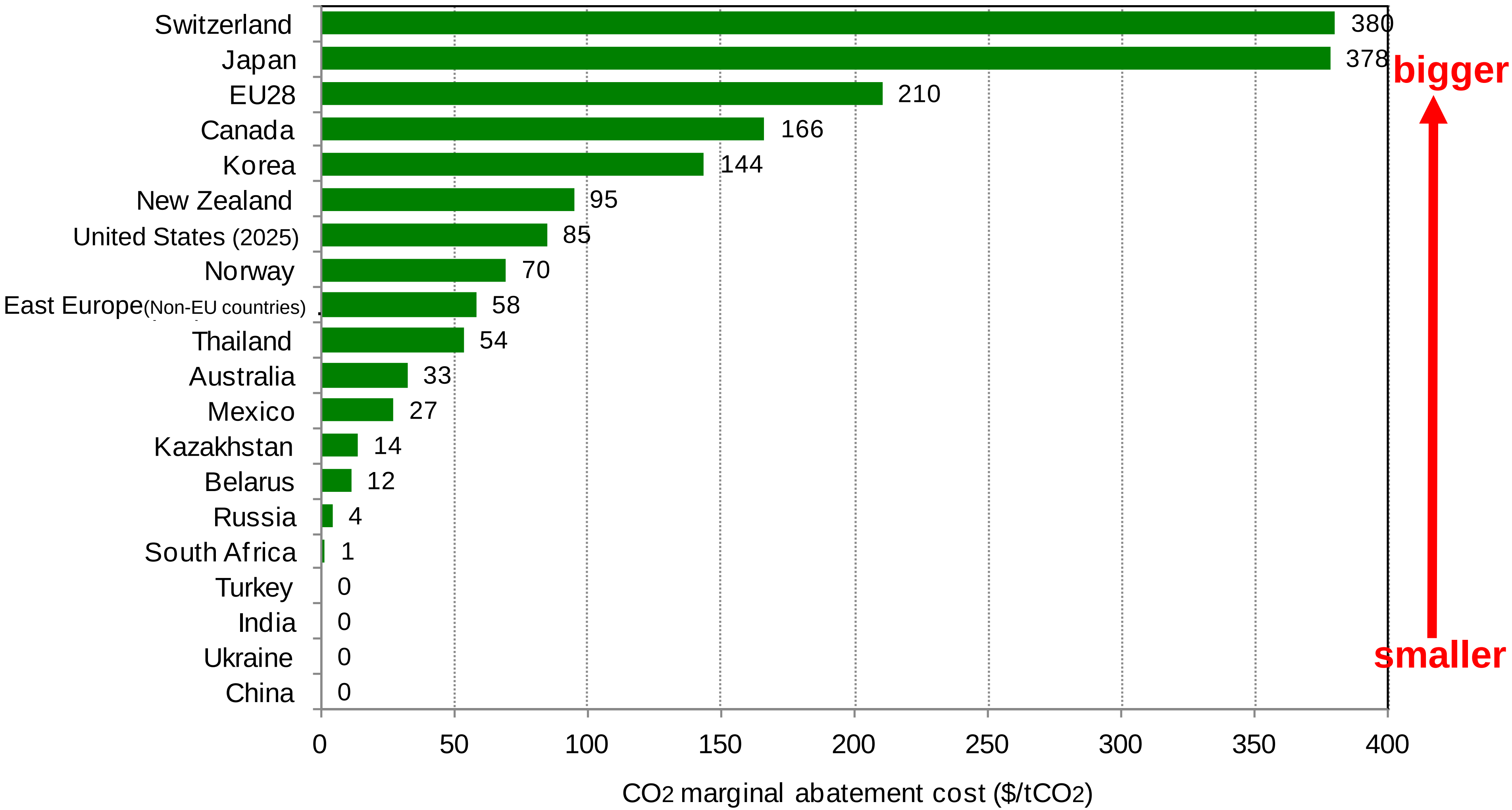
高中位所得国 (UMC)
($4,086 to $12,615)
(中国、ブラジル、イラン、マレーシア、南アなど)

製品に体化されたCO2排出移転(逆転すれば炭素漏洩):
Transfer of Embodied CO_2(inverse flow of carbon leakage)

低中位所得国(LMC)
($1,036 to $4,085)
(インド、インドネシア、フィリピン、エジプトなど)

低所得国(LIC)
(less than $1,035)

International comparison of CO_2 marginal abatement costs (RITE DNE21+ model)



* The average values are shown for the countries submitted the INDC with the upper and lower ranges.

Large differences in marginal abatement costs are estimated across countries. The large differences raise concern about inducing the carbon leakage and the ineffectiveness of global emission reductions.


SUSTAINABLE DEVELOPMENT GOALS
17 GOALS TO TRANSFORM OUR WORLD
1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE, JUSTICE AND STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS
SUSTAINABLE DEVELOPMENT GOALS

地球温暖化リスクへの基本戦略

Principles of Responses to the Climate Risk

・多様な選択肢：Diversified Response Options
排出削減、気候変動適応からジオエンジニアリングまで
：mitigation/adaptation + geoengineering(緊急事態への備え)
→イノベーションの創出と国際展開：global deployment of innovations

・システム全体を俯瞰する視点：Holistic Systems View
ライフサイクル評価、グローバルな貢献
：assessment of global life cycle effects of countermeasures

・総合的アプローチ：Integrated Approach
SDGsの複数のゴールの同時達成：co-benefits in achieving SDGs

・客観的な科学データの共有：Shared Scientific Data Base
→世界共通リスクの認識：shared understanding of global risks

・多様な価値観の容認：Acceptance of Diversified Value Systems
→国際フレームワークの維持：maintain international framework

多様な対策を活用できるクリーンなエネルギー媒体(電気、水素等)の重要性

Key Role of Clean and Efficient Energy Carrier (Electricity, H_2 etc.)

電化とスマート化による大規模省エネ

Revolutionary Energy Saving through Electrification and Digitalization of Energy

ゼロエミッション電源:

再生可能エネルギー,
原子力, 化石燃料＋CCS

**Carbon Free Power Source:
Renewables, Nuclear,
Fossil Fuel with CCS**

**クリーンで効率的な利用ができる
エネルギー媒体（電気・水素等）**

**Clean and Efficient Energy Carrier
(Electricity, Hydrogen etc.)**

ゼロエミッション燃料

(バイオマス等）

**Carbon Free Fuel:
Biomass, etc.**

ゼロエミッション熱源 :

太陽熱、地(中)熱、未利用熱等

**Carbon Free Heat Source:
Solar Heat, Geothermal, etc.**

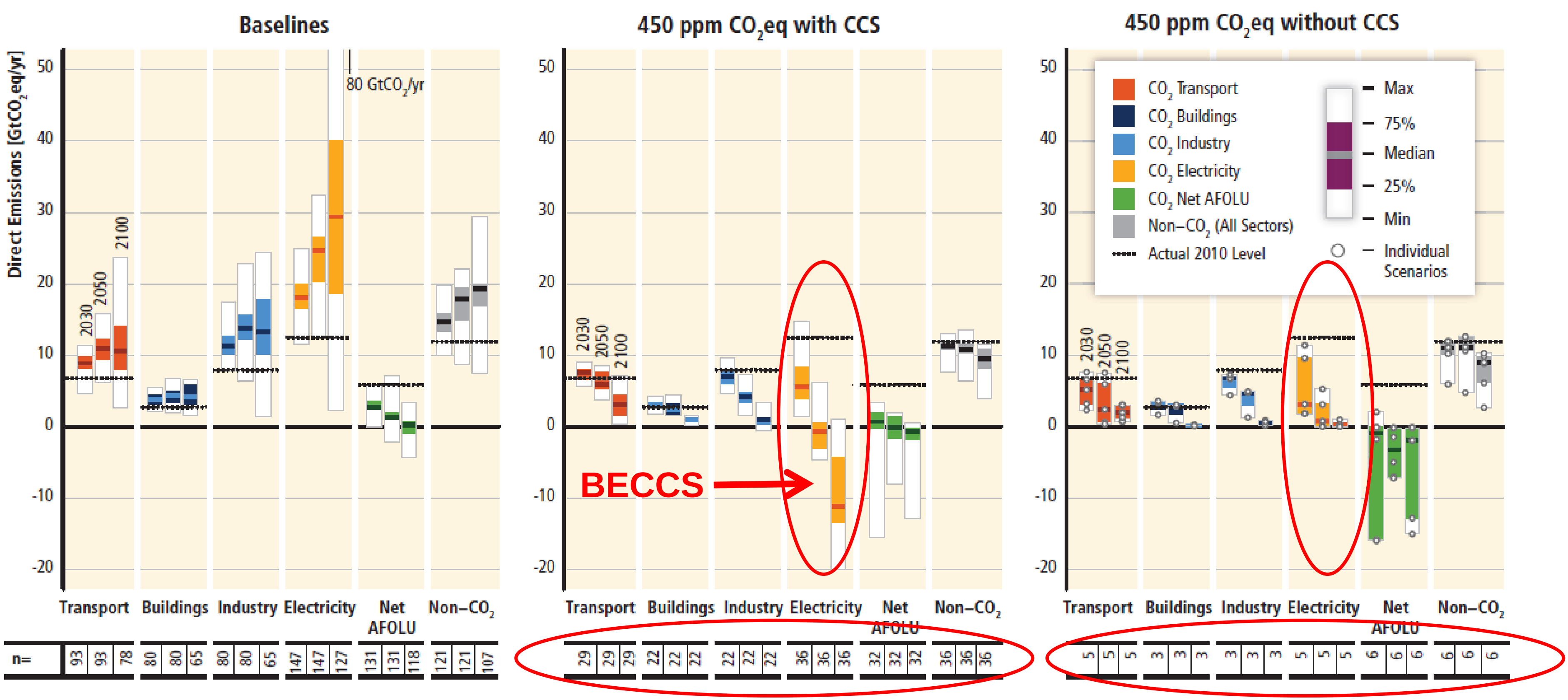
**Global Net Zero Emission　には更なる工夫が必要:
BECCS(Bioenergy+CCS)、CO_2吸収増大(植林等）など**

Value of Technology Option: Case of CCS

Almost impossible to keep 450ppmCO_2eq without CCS; a few models, which get a feasible solution, estimate the mitigation cost is to be more than doubled.

Direct Sectoral CO_2 and Non-CO_2 GHG Emissions in Baseline and Mitigation Scenarios with and without CCS

Figure SPM.7



「**450ppmCO_2 by 2100 is infeasible in most models without CCS**」
(WG3 SPM 19 of 31)

「**Fossil fuel power generation without CCS is almost extinguished by 2100**」
(WG3 SPM 21 of 31)

Source: IPCC WG3 AR5

Outlook on of NESTI2050

Ⅰ. Positioning of the Strategy

◆ To meet the “2℃ target” referred in COP21, reducing the amount of global GHG emissions to about 24 billion tons by 2050 is necessary. At present, the total amount of global GHG emissions is about 50 billion tons. Since the amount is expected to be about 57 billion tons by calculating the total global emissions based on the INDCs of each country, about 30 billion tons of additional reductions are necessary. In so doing, it is essential to promote the innovation for drastically reducing emissions on a world wide scale.

◆ On the premise that the entire energy system will be optimized with the advent of “Super smart society”, and with looking ahead to 2050, promising innovative technologies that have big impacts of potential reductions were identified. Technological issues are clarified and medium- and long-term development will be facilitated.

⇒ As a part of 30 billion tons of CO_2 reductions, which is necessary to meet the 2 ℃ target, **several billion to 10 billion tons or more** of the reductions will be possible through this strategy.

* Based on the figures estimated by IEA. In the selected technological areas, the application of innovative technologies is added to the application of technologies whose development and demonstration have already been advanced.

Ⅱ. Identifying promising technological fields

1. The innovative technologies that are not the extension of the existing efforts but are discontinuous and have big impacts.
2. The technologies that can introduce on a large scale and are expected to have big potential reductions.
3. The technologies that need medium- and long terms to be practical and require to gather the total powers of business, academia and government.
4. The technologies that Japan can lead the world and utilize our superiority.

Technologies to integrate energy systems
(each areas of energy production, transport, consumption are networked by ICT, and energy system is optimized by AI, big date, IoT.)

Core technologies constituting energy systems
(Next generation power electronics, Innovative sensor, Superconductivity)

Innovative technologies in each area

Energy Saving	1 Production Process	Innovative separation membrane, catalyst
	2 Structural material	Ultralight and heat-resistant
Energy Storage	3 Battery	Post lithium battery
	4 Hydrogen	CO_2 free hydrogen
Energy Generation	5 Photovoltaic	Perovskite structure, quantum dot
	6 Geo-Thermal	Hot dry rock geo-thermal, super critical geo-thermal
	7 CO_2 fixation and utilization	

Ⅲ. Reinforcing R&D system

1. Structuring R&D system with cooperation of the entire government
2. Creating new seeds, and their positioning in this strategy
3. Inducing R&D investments by business circle
4. Promoting international linkage and international cooperative development

Leading the world through innovation, and keeping climate efforts and economic growth compatible with each other

3つのキーワード Three Key Words

山地憲治 by Kenji YAMAJI

Decoupling: Economy ⇒✕ Energy ⇒✕ CO_2

・社会全体としてのエネルギー効率向上（Digitalized Energy, Society 5.0, ・・・）
・低炭素エネルギーへのシフト(Low Carbon Power/Fuel/Heat、・・・)
・エネルギーシステムの柔軟性向上（Energy Storage (battery, etc.)、・・・）

Smart Integration: Energy + ICT, Supply + Demand

・スマートネットワークによる需要側資源の活用（Demand Response、VPP、・・・）
・人間の行動変化や社会インフラ整備による省エネ(Behavior Change by IT, etc.)
・サプライチェーン全体のマネジメント(Digital Integration of Supply Chain, etc.)

Globalization: Innovation + Contribution

・イノベーション（Open Innovation from Seeds to Implementation, Capacity Building)
・JCMなどを通した地球温暖化対策への国際貢献（Global Contribution through JCM）
・国際標準＋国際認証 with 知財戦略(Strategic Standardization, etc.)

ご清聴ありがとうございました

Thanks for your attention

公益財団法人　地球環境産業技術研究機構 (RITE)

Research Institute of Innovative Technology for the Earth