Climate Goals and CCS

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Recent Development of Climate Policy in Japan

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

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

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Paris Agreement (Dec. 2015)

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

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NESTI 2050

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

↓

Plan for Global Warming Countermeasures (May 2016)

Positioning of NESTI2050 (National Energy and Environment Strategy for Technological Innovation towards 2050)

Ⅰ. Discussion in COP21

Paris Agreement adopted in COP21:

- ◆ 2℃ target as a long-term target on a world wide scale was set. Pursuing 1.5℃ target was referred to.
- ◆ All countries including major emitters submit and update their reduction targets every 5 years.
- ◆ Positioning of the importance of Innovation, etc.

Extracts from the Speech by Prime Minister Abe:

- ◆ "The key to acting against climate change without sacrificing economic growth is the development of innovative technologies. By next spring Japan will formulate the "Energy and Environment Innovation Strategy." Prospective focused areas will be identified and research and development on them will be strengthened." (The strategy was formulated on April 19th and are currently called NESTI2050)

Ⅱ. Domestic global warming measures after COP21

Global Warming Measure Program
(Global Warming Prevention Headquarters)
【Cabinet Secretariat・MOE・METI】

1. Total program based on Paris Agreement and INDCs

- Based on Act on Promotion of Global Warming Countermeasures, 26% of reductions compared with the level of 2013 is clearly written as a Japan's target of GHG emission reductions, and the measures by such entities as companies and universities as well as the plans by the country and autonomous bodies are set forth in the program.
- Moreover, new directions are offered for the strategic efforts looking ahead to the long-term targets and for the efforts to the world-wide reduction of GHGs.
- Taking the public comments into account, the cabinet decision will be made on May, 2016.

Energy Innovation Strategy
【METI】

2. Strategy to realize the planned energy mix looking ahead to the year 2030

- To realize the planned energy mix in 2030, the related systems will be integrally consolidated through completion of energy savings, expansion of renewable energy and formulation of new energy systems as main pillars.
- By implementing the strategy to increase energy-related investments and to improve energy efficiency, the contribution of Abenomics to realizing 600 trillion yen of GDP will be reached while reducing CO_2 emissions.
- This strategy will be developed by METI.

NESTI2050 (National Energy and Environment Strategy for Technological Innovation towards 2050)
(Council for Science, Technology and Innovation)
【Cabinet office】

3. Strategy for innovative technologies looking ahead to the year 2050

- The total amount of global emissions in 2030 is expected to be about 57 billion tons. In a scenario that will realize the 2℃ target, more than 30 billion tons of additional reductions are necessary.
- The innovation to realize drastic emission reductions on a world-wide basis is essential.
- Looking ahead to the year 2050, promising innovative technologies that have big potential impacts of reductions were identified, and a system to promote the long-term R&Ds be established.
- This strategy was developed in the Council for Science, Technology and Innovation this April.

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

Climate Goals in Paris Agreement

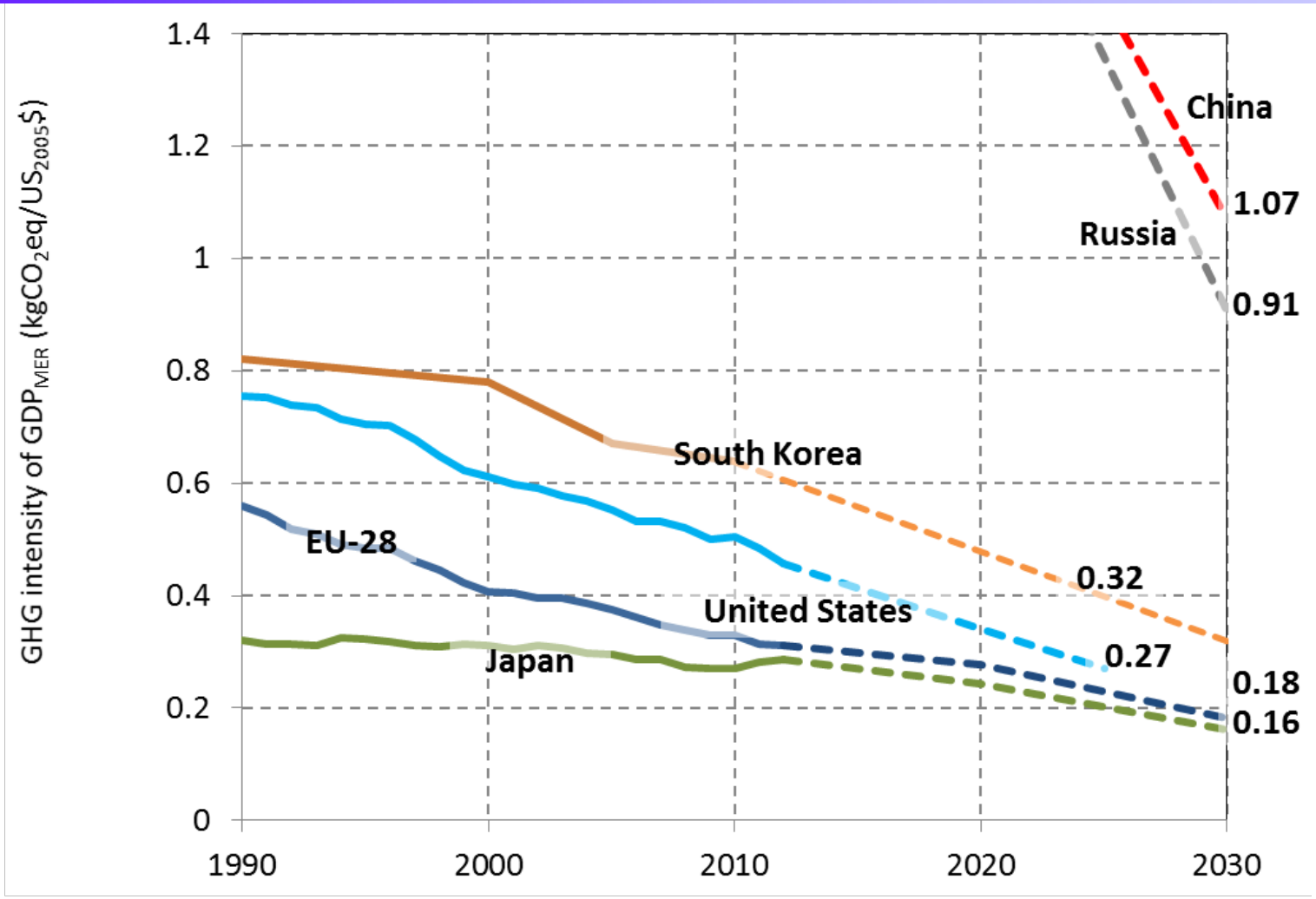
- Under the Paris Agreement, almost all nations tackle greenhouse gas (GHG) emission reductions for the post-2020 terms with legally binding processes. (Reduction targets are not legally bound)
- All of the member nations are required to submit their emission targets as the Nationally Determined Contribution (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."
- 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."
- On the other hand, the emission pathway cannot be uniquely determined for a certain level of temperature target because of scientific and policy uncertainties; there still exists a large uncertainty in climate sensitivity; as to the temperature target, the target year, temperature profile (whether or not to allow overshoot), probability of achieving the target, are not politically clarified.

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.

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.**

Atmospheric GHG Concentration, Emission Reduction in 2050, and Expected Temperature Increase

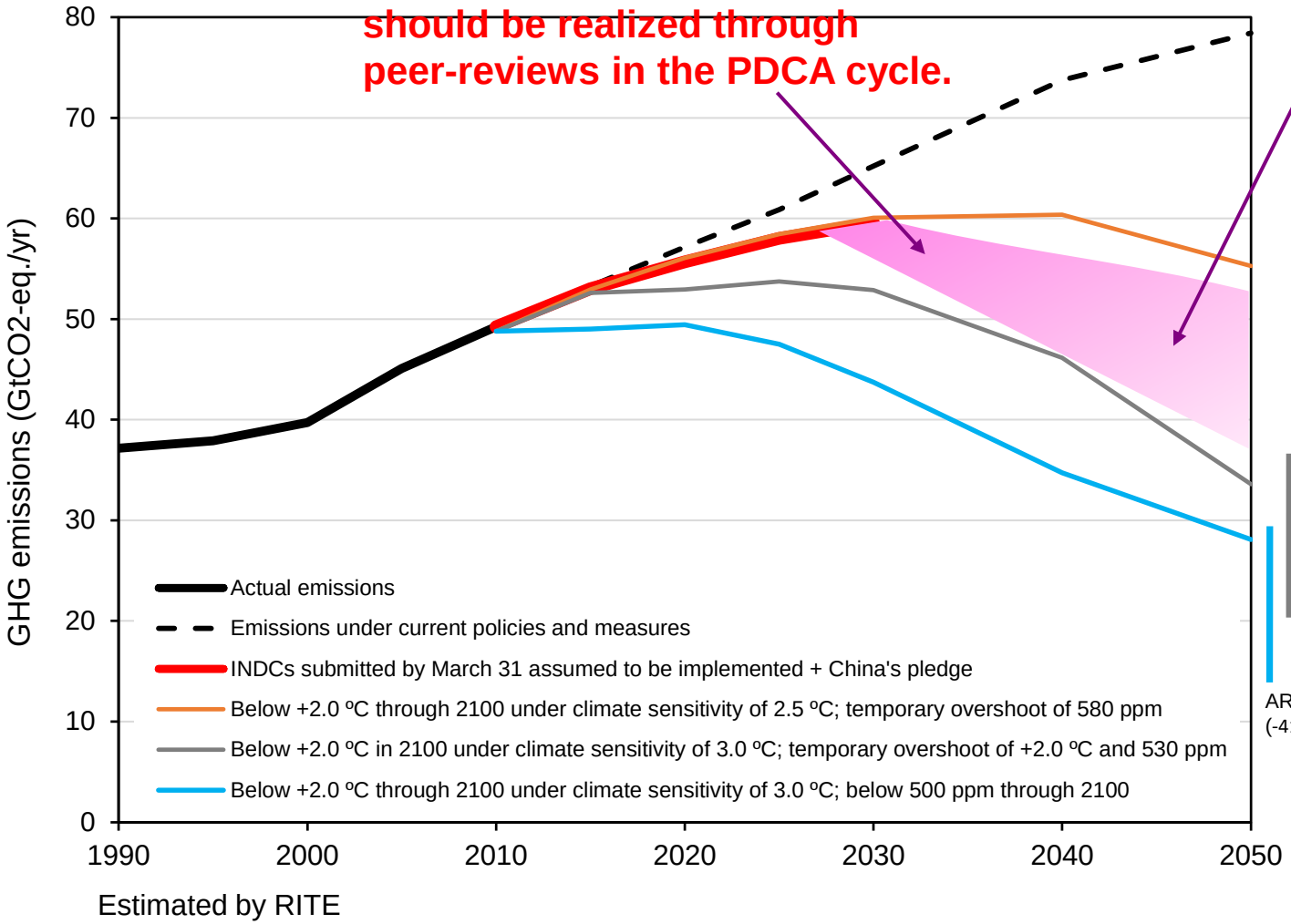
Category by concentration in 2100 (ppm CO2eq)	Sub-category	RCPs	Global GHG emissions in 2050 (relative to 2010)	Temperature in 2100 (°C, relative to 1850-1900)	Probability of exceeding the temperature rise over 21st century (relative to 1850-1900)		
					1.5 °C	2.0 °C	3.0 °C
[1] 450 (430-480)	—	RCP2.6	-72 to -41%	1.5–1.7°C (1.0–2.8)	49-86%	12-37%	1-3%
[2] 500 (480-530)	[a] No exceedance of 530 ppm CO2eq		-57 to -42%	1.7–1.9°C (1.2–2.9)	80-87%	32-40%	3-4%
	[b] Exceedance of 530 ppm CO2eq		-55 to -25%	1.8–2.0°C (1.2–3.3)	88-96%	39-61%	4-10%
[3] 550 (530-580)	[a] No exceedance of 580 ppm CO2eq		-47 to -19%	2.0–2.2°C (1.4–3.6)	93-95%	54-70%	8-13%
	[b] Exceedance of 580 ppm CO2eq		-16 to +7%	2.1–2.3°C (1.4–3.6)	95-99%	66-84%	8-19%
(580-650)	—	RCP4.5	-38 to +24%	2.3–2.6°C (1.5–4.2)	96-100%	74-93%	14-35%
(650-720)	—		-11 to +17%	2.6–2.9°C (1.8–4.5)	99-100%	88-95%	26-43%
(720-1000)	—	RCP6.0	+18 to +54%	3.1–3.7°C (2.1–5.8)	100-100%	97-100%	55-83%
>1000	—	RCP8.5	+52 to +95%	4.1–4.8°C (2.8–7.8)	100-100%	100-100%	92-98%

Source) IPCC WG3 AR5, 2014

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.



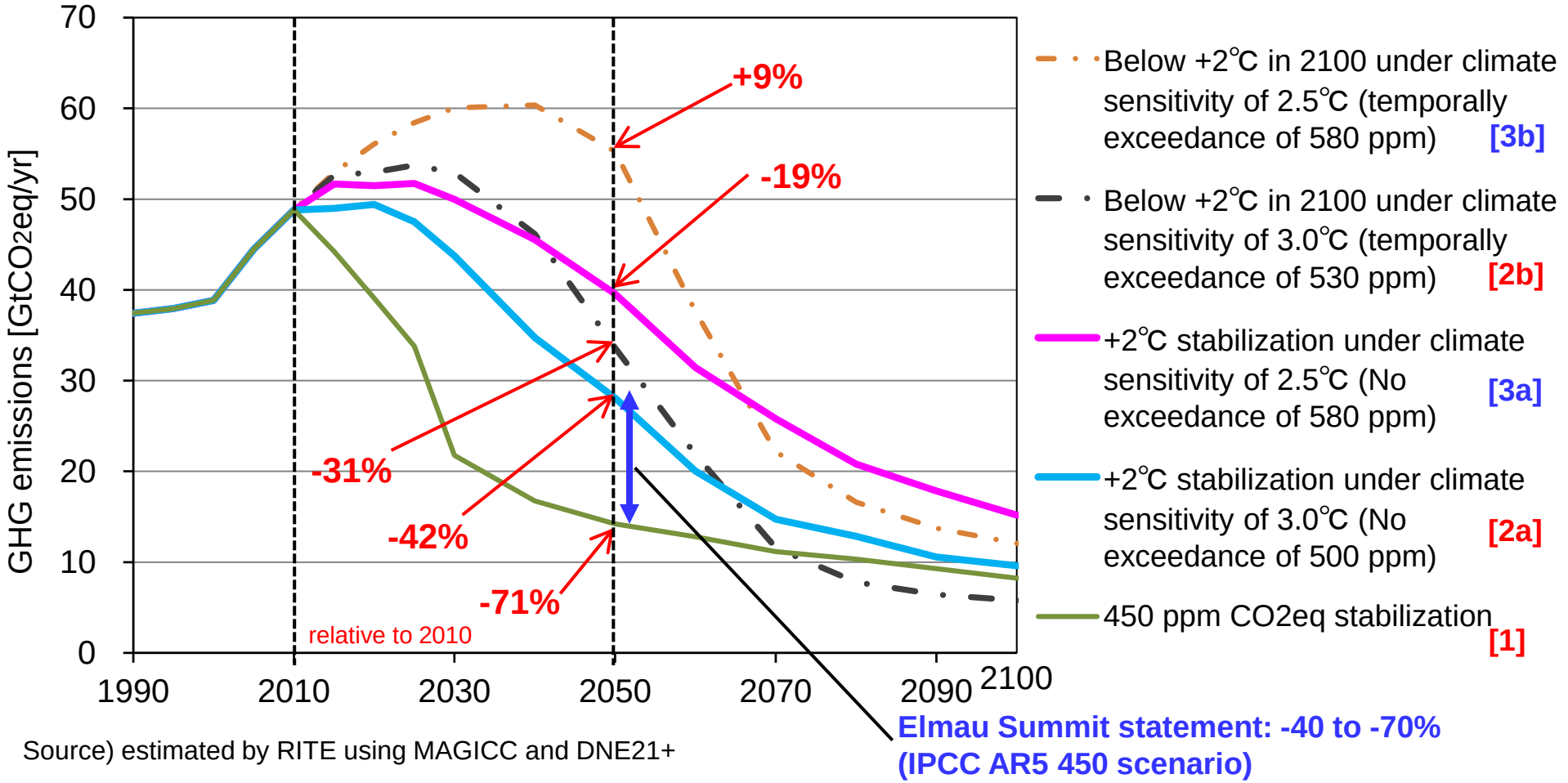
Estimated by RITE

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.

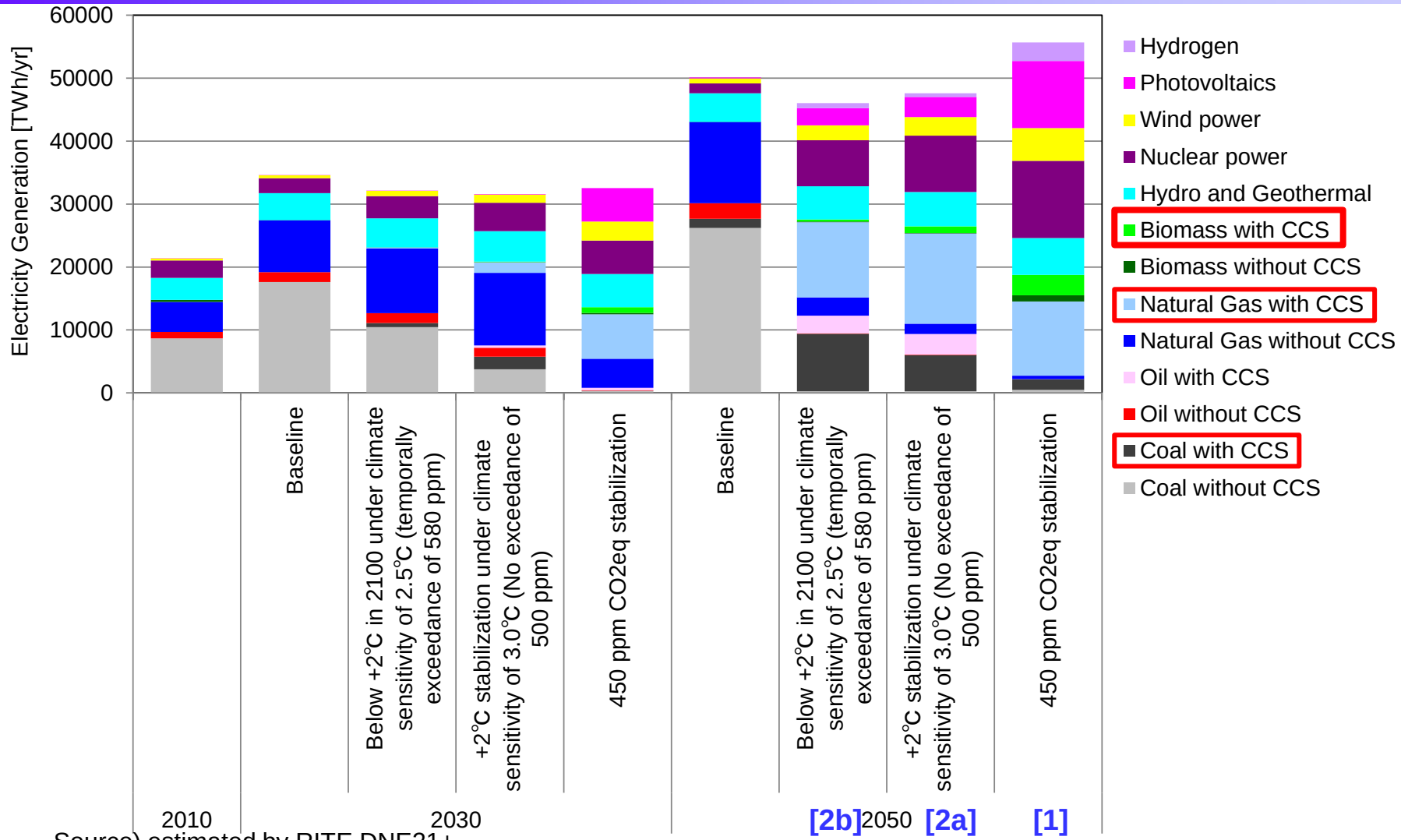
Global GHG emission profiles toward 2100 for the 2 °C target



Source) estimated by RITE using MAGICC and DNE21+

- The corresponding GHG emission profiles also vary widely particularly before 2050. (e.g., +9 to -71% in 2050 compared to 2010)
- The Paris Agreement states the 2 °C target politically; however, the emission pathways and reduction measures vary widely. We need to seek a better strategy for the 2 °C target considering other kind of risks than climate change as well.

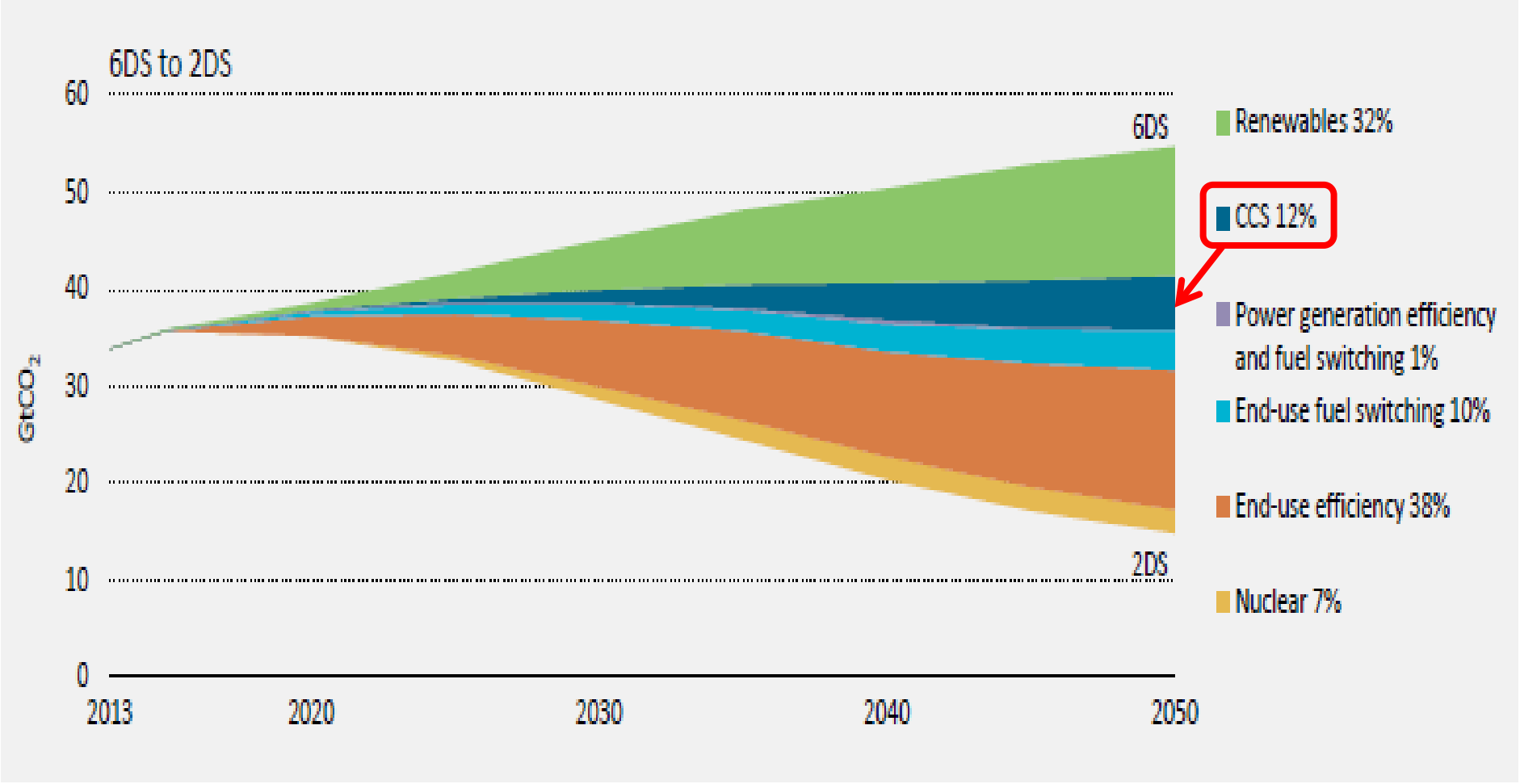
Global Electricity Generation



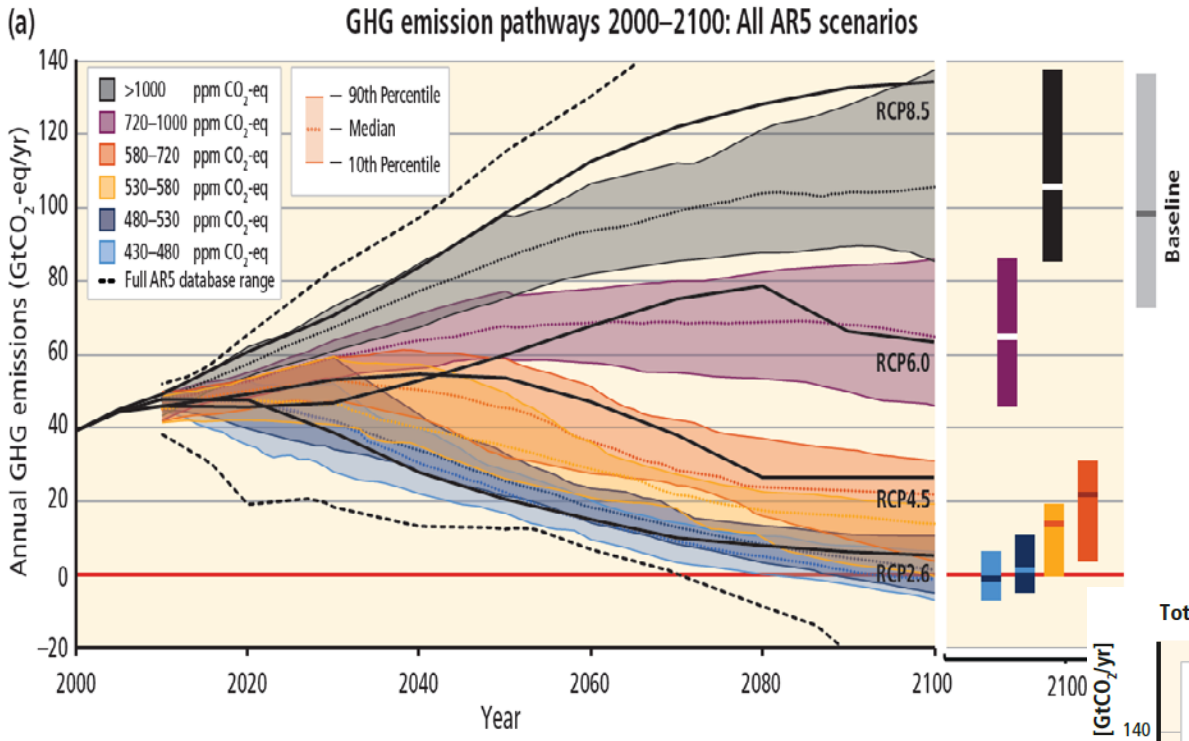
Source) estimated by RITE DNE21+

- CO2 emissions from power sector in most of the scenarios for the 2 °C target are nearly zero.
- The total amounts of electricity for the 2 °C target will increase with deeper emission reductions due to substitution for fossil fuel use in other sectors.

【IEA ETP2016】
Contribution of CO_2 by 2050



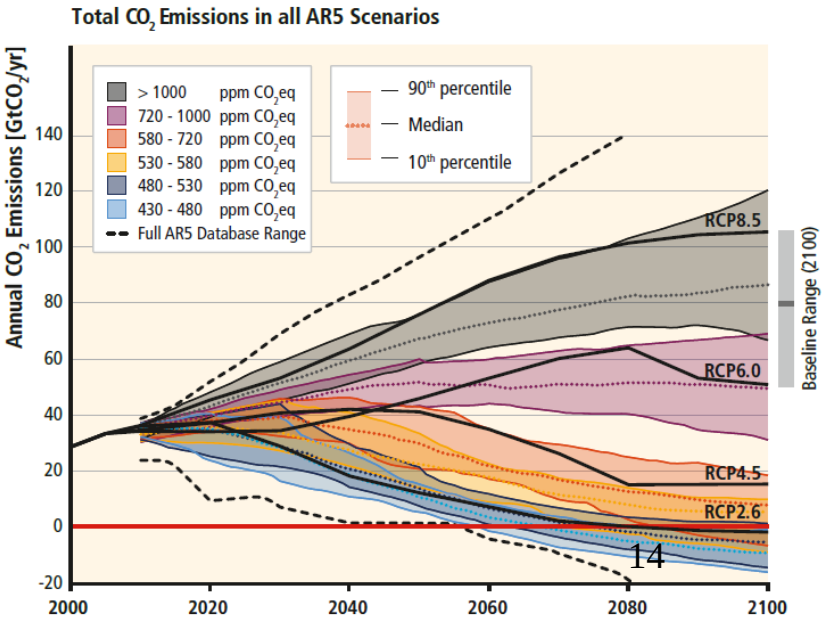
GHG Emission Pathways in IPCC WG3 AR5 Scenarios



+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.

Mitigation cost will increase substantially if CCS is not available

2100 Concentration (ppm CO_2eq)	Increase in total discounted mitigation costs in scenarios with limited availability of technologies [% increase in total discounted mitigation costs (2015–2100) relative to default technology assumptions]				Increase in medium- and long-term mitigation costs due to delayed additional mitigation until 2030 [% increase in mitigation costs relative to immediate mitigation]			
					≤55 $GtCO_2$eq		>55 $GtCO_2$eq	
	No CCS	Nuclear phase out	Limited Solar/Wind	Limited Bioenergy	2030–2050	2050–2100	2030–2050	2050–2100
450 (430–480)	138 (29–297) [N: 4]	7 (4–18) [N: 8]	6 (2–29) [N: 8]	64 (44–78) [N: 8]	28 (14–50) [N: 34]	15 (5–59)	44 (2–78) [N: 29]	37 (16–82)
500 (480–530)								
550 (530–580)	39 (18–78) [N: 11]	13 (2–23) [N: 10]	8 (5–15) [N: 10]	18 (4–66) [N: 12]	3 (–5–16) [N: 14]	4 (–4–11)	15 (3–32) [N: 10]	16 (5–24)
580–650								

Table SPM.2

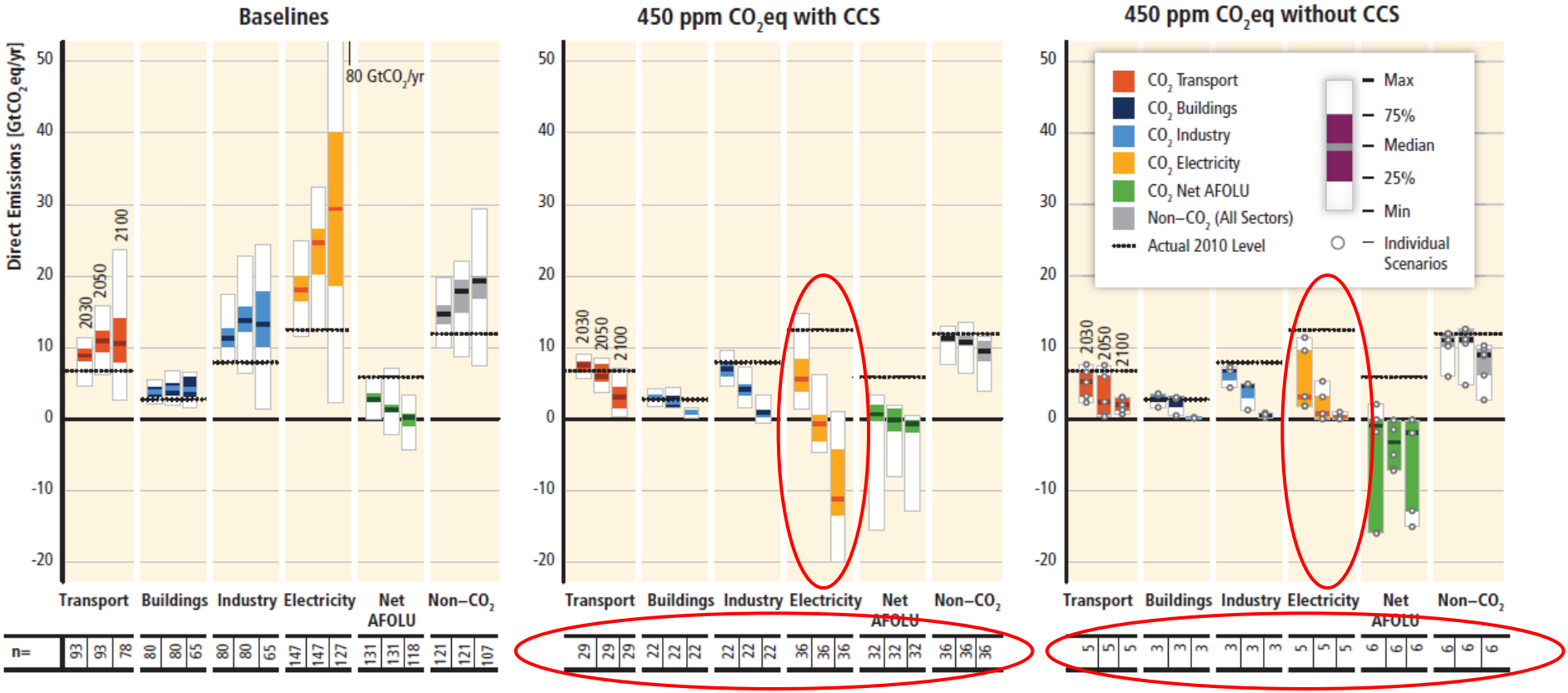
【IPCC AR5 WG3】（WG3 SPM 15 of 31）

【IPCC WG3 AR5】

Almost impossible to keep 450ppmCO_2eq without CCS

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）

Conclusion

- The COP21 successfully adopted the Paris Agreement, which requires all nations to submit the nationally determined contributions (NDCs), and states long-term targets including the 2 ºC target.
- However, there are several scientific and policy uncertainties even for the 2 ºC target.
- There are still large uncertainty in climate sensitivity, and the allowable emissions vary widely even for a specific level of temperature rise target, e.g., the 2 ºC target.
- The 2030 global emission expected by the submitted NDCs has large gaps from the emission pathways for the 2 ºC target with a high climate sensitivity & a high achieving probability, but is consistent with those under a low climate sensitivity.
- It is important to seek deeper emission reduction possibilities through developments and deployments of innovative technologies.
- CCS is indispensable to achieve the net zero GHG emission by 2100.