Twenty-third Asia-Pacific Seminar on Climate Change
Kanazawa, Ishikawa Pref., Japan
25-26 August 2014

The latest scientific findings from UNEP GAP report and IPCC AR5 - 2 ℃ global temperature change limit target and Global GHG reductions by 2050 -

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ASIA-PACIFIC INTEGRATED MODEL

NIES JAPAN

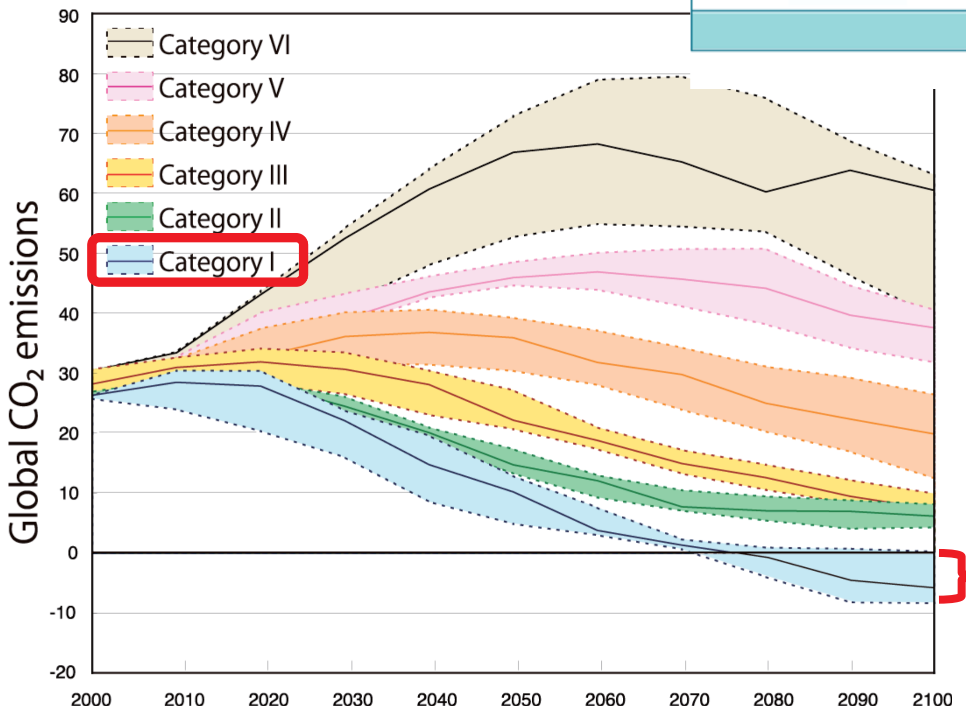
IPCC AR4: Long-term Emissions Pathways

Right Top Table：
Classification of the stabilization targets for the GHGs reviewed in the IPCC AR4

Left Bottom Figure：
Target-specific CO2 emissions reviewed in the IPCC AR4

Category	Radiative forcing	CO_2 concentrations	CO_2-equivalent of GHG concentrations	Global temperature increase after the industrial revolution	Peaking year for CO_2 emissions	Change in global CO_2 emissions in 2050 (percent of 2000 emissions)	Number of assessed scenarios
	W/m²	ppm	ppm	℃	Year	%	
I	2.5 ～ 3.0	350 ～ 400	445 ～ 490	2.0 ～ 2.4	2000 ～ 2015	-85 ～ -50	6
II	3.0 ～ 3.5	400 ～ 440	490 ～ 535	2.4 ～ 2.8	2000 ～ 2020	-60 ～ -30	18
III	3.5 ～ 4.0	440 ～ 485	535 ～ 590	2.8 ～ 3.2	2010 ～ 2030	-30 ～ +5	21
IV	4.0 ～ 5.0	485 ～ 570	590 ～ 710	3.2 ～ 4.0	2020 ～ 2060	+10 ～ +60	118
V	5.0 ～ 6.0	570 ～ 660	710 ～ 855	4.0 ～ 4.9	2050 ～ 2080	+25 ～ +85	9
VI	6.0 ～ 7.5	660 ～ 790	855 ～ 1130	4.9 ～ 6.1	2060 ～ 2090	+90 ～ +140	5
						Total	177

Source: IPCC 4th Assessment Report, Working Group III



2 ℃ global temperature change limit

It requires "negative CO2 emissions" in the latter half of the 21 century

Source)
National Institute for Environmental Studies
Center for Global Environmental Research
IPCC scenario database
http://www.cger.nies.go.jp/db/scenario/index.html

Transition from IPCC AR4 to IPCC AR5

IPCC AR4 WG3 (2007)

Three papers discussed **how to achieve 450 CO_2eq ppm concentration target which is equivalent to 2℃ global temperature limit above pre-industrial levels**

Policy makers in **COP15 paid attention to the 2℃ global temperature limit** above pre-industrial levels **in the Copenhagen Accord** in 2009

UNEP GAP report (2010, 2011, 2012, 2013)

note) the 2014 version will be published

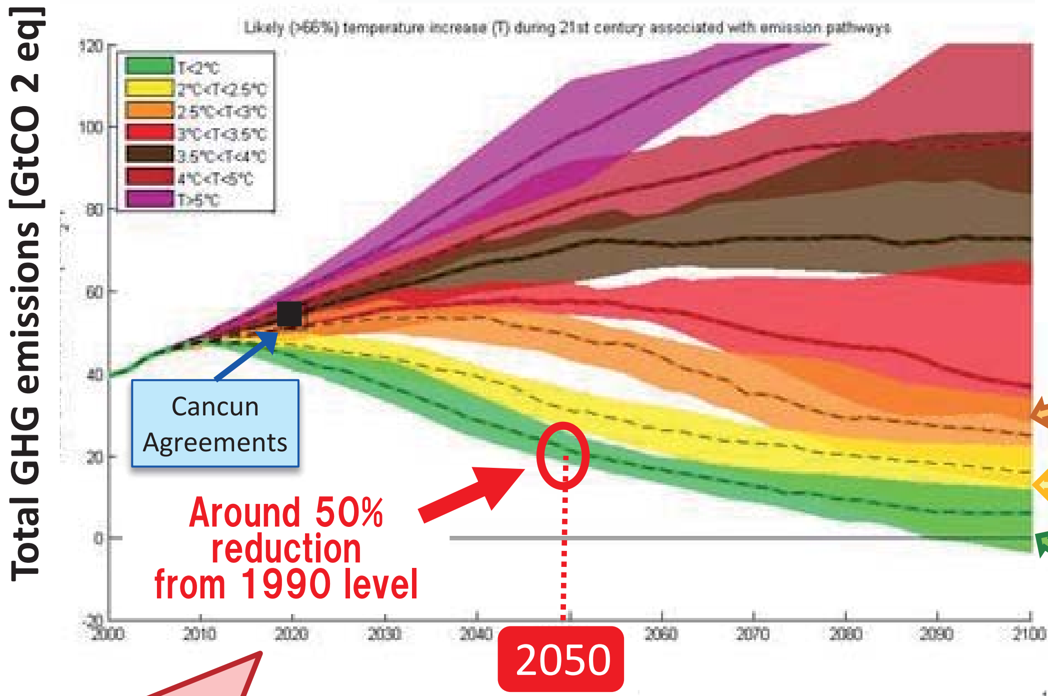
UNEP analysed **gaps** of GHG emissions **between 2 ℃ global temperature limit pathways and Cancun Agreements** in 2010.

IPCC AR5 WG3 (2014)

Various papers analysed **the role of negative CO_2 emissions for achieving GHG emission pathways consistent with the 2℃ global temperature limit target**

- Biomass energy with CCS (BECCS) is one of the essential technologies and it is difficult to achieve the 2℃ target without BECCS
- Energy efficiency improvement plays a key role. But the rate of change toward the 2℃ target is not in line with the current trends, much faster.

UNEP GAP report 2012
Global GHG emissions constraint



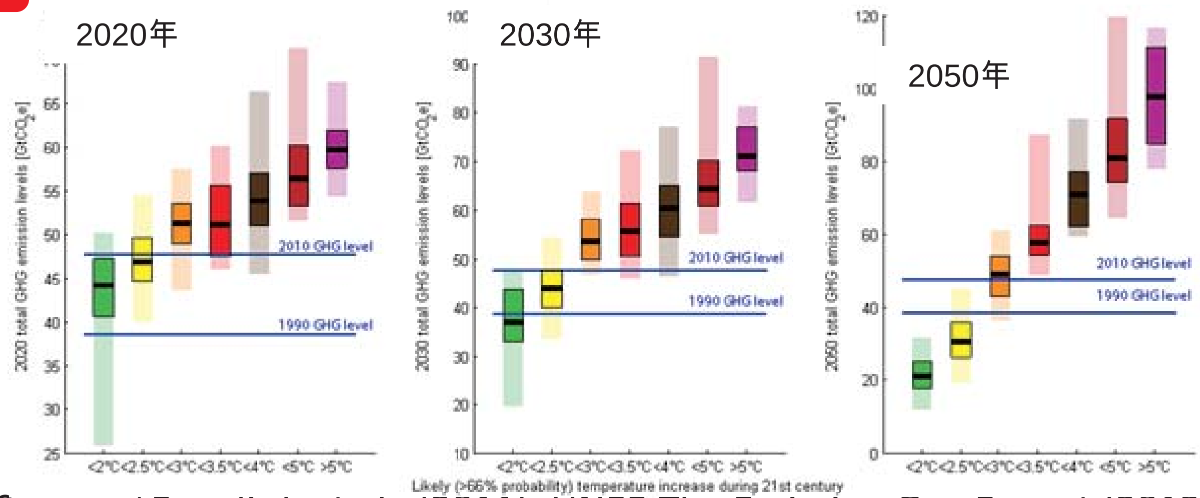
Dotted lines show
the median global GHG emissions pathway in the range of global GHG emissions pathways with a "likely" probability (greater than 66%)" of staying below a specific temperature relative to pre-industrial levels

3 degree relative to pre-industrial levels

2.5 degree relative to pre-industrial levels

2 degree relative to pre-industrial levels

National pledges for 2020 are not enough to meet the global emission pathways in line with achieving 2℃ target

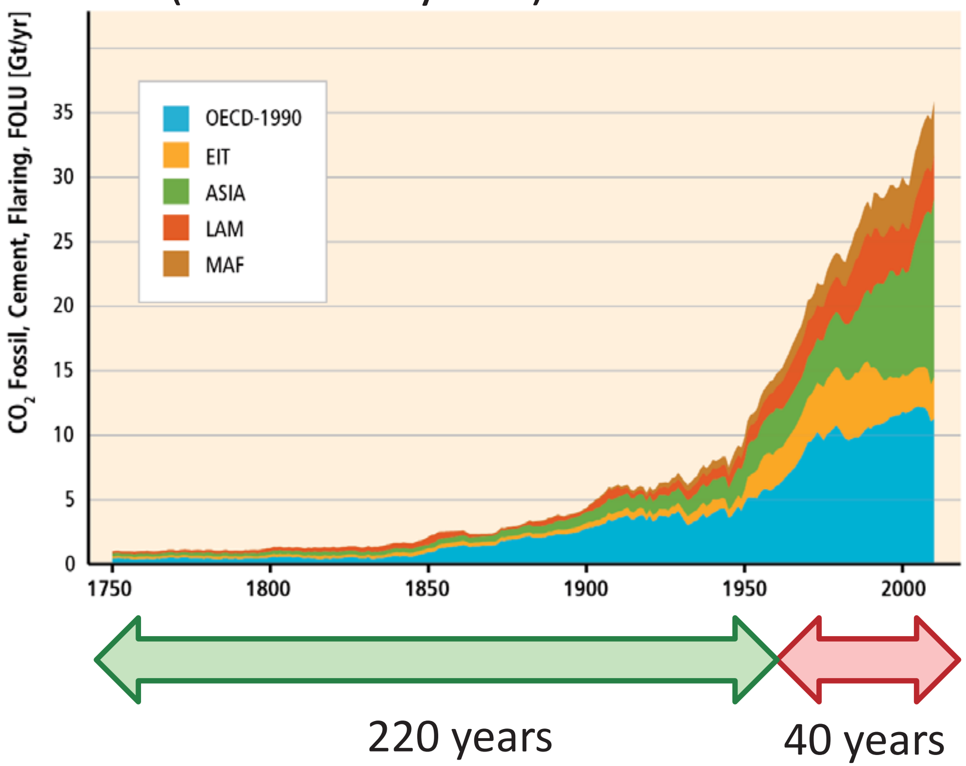


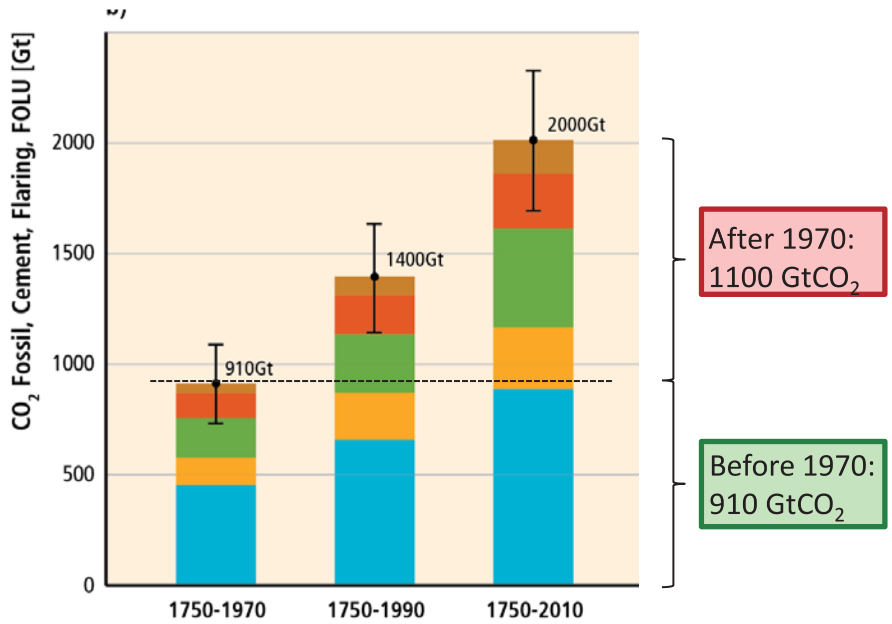
Caveat)
This study considers 6 GHGs emissions pathways. but not includes feedback effects of reductions of air pollutants and Short-lived Climate Pollutants(SLCPs.)

Sources）Rogelj, J. et al., (2011), UNEP The Emission Gap Report (2012)

Historical Trends of Cumulative CO2 Emissions

- IPCC AR5 WG1 says that there is a proportional relation between temperature increase and cumulative GHG emissions. Thus, when discussing future temperature increase, it is important to pay attention to amount of cumulative emissions.
- Historical cumulative anthropogenic CO_2 emissions have more than doubled since 1970 (i.e. last 40 years).





Source) IPCC AR5, Figure TS.2

Note)
OECD-1990: OECD countries affiliated in 1990
EIT: Economies in Transition
ASIA: Asian countries
LAM: Latin America countries
MAF: Middle East and Africa countries

Characteristics of scenarios in IPCC AR5

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AIM ASIA-PACIFIC INTEGRATED MODEL

- Since IPCC AR4, IPCC AR5 collected various papers and reviewed around 1200 scenarios.
- In order to achieve 2℃ global temperature change limit target above pre-industrial levels with a "likely" probability (greater than 66%), it is necessary to reduce GHG emissions around 40-70% by 2050 compared to the level in 2010, and almost zero emission by 2100.

CO_2eq Concentrations in 2100 (CO_2eq) Category label (concentration range)[9]	Subcategories	Relative position of the RCPs[5]	Cumulative CO_2 emissions[3] ($GtCO_2$)		Change in CO_2eq emissions compared to 2010 in (%)[4]		Temperature change (relative to 1850–1900)[5,6]				
			2011–2050	2011–2100	2050	2100	2100 Temperature change (°C)[7]	Likelihood of staying below temperature level over the 21st century[8]: 1.5 °C	2.0 °C	3.0 °C	4.0 °C
< 430	Only a limited number of individual model studies have explored levels below 430 ppm CO_2eq										
450 (430–480)	Total range[1, 10]	RCP2.6	550–1300	630–1180	−72 to −41	−118 to −78	1.5–1.7 (1.0–2.8)	More unlikely than likely	Likely	Likely	Likely
500 (480–530)	No overshoot of 530 ppm CO_2eq		860–1180	960–1430	−57 to −42	−107 to −73	1.7–1.9 (1.2–2.9)	Unlikely	More likely than not		
	Overshoot of 530 ppm CO_2eq		1130–1530	990–1550	−55 to −25	−114 to −90	1.8–2.0 (1.2–3.3)		About as likely as not		
550 (530–580)	No overshoot of 580 ppm CO_2eq		1070–1460	1240–2240	−47 to −19	−81 to −59	2.0–2.2 (1.4–3.6)		More unlikely than likely[12]		
	Overshoot of 580 ppm CO_2eq		1420–1750	1170–2100	−16 to 7	−183 to −86	2.1–2.3 (1.4–3.6)				
(580–650)	Total range	RCP4.5	1260–1640	1870–2440	−38 to 24	−134 to −50	2.3–2.6 (1.5–4.2)				
(650–720)	Total range		1310–1750	2570–3340	−11 to 17	−54 to −21	2.6–2.9 (1.8–4.5)		Unlikely	More likely than not	
(720–1000)	Total range	RCP6.0	1570–1940	3620–4990	18 to 54	−7 to 72	3.1–3.7 (2.1–5.8)	Unlikely[11]		More unlikely than likely	
>1000	Total range	RCP8.5	1840–2310	5350–7010	52 to 95	74 to 178	4.1–4.8 (2.8–7.8)		Unlikely[26]	Unlikely	More unlikely than likely

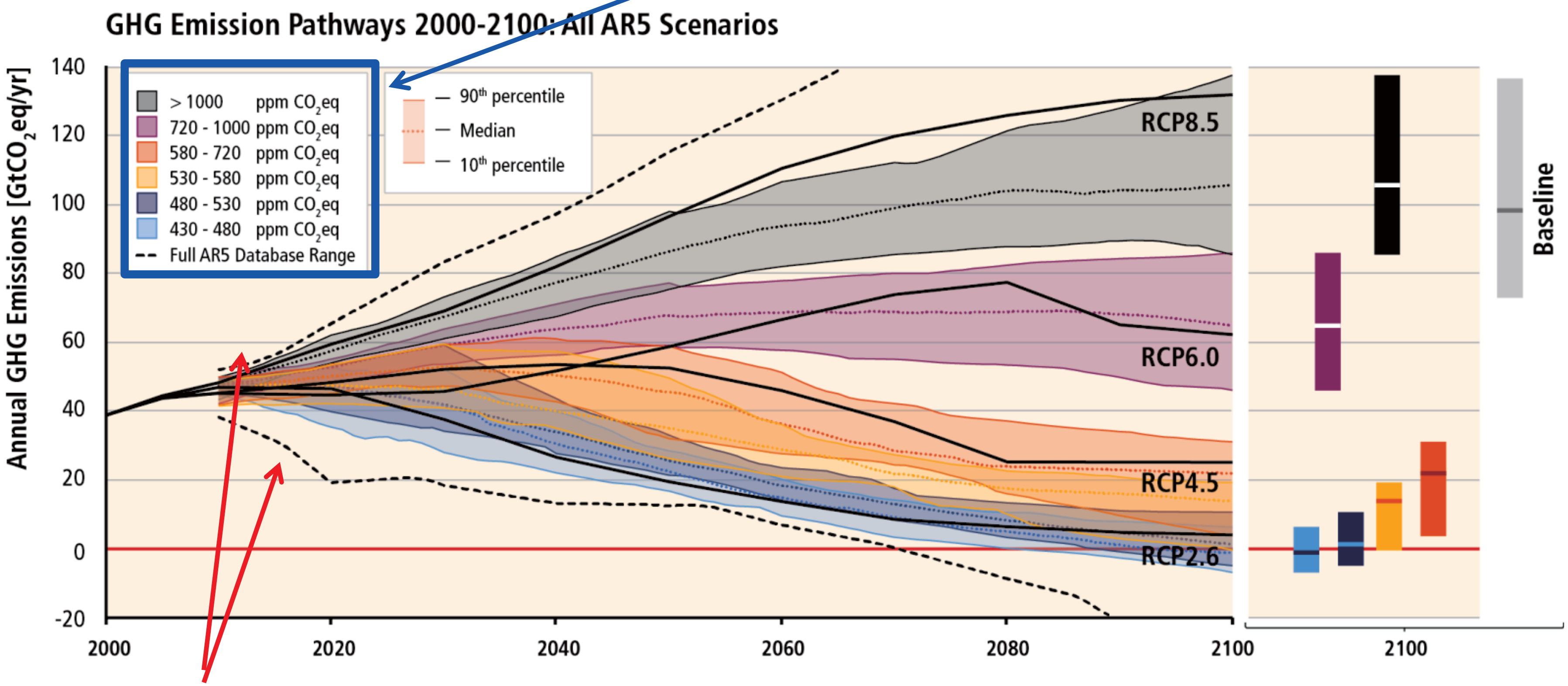
Source) IPCC AR5, Table SPM.1

Caveat) AR5 classified categories & discussed temperature change in 2100, but AR4 classified categories & discussed temperature change in long-term GHG equilibrium.

IPCC AR5: Long-term Emissions Pathways

◆ Without more mitigation, global mean surface temperature might increase by 3.7℃ to 4.8℃ over the 21st century.

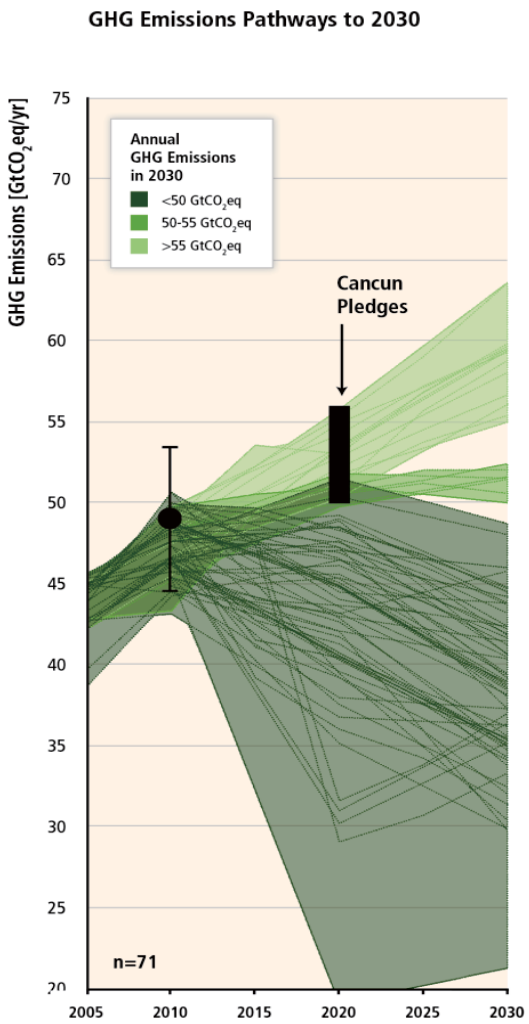
Different colors show different categories which achieve the same CO2-eq concentration at the point in 2100



Dash line: the range of around 1200 scenarios

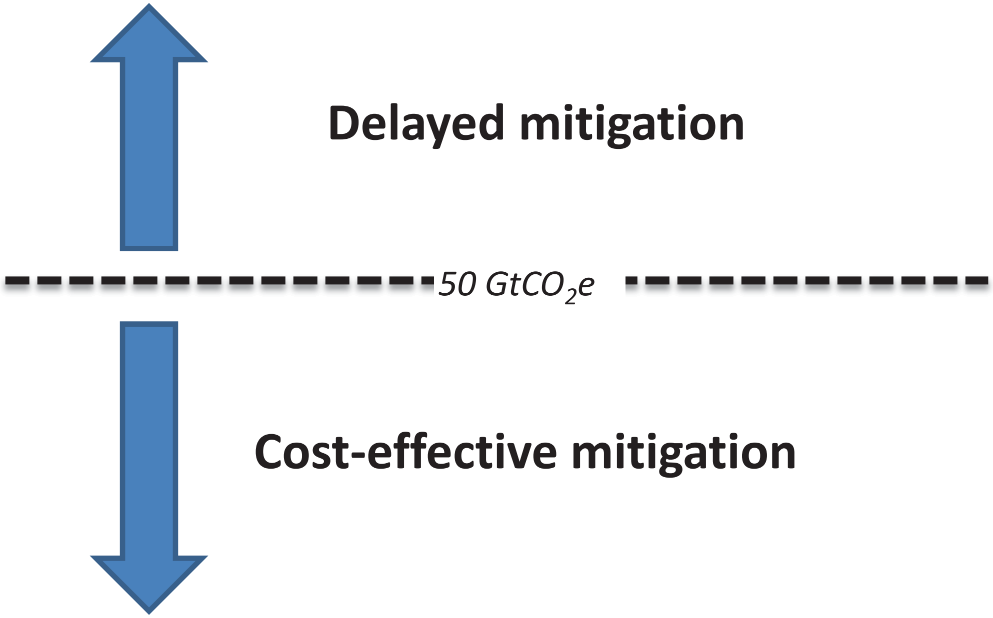
Source) IPCC AR5, Figure SPM. 4

Delayed mitigation VS cost-effective mitigation



Source) IPCC AR5, Figure SPM. 5

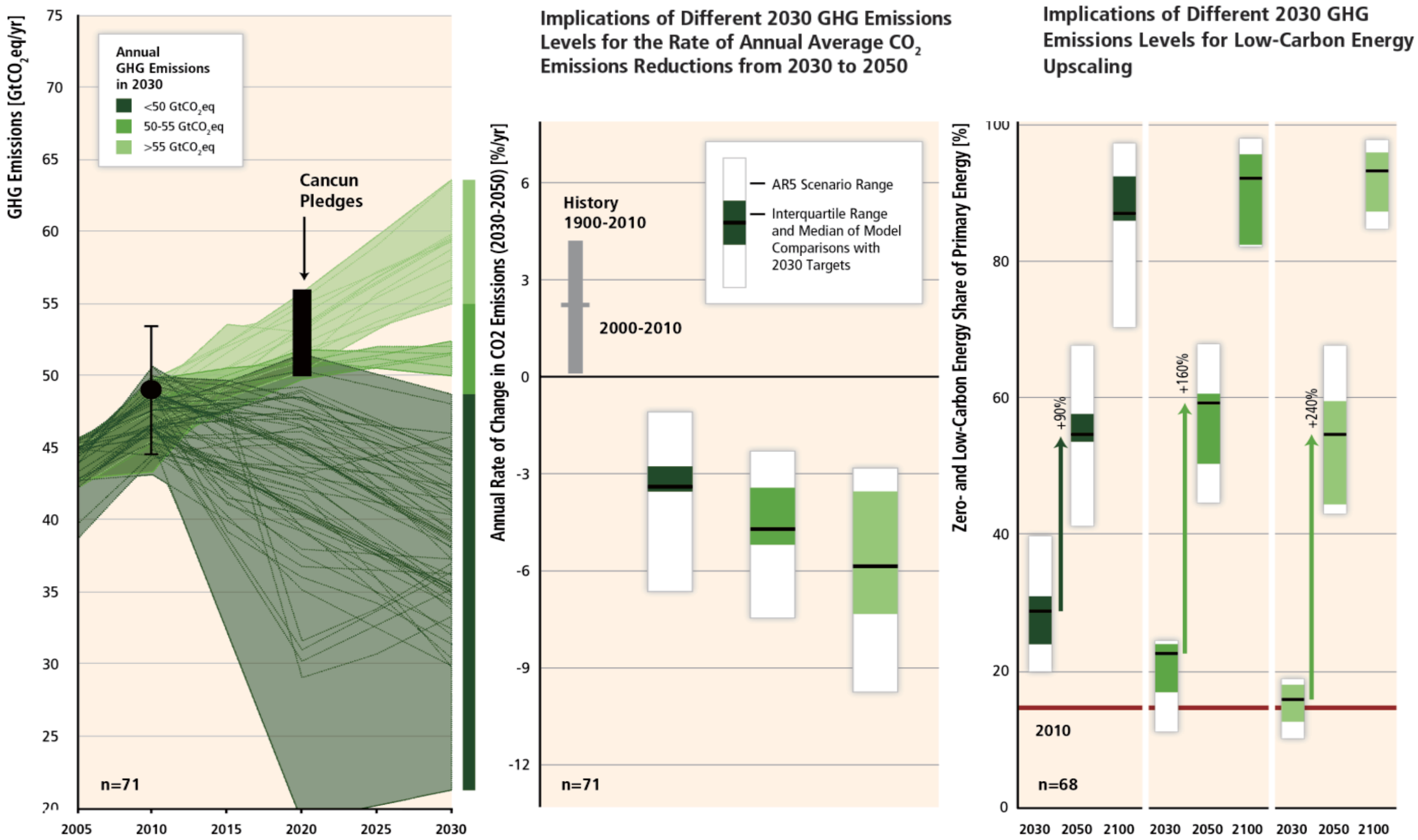
Delayed mitigation significantly increases the challenge to reach low concentration targets.



In cost-effective 2°C mitigation strategies, emissions have peaked and emission levels in 2030 tend to be lower than today.

Cancun Agreements and 2℃ target

- Cancun pledges correspond to staying below 3 ℃ target with "likely" probability. **Current Cancun Pledges imply increased mitigation challenges for reaching 2°C.**
- If we delay mitigation action, it becomes more difficult to shift to lower GHG emissions levels such as 2 ℃ target.



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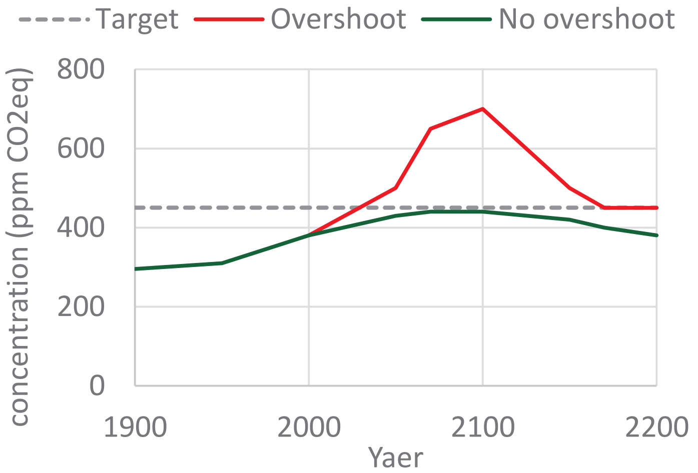
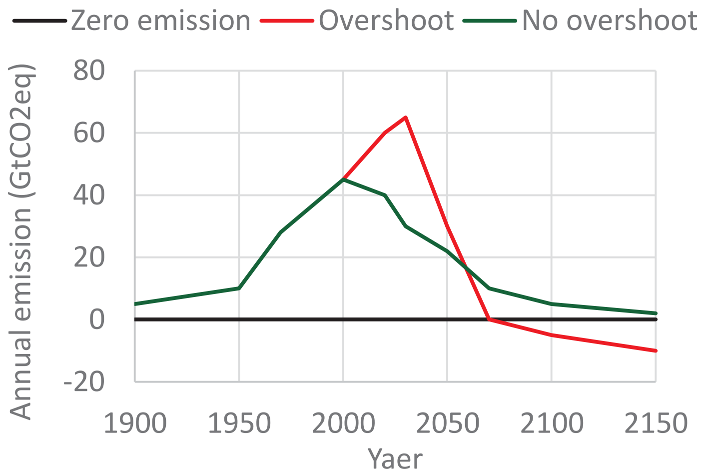
Risks of Delayed Action and Overshoot Scenarios

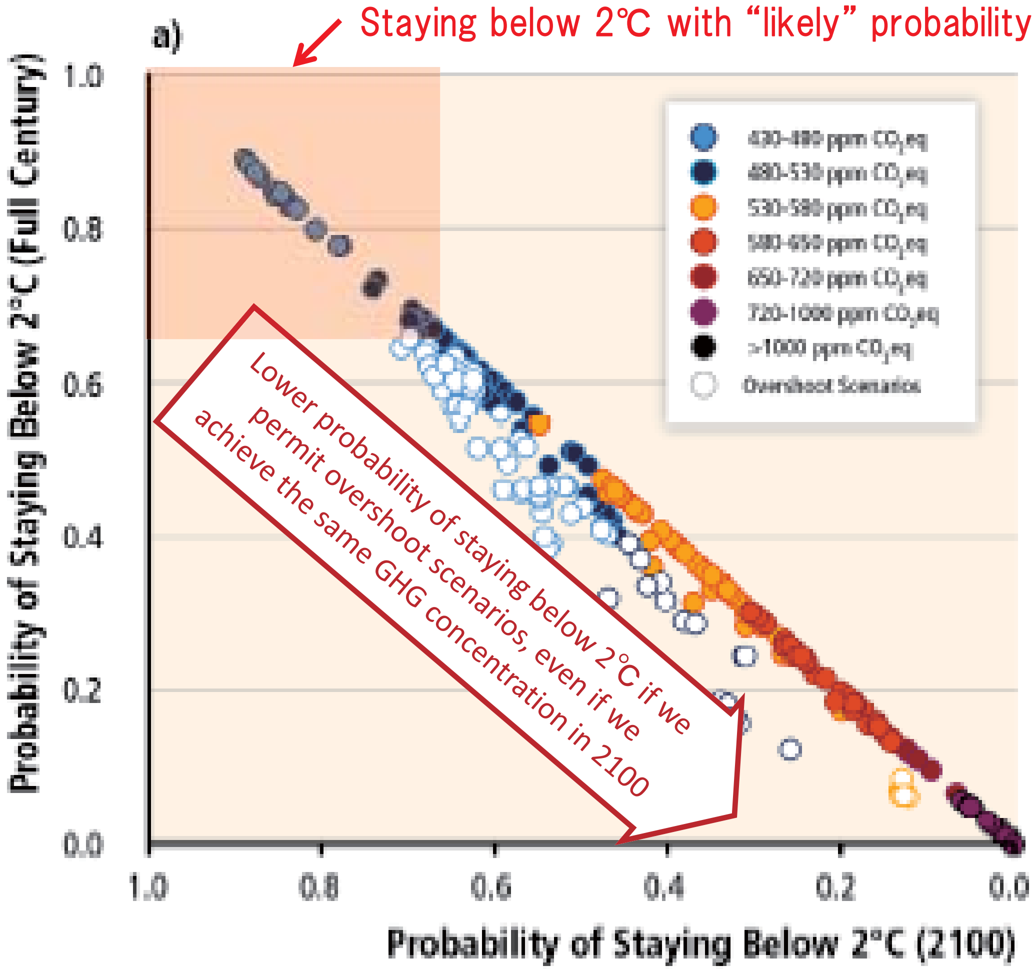
◆ **Example of overshoot in concentration**



◆ **Example of overshoot in emission**



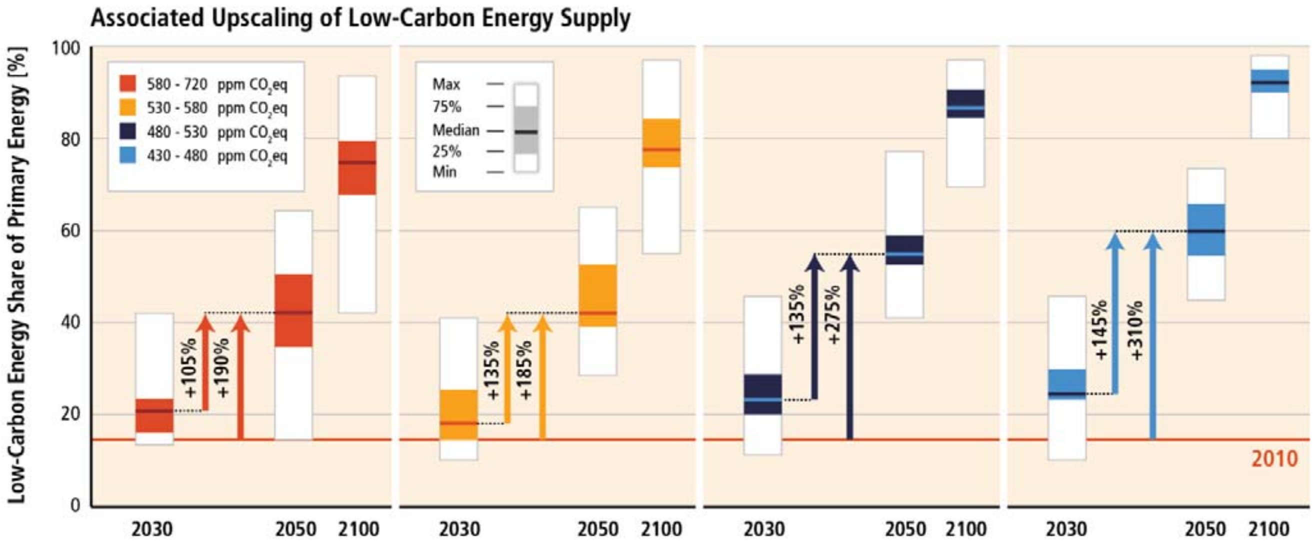
Discussions on with & without overshoot scenarios when achieving stringent GHG concentration scenarios



Source) IPCC AR5, Chapter 6, Final Draft Figure 6.14(a)

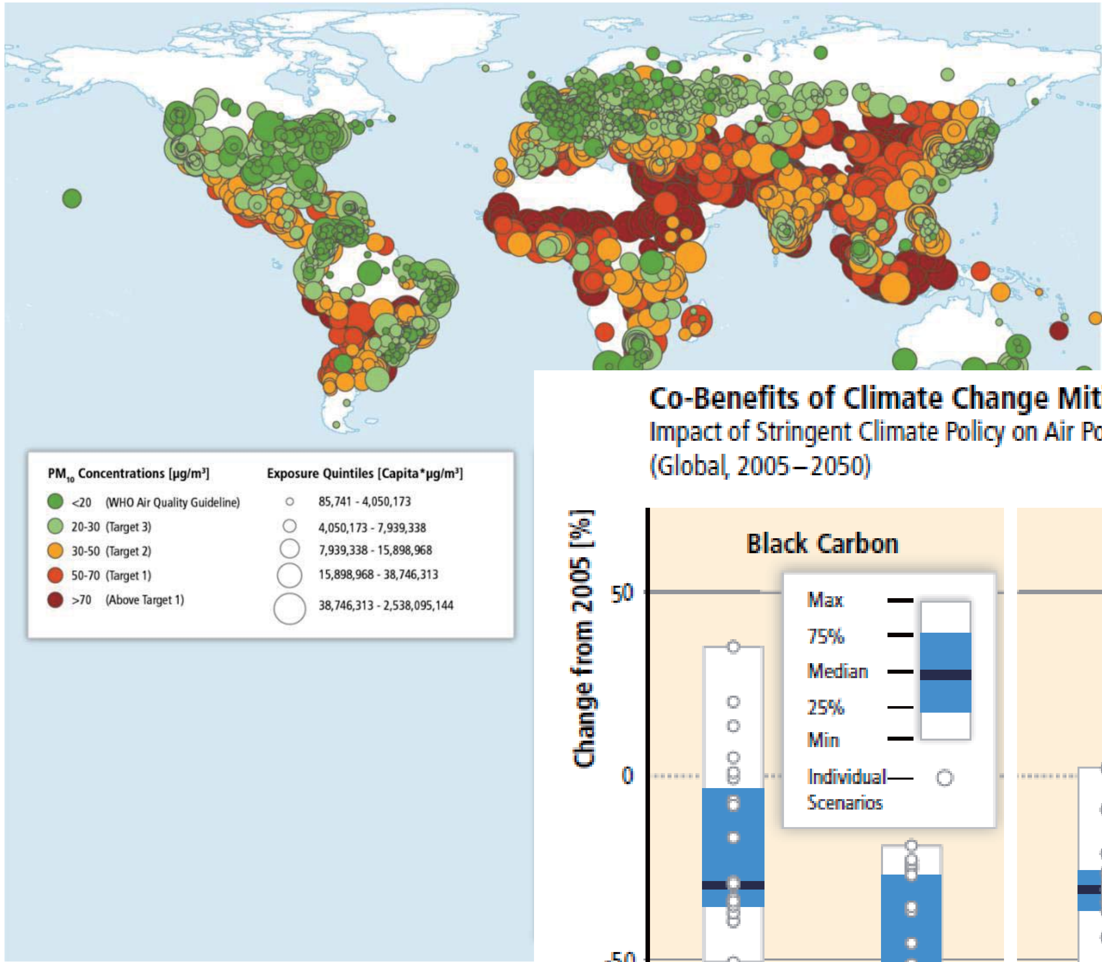
Other findings in IPCC AR5

- Historical national per-capita GHG emissions are highly variable within and between income groups. (IPCC AR5, Figure TS. 4)
- Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy (IPCC AR5, Figure SPM. 4)

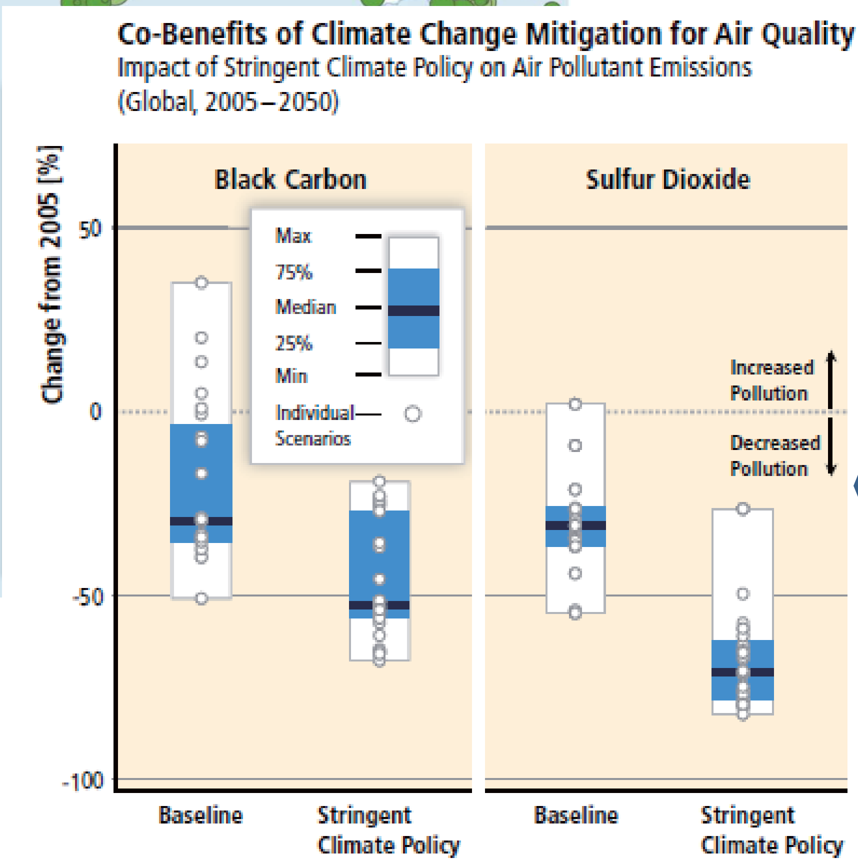


- Estimation for mitigation costs vary widely depending on scenario settings. Mitigation costs in cost-effective scenarios and estimated cost increases due to assumed limited availability of specific technologies and delayed additional mitigation (IPCC AR5, Table SPM. 2)
- Since AR4, there has been an increased focus on policies designed to integrate multiple objectives, increase co-benefits and reduce adverse side-effects.

Co-benefits of GHG mitigations



Mitigation can result in large co-benefits for human health and other societal goals.



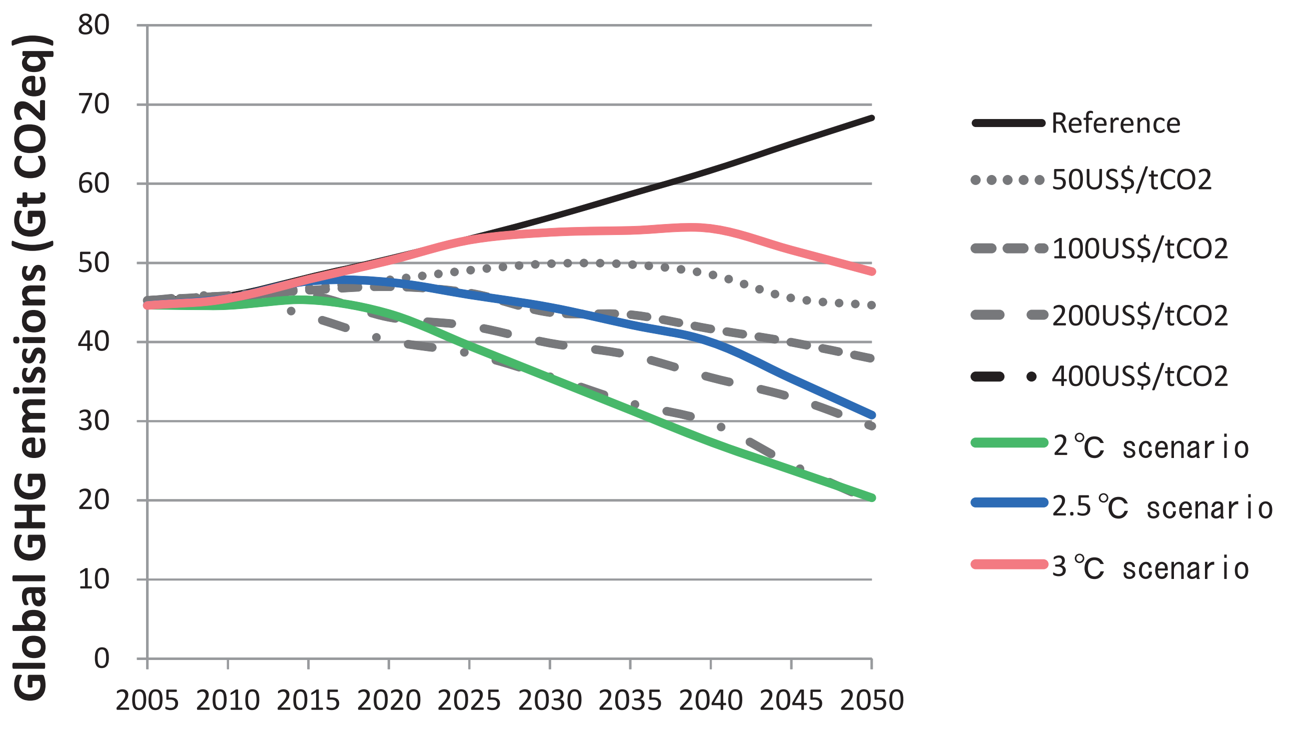
One of additional focuses in AR5 compared to AR4

Source) IPCC AR5, Figure TS. 14, Figure SPM. 6

Global GHG emissions pathways and comparison with 2 ℃ target pathways

The global GHG emissions pathways by AIM/Enduse[Global] are compared with the emissions pathways consistent with the 2℃ target scenarios.

- Transitions toward the 2℃ target are not in line with the current trend.
- It requires high carbon price around **400 US$/t$CO_2$ in 2050**, which is necessary to consider comprehensive strategies to promote mitigation technologies to achieve the maximum potentials of energy savings.

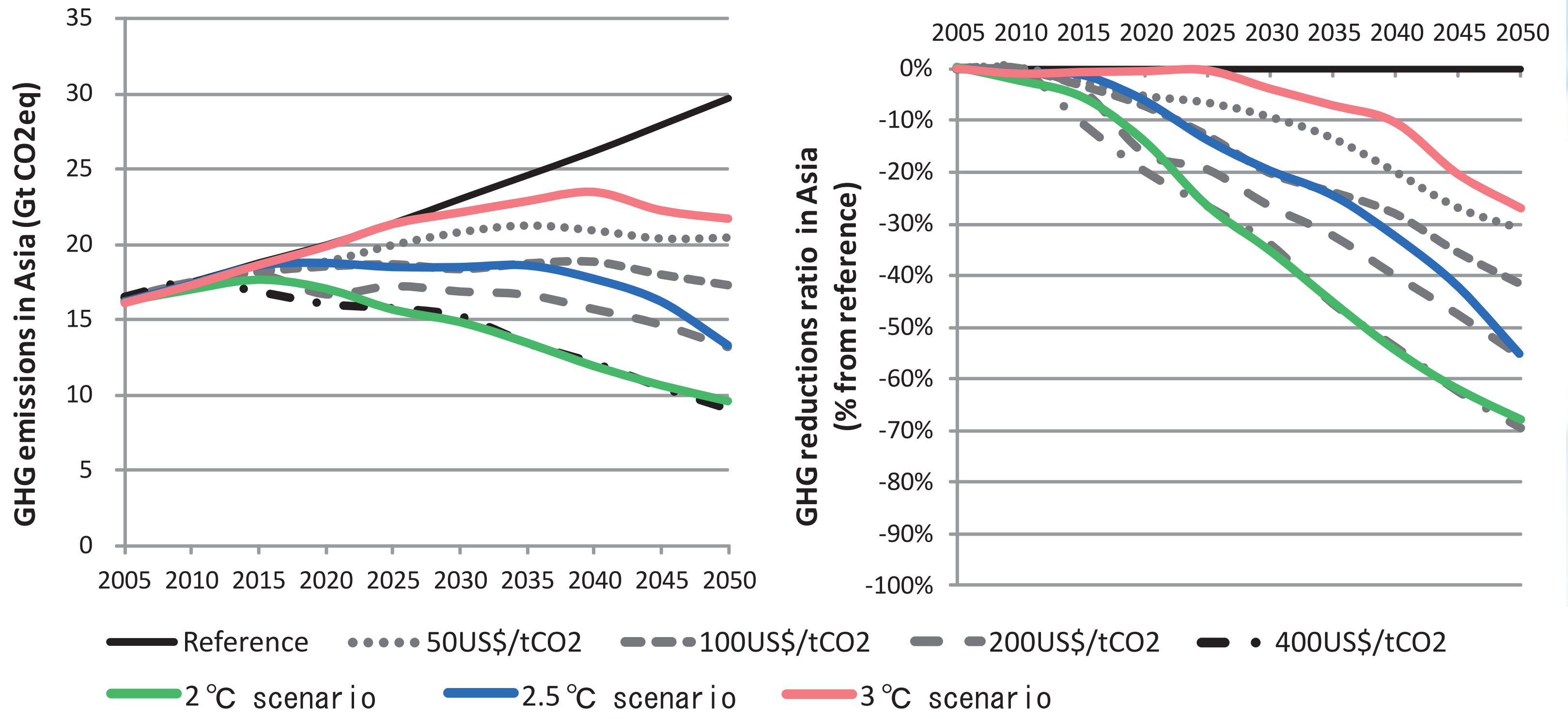


Source) modified from Hanaoka et al, Environmental Pollution, 2014

GHG emissions pathways in Asia and comparison with 2 ℃ target pathways

- Mitigation potentials are influenced by the portfolio of various mitigation measures, and various options are available for accelerating the introduction of energy efficient technologies on both the demand side and the supply side
- In **400 US$/tCO2 scenario, GHG emissions in Asia in 2050** are largely reduced
  - at 20.5Gt CO_2eq which correspond to **69% reductions from baseline**.

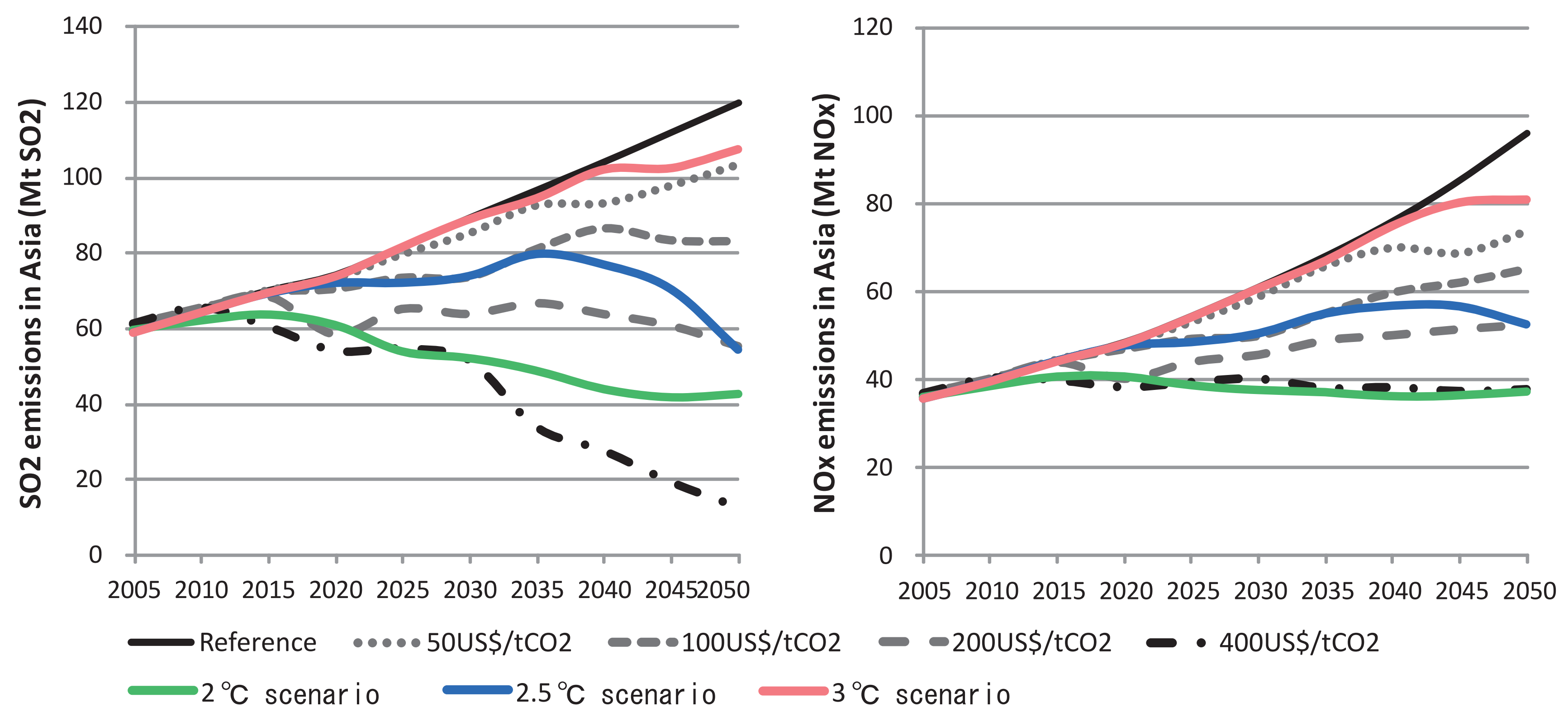
(at 7.5 Gt CO_2eq which correspond to **45% reductions from the levels in 2005.**)



Source) modified from Hanaoka et al, Environmental Pollution, 2014

SO_2 & NOx emissions pathways in Asia
- Cobenefits of implementing CO2 mitigation policies-

- In order to focus on cobenefits of reducing air pollutants by introducing GHG mitigation measures, **air pollutant removal devices are not considered**
- **SO_2 and NOx emissions in Asia will be significantly reduced as cobenefits** of achieving the GHG emissions pathways of 2℃ target scenarios.

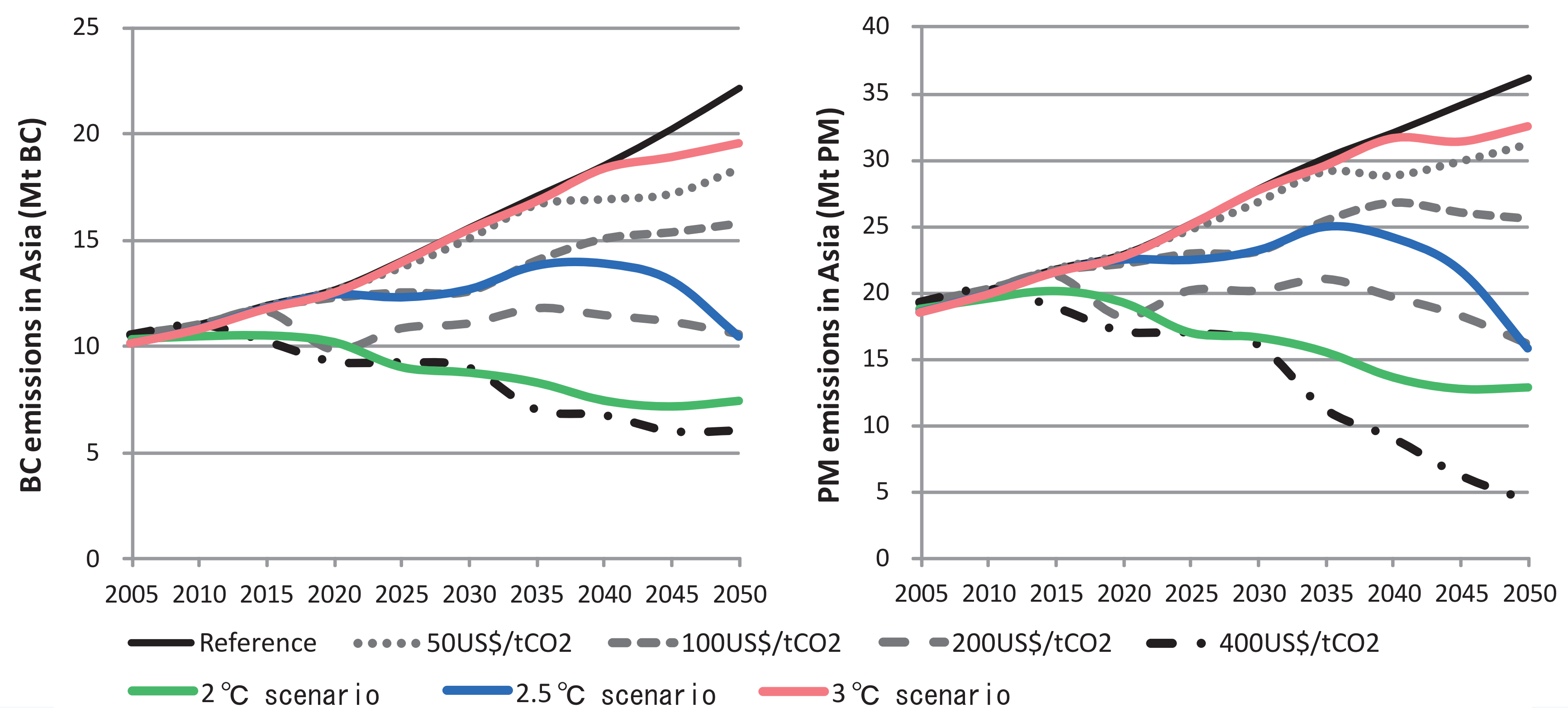


Demonstrating cobenefits may help to overcome various barriers for achieving LCS?

Source) modified from Hanaoka et al, Environmental Pollution, 2014

BC & PM emissions pathways in Asia
- Cobenefits of implementing CO2 mitigation policies-

- **BC and PM emissions in Asia will be significantly reduced as cobenefits** of achieving the GHG emissions pathways of 2℃ target scenarios.
- These are due to measures of energy efficiency improvement on the demand side and also a drastic energy shift on the supply side.



Demonstrating cobenefits may help to overcome various barriers for achieving LCS?

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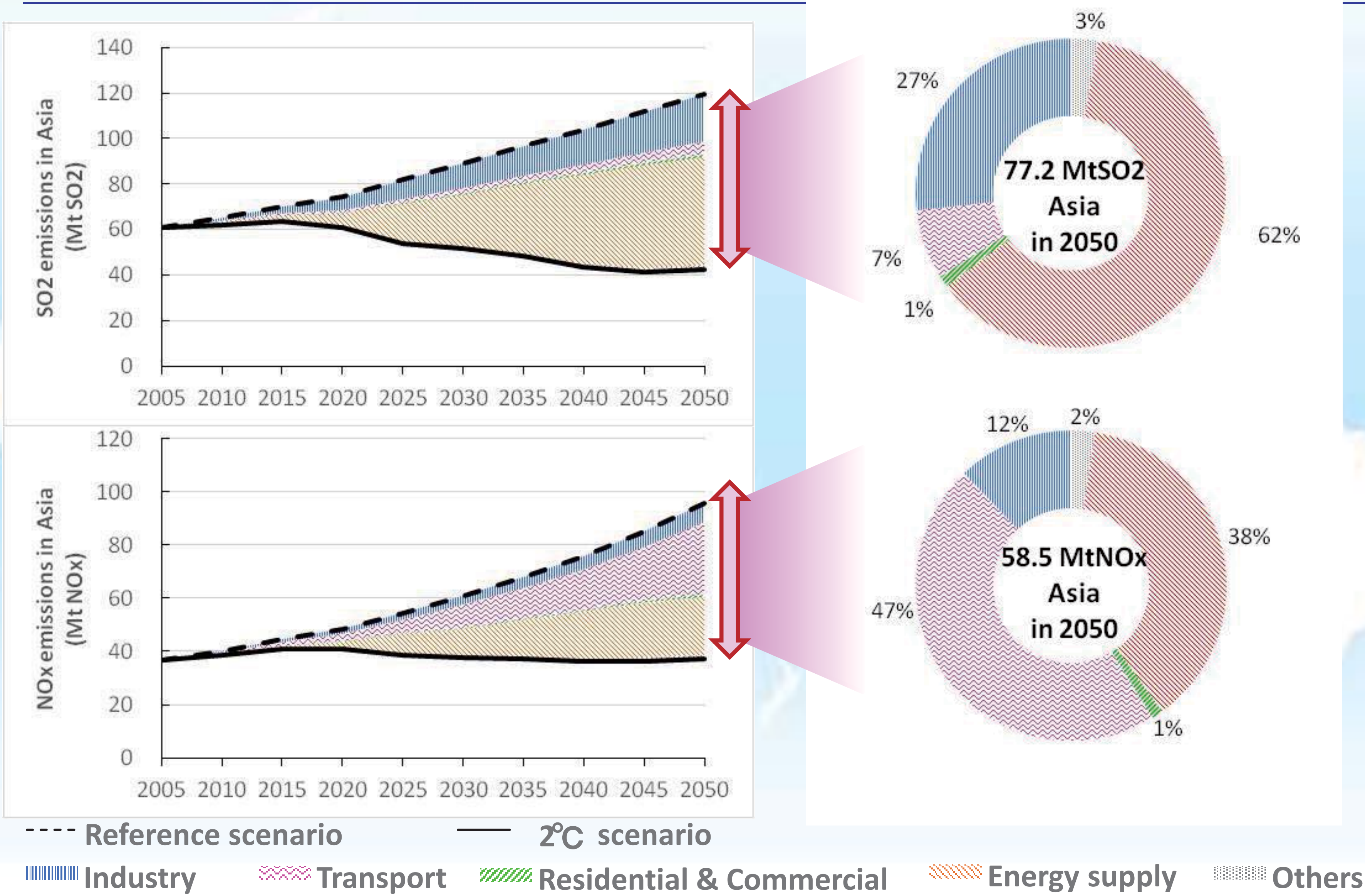
SO_2 & NOx reduction potentials in Asia
- Cobenefits of implementing CO2 mitigation policies-



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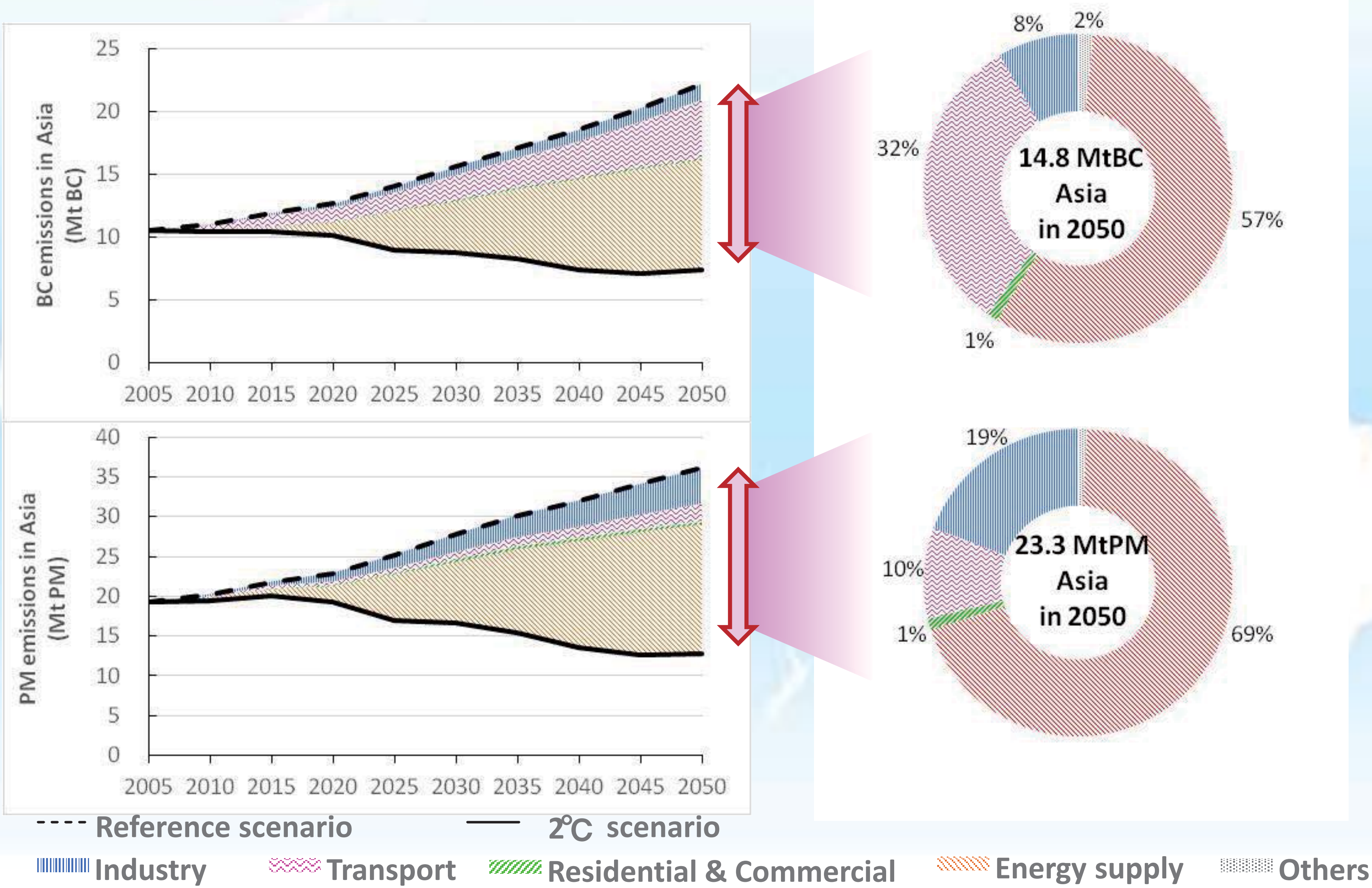

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