Transformation pathways and limiting warming to specific levels, notably a global mean warming of 2°C or 1.5°C relative to pre-industrial levels

CLIMATE CHANGE 2014

Mitigation of Climate Change

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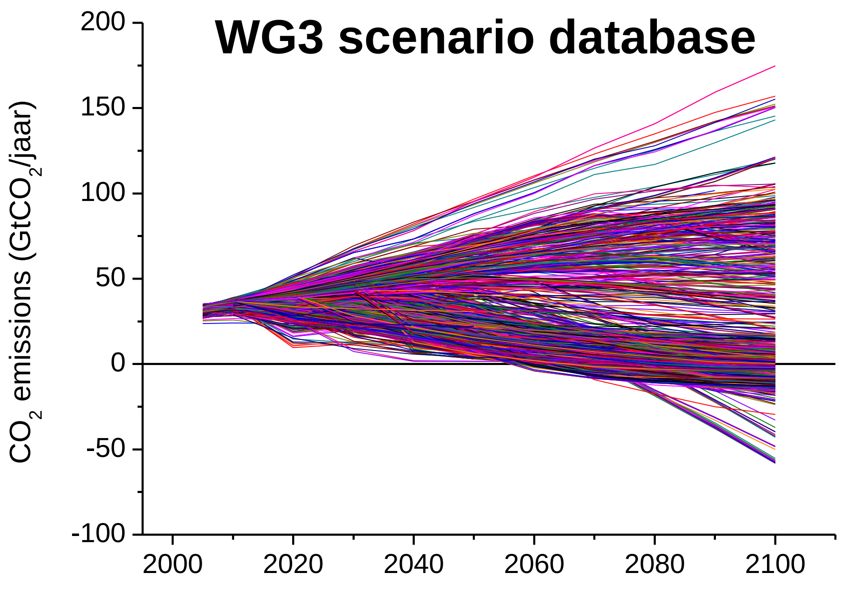
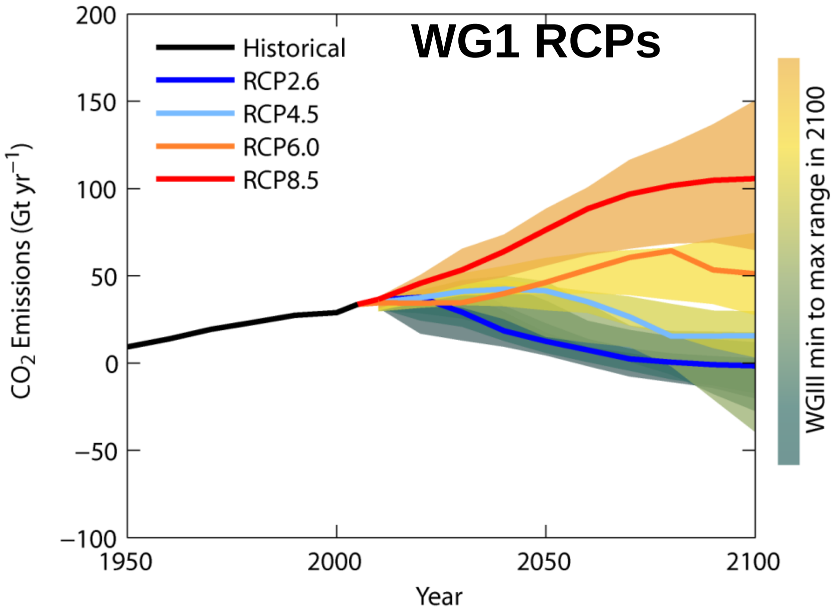
Working Group III contribution to the
IPCC Fifth Assessment Report

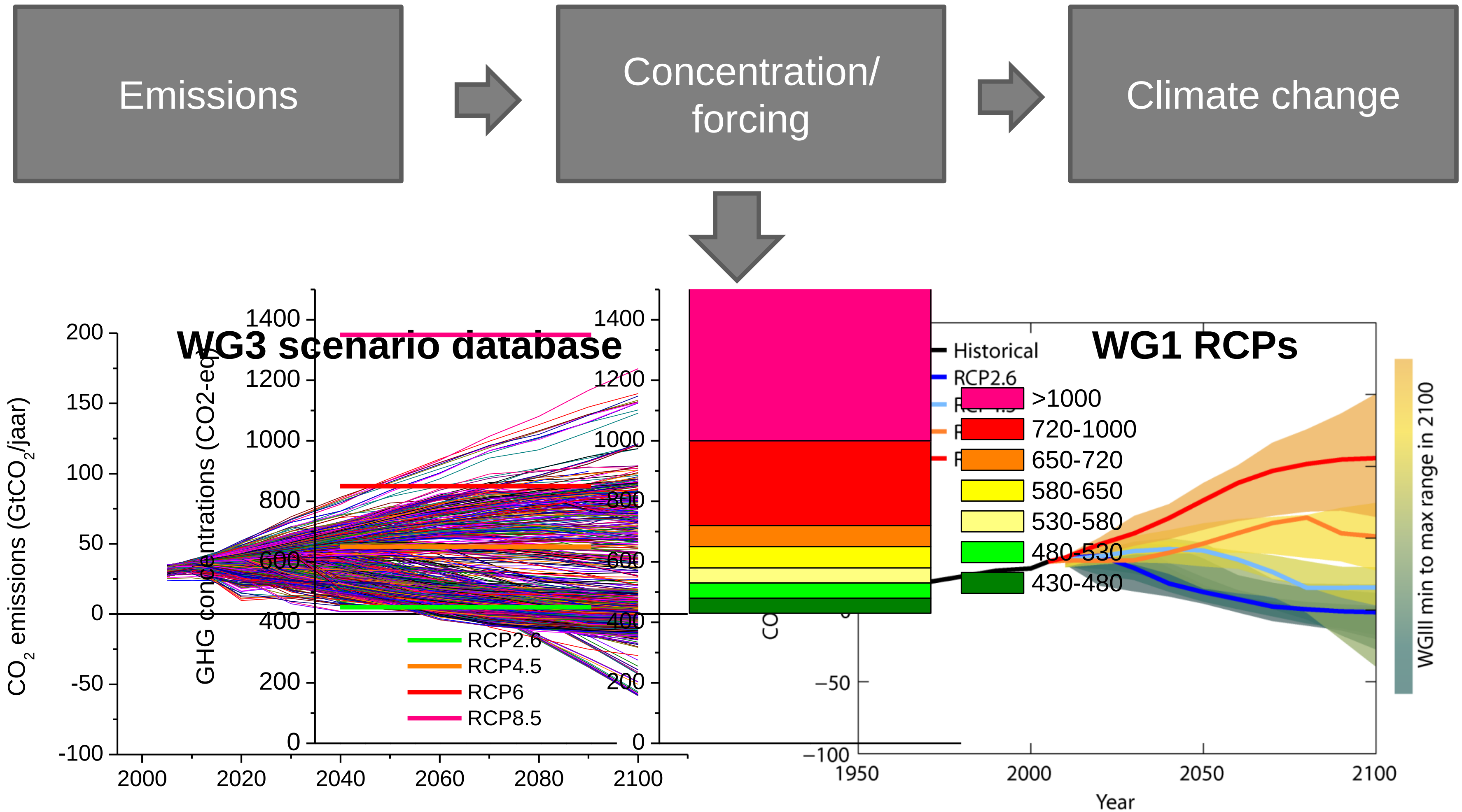
Working Group III assessment of transformation pathways

- Collected ~1200 scenarios from existing literature in “AR5 scenario database” to assess costs and mitigation implications.
- Both scenarios without new climate policy (baseline) and stringent mitigation scenarios
- For statements on climate benefits, connection with Representative Concentration Pathways (RCPs) as run by WG1 needed

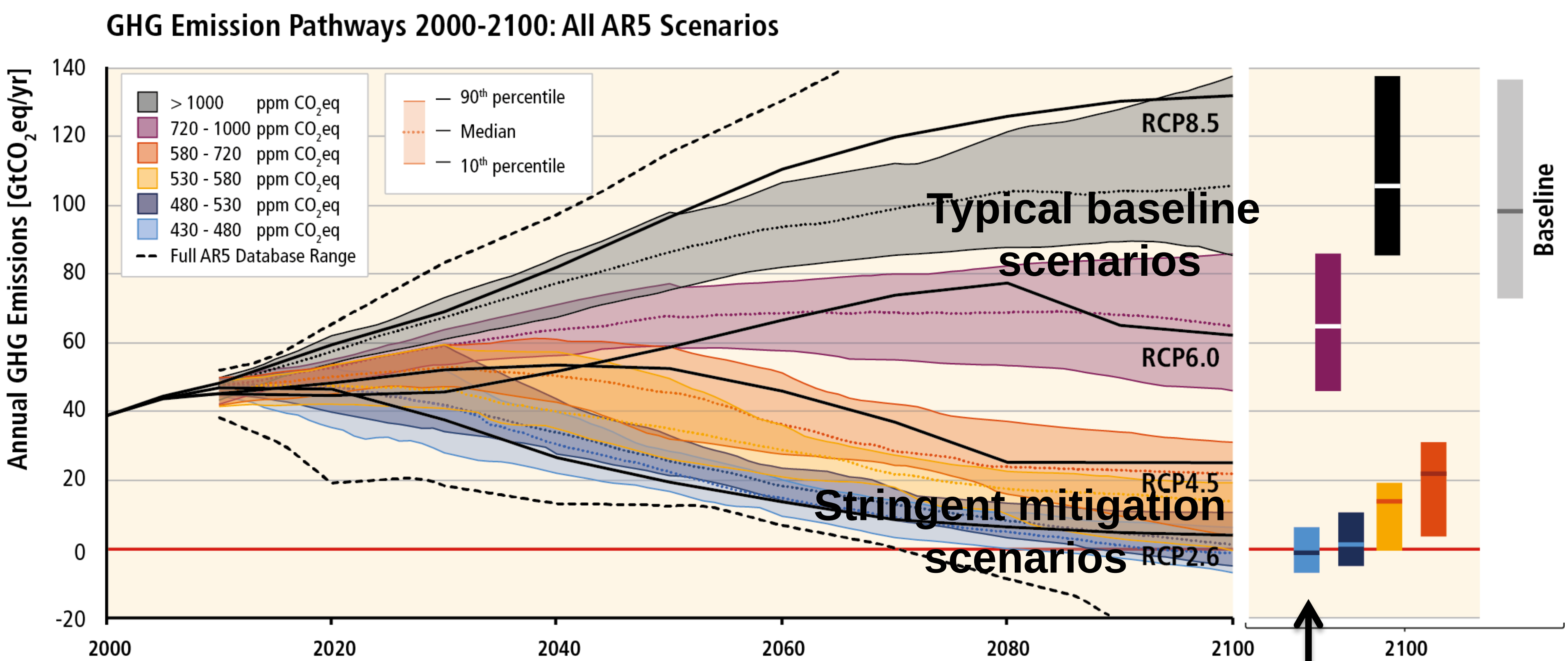




WG3 categorised scenarios based on their CO_2-eq concentration in order to link them with RCPs

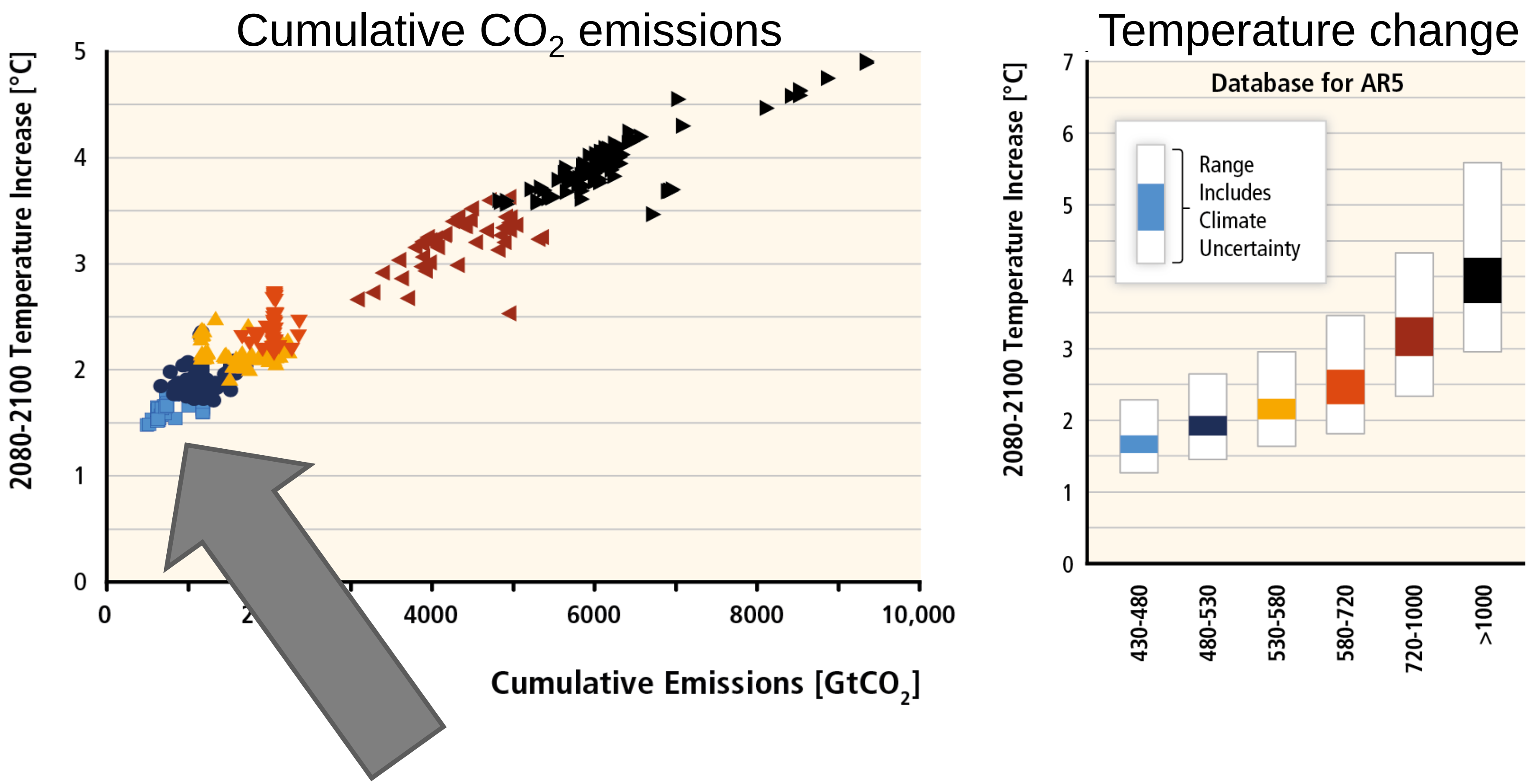


Wide range of scenarios in the literature – stringent emission reduction required to reach 2ºC target



Lowest scenarios “***likely***” to stay below 2°C

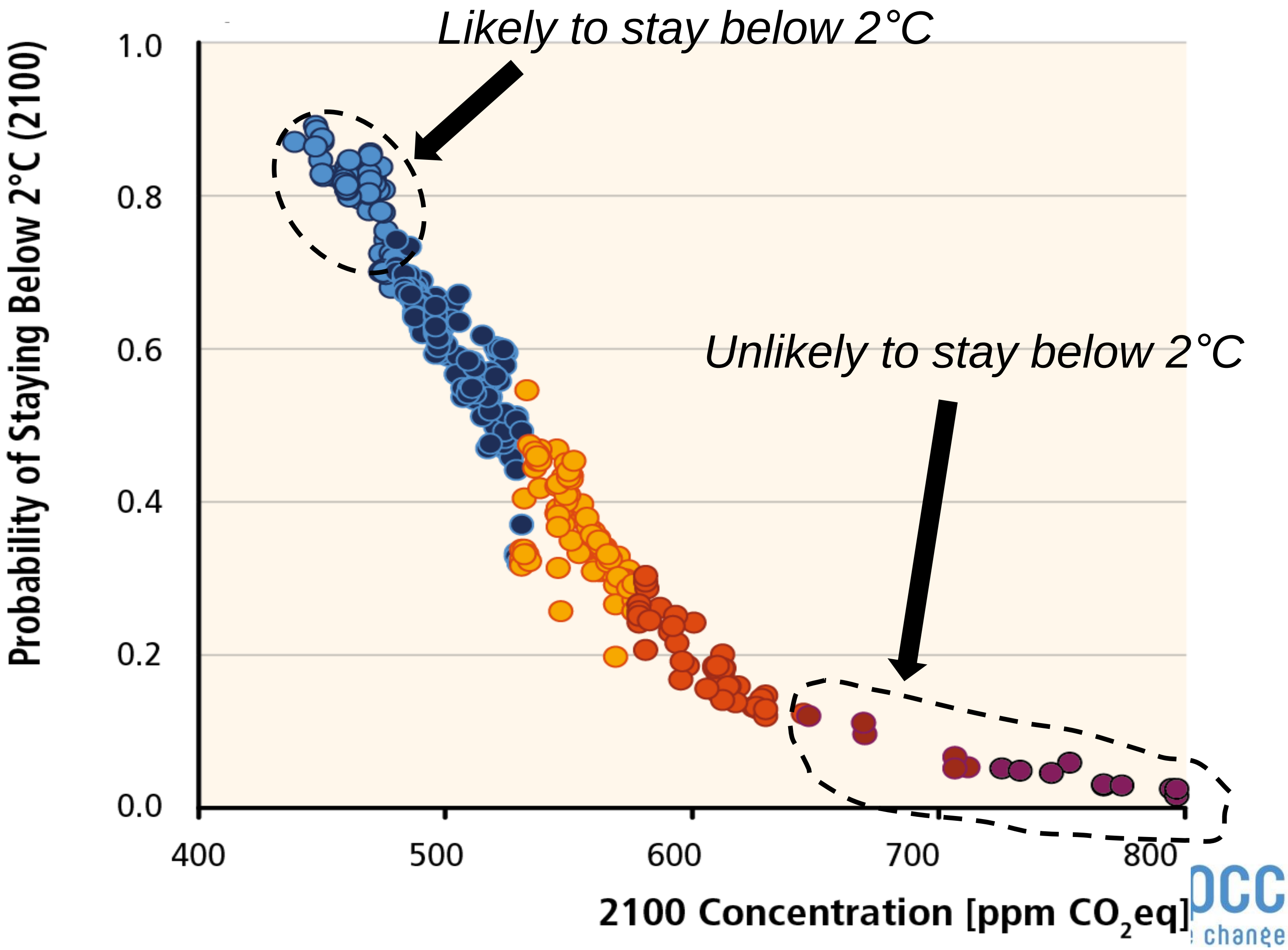
Achieving low levels of temperature change requires to limit cumulative CO_2 emissions



Emissions budget for 2°C is about 600-1200 $GtCO_2$

(historical emissions are about 1850 $GtCO_2$)

Major advancement since AR4: Probabilistic interpretation of the scenario literature

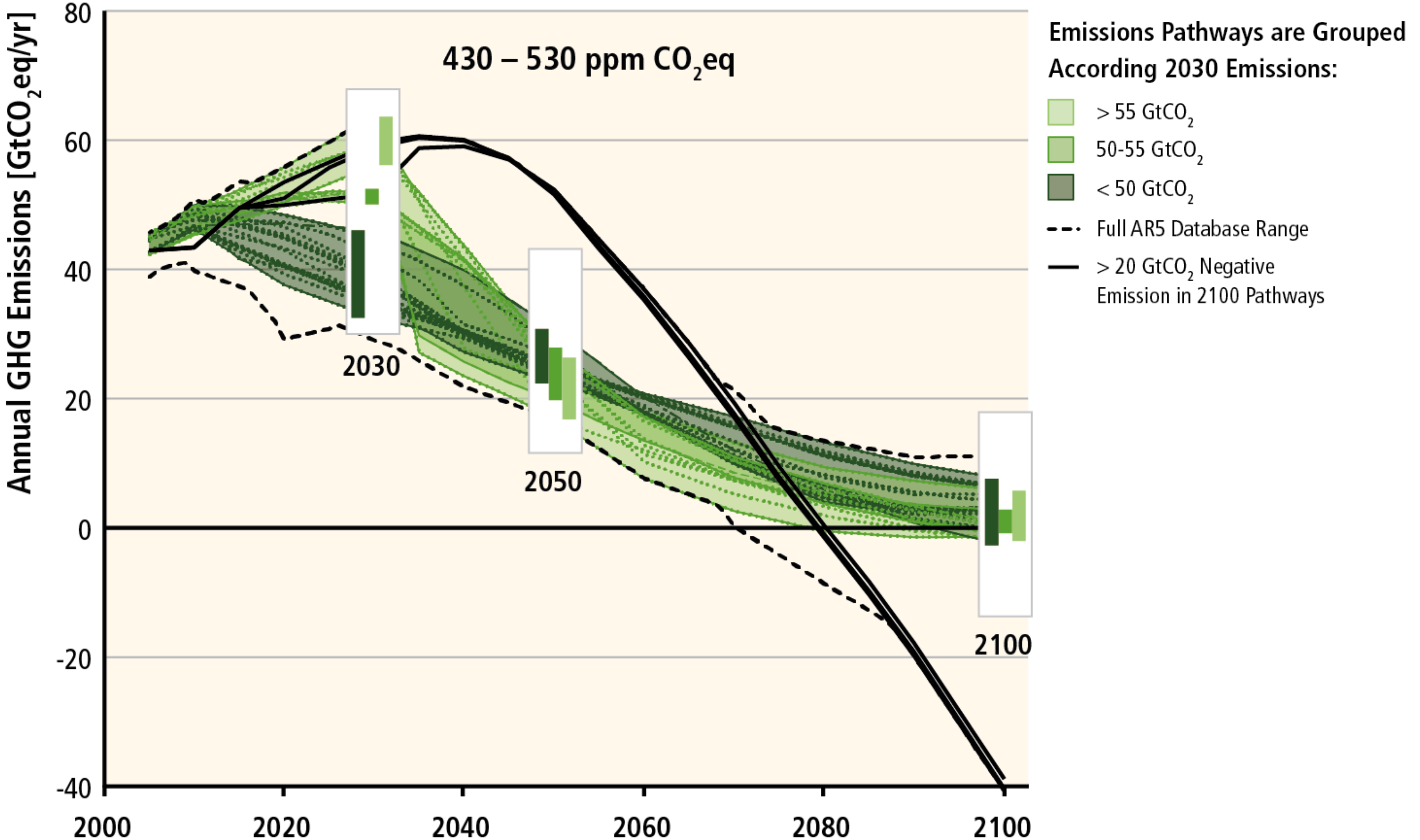


Relationship between global GHG emissions and the likelihood of different temperature targets

Concentration Levels | *Emissions budgets* | *Emissions reductions* | *Likelihood of temperature change*

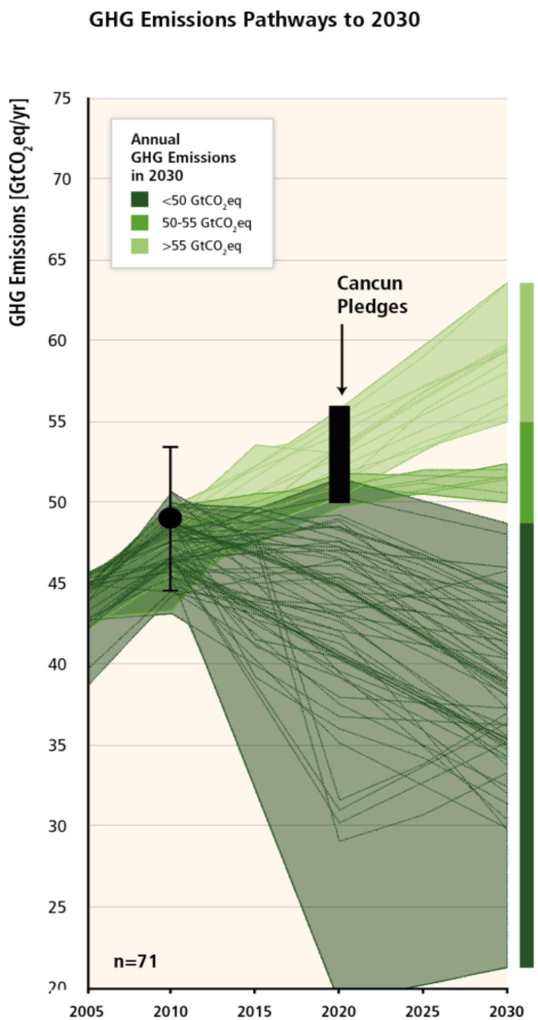
CO_2eq Concentrations in 2100 (CO_2eq) *Category label (concentration range)* [9]	*Subcategories*	*Cumulative CO_2 emission[3] ($GtCO_2$)*	*Change in CO_2eq emissions compared to 2010 in (%)*[4]		*Temperature change (relative to 1850–1900)*[5,6]			
					Likelihood of staying below temperature level over the 21st century[8]			
		2011–2100	*2050*	*2100*	*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]	630–1180	-72 to -41	-118 to -78	*More unlikely than likely*	*Likely*	*Likely*	*Likely*
500 (480–530)	No overshoot of 530 ppm CO_2eq	960–1430	-57 to -42	-107 to -73	*Unlikely*	*More likely than not*		
	Overshoot of 530 ppm CO_2eq	990–1550	-55 to -25	-114 to -90		*About as likely as not*		
550 (530–580)	No overshoot of 580 ppm CO_2eq	1240–2240	-47 to -19	-81 to -59		*More unlikely than likely*[12]		
	Overshoot of 580 ppm CO_2eq	1170–2100	-16 to 7	-183 to -86				
(580–650)	Total range	1870–2440	-38 to 24	-134 to -50				
(650–720)	Total range	2570–3340	-11 to 17	-54 to -21		*Unlikely*	*More likely than not*	
(720–1000)	Total range	3620–4990	18 to 54	-7 to 72	*Unlikely*[11]		*More unlikely than likely*	
>1000	Total range	5350–7010	52 to 95	74 to 178		*Unlikely*[11]	*Unlikely*	*More unlikely than likely*

Different trajectories possible to the same target – delay scenarios rely heavily on negative emissions (BECCS)



Overshoot requires less short term emissions, but more reliance on negative emission technologies, and larger risk of temperature overshoot

In cost-effective 2°C mitigation strategies, emissions are reduced to about current levels or less by 2030



Delayed mitigation

50 $GtCO_2e$

Cost-effective mitigation

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Source: Figure SPM.5

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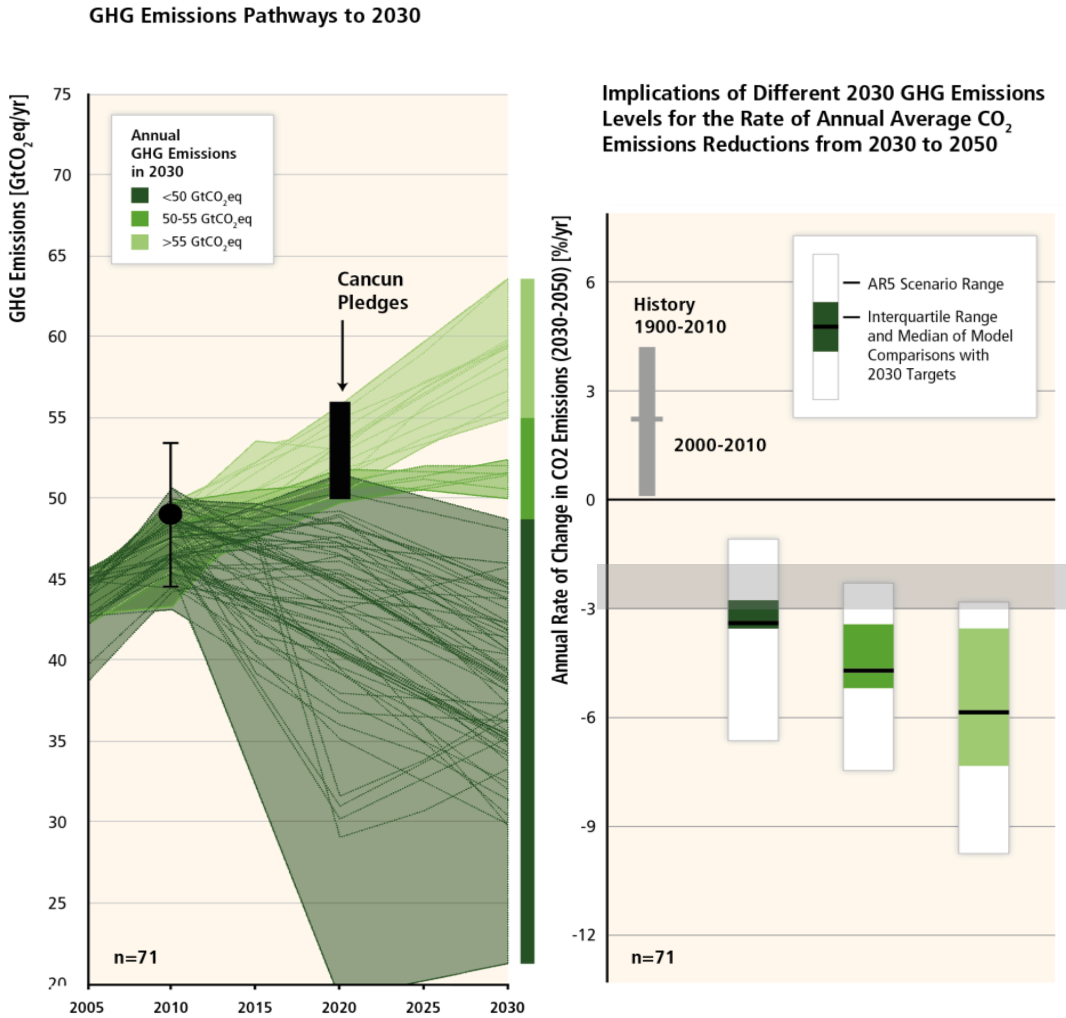
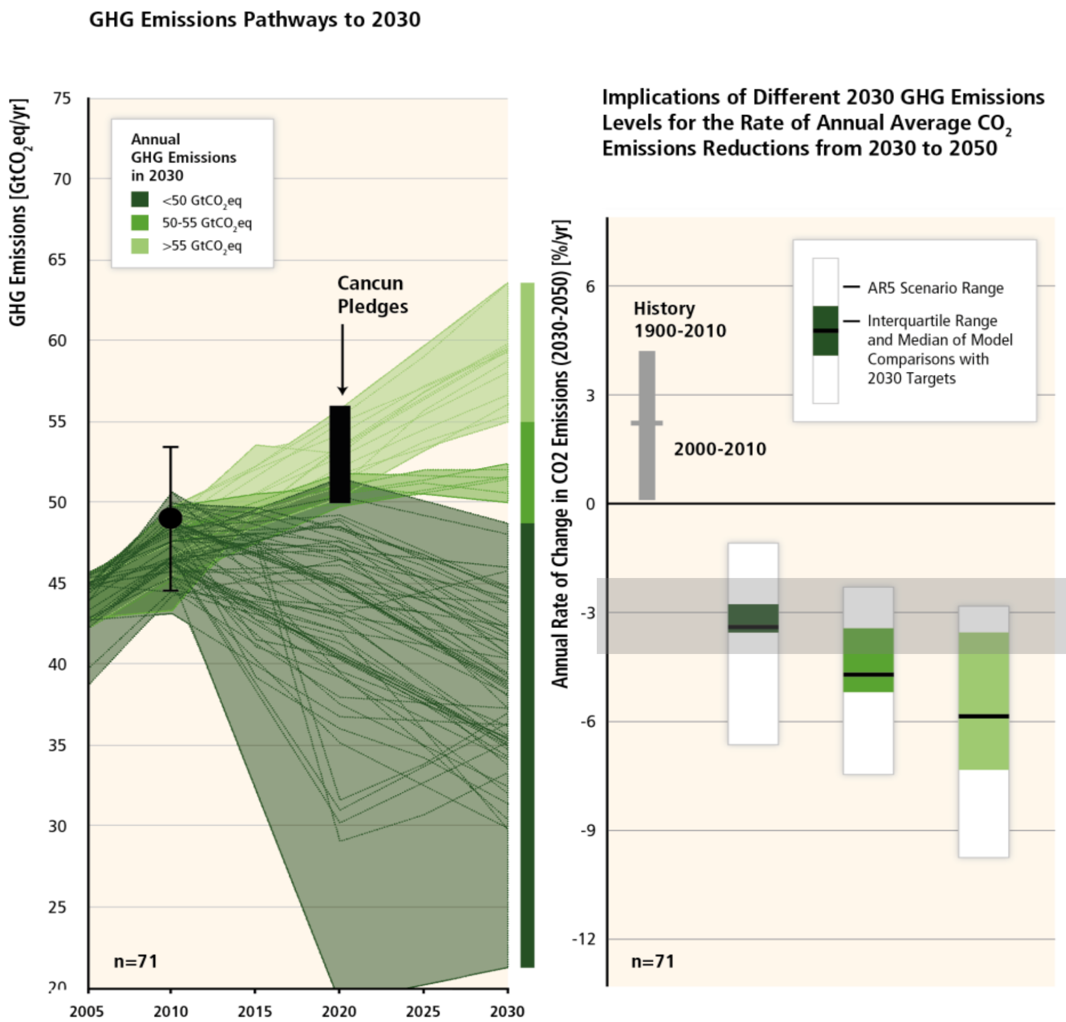
Delayed mitigation significantly increases the challenge to reach low concentration targets



Sweden & France after the oil crisis

Delayed mitigation significantly increases the challenge to reach low concentration targets

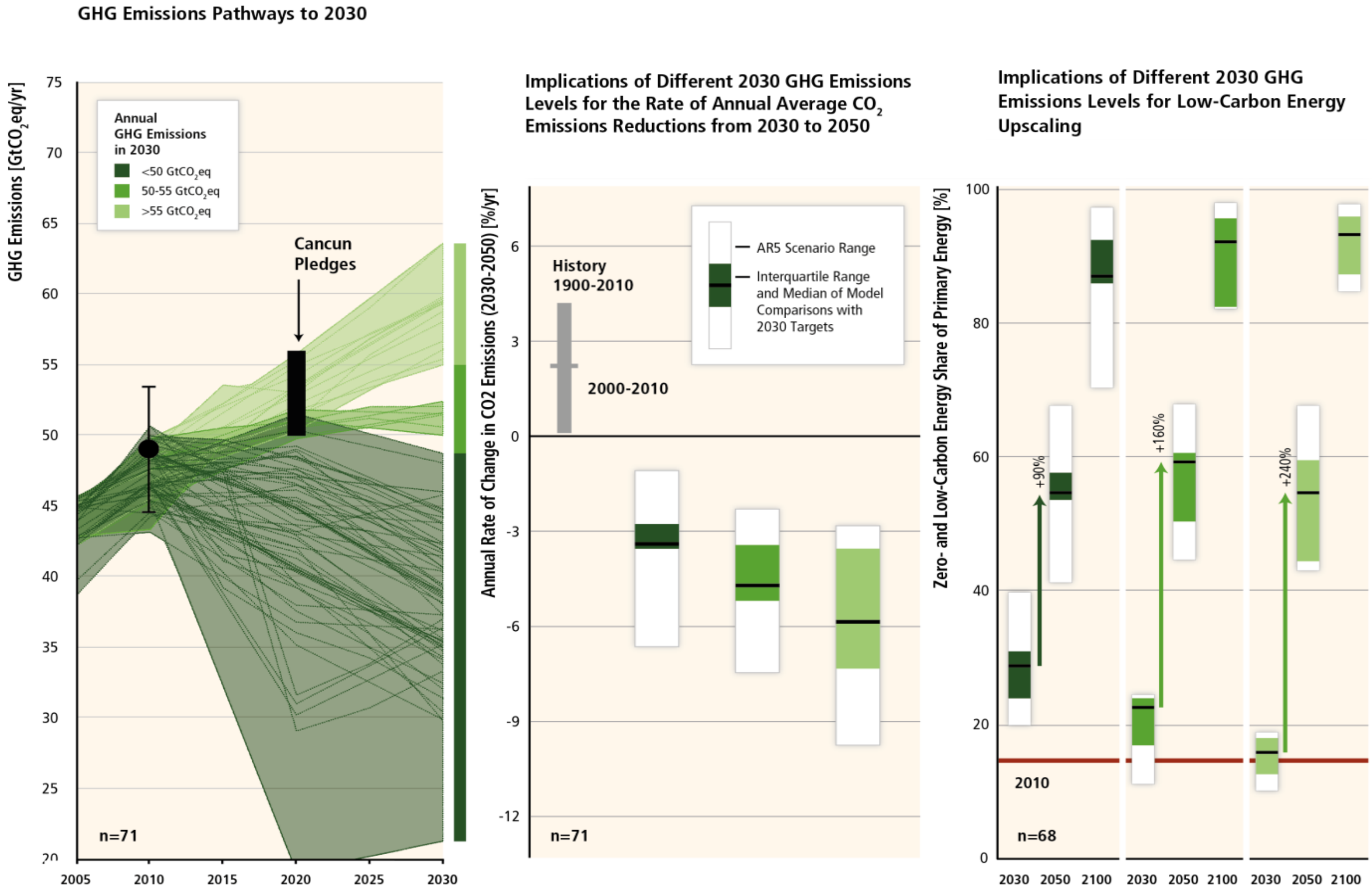


Collapse of the former Soviet Union

Europe WWI & II (>4%)

Source: Figure SPM.5

Delayed mitigation significantly increases the challenge to reach low concentration targets



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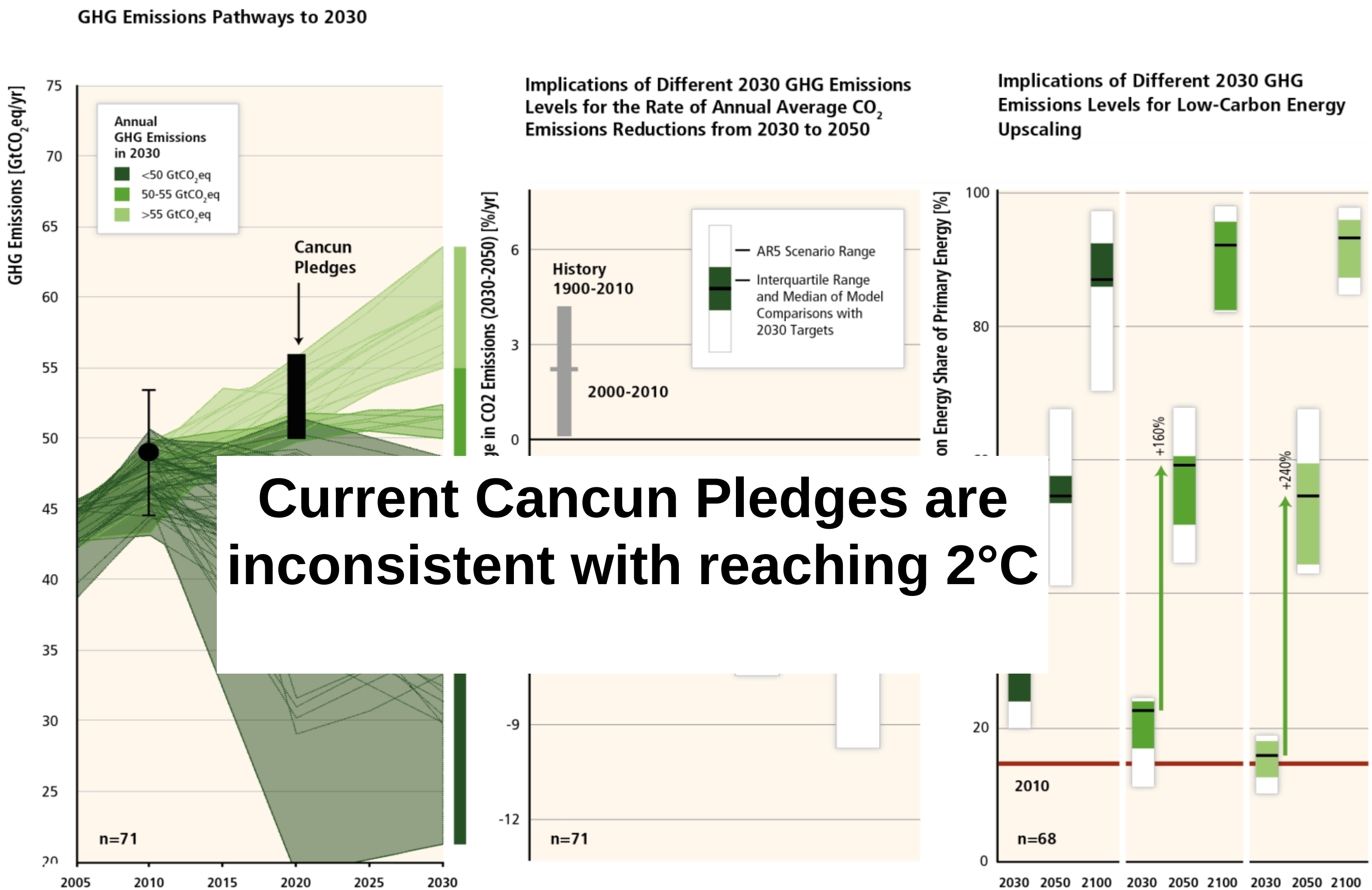
Source: Figure SPM.5

Delayed mitigation significantly increases the challenge to reach low concentration targets



Current Cancun Pledges are inconsistent with reaching 2°C

Source: Figure SPM.5

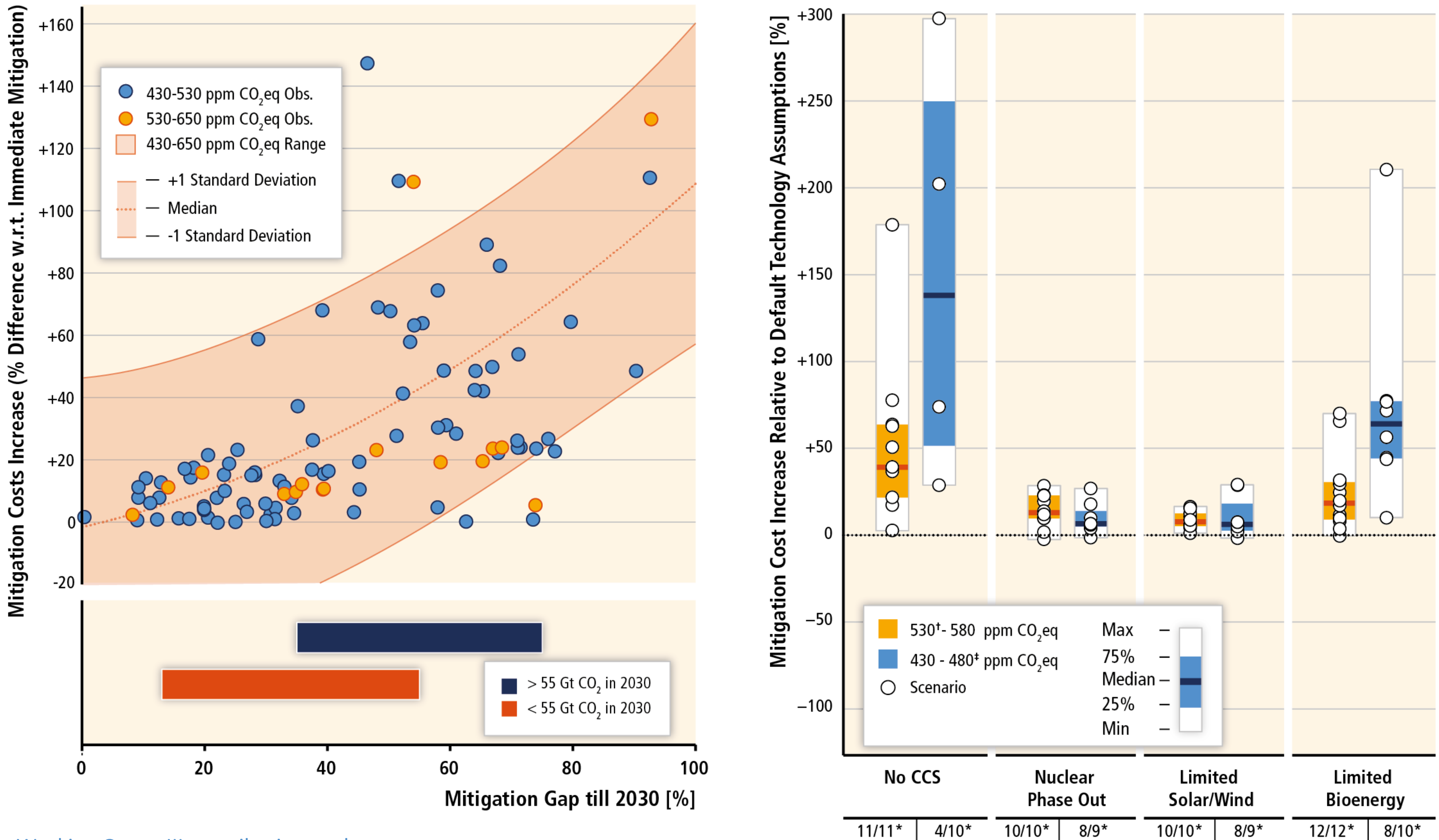
Mitigation costs vary widely, however, they are relatively modest compared to the overall economic growth

	Consumption losses in cost-effective implementation scenarios			
	[% reduction in consumption relative to baseline]			[percentage point reduction in annualized consumption growth rate]
2100 Concentration (ppm CO_2eq)	2030	2050	2100	2010-2100
450 (430–480)	1.7 (1.0–3.7)	3.4 (2.1–6.2)	4.8 (2.9–11.4)	0.06 (0.04–0.14)
500 (480–530)	1.7 (0.6–2.1)	2.7 (1.5–4.2)	4.7 (2.4–10.6)	0.06 (0.03–0.13)
550 (530–580)	0.6 (0.2–1.3)	1.7 (1.2–3.3)	3.8 (1.2–7.3)	0.04 (0.01–0.09)
580–650	0.3 (0–0.9)	1.3 (0.5–2.0)	2.3 (1.2–4.4)	0.03 (0.01–0.05)

- By comparison overall consumption grows by 300-900% in the baselines
- Costs exclude benefits of mitigation (reduced impacts as well as other co-benefits (e.g., improvements for local air quality).

Source: Table SPM.2

Mitigation costs increase due to delayed mitigation and limited availability of technologies



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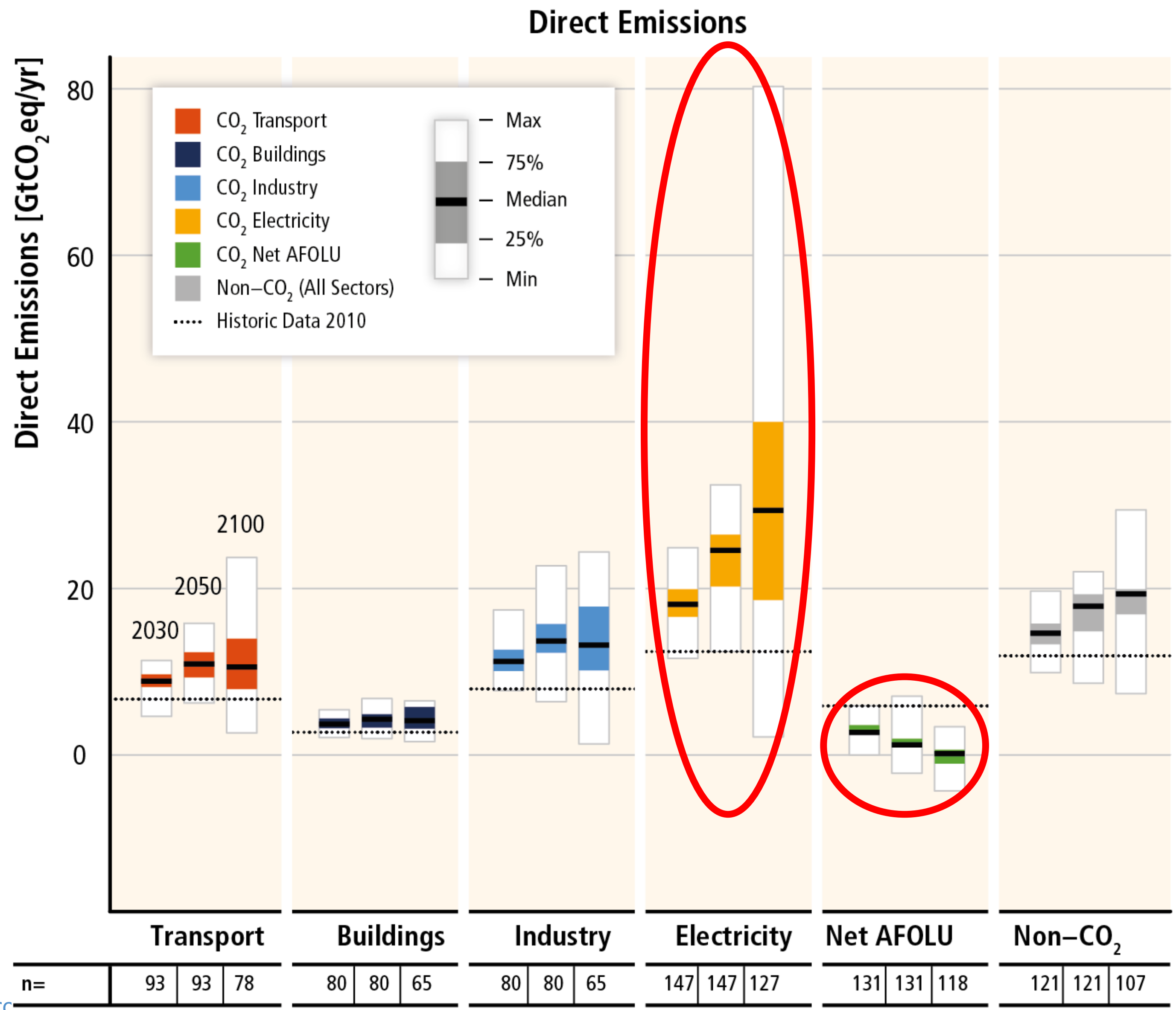
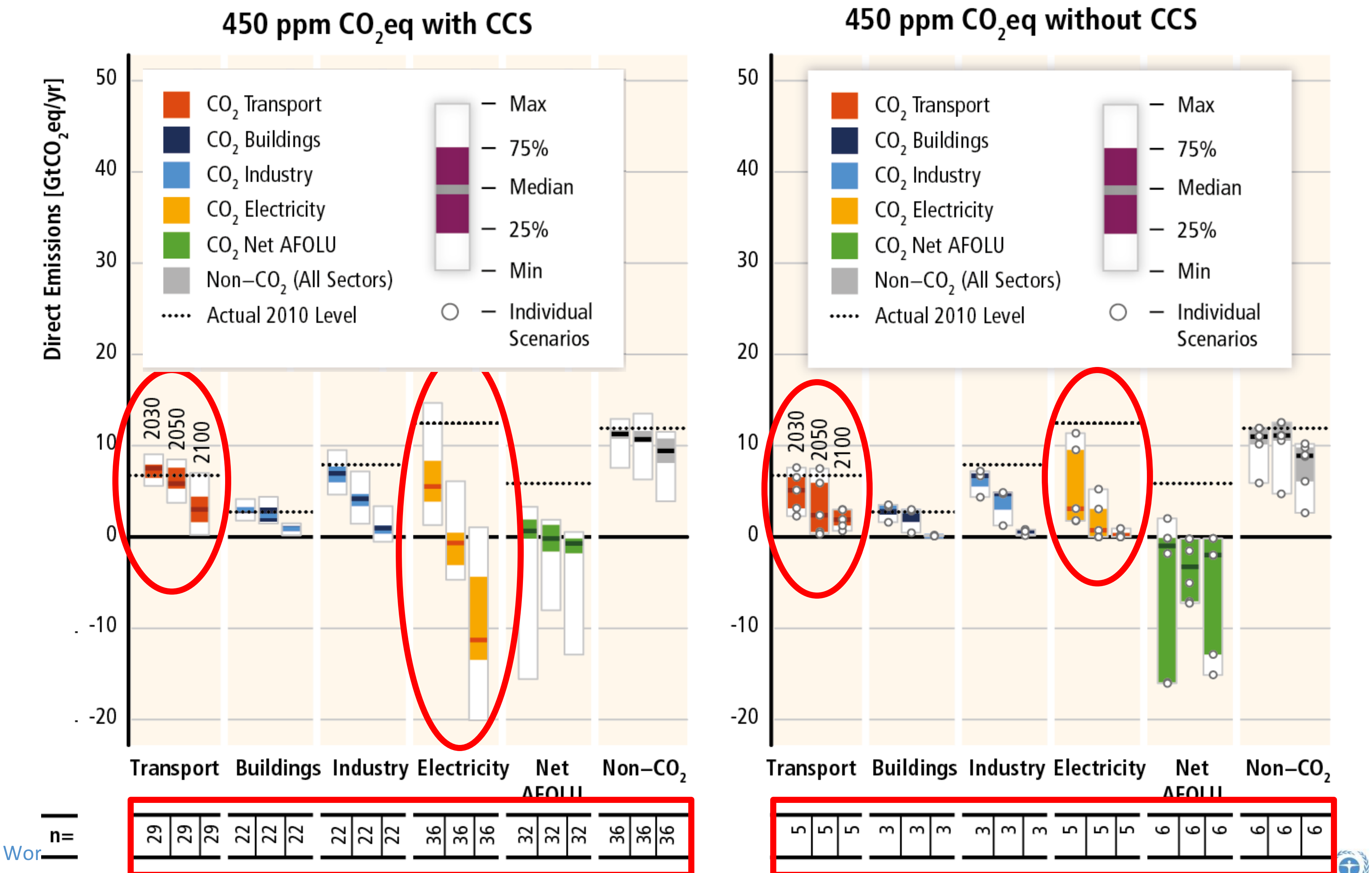
Source: Figure TS.13

Sectoral emissions in baseline scenarios



Source: Figure SPM.7, TS.15

Sectoral emissions in 450 ppm CO_2eq scenarios (with and without CCS or negative emissions)



Source: Figure SPM.7

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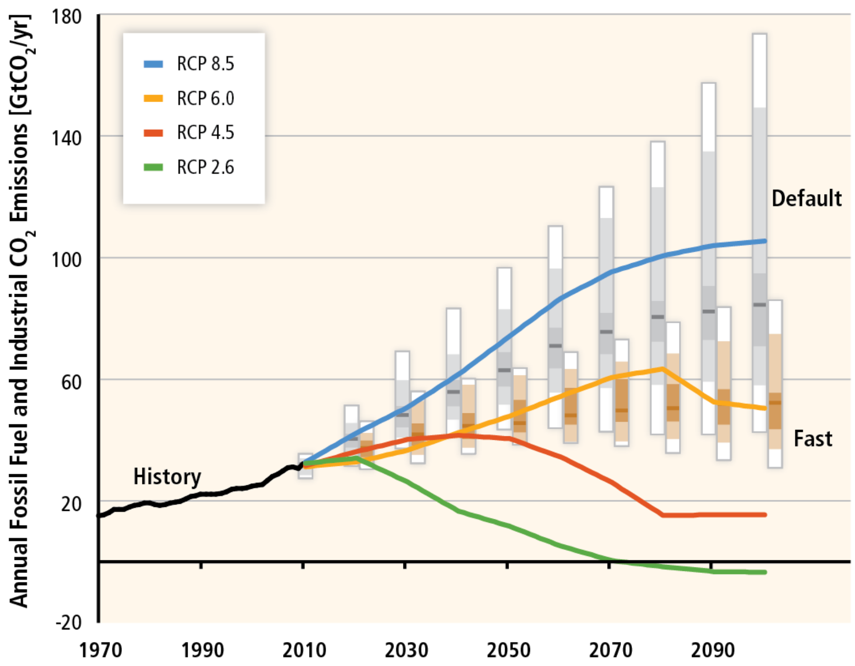
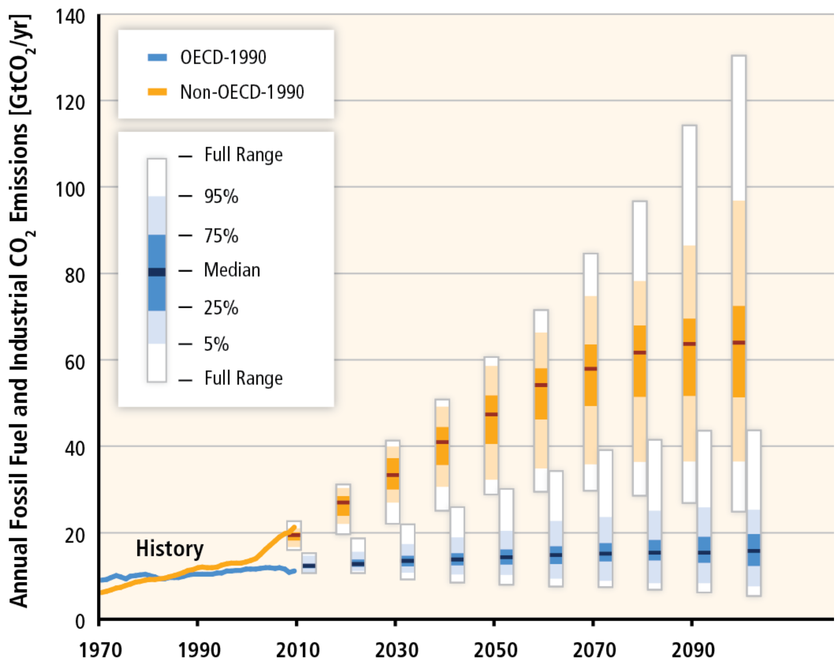
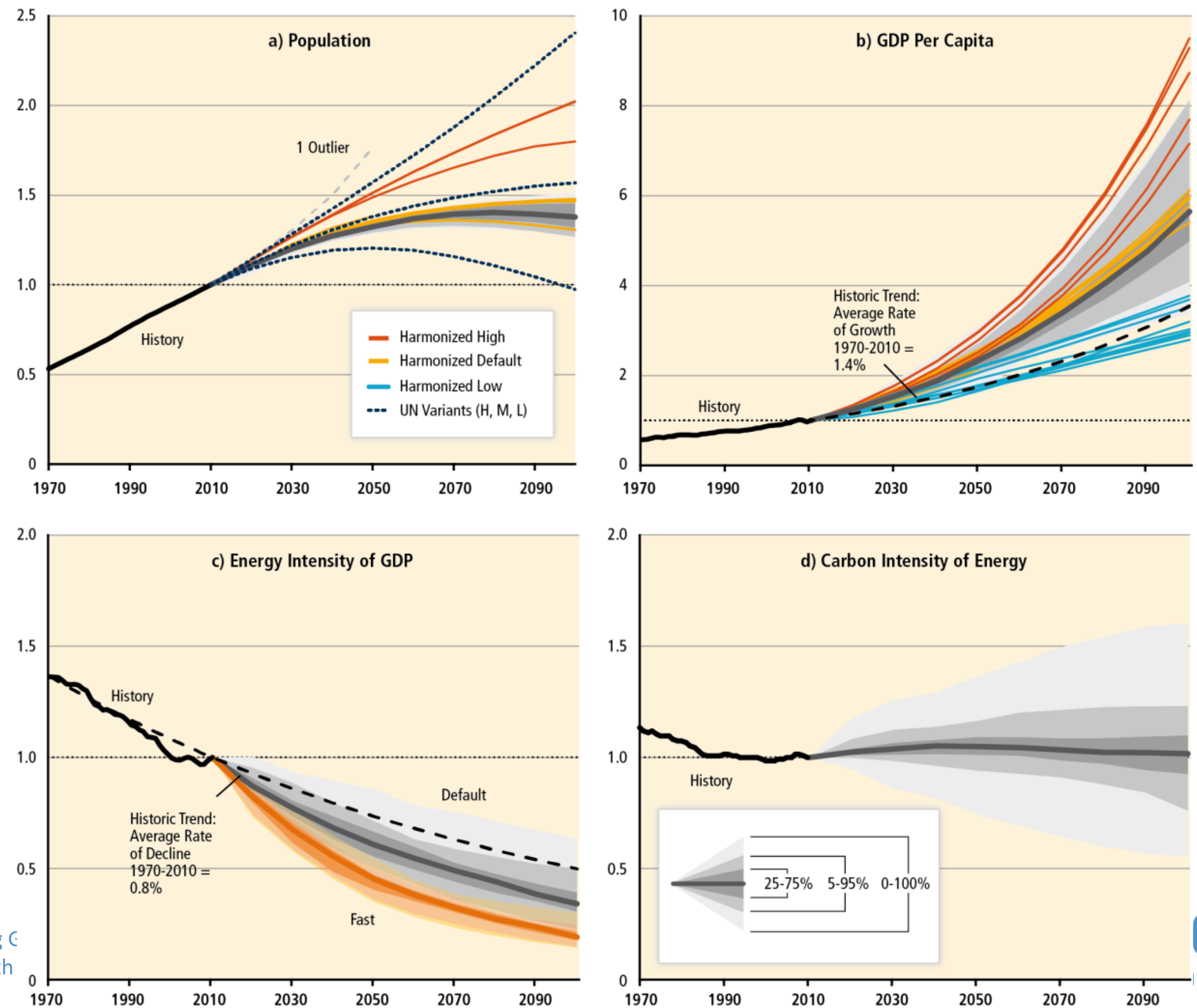
Additional slides

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





Drivers of emissions growth (baseline scenarios)



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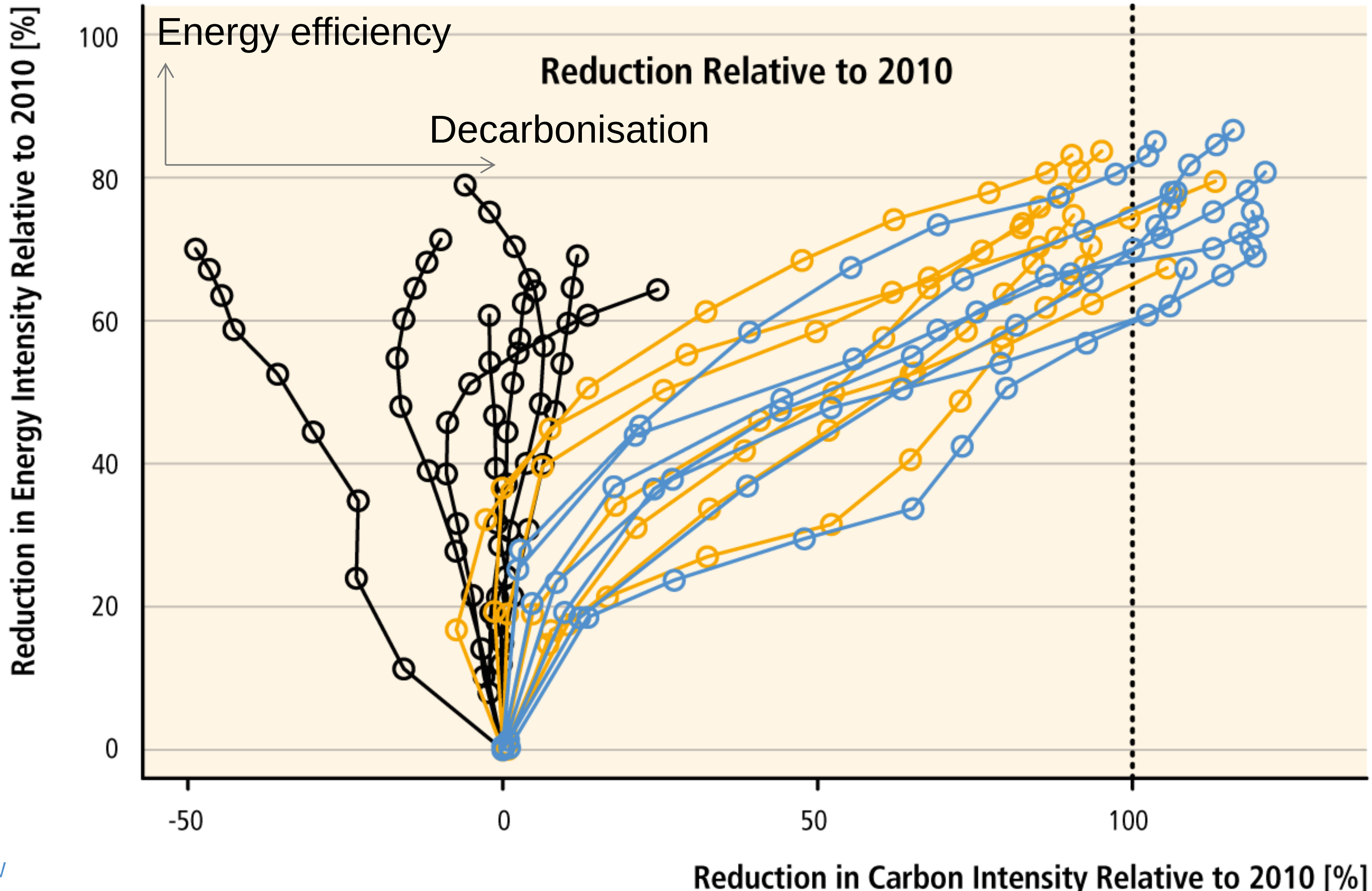
Emission reduction requires decarbonisation of energy system and more energy efficiency.



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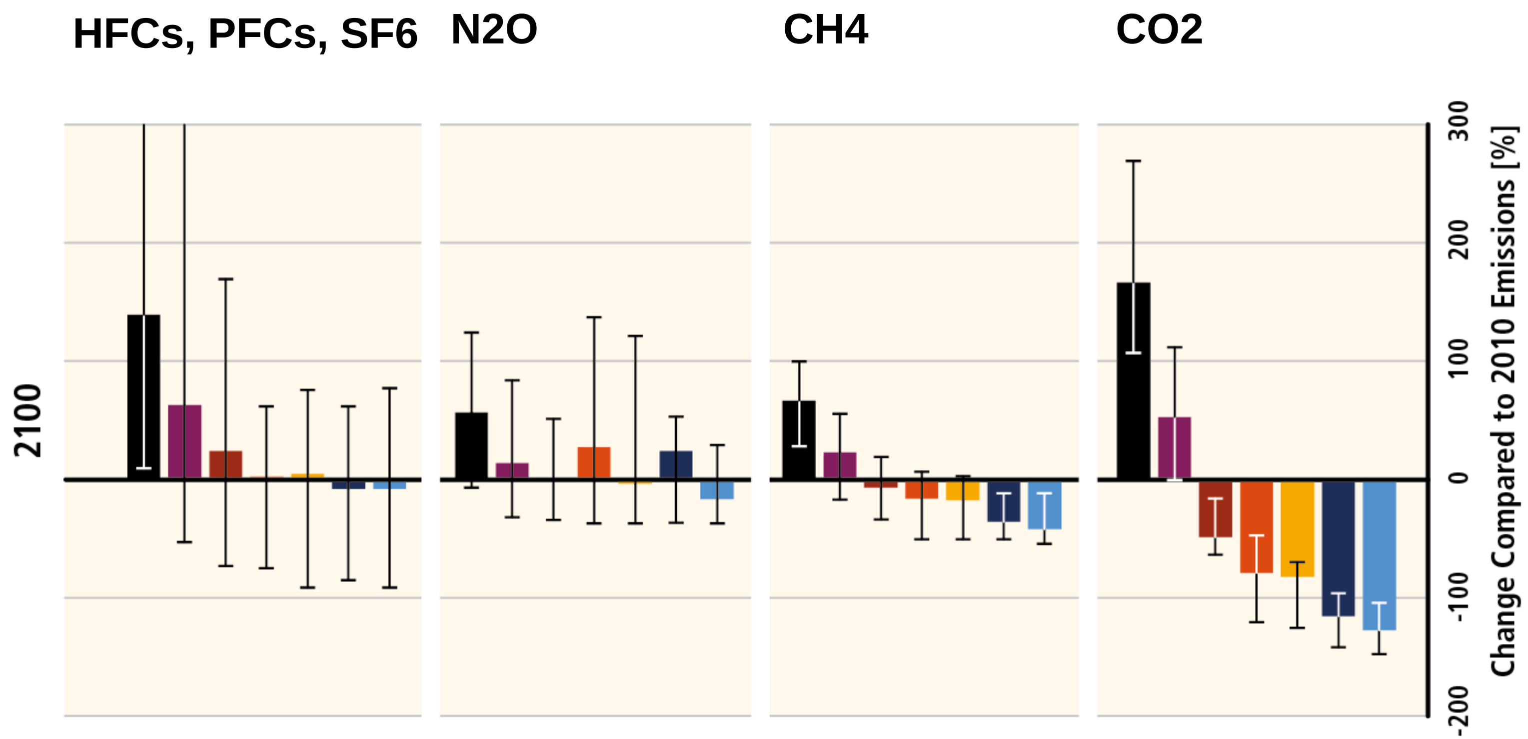
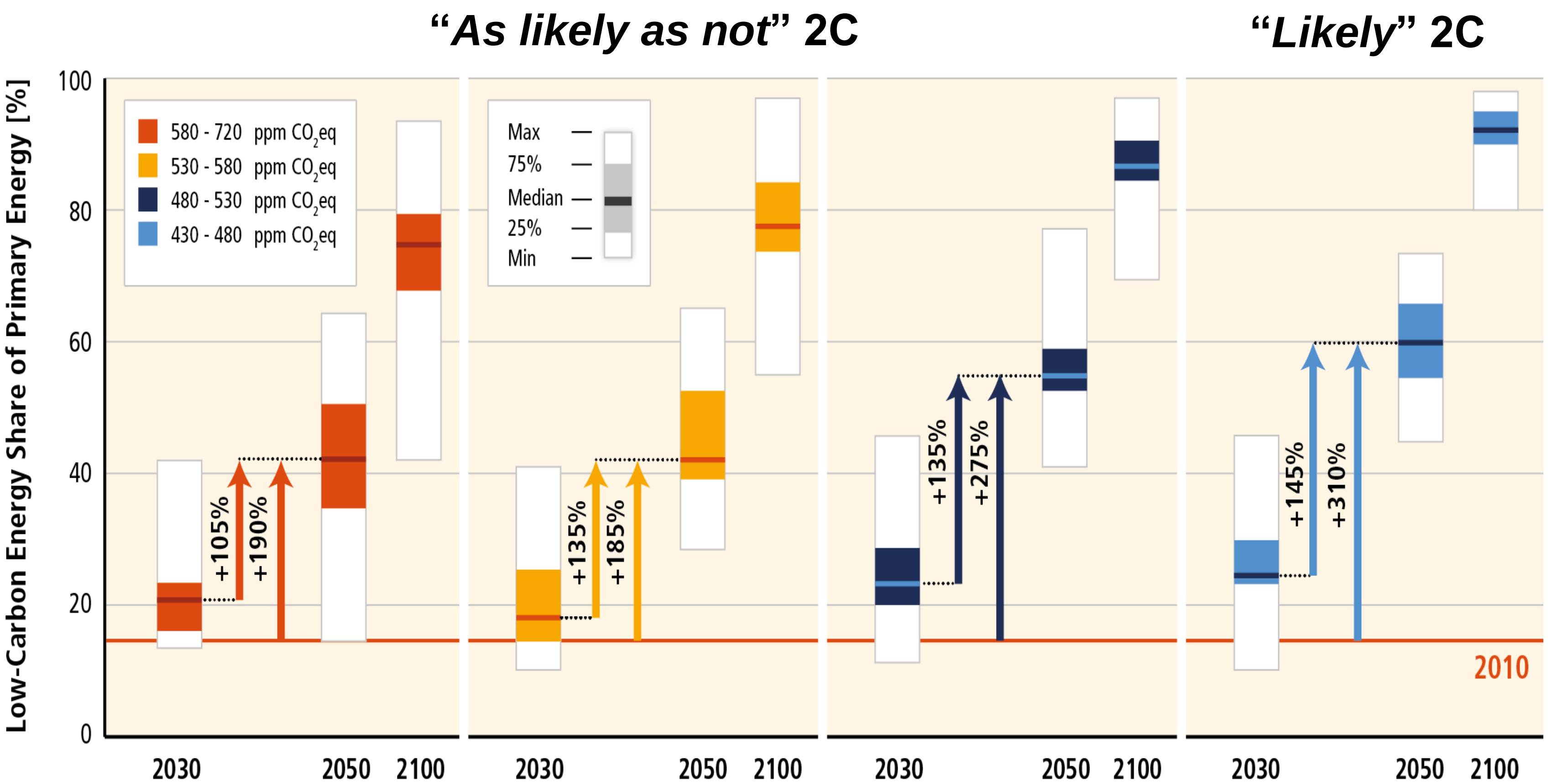
Emissions reductions needed for all gases



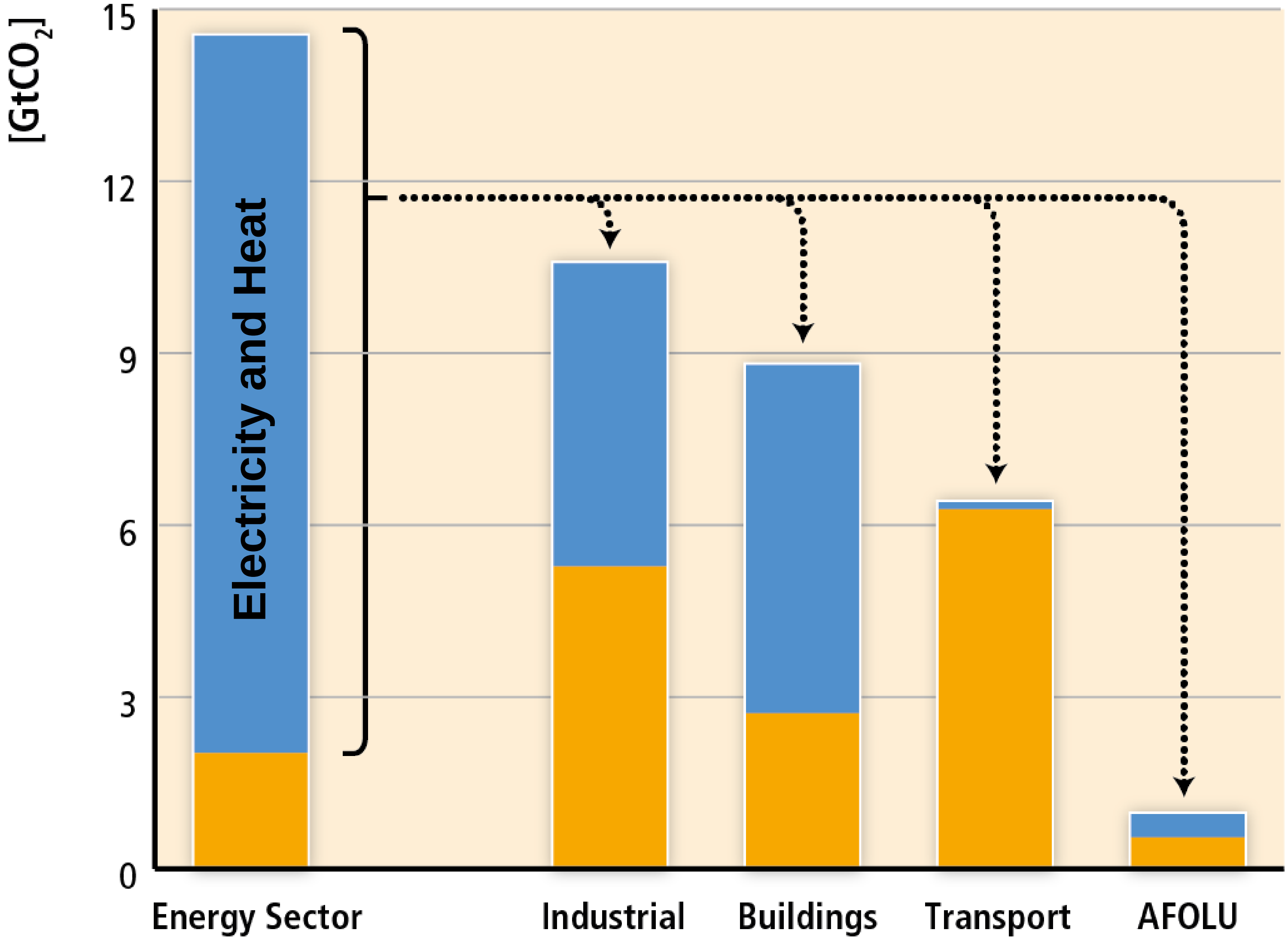
Mitigation requires major technological and institutional changes including the upscaling of low- and zero carbon energy



Mitigation costs increase with limited availability of technologies (and delayed mitigation)

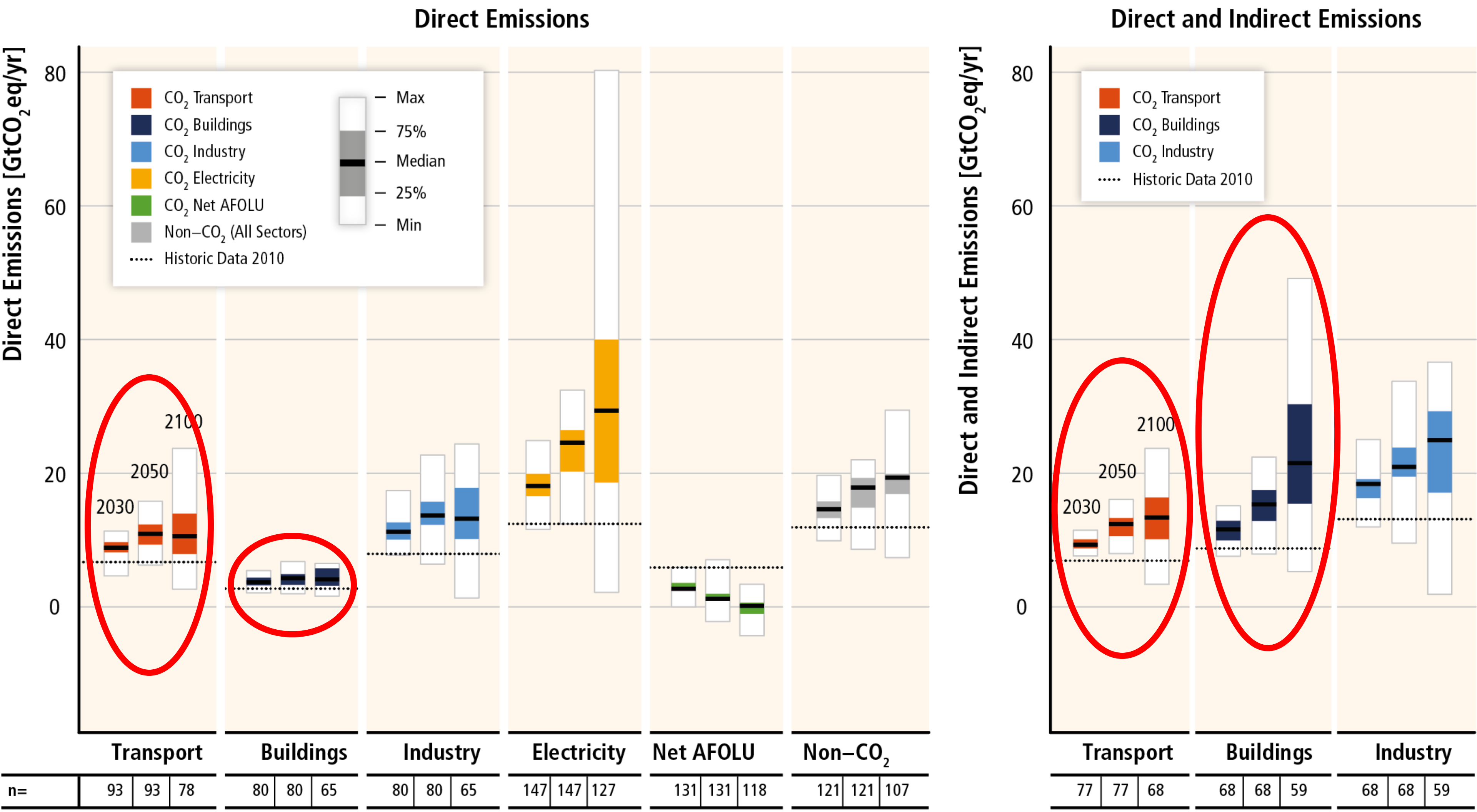
	Consumption losses in cost-effective implementation scenarios				Increase in total discounted mitigation costs in scenarios with limited availability of technologies			
	[% reduction in consumption relative to baseline]			[percentage point reduction in annualized consumption growth rate]	[% increase (2015–2100) relative to default technology assumptions]			
2100 Concentration (ppm CO_2eq)	2030	2050	2100	2010-2100	No CCS	Nuclear phase out	Limited Solar / Wind	Limited Bio-energy
450 (430–480)	1.7 (1.0–3.7)	3.4 (2.1–6.2)	4.8 (2.9–11.4)	0.06 (0.04–0.14)	138 (29–297)	7 (4–18)	6 (2–29)	64 (44–78)
500 (480–530)	1.7 (0.6–2.1)	2.7 (1.5–4.2)	4.7 (2.4–10.6)	0.06 (0.03–0.13)				
550 (530–580)	0.6 (0.2–1.3)	1.7 (1.2–3.3)	3.8 (1.2–7.3)	0.04 (0.01–0.09)	39 (18–78)	13 (2–23)	8 (5–15)	18 (4–66)
580–650	0.3 (0–0.9)	1.3 (0.5–2.0)	2.3 (1.2–4.4)	0.03 (0.01–0.05)				

Allocation of Electricity/Heat Generation Emissions to End-use Sectors for 2010



Source: Figure A.II.2

Direct vs. indirect sectoral emissions in baseline scenarios



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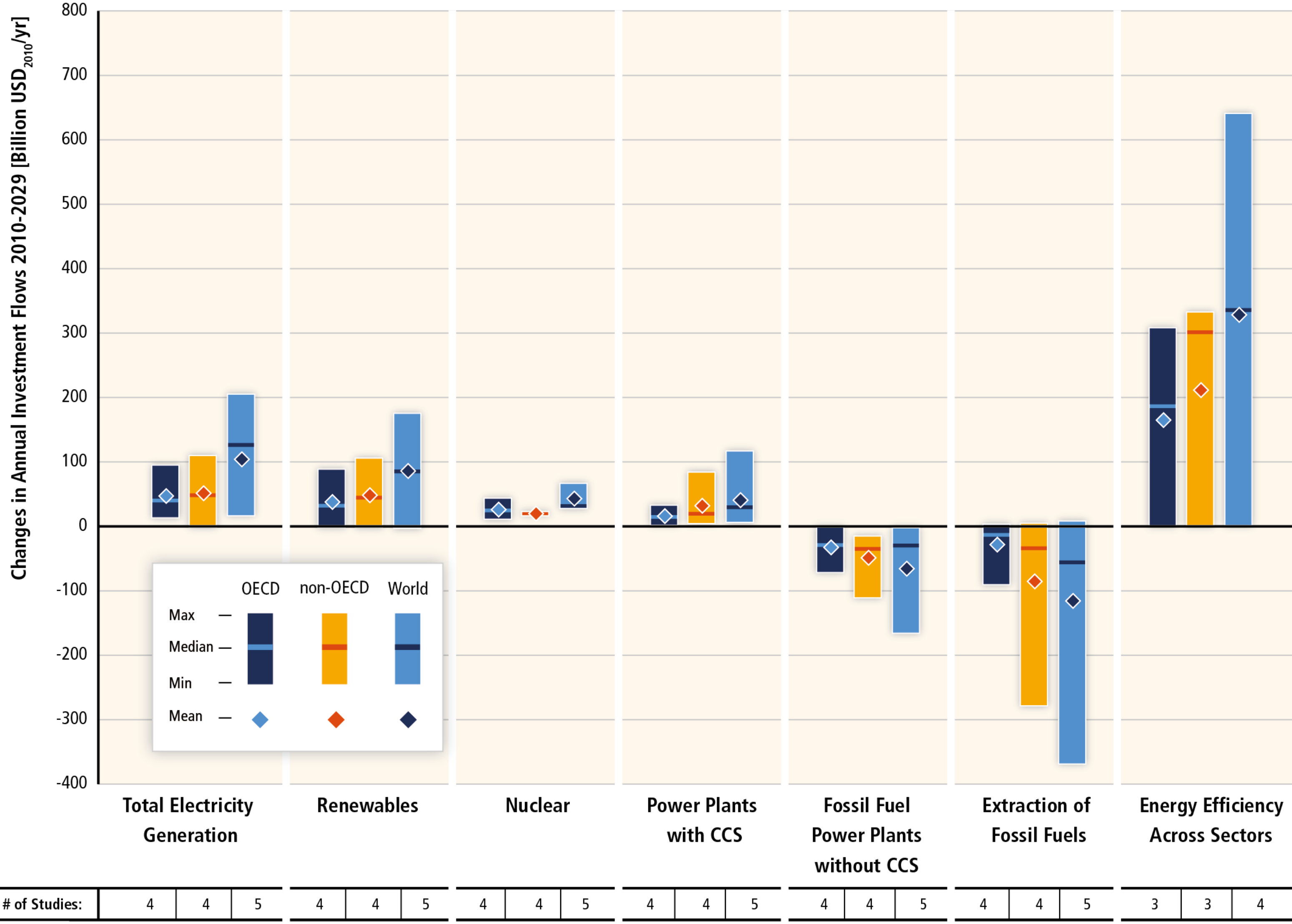
Source: Figure SPM.7, TS.15

Source: Figure TS.15

Substantial reductions in emissions would require large changes in investment patterns



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Source: Figure SPM.9