CIGS キヤノングローバル戦略研究所 The Canon Institute for Global Studies

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Equitable Global Low Carbon Scenario and Approach

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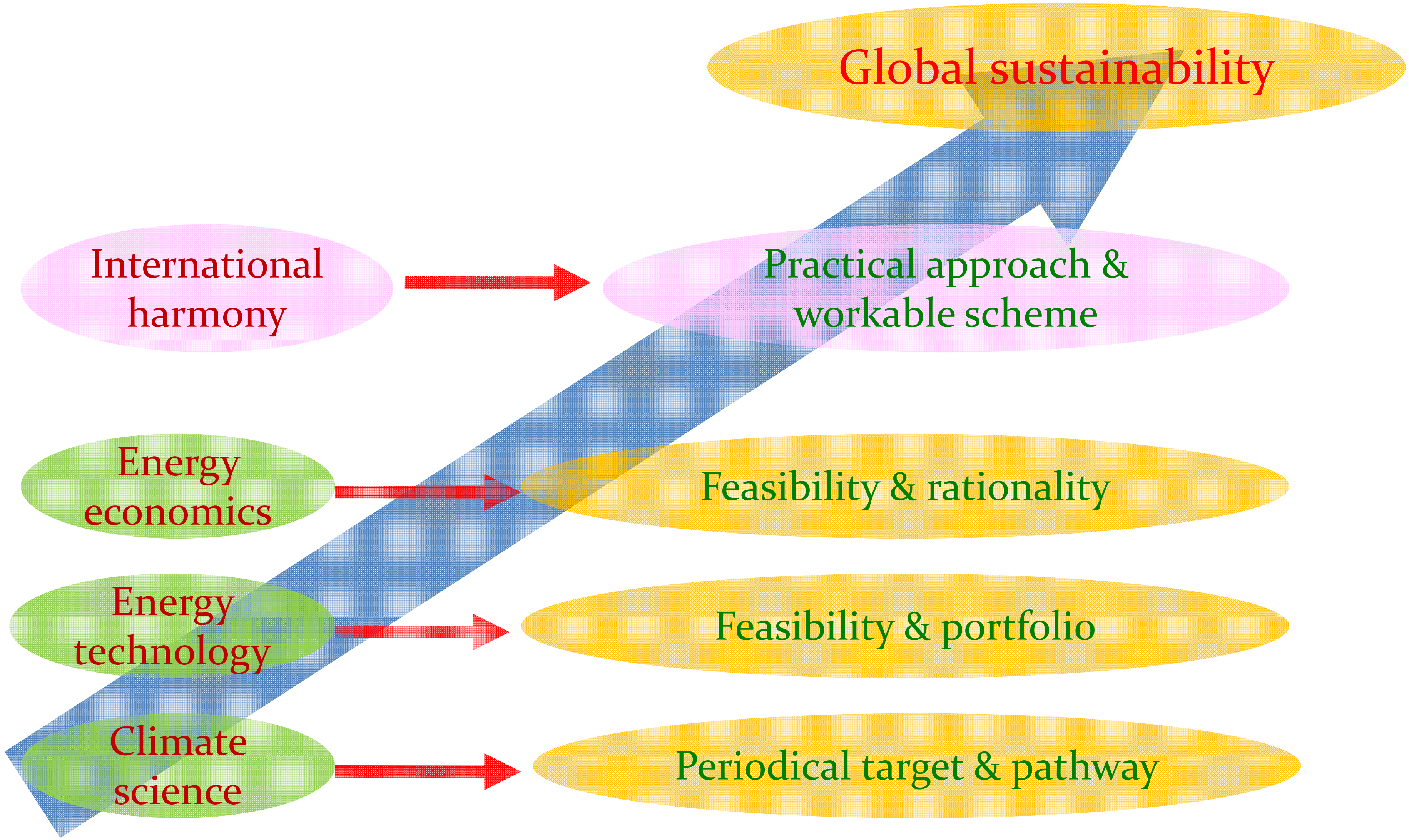
Towards the solution



7 questions for global warming and energy issues

1. What kind of long term GHG reduction pathway should be shared to combat global warming?
2. What kind of long term energy mix and the relative emission pathway for each country should be under the global limitation of CO_2 emission?
3. Is it balanced between the cumulative additional investment and the benefit to realize the long term energy mix?
4. What are the innovative technologies that support the low carbon industrial society to achieve the long term energy mix, and what is the deployment scheme of those technologies?
5. According to the IPCC AR5, Is the international cooperation toward the achievement of the long term energy mix possible?
6. What should the contributions to the economic growth and environment protection in Asia be?
7. What kind of long term energy mix should be for the main countries such as Japan and US? Is it enough to be the model of future industrial society?

Outline

-Energy related CO_2 emission pathway

-Optimal way to achieve the scientific request

-Practical approaches to the proposal

-Enhancement of international cooperation

Global Emission Pathway

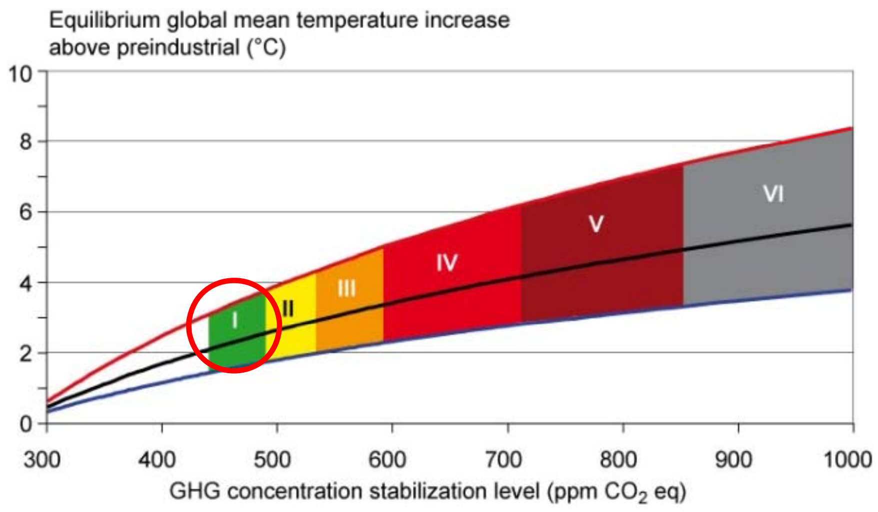
Climate Science

Concentration stabilization to Cumulative emissions

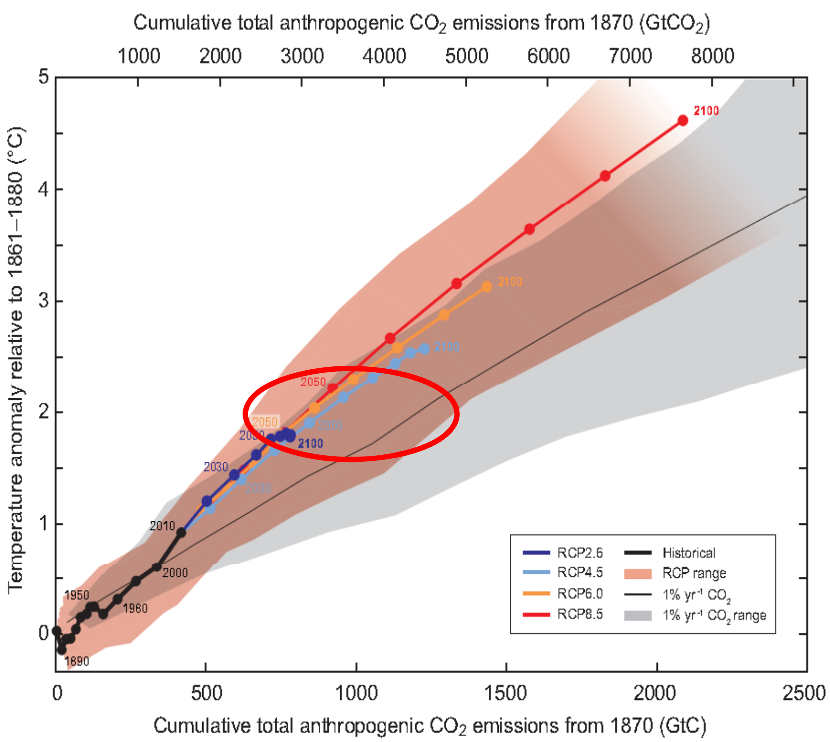
→ flexible pathway

ESC to TCR

→ more possible pathway



IPCC AR4



IPCC AR5

Global Emission Pathway

Scientific base

Category	Radiative forcing (W/m²)	CO_2 concentration[c] (ppm)	CO_2-eq concentration[c] (ppm)	Global mean temperature increase above pre-industrial at equilibrium, using "best estimate" climate sensitivity[b, c] (°C)	Peaking year for CO_2 emissions[d]	Change in global CO_2 emissions in 2050 (% of 2000 emissions)[d]	No. of assessed scenarios
I	2.5-3.0	350-400	445-490	2.0-2.4	2000-2015	-85 to -50	6
II	3.0-3.5	400-440	490-535	2.4-2.8	2000-2020	-60 to -30	18
III	3.5-4.0	440-485	535-590	2.8-3.2	2010-2030	-30 to +5	21
IV	4.0-5.0	485-570	590-710	3.2-4.0	2020-2060	+10 to +60	118
V	5.0-6.0	570-660	710-855	4.0-4.9	2050-2080	+25 to +85	9
VI	6.0-7.5	660-790	855-1130	4.9-6.1	2060-2090	+90 to +140	5
						Total	177

IPCC AR4

<table>
<tr><th rowspan="3">CO_2eq Concentrations in 2100 (CO_2eq)
Category label (concentration range)[9]</th><th rowspan="3">Subcategories</th><th rowspan="3">Relative position of the RCPs[5]</th><th colspan="2">Cumulative CO_2 emissions[3] ($GtCO_2$)</th><th colspan="2">Change in CO_2eq emissions compared to 2010 in (%)[4]</th><th colspan="5">Temperature change (relative to 1850–1900)[5,6]</th></tr>
<tr><th rowspan="2">2011–2050</th><th rowspan="2">2011–2100</th><th rowspan="2">2050</th><th rowspan="2">2100</th><th rowspan="2">2100 Temperature change (°C)[7]</th><th colspan="4">Likelihood of staying below temperature level over the 21st century[8]</th></tr>
<tr><th>1.5 °C</th><th>2.0 °C</th><th>3.0 °C</th><th>4.0 °C</th></tr>
<tr><td>< 430</td><td colspan="11">Only a limited number of individual model studies have explored levels below 430 ppm CO_2eq</td></tr>
<tr><td>450 (430–480)</td><td>Total range[1, 10]</td><td>RCP2.6</td><td>550–1300</td><td>630–1180</td><td>−72 to −41</td><td>−118 to −78</td><td>1.5–1.7 (1.0–2.8)</td><td>More unlikely than likely</td><td>Likely</td><td rowspan="6">Likely</td><td rowspan="8">Likely</td></tr>
<tr><td rowspan="2">500 (480–530)</td><td>No overshoot of 530 ppm CO_2eq</td><td></td><td>860–1180</td><td>960–1430</td><td>−57 to −42</td><td>−107 to −73</td><td>1.7–1.9 (1.2–2.9)</td><td rowspan="6">Unlikely</td><td>More likely than not</td></tr>
<tr><td>Overshoot of 530 ppm CO_2eq</td><td></td><td>1130–1530</td><td>990–1550</td><td>−55 to −25</td><td>−114 to −90</td><td>1.8–2.0 (1.2–3.3)</td><td>About as likely as not</td></tr>
<tr><td rowspan="2">550 (530–580)</td><td>No overshoot of 580 ppm CO_2eq</td><td></td><td>1070–1460</td><td>1240–2240</td><td>−47 to −19</td><td>−81 to −59</td><td>2.0–2.2 (1.4–3.6)</td><td rowspan="3">More unlikely than likely[12]</td></tr>
<tr><td>Overshoot of 580 ppm CO_2eq</td><td></td><td>1420–1750</td><td>1170–2100</td><td>−16 to 7</td><td>−183 to −86</td><td>2.1–2.3 (1.4–3.6)</td></tr>
<tr><td>(580–650)</td><td>Total range</td><td rowspan="2">RCP4.5</td><td>1260–1640</td><td>1870–2440</td><td>−38 to 24</td><td>−134 to −50</td><td>2.3–2.6 (1.5–4.2)</td></tr>
<tr><td>(650–720)</td><td>Total range</td><td>1310–1750</td><td>2570–3340</td><td>−11 to 17</td><td>−54 to −21</td><td>2.6–2.9 (1.8–4.5)</td><td rowspan="2">Unlikely</td><td>More likely than not</td></tr>
<tr><td>(720–1000)</td><td>Total range</td><td>RCP6.0</td><td>1570–1940</td><td>3620–4990</td><td>18 to 54</td><td>−7 to 72</td><td>3.1–3.7 (2.1–5.8)</td><td>Unlikely[11]</td><td>More unlikely than likely</td></tr>
<tr><td>>1000</td><td>Total range</td><td>RCP8.5</td><td>1840–2310</td><td>5350–7010</td><td>52 to 95</td><td>74 to 178</td><td>4.1–4.8 (2.8–7.8)</td><td></td><td>Unlikely[26]</td><td>Unlikely</td><td>More unlikely than likely</td></tr>
</table>

IPCC AR5

Global Emission Pathway

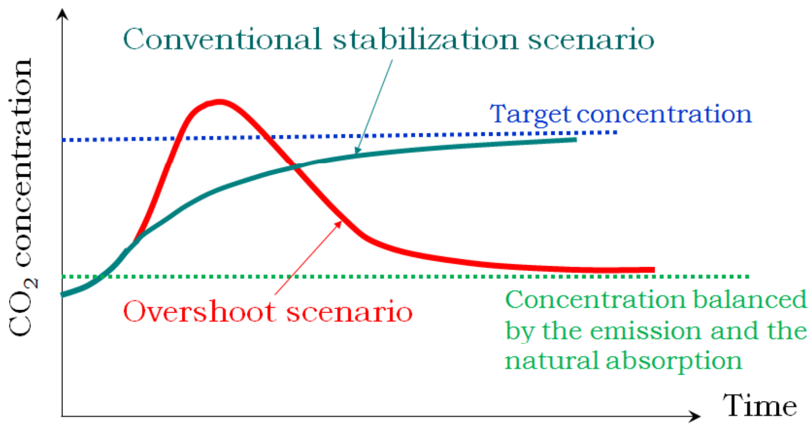
Scientific analysis based on

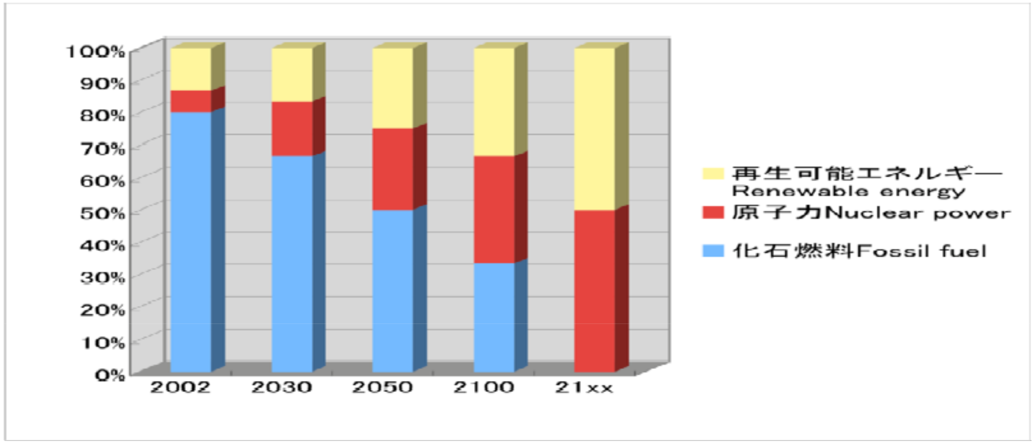
--- target of global mean temperature rise

to limit the global surface temperature rise to approximate 2℃ compared to pre-industrial levels

--- overshoot scenario with zero emission

to decrease the CO2 concentration by zero emission after a peak over the target concentration





Global Emission Pathway

Z650 Scenario

--- 650GtC

to be the amount of cumulative CO2 emissions during 21st century

--- Zero emission

to be achieved at the middle of 22nd century (2160)

--- Pathway

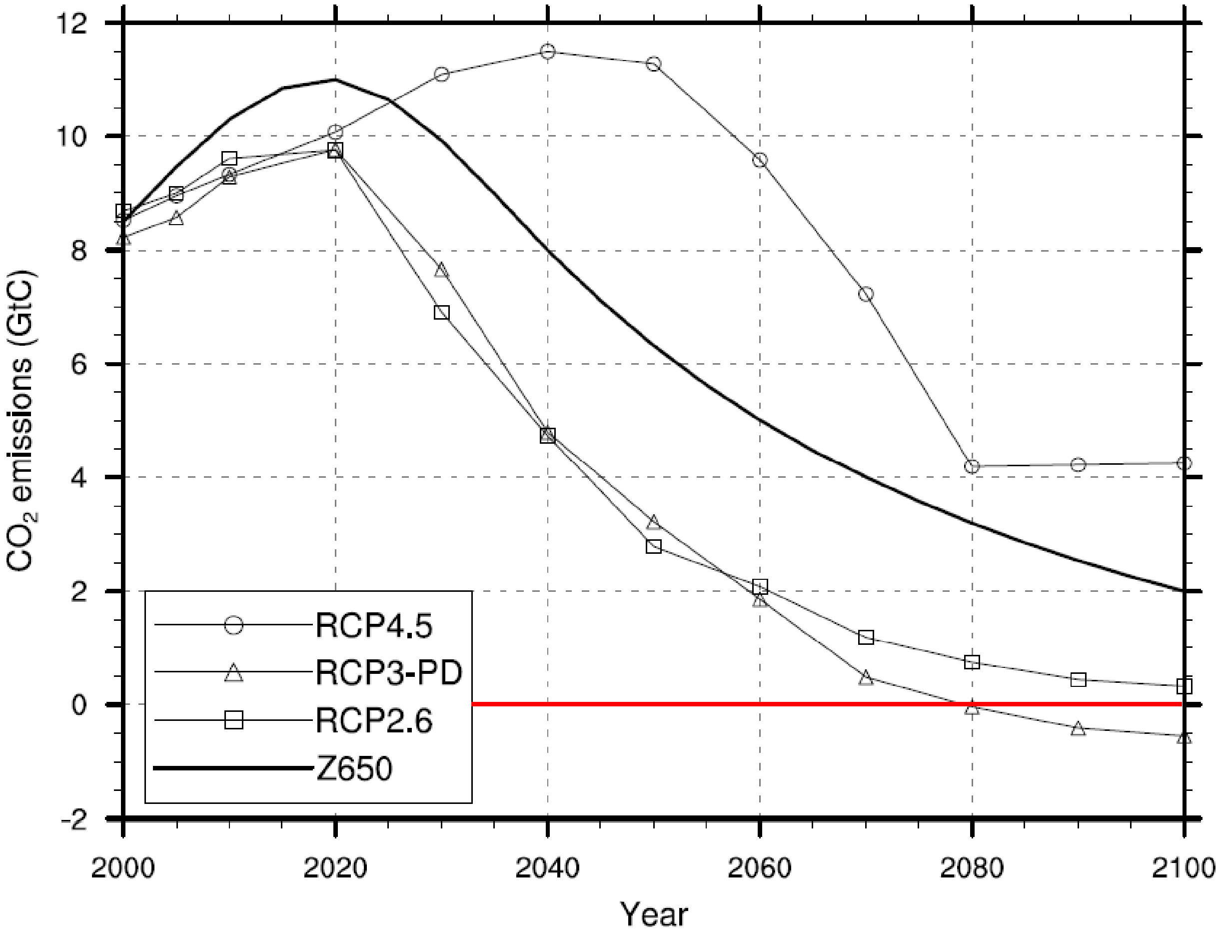
to peak at 2020 (11GtC) according to the trend of recent years

with approximate two percent of annual reduction till 2100

with increasing reduction rates in 22nd century till zero emission

Source: Matsuno et al., "Stabilization of the CO2 concentration via zero-emission in the next century", presented at the CIGS Symposium on Oct. 27, 2009

Global Emission Pathway



Source: Matsuno et al., "Stabilization of the CO2 concentration via zero-emission in the next century", presented at the CIGS Symposium on Oct. 27, 2009

Z650 is located in the middle of the two RCP scenarios, therefore it could take the advantage of second best solution, i.e., to be more feasible than RCP2.6, and to have better climate performance than RCP4.5.

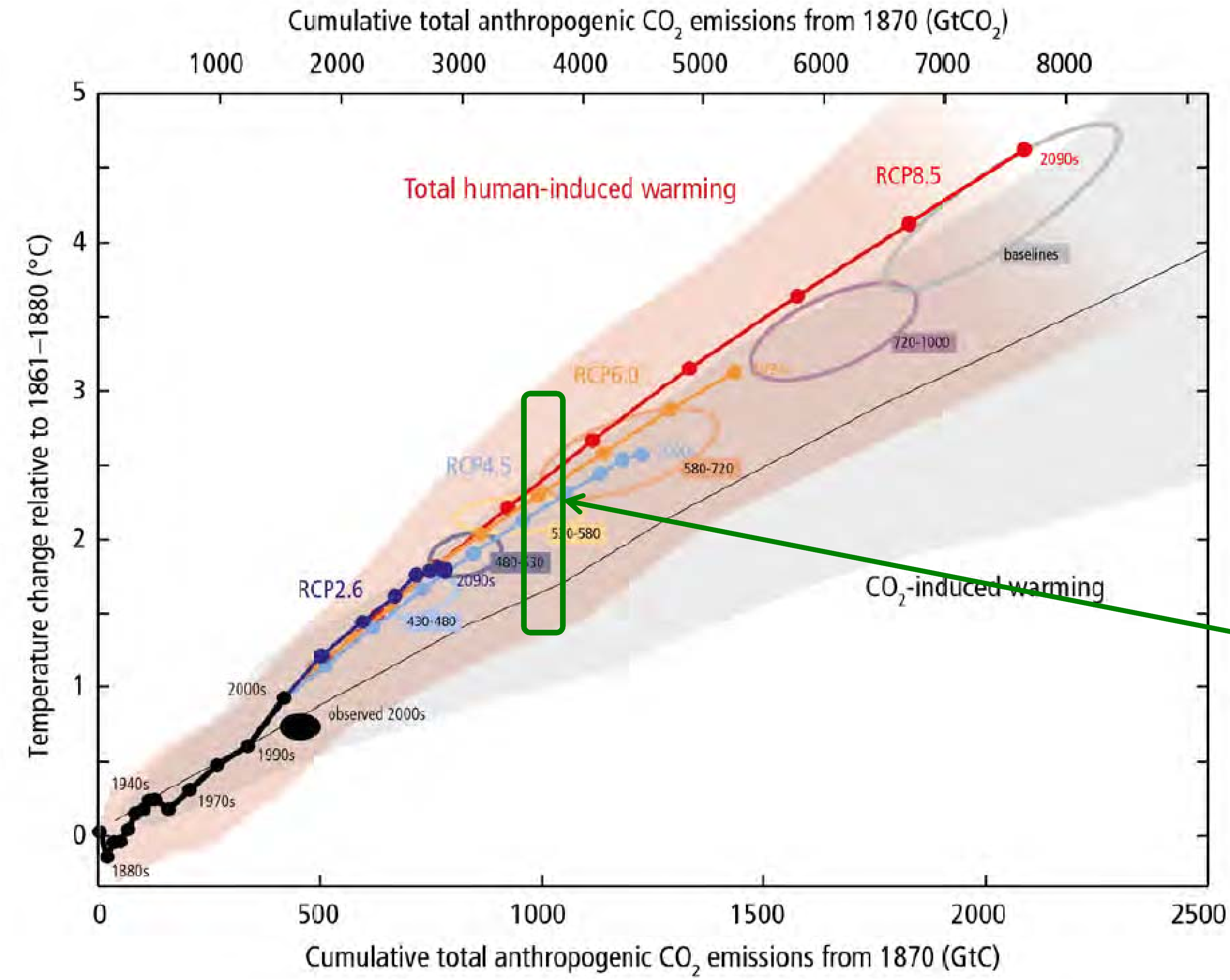
Global Emission Pathway

Table 3.1 [TABLE SUBJECT TO FINAL COPYEDIT]

CO_2eq Concentrations in 2100 (CO_2eq)[6] Category label (conc. range)	Subcategories	Relative position of the RCPs[4]	Change in CO_2eq emissions compared to 2010 (in %)[3]		Likelihood of staying below a specific temperature level over the 21st century (relative to 1850-1900)[4,5]			
			2050	2100	1.5°C	2°C	3°C	4°C
< 430	*Only a limited number of individual model studies have explored levels below 430 ppm CO_2eq*[10]							
450 (430 – 480)	Total range[1,7]	*RCP2.6*	-72 to -41	-118 to -78	*More unlikely than likely*	*Likely*		
500 (480 – 530)	No overshoot of 530 ppm CO_2eq		-57 to -42	-107 to -73		*More likely than not*		
	Overshoot of 530 ppm CO_2eq		-55 to -25	-114 to -90		*About as likely as not*	*Likely*	
550 (530 – 580)	No overshoot of 580 ppm CO_2eq		-47 to -19	-81 to -59	*Unlikely*	*More unlikely than likely*[9]		*Likely*
	Overshoot of 580 ppm CO_2eq		-16 to 7	-183 to -86				
(580 – 650)	Total range	*RCP4.5*	-38 to 24	-134 to -50				
(650 – 720)	Total range		-11 to 17	-54 to -21		*Unlikely*	*More likely than not*	
(720 – 1000)[2]	Total range	*RCP6.0*	18 to 54	-7 to 72	*Unlikely*[8]		*More unlikely than likely*	
>1000[2]	Total range	*RCP8.5*	52 to 95	74 to 178		*Unlikely*[8]	*Unlikely*	*More unlikely than likely*

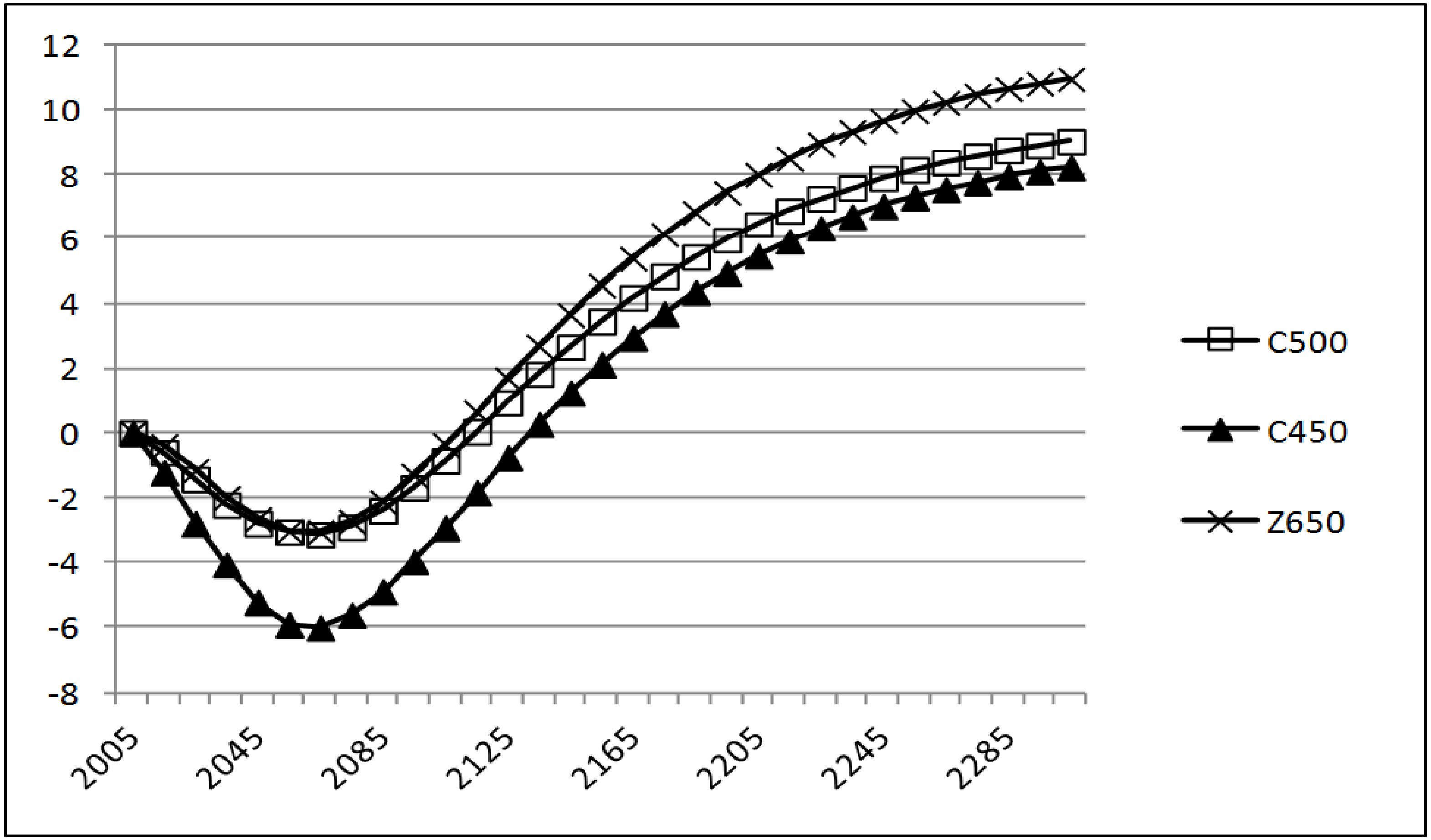
Global Emission Pathway

Figure 2.3 [FIGURE SUBJECT TO FINAL COPYEDIT AND QUALITY CONTROL]



Z650
980-1120GtC

Global Emission Pathway



Total economic performances (Trillion USD, compared with BAU)

Global Emission Pathway

	Cost	Damage	Sum
C500	small	large	medium
C450	large	medium	large
Z650	**small**	**medium**	**small**

Optimal Way to Global Vision

--- Global energy system optimization model (GRAPE)

-- to maintain a sustainable global energy system till 2150

-- to minimize the global energy costs

-- no international emission trading

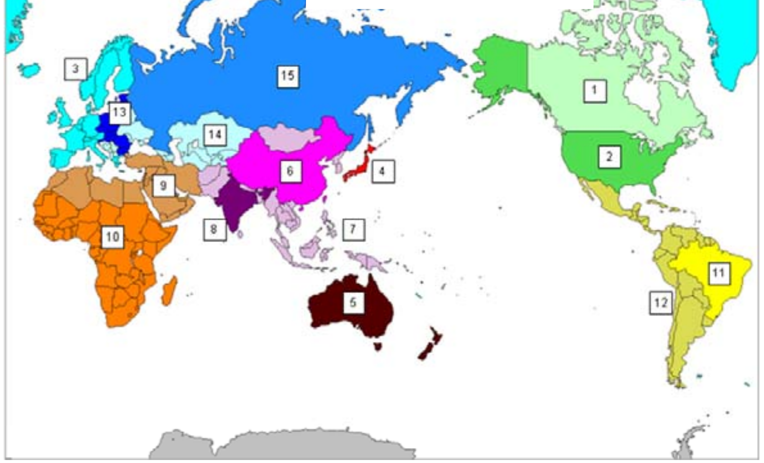
--- Mainstream scenarios

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Economy</th><th colspan="2">Energy policy</th><th rowspan="2">CO2 emission</th></tr>
<tr><th>Demand side</th><th>Supply side</th></tr>
<tr><td>BAU</td><td rowspan="3">Moderate global growth, higher in developing countries, and lower in industrialized countries</td><td colspan="2">No</td><td rowspan="2">No cap</td></tr>
<tr><td>REF</td><td>Yes</td><td>No</td></tr>
<tr><td>Z650</td><td colspan="2">Yes</td><td>Capped by Z650</td></tr>
</table>

BAU (Business as usual): traditional growth pattern
REF(Energy saving): new growth pattern in harmonious with environment and resources
Z650(Low carbon): to mitigate the global warming

Optimal Way to Global Vision

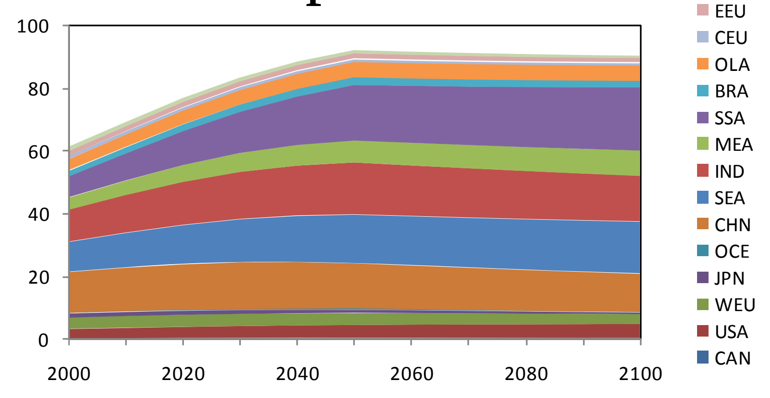
Regions



Industrialized countries
- Canada, USA, Oceania, Japan, Russia, WEU, CEU, EEU

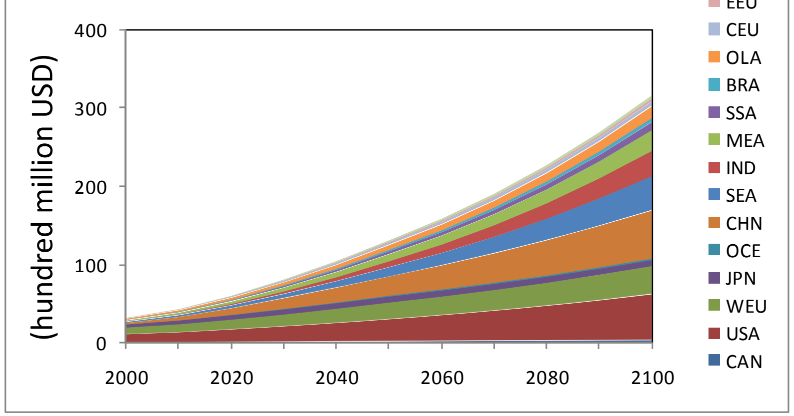
Developing countries
- China, India, ASEAN, Brazil, Latin, MENA, Sub-Sahara

Population



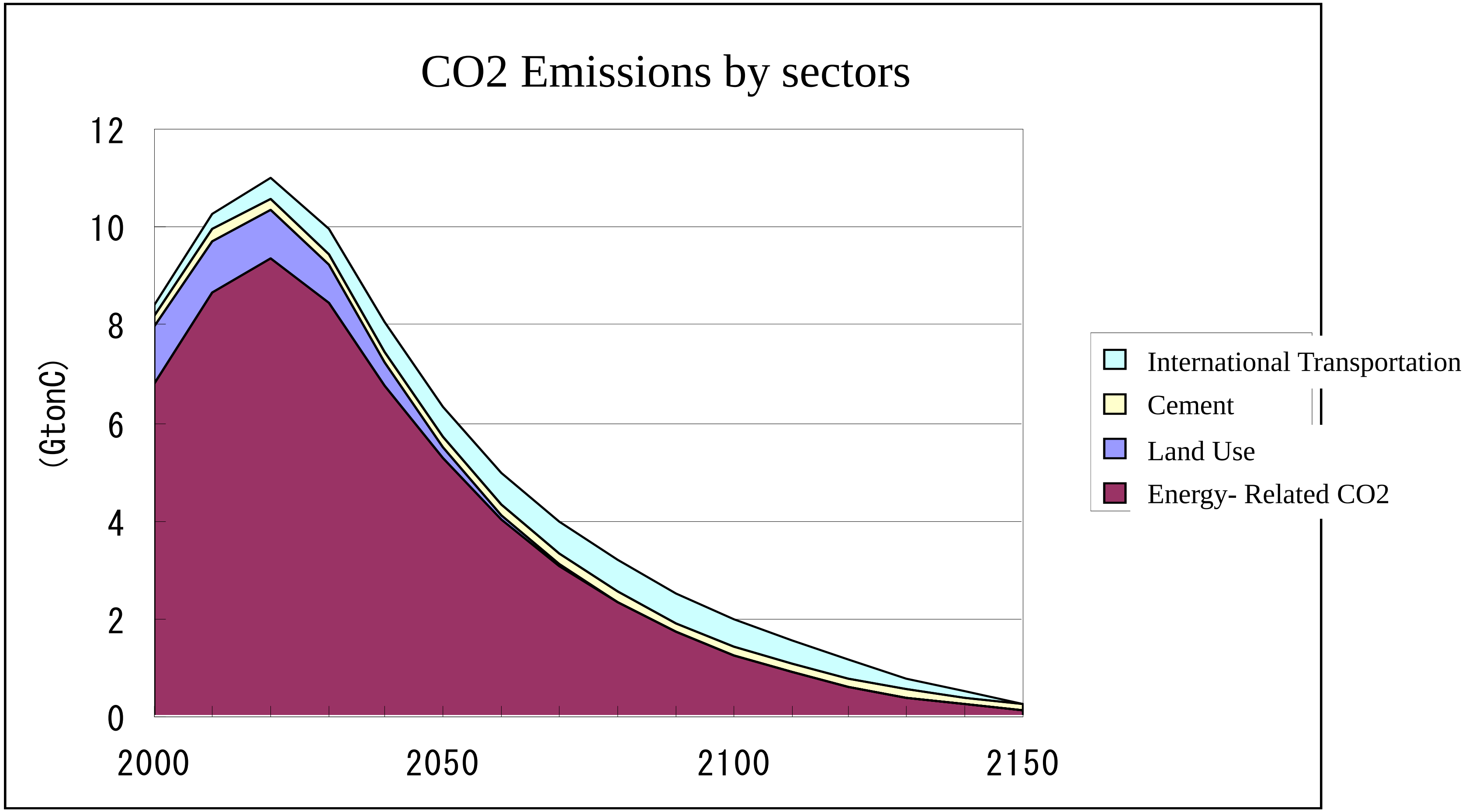
Based on UN medium level projection

GDP



Referred to IEA and IMF estimate

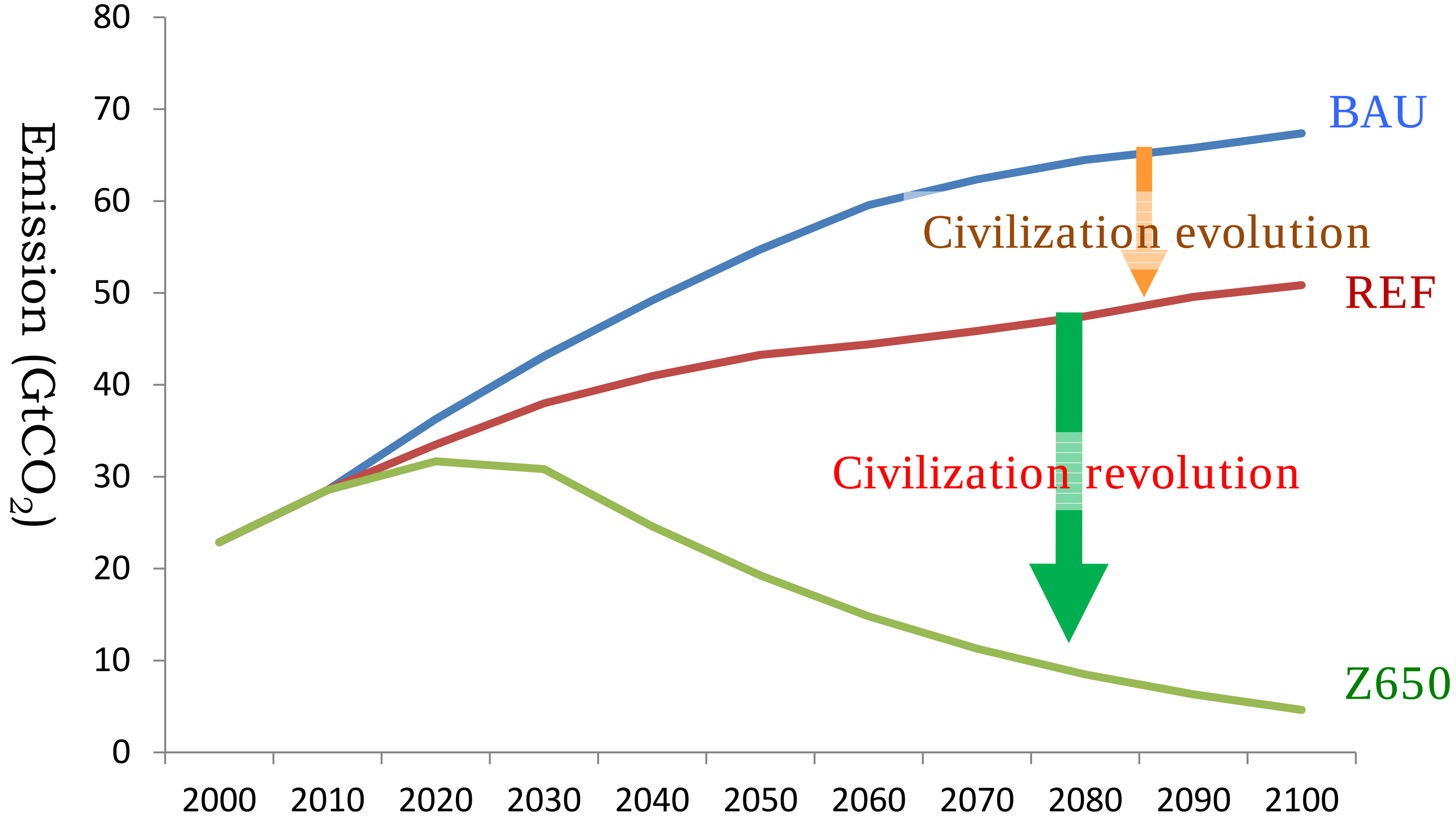
Optimal Way to Global Vision



Energy-related CO2 emissions were calculated as the CO2 cap of the simulations.

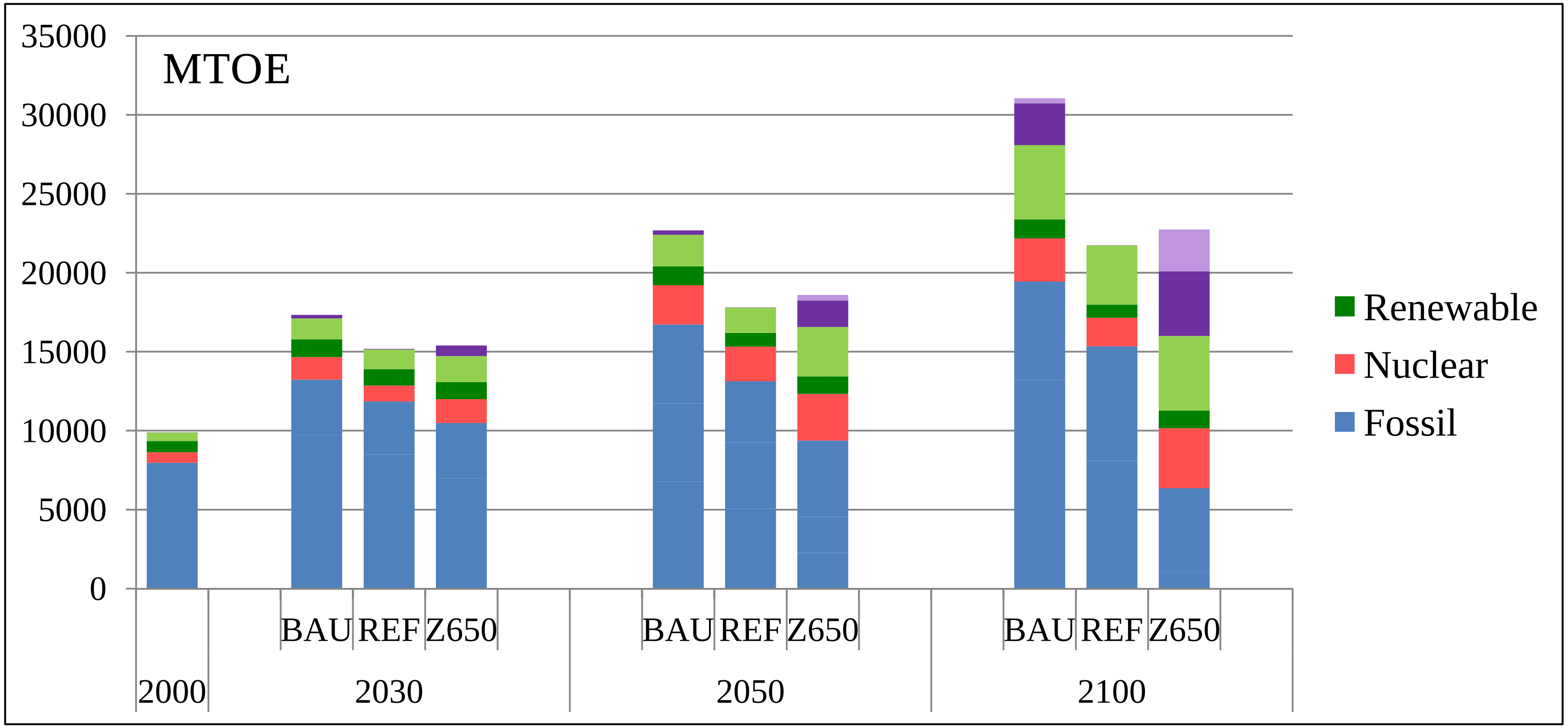
Optimal Way to Global Vision

Global emissions of Energy Related CO_2



Total Primary Energy

Total Primary Energy continuously increases up to 2100
Less energy consumptions in REF and Z650
More clean energy combination in Z650



Changes of Primary Energy Mixture in Z650 (Fossil: Nuclear: Renewable)
7: 1: 2 (2030) → 5: 2: 3 (2050) → 3: 2: 5 (2100)

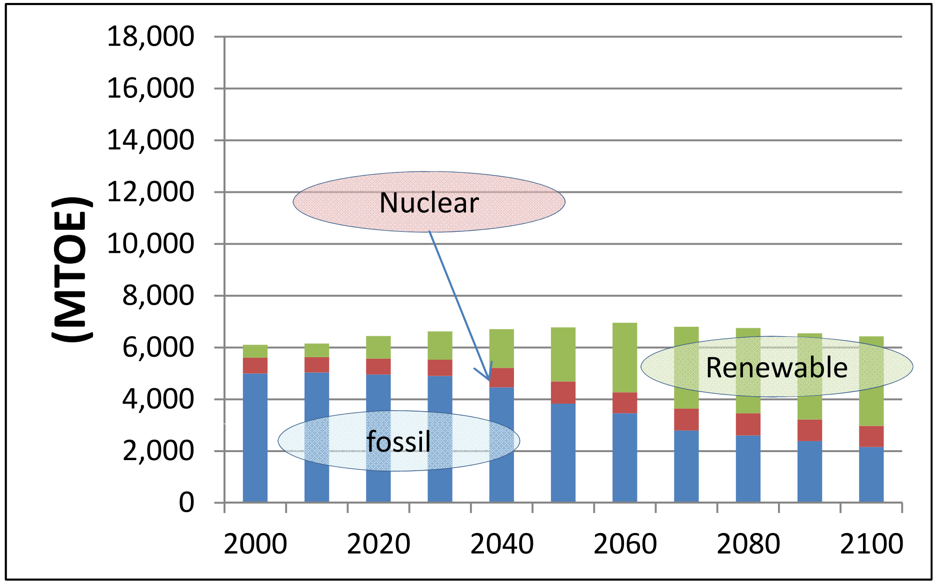
Region Total Primary Energy for Z650

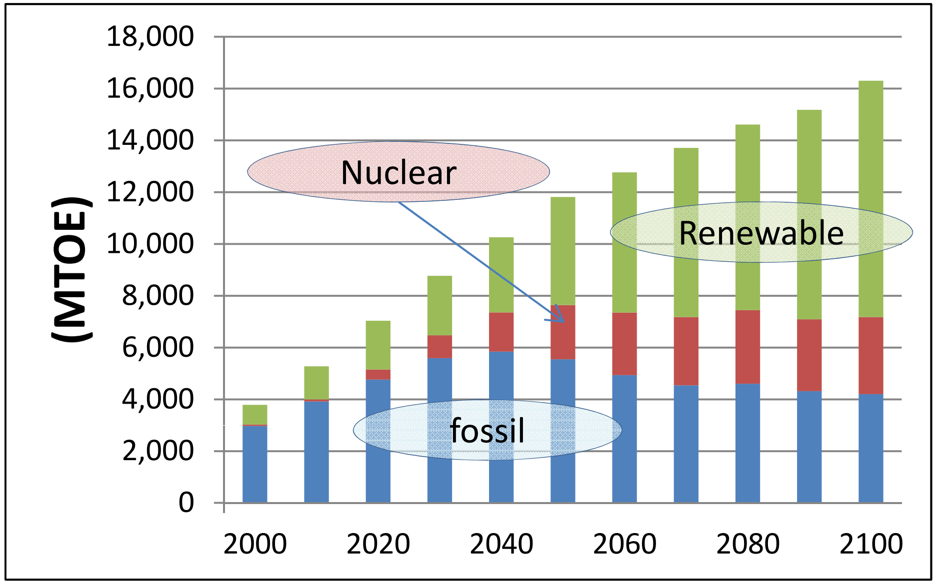
Industrialized countries

- Total Primary Energy is almost constant up to 2100.
- Share of fossil fuel gradually decreases
- Alternatively, share of renewable energy mainly increases

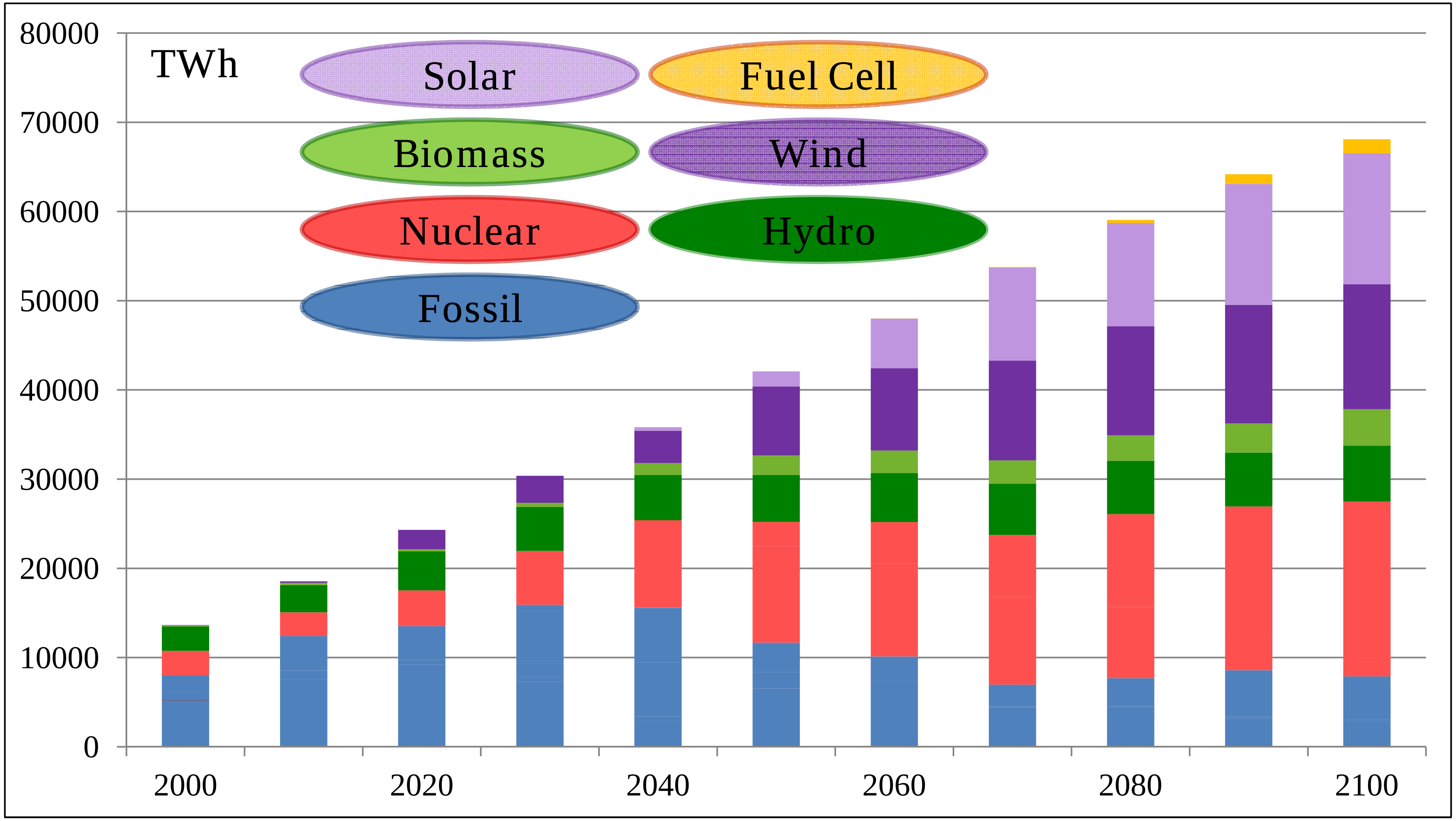
Developing countries

- Total Primary Energy continuously increases up to 2100
- Peak of fossil fuel consumption at 2040
- Both Nuclear and renewable energy increase remarkably



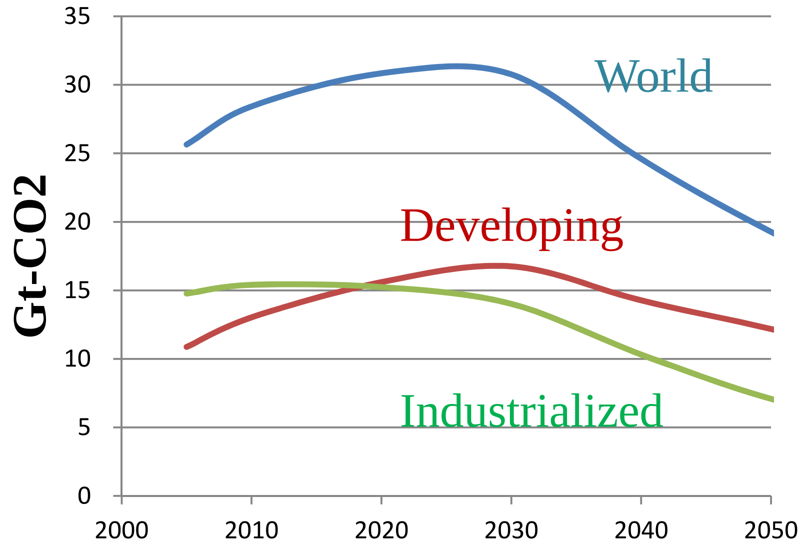


Global Power Generation of Z650

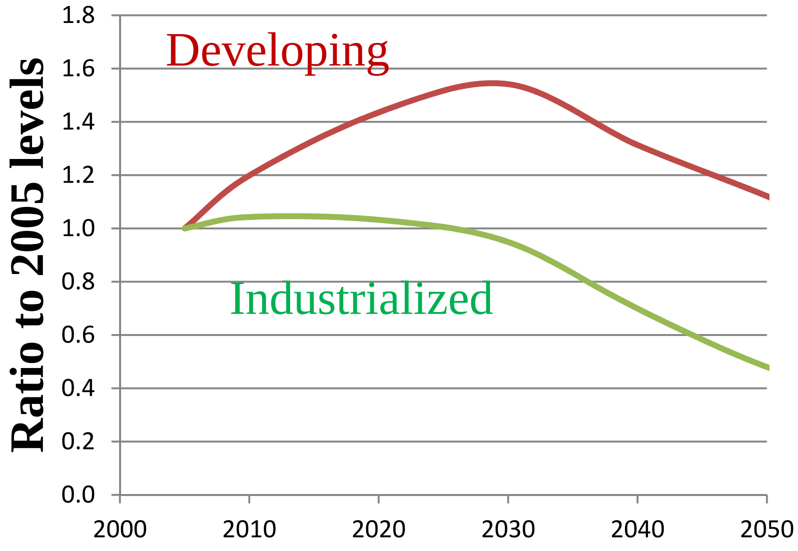


Nuclear Power Capacity (GWe)	2000	2030	2050	2100
	370	810	1,800	2,600

CO_2 emissions of Z650 scenario



Amount of CO2 emission



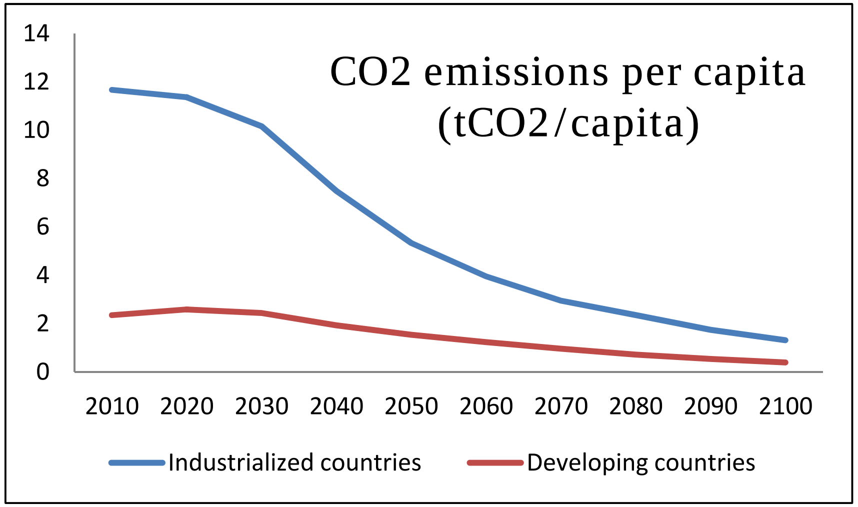
Ratio to 2005 levels

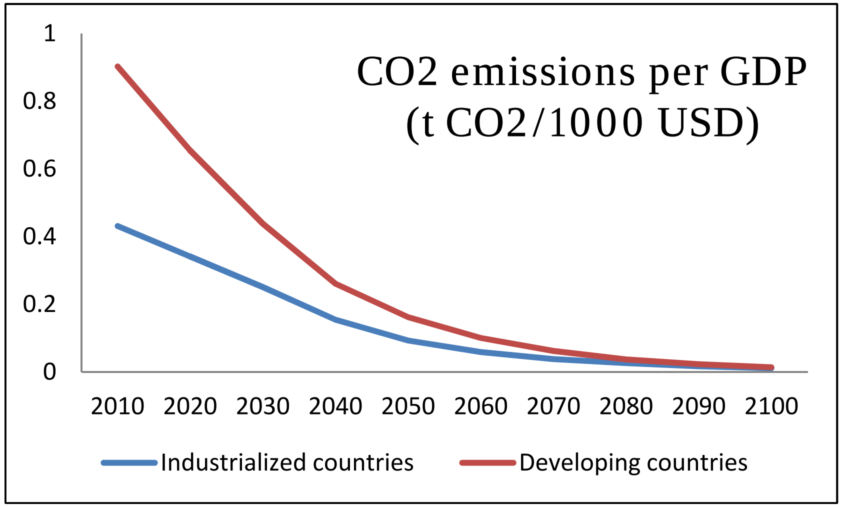
Industrialized countries peak out in 2010, and reduce their emissions by 50% in 2050 compared to the 2005 levels. Developing countries peak out in 2030, and their emissions increase by 10% in 2050 compared to the 2005 levels.

Regional Equitability

Regional emissions and carbon intensities of Z650

Ratio to 2005 levels	2030	2050
World	1.20	0.75
Industrialized countries	0.95	0.48
Developing countries	1.54	1.12





Accumulative CO_2 emissions per capita (2010-50)

Industrialized countries: 375t   Developing countries: 89t

Accumulative CO_2 emissions per GDP (1000USD) (2010-50)

Industrialized countries: 10t   Developing countries: 19t

Regional Equitability

Major industrialized and developing countries

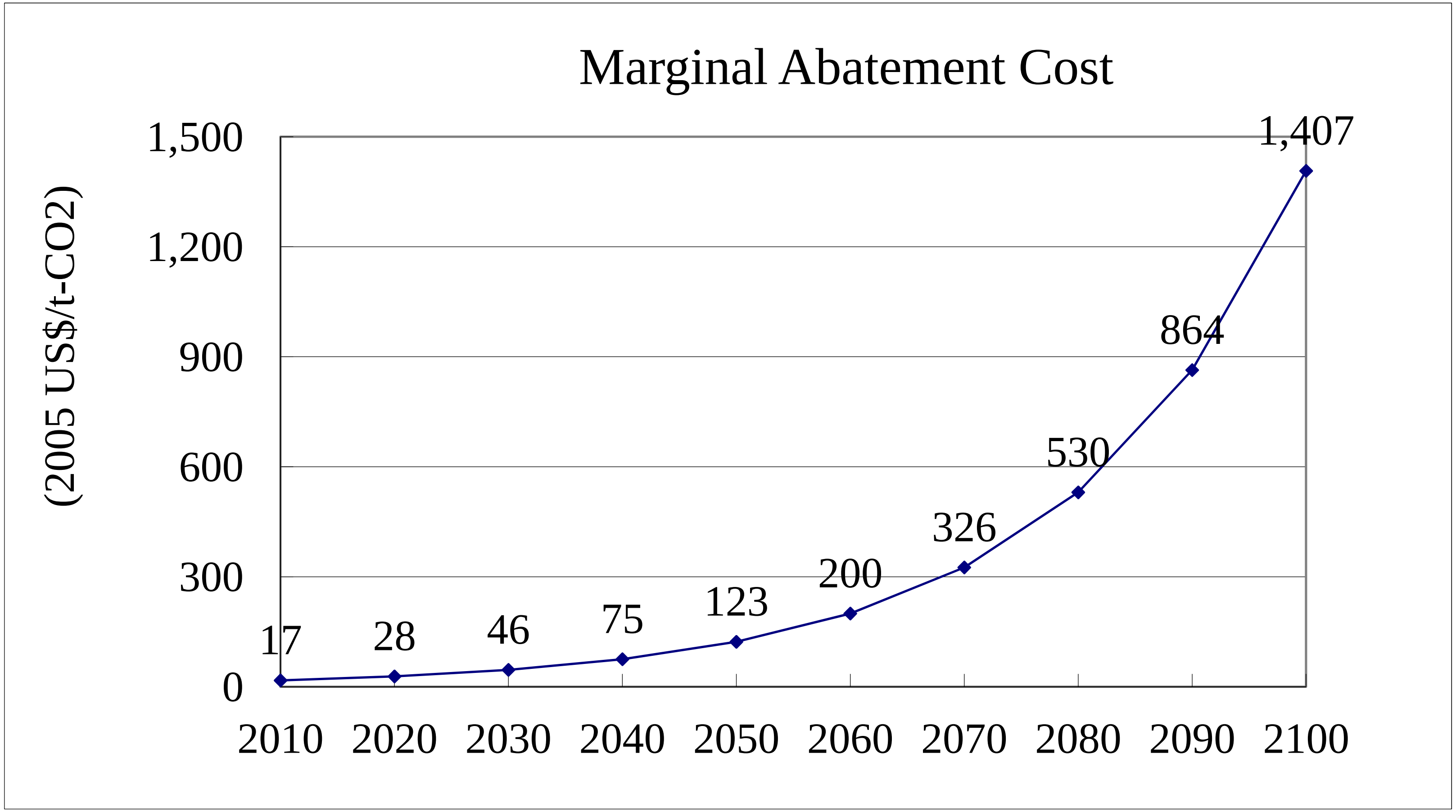
Ratio to 2005 levels	CO2 Emissions		CO2 Emissions per capita	
	2030	2050	2030	2050
World	1.20	0.75	0.94	0.53
Industrialized countries	0.95	0.48	0.89	0.47
USA	0.96	0.47	0.79	0.35
EU15	0.86	0.45	0.82	0.43
Japan	0.79	0.47	0.87	0.63
Developing countries	1.54	1.12	1.18	0.74
China	1.48	0.82	1.34	0.77
India	1.91	1.57	1.43	1.08
ASEAN	1.64	1.50	1.24	1.00

Regional Equitability

Major industrialized and developing countries

Region	CO2 Emissions					
	2030			2050		
	Ratio to 1990 levels	Ratio to 2005 levels	Ratio to REF of 2030	Ratio to 1990 levels	Ratio to 2005 levels	Ratio to REF of 2050
World	1.60	1.20	0.82	1.00	0.75	0.46
Industrialized countries	1.05	0.95	0.89	0.53	0.48	0.48
USA	1.16	0.96	0.90	0.57	0.47	0.47
EU15	0.89	0.86	0.91	0.46	0.45	0.53
Japan	0.93	0.79	0.90	0.55	0.47	0.66
Developing countries	2.82	1.54	0.77	2.05	1.12	0.45
China	2.77	1.48	0.74	1.53	0.82	0.37
India	3.42	1.91	0.72	2.83	1.57	0.37
ASEAN	3.74	1.64	0.80	3.41	1.50	0.57

Equal Marginal Abatement Cost



Global and Regional Cost and Benefit

From traditional development to energy conservation

BAU	CO2 Emissions (ratios to 2005 level)		Acc. Emissions GtCO2 (2010-50)	Acc. Cost T$ (2010-50)
	2030	2050		
World	1.7	2.1	1677	335
Industrialized Countries	1.1	1.2	671	160
Developing Countries	2.4	3.3	1006	175

REF	CO2 Emissions (ratios to 2050 level)		Acc. Reductions	Additional Investment	Fuel Saving
	2030	2050			
World	1.5	1.6	215	9	-21
Industrialized Countries	1.1	1.0	49	1	-7
Developing Countries	2.0	2.5	166	8	-14

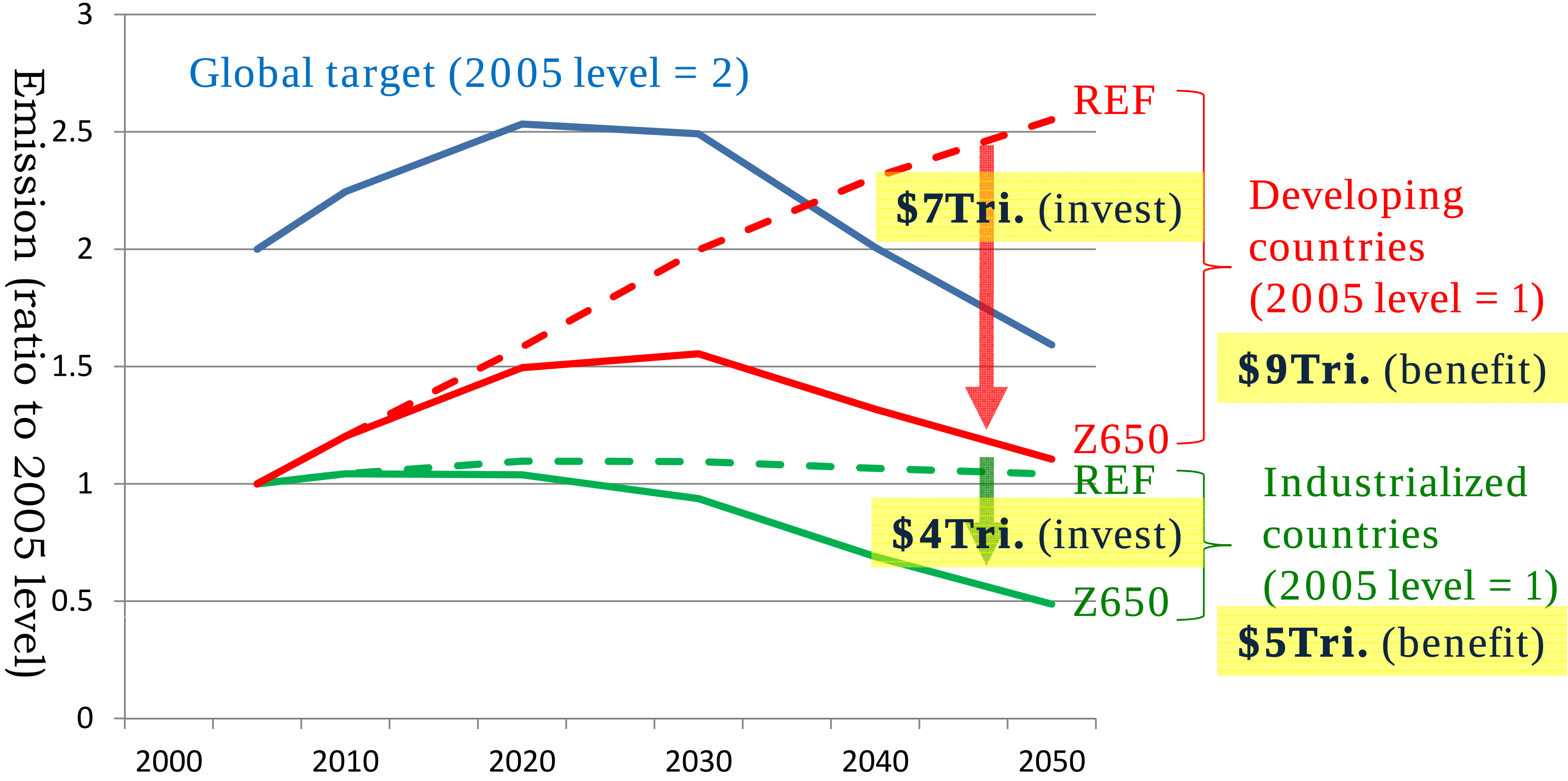
Global and Regional Cost and Benefit

From energy conservation to low carbon vision

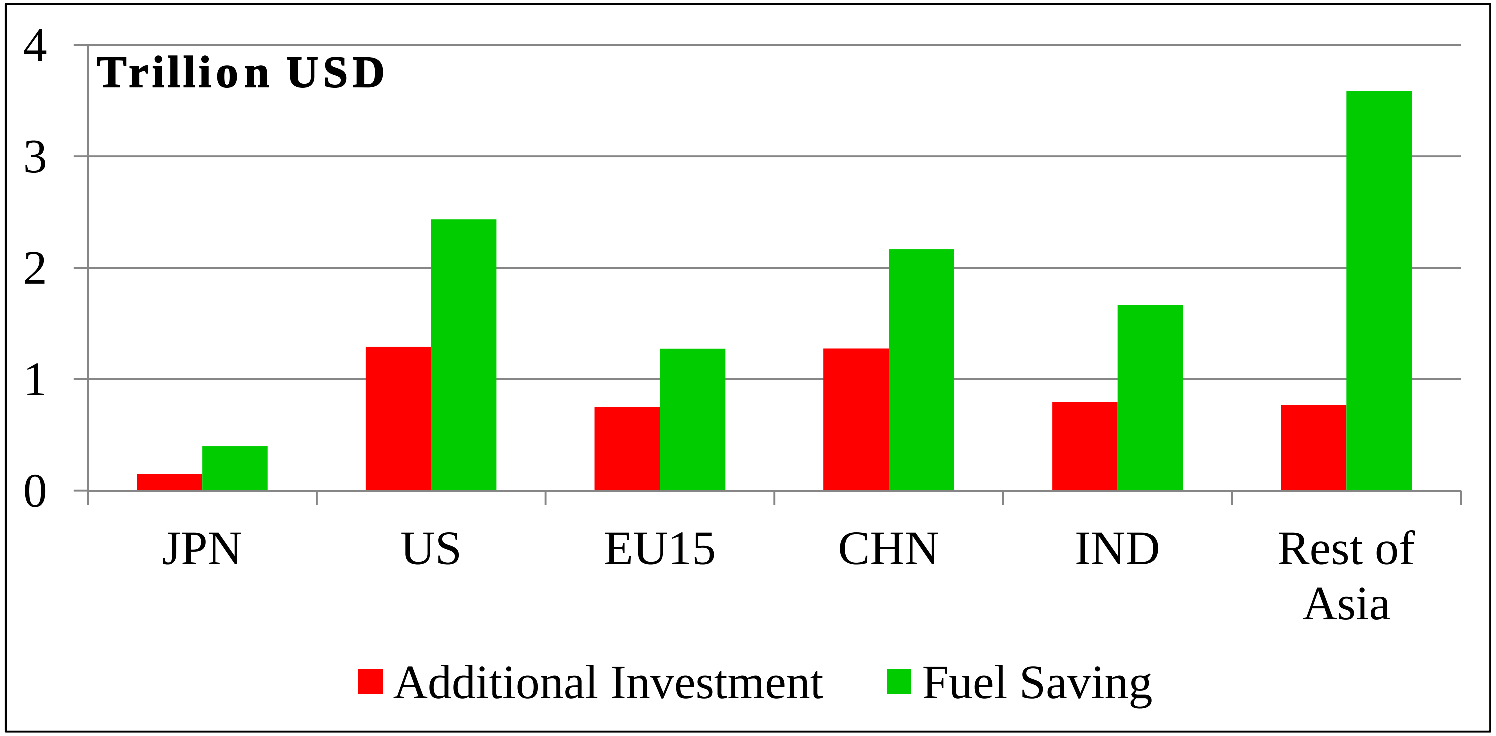
REF	CO2 Emissions (ratios to 2005 level)		Acc. Emissions GtCO2 (2010-50)	Acc. Cost T$ (2010-50)	
	2030	2050			
World	1.5	1.6	1462	323	
Industrialized Countries	1.1	1.0	622	154	
Developing Countries	2.0	2.5	840	169	
Z650	CO2 Emissions (ratios to 2050 level)		Acc. Reductions	Additional Investment	Fuel Saving
	2030	2050			
World	1.2	0.75	362	11	-14
Industrialized Countries	1.0	0.5	114	4	-5
Developing Countries	1.5	1.1	248	7	-9

Additional Investments vs. Fuel Saving Benefits

Global and regional emissions of Energy Related CO_2



Additional Investments vs. Fuel Saving Benefits



Equitability vs. Capacity

Share in regional GDP	Additional Investment	Fuel Saving
World	0.28	0.35
Industrialized countries	0.18	0.22
US	0.14	0.27
EU15	0.11	0.18
Japan	0.05	0.12
Developing countries	0.43	0.55
China	0.20	0.34
India	0.49	1.02
Other Asia	0.29	1.36

Region Specific Scenario Analysis

Z650+ scenario

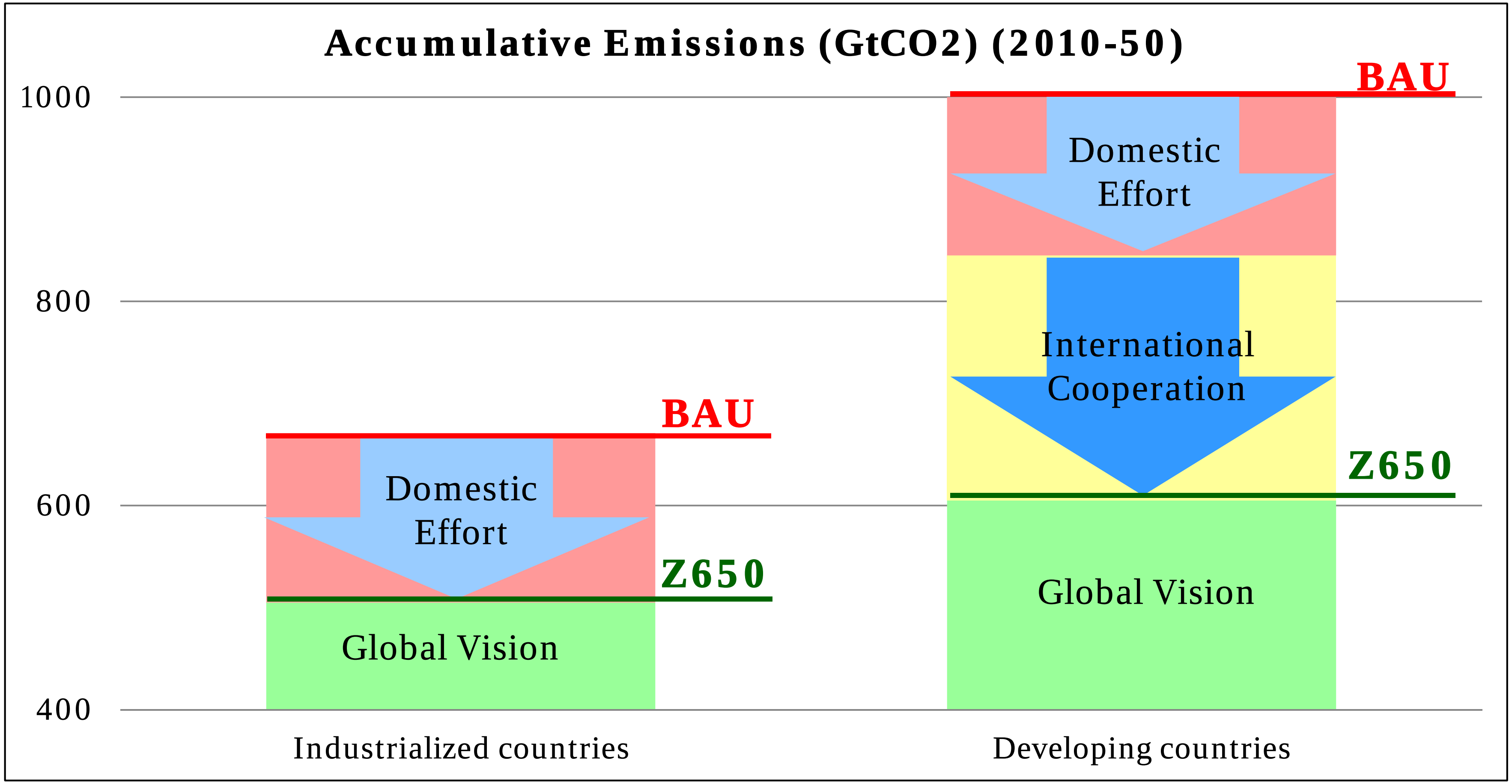
emissions of the developed countries caped by G8 Summit Proposal
(to reduce their emissions by 80% in 2050 compared with 2005 levels)

Result of Region Specific Scenario

Global and Regional Cost and Benefit

REF	CO2 Emissions (ratios to 2005 level)		Acc. Emissions GtCO2 (2010-50)	Acc. Cost T$ (2010-50)	
	2030	2050			
World	1.5	1.6	1462	323	
Industrialized Countries	1.1	1.0	622	154	
Developing Countries	2.0	2.5	840	169	
Z650 (Z650+)	CO2 Emissions (ratios to 2005 level)		Acc. Reductions	Additional Investment	Fuel Saving
	2030	2050			
World	1.2	0.75	362	11 (42)	-14 (-10)
Industrialized Countries	1.0 (0.7)	0.5 (0.2)	114 (256)	4 (37)	-5 (-10)
Developing Countries	1.5 (1.9)	1.1 (1.5)	248 (106)	7 (5)	-9 (0)

Practical Approach



BAU: traditional development **Z650:** Low carbon vision

Fill in the gap in developing countries with international cooperation

Promotion Process

Beneficial action combining investment (loan) and technology in developing country with high reduction potential

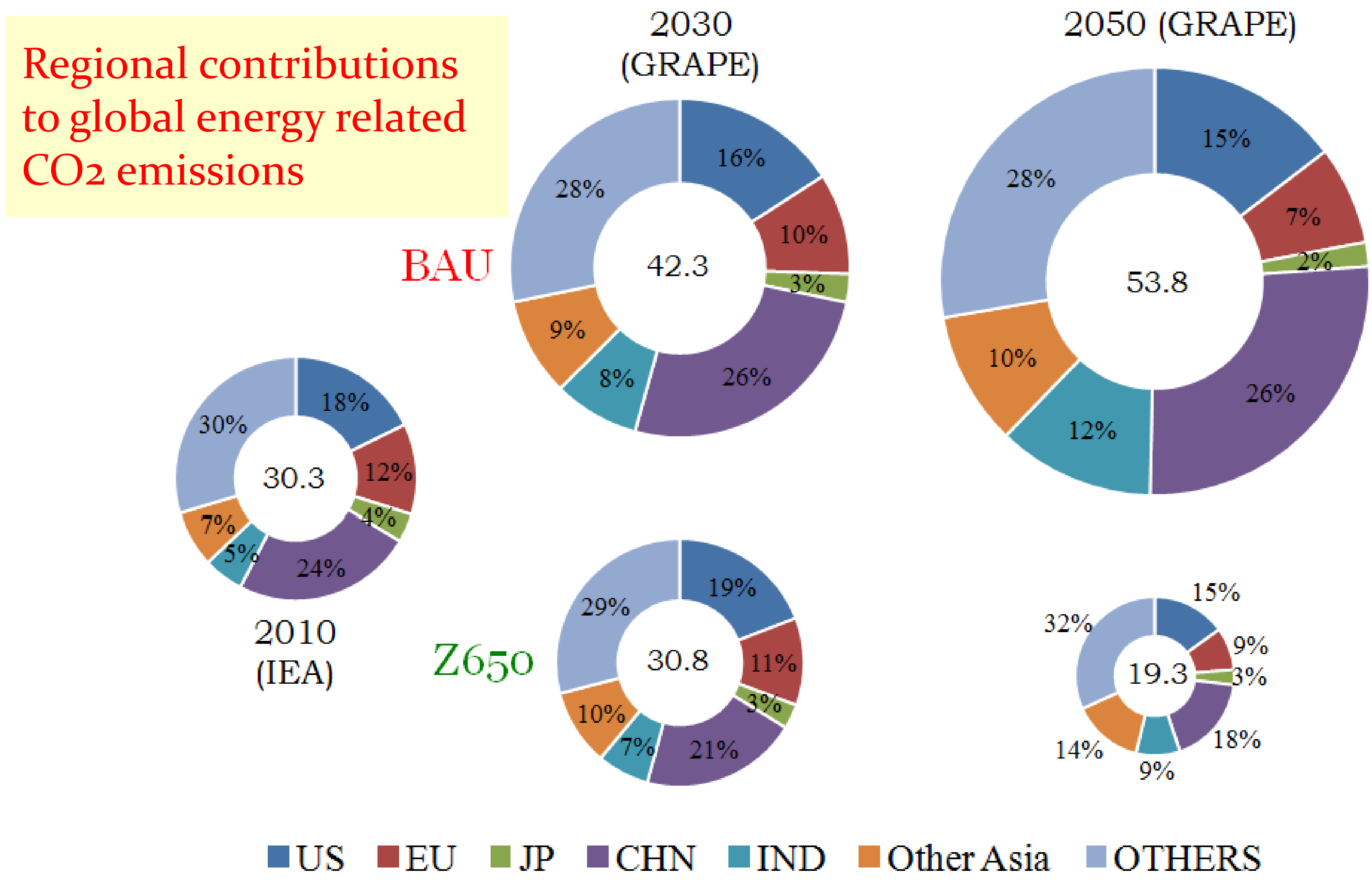
↓ For demonstration

Model development by Japan, US and China that have full capacity of finance, technology, resource and production

↓ Deployment to developing countries

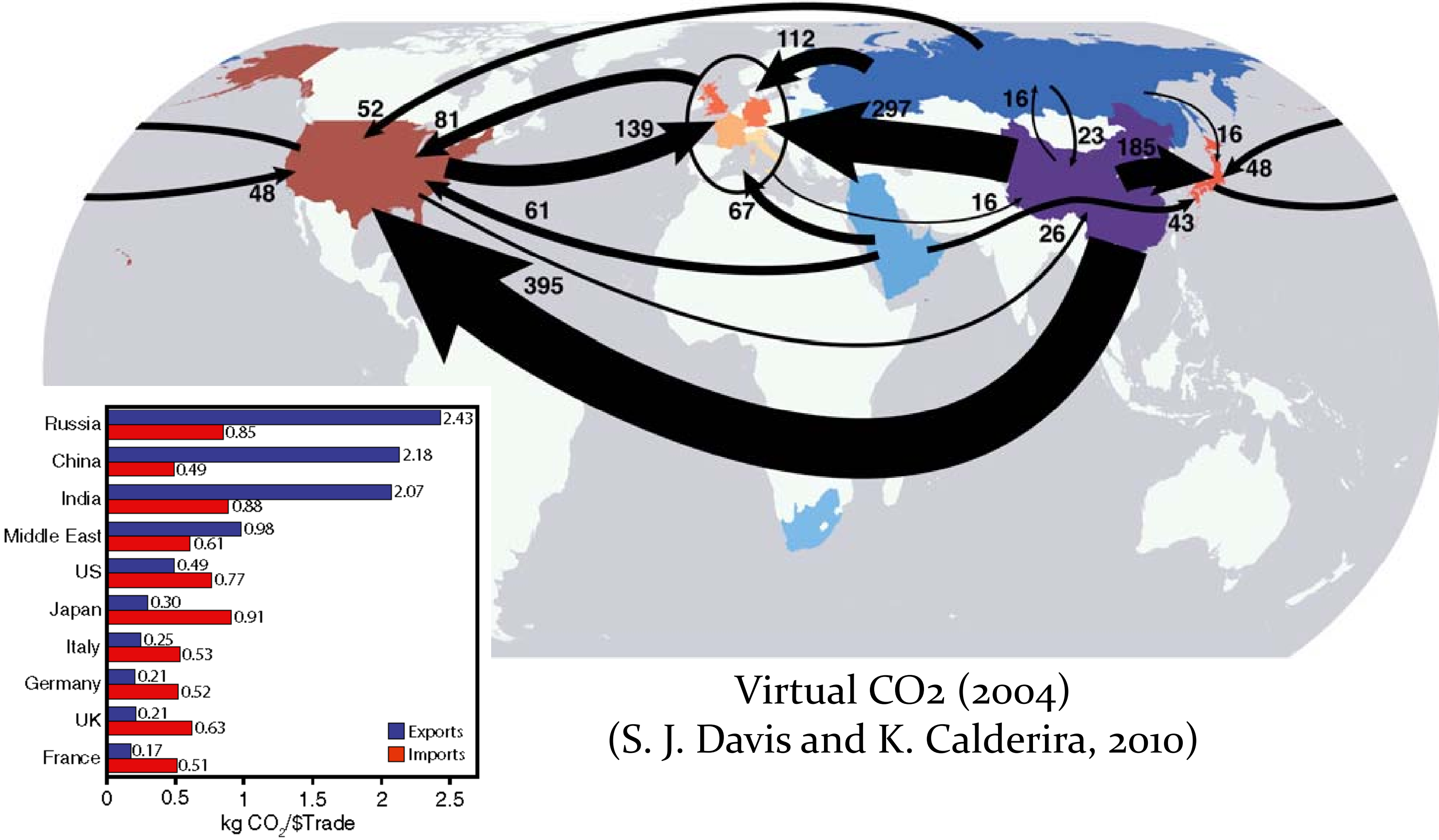
Low carbon society

Why United States, Japan and China?



Why United States, Japan and China?

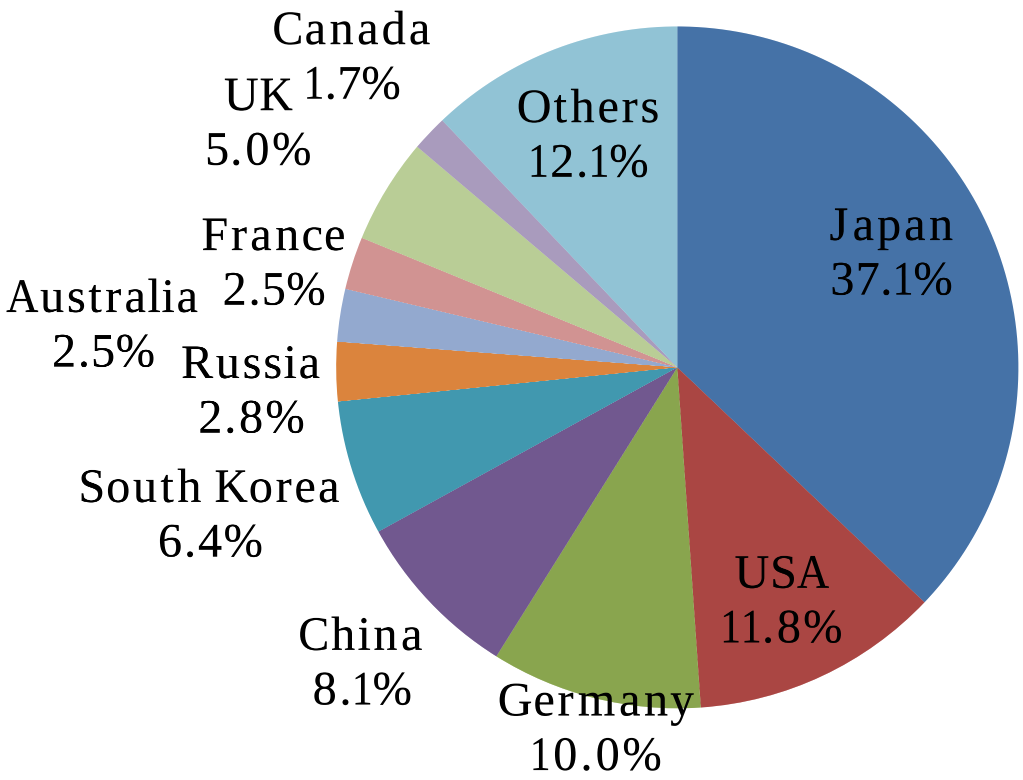
Inter dependence on CO_2 emissions



Virtual CO_2 (2004)
(S. J. Davis and K. Calderira, 2010)

Why China, Japan and United States?

Global distribution of Climate Technologies



Global Climate Technology Innovation (2000-05)
(A. Dechezlepretre, et al., 2009)

Why Cooperation?

Trilateral complementary relationships for CO_2 emission reduction

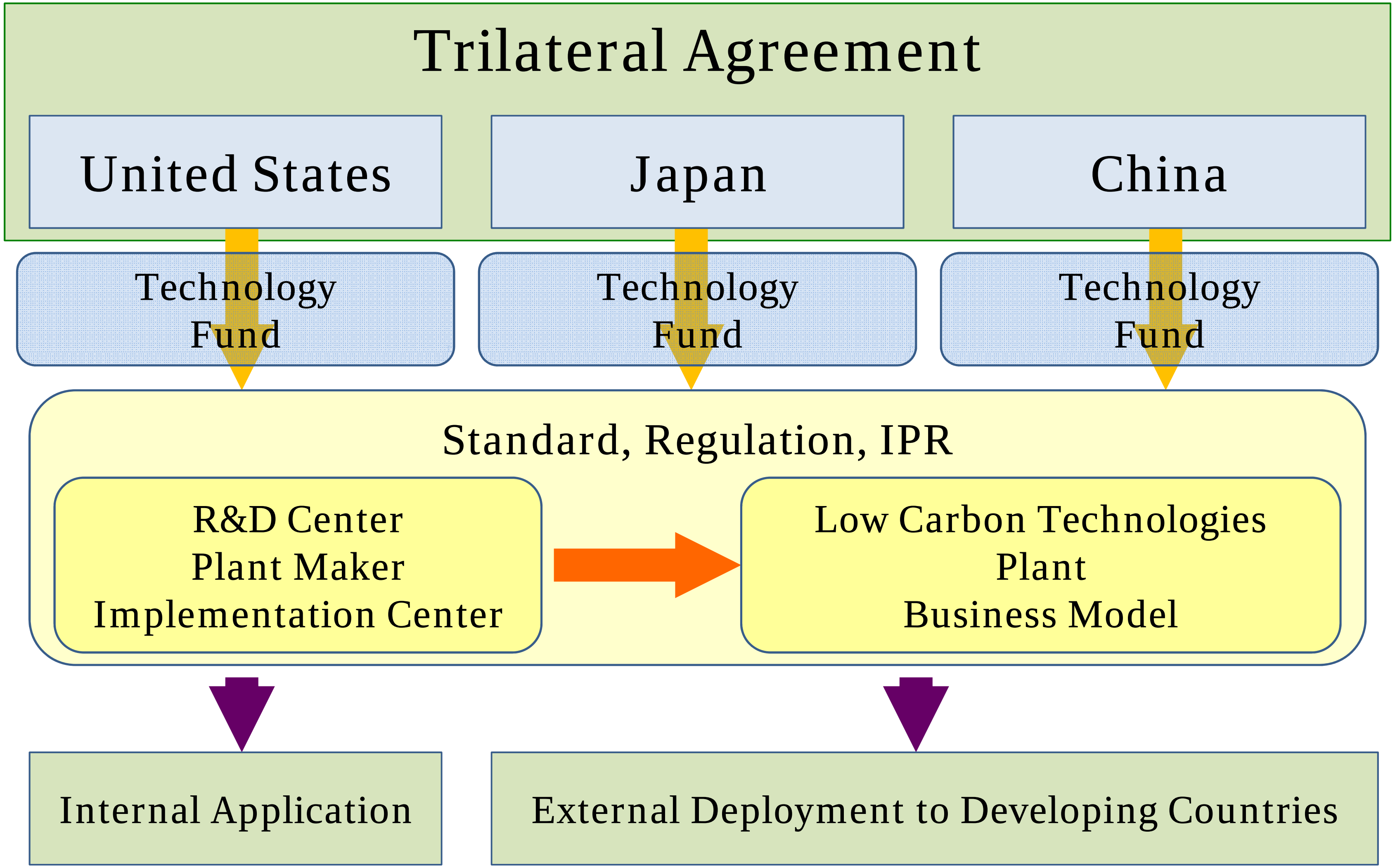
	China	Japan	United States
Resources Potential	△	×	○
Technology Capacity	×	○	△
Production Capacity	○	×	△
Economic Capacity		○	

How to Cooperate?

Current status of cooperation

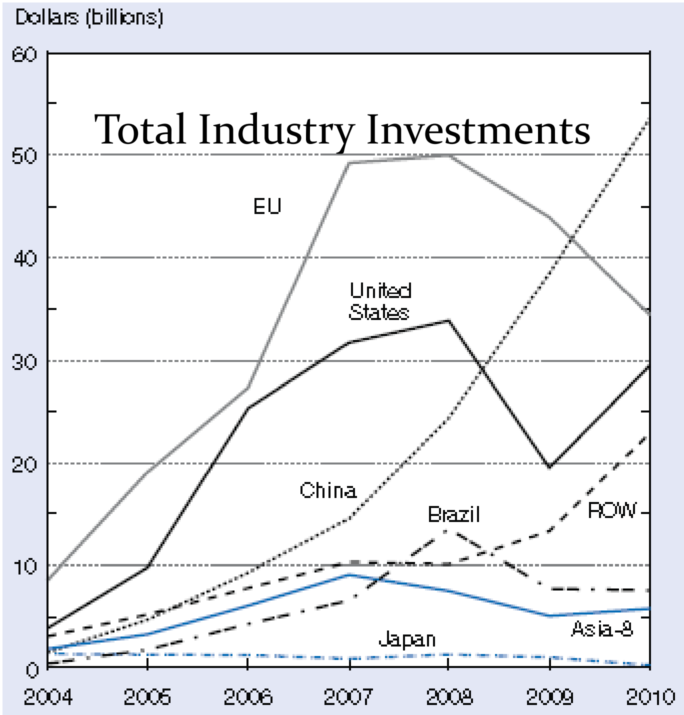
	China-Japan	China-US	Japan-US
Approach	Governmental dialogue Private sector	Governmental dialogue Think tank	Governmental dialogue Institution
Contents	Technology cooperation Project	Strategy Policy	R&D
Characteristic	Business oriented	Policy oriented	Innovation oriented
Limitation	Strategic scope	Workability	Deployment

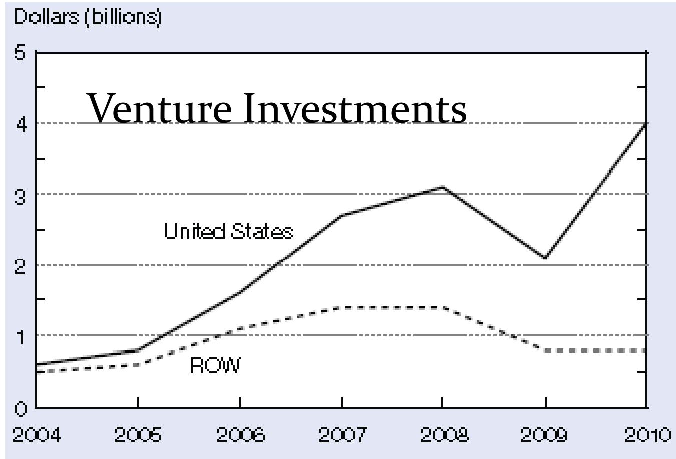
How to Cooperate?

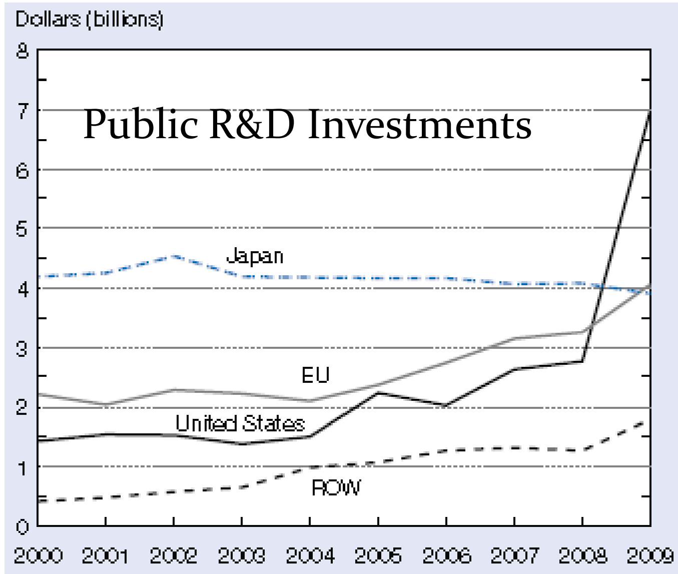


How to Cooperate?

Sample
Japan: R&D of basic technology
US: Innovation of commercial technology
China: Technology industrialization



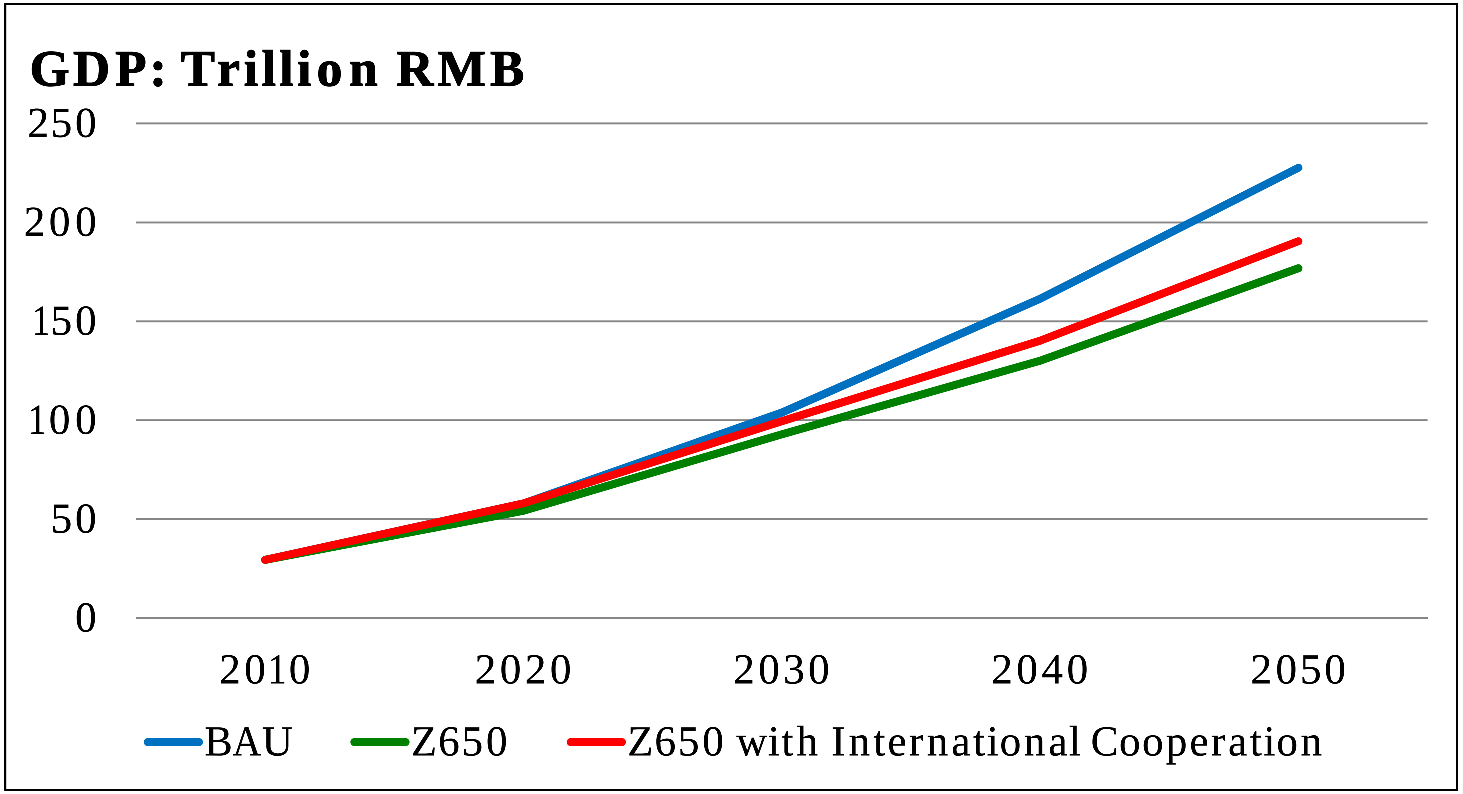




Investments on green energy industry and technology (NSF,2012)

Is the Cooperation Effective?

Case Study in China



Significant economic damage will be caused by achieving Z650 target by domestic effort only. The damage could be reduced by almost one third through simply introducing the advanced technologies in the projection.

Internal Contribution
Co-benefits for the three countries

-United States

Industrial competitiveness improvement

Carbon footprint reduction

-Japan

Energy security improvement

Keep the leadership in climate technologies

-China

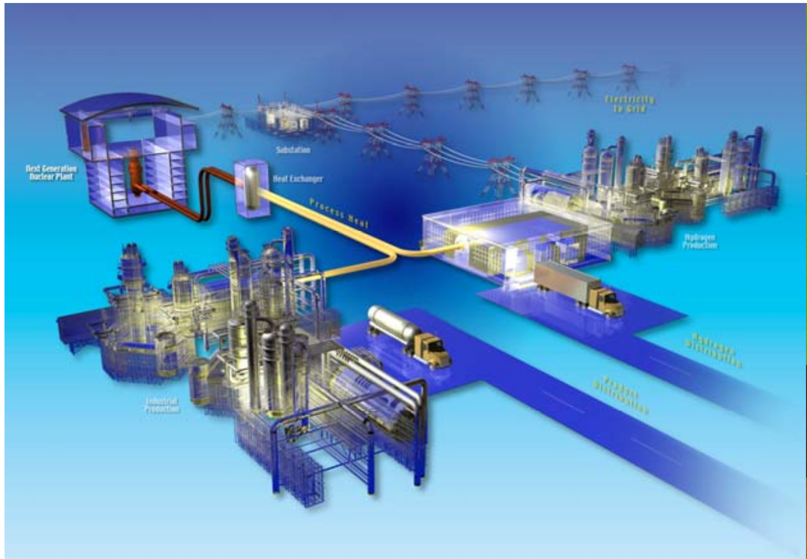
Local environment improvement

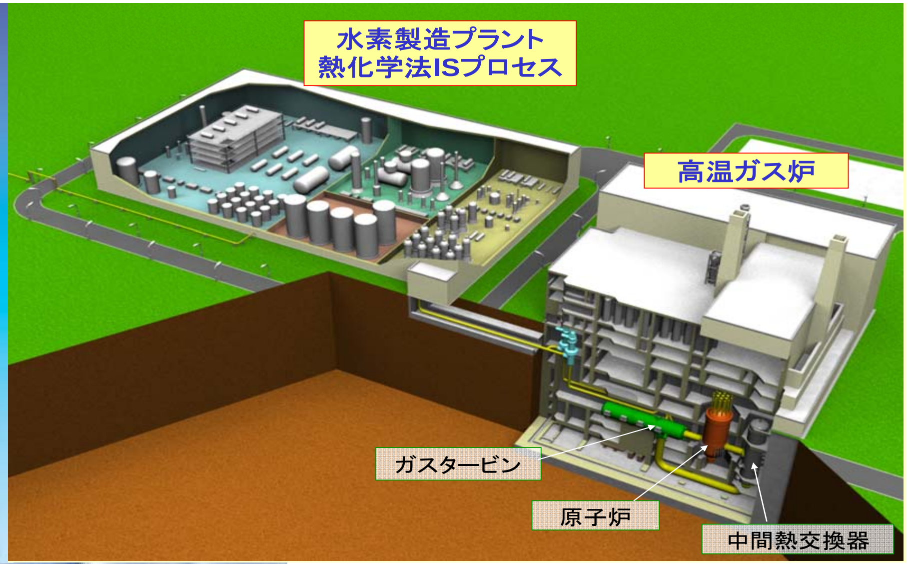
Industrial structure reform

External Contribution
Industrialization path for developing countries

	China	Japan	United States
Green Energy Production	Coal, RE	RE	Coal, Oil, Gas
	Best Energy Mix		
Green Highly Efficient Energy Conversion	Nuclear, RE, CCS	Fossil, Nuclear	Nuclear, RE, CCS
	Zero Emission Power Generation		
Improvement of Energy Consumption	Transportation	Industry, Residential	Residential
	High Energy Efficiency		
Establishment of Green Life Style	Reverse Innovation	Advanced Technology	Advanced Social System
	Industrialization Model for Developing Countries		

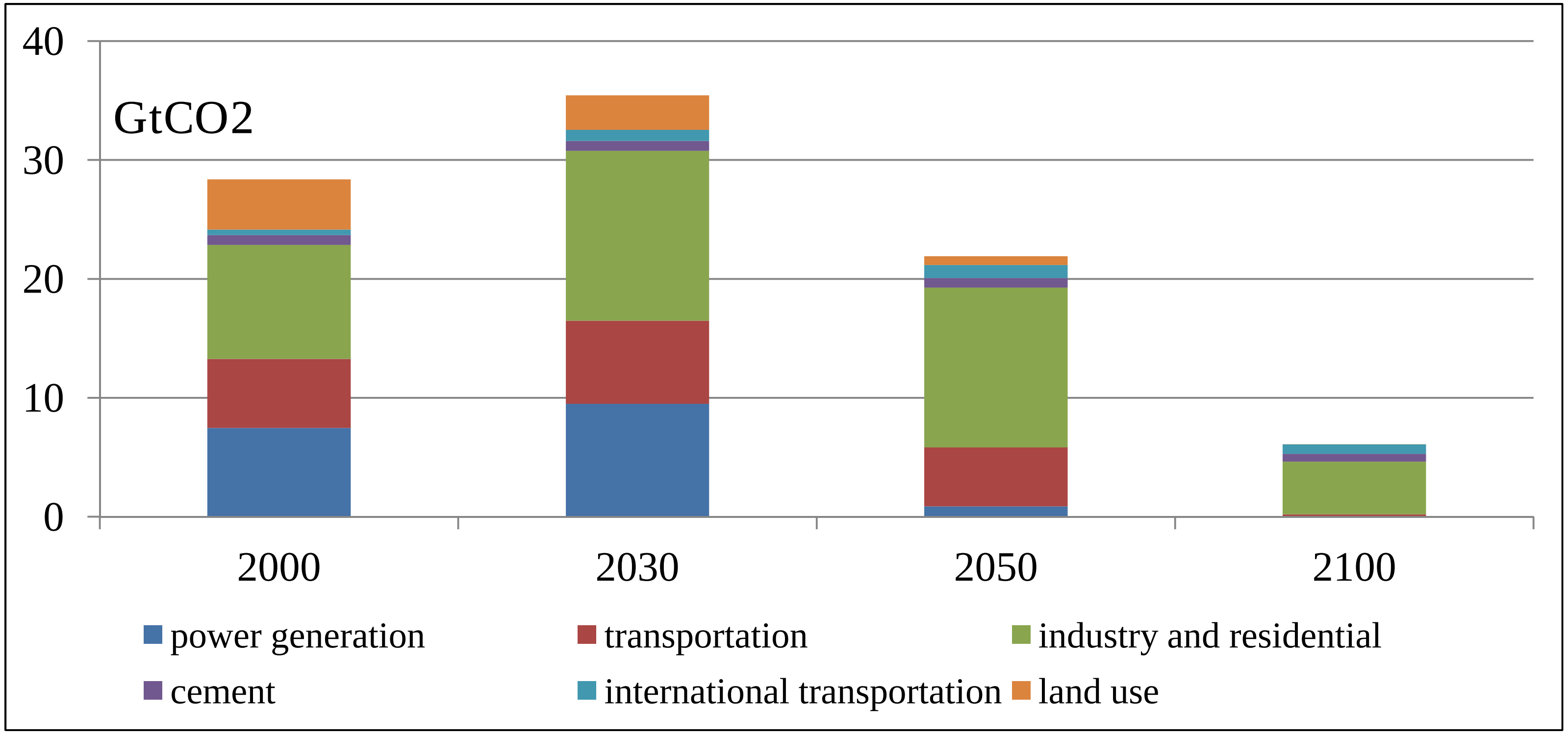
Potential Cooperation Sample





Potential Sample - HTGR
China: Demonstration plant (HTR-PM)
US: Process heat (NGNP)
Japan: Hydrogen production (HTTR)

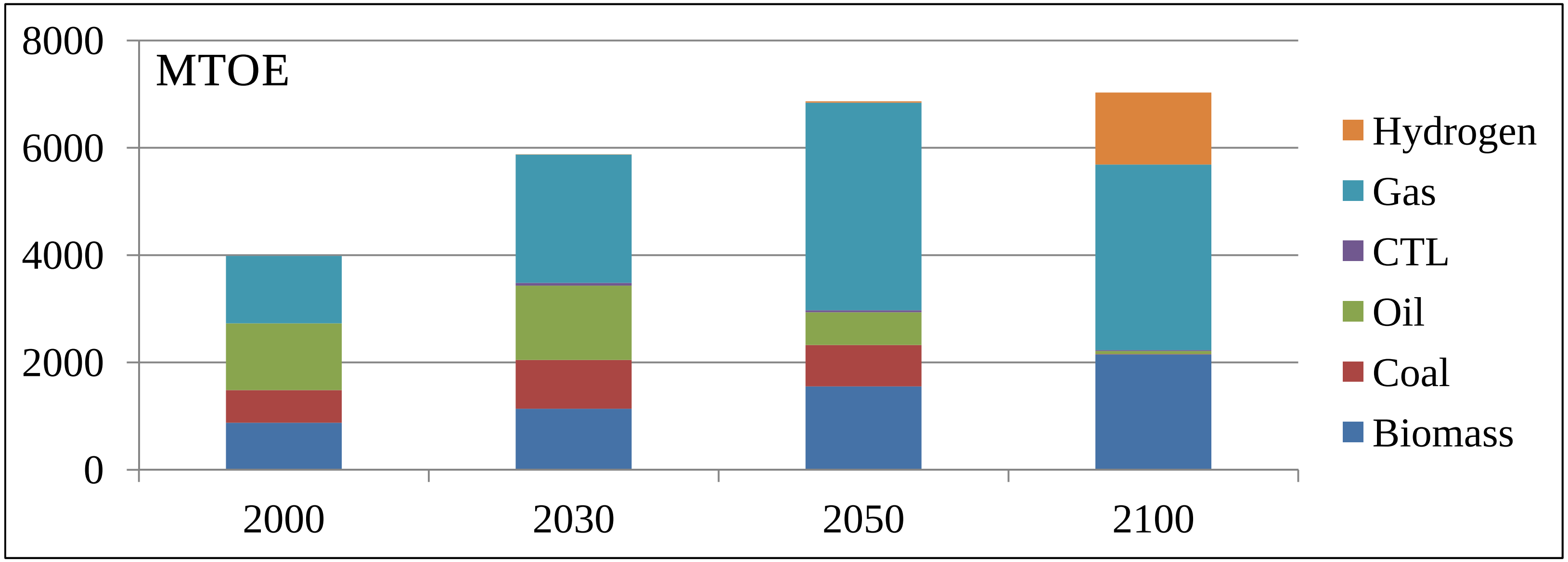
CO_2 Emissions by sectors

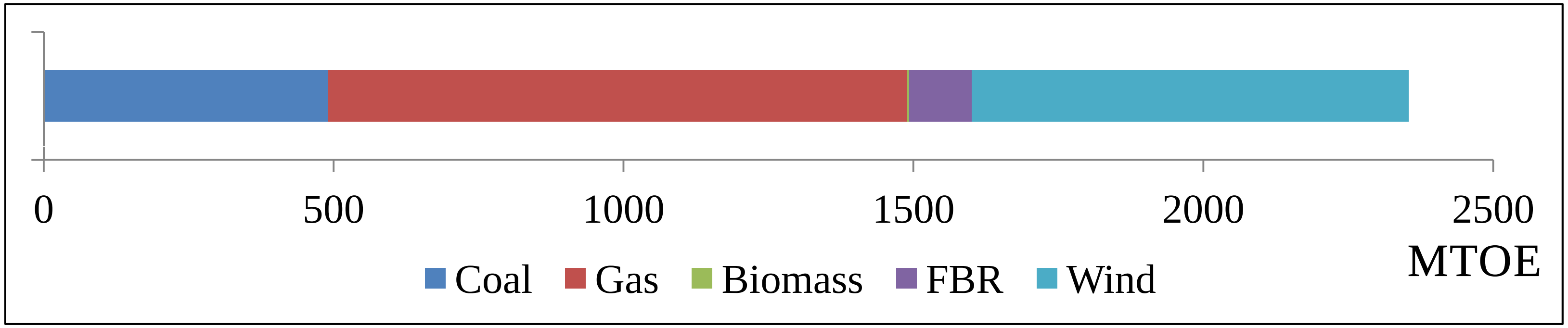


Analysis results through energy engineering model (GRAPE)

・emissions from industry and residential sectors decrease slowly (share in total emissions: 33%→73%)

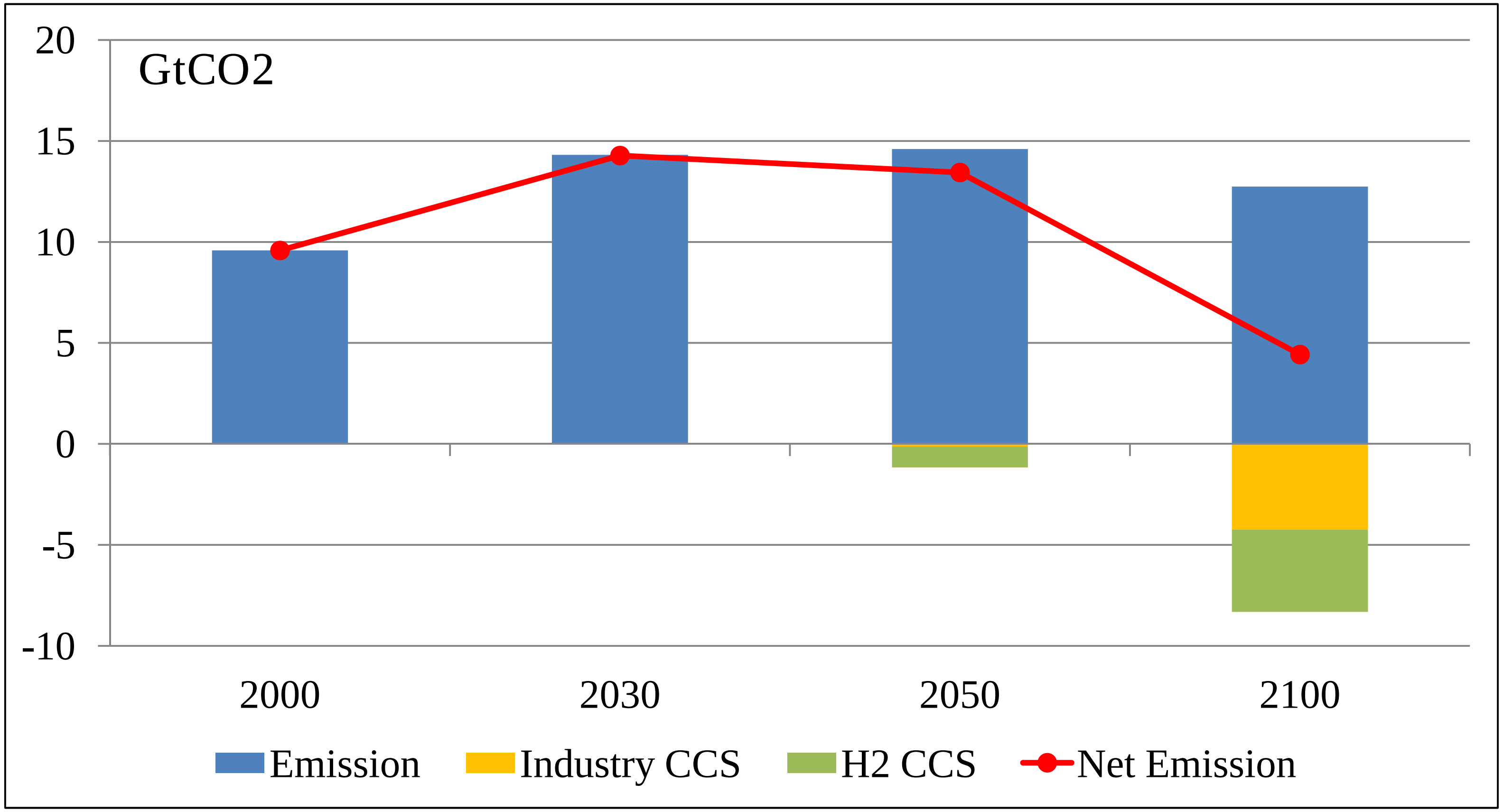
Energy for Industry and Residential



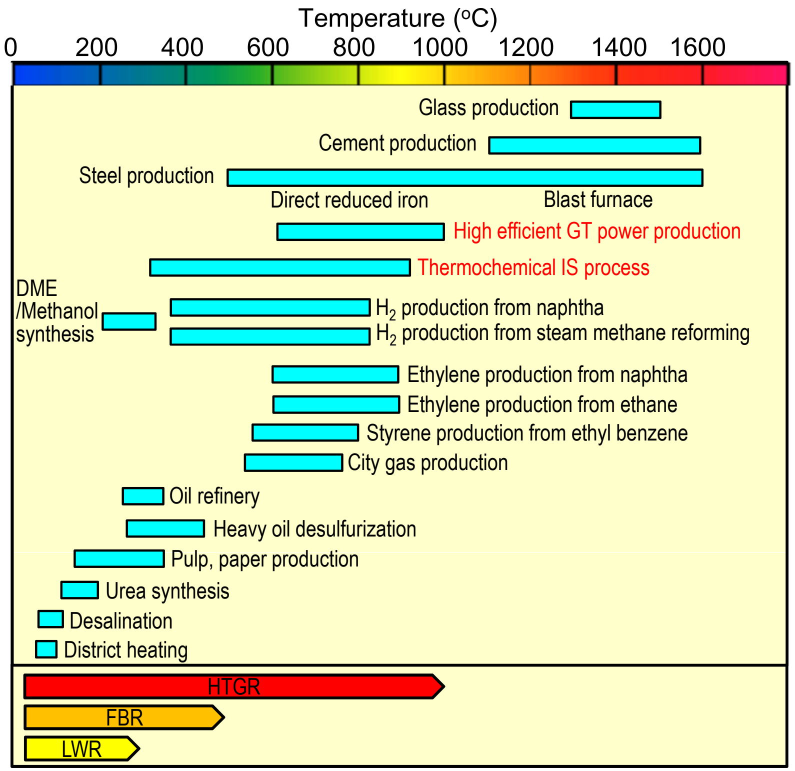


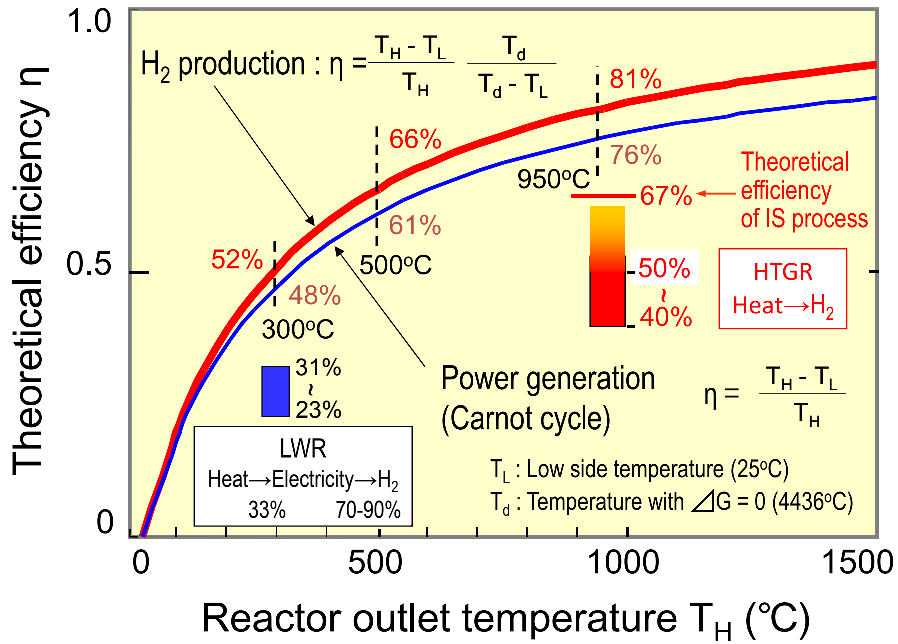
Energy for Hydrogen Production in 2100

Emission from Industry and Residential



Possibility of Heat Supply by HTGR





Masuro OGAWA, CIGS 3rd international symposium on global warming

Sample Scenario for HTGR Utilization

Mission

To keep the same emission pathway by reallocating emissions between power and industrial sectors

Modification

To replace a part of fossil heat resource by HTGR in industrial sector
To replace LWR/FBR by the replaced fossil fuel in power sector

Fuel Target and Scale

Natural gas:
  low carbon intensity and high power generation efficiency
  occupies approximately 20% of total industrial energy consumption
HTGR application scale:
  2000 module (2030), 6000 module (2050), 6000 module (2100) *
  1 HTGR module (200MWt with 90% operational rate) = 0.136MTOE

*NGNP: 1000 module in 2030 and 3000 module in 2050 in US

Changes by Modification

<table>
<tr><th colspan="2"></th><th>2030</th><th>2050</th><th>2100</th></tr>
<tr><td rowspan="3">Industrial sector</td><td>Increasing HTGR (GWt)</td><td>400</td><td>1200</td><td>1200</td></tr>
<tr><td>Heat supply* (MTOE)</td><td>218</td><td>653</td><td>653</td></tr>
<tr><td>Replacing gas (MTOE)</td><td rowspan="2">230</td><td rowspan="2">690</td><td rowspan="2">690</td></tr>
<tr><td rowspan="3">Power sector</td><td>Increasing gas (MTOE)</td></tr>
<tr><td>Power generation** (TWh)</td><td>1740</td><td>5215</td><td>5215</td></tr>
<tr><td>Replacing nuclear *** (GWe)</td><td>235</td><td>700</td><td>700</td></tr>
</table>

*the heat utility efficiencies for HTGR and Gas is 80% and 95% respectively
**the power generation efficiency of gas is 65%
***the operational rate of LWR/FBR is 85% in the model

Different Nuclear Scenarios

Current: power only		2030	2050	2100
LWR	Electricity (TWh)	6037	10758	1655
	Fuel (MTOE)	1512	2407	344
FBR	Electricity (TWh)	-	2788	17942
	Fuel (MTOE)	-	551	3342
Primary fuel (MTOE)		1512	2407	344
Cycled fuel (MTOE)		-	551	3342

Cumulative primary fuel (2030~2100): 108GTOE

Different Nuclear Scenarios

Alternative: power + heat		2030	2050	2100
LWR	Electricity (TWh)	4297	5543	0
	Fuel (MTOE)	1075	1240	0
FBR	Electricity (TWh)	-	2788	14382
	Fuel (MTOE)	-	551	2679
HTGR	Heat (MTOE)	218	653	653
	Fuel (MTOE)	272	816	816
Primary fuel(MTOE)		1347	2056	816
Cycled fuel (MTOE)		-	551	2679

Cumulative primary fuel (2030~2100): 106GTOE

Different Nuclear Scenarios

Capacity		2030	2050	2100
Current Scenario	LWR (GWe)	810	1445	220
	FBR (GWe)	-	375	2410
Alternative Scenario	LWR (GWe)	575	745	0
	FBR (GWe)	-	375	1930
	HTGR (GWt)	400	1200	1200

Impact to System Cost

A simple estimation

Cost unit: Billion $			2030	2050	2100
Cost Up	HTGR (1440$/KWt)*	GWt	400	1,200	1,200
		Cost	11.5	34.5	34.5
	Heat Pipeline (3 million $/km)**	km	20,000	60,000	60,000
		Cost	2.0	6.0	6.0
	GTCC (750$/KWe)*	GWe	235	700	700
		Cost	5.9	17.5	17.5
Cost Down	Gas Pipeline (3 million $/km)**	km	20,000	60,000	60,000
		Cost	2.0	6.0	6.0
	LWR (3,600$/KWe)*	GWe	235	700	220
		Cost	16.9	50.4	15.8
	FBR (4500$/KWe)*	GWe	-	-	480
		Cost	-	-	43.2
	FBR Fuel*** (80$/TOE)	MTOE	-	-	663
		Cost	-	-	53.0
Total impact (cost down)			-0.5	-1.6	60.0

*IEA and JAEA **METI (Improvement of Gas Infrastructure) ***IAE(GRAPE)

Summary

Instead of the traditional 450ppm equilibrium stabilization of IPCC, a new scenario based on zero-emission and overshoot schemes was proposed. The scientific examinations demonstrated that the so called Z650 scenario could avoid long-term risks while meeting short term need of relatively large emissions. The scenario is in the category of 500ppm with overshoot defined in IPCC AR5.

The technical feasibility and the economical rationality of the Z650 scenario were demonstrated through numerical experiments of global energy system optimization. Compared with the reference case, the additional investments in Z650 scenario could be covered by the fuel savings during the following 40 years (2010-50) both globally and regionally.

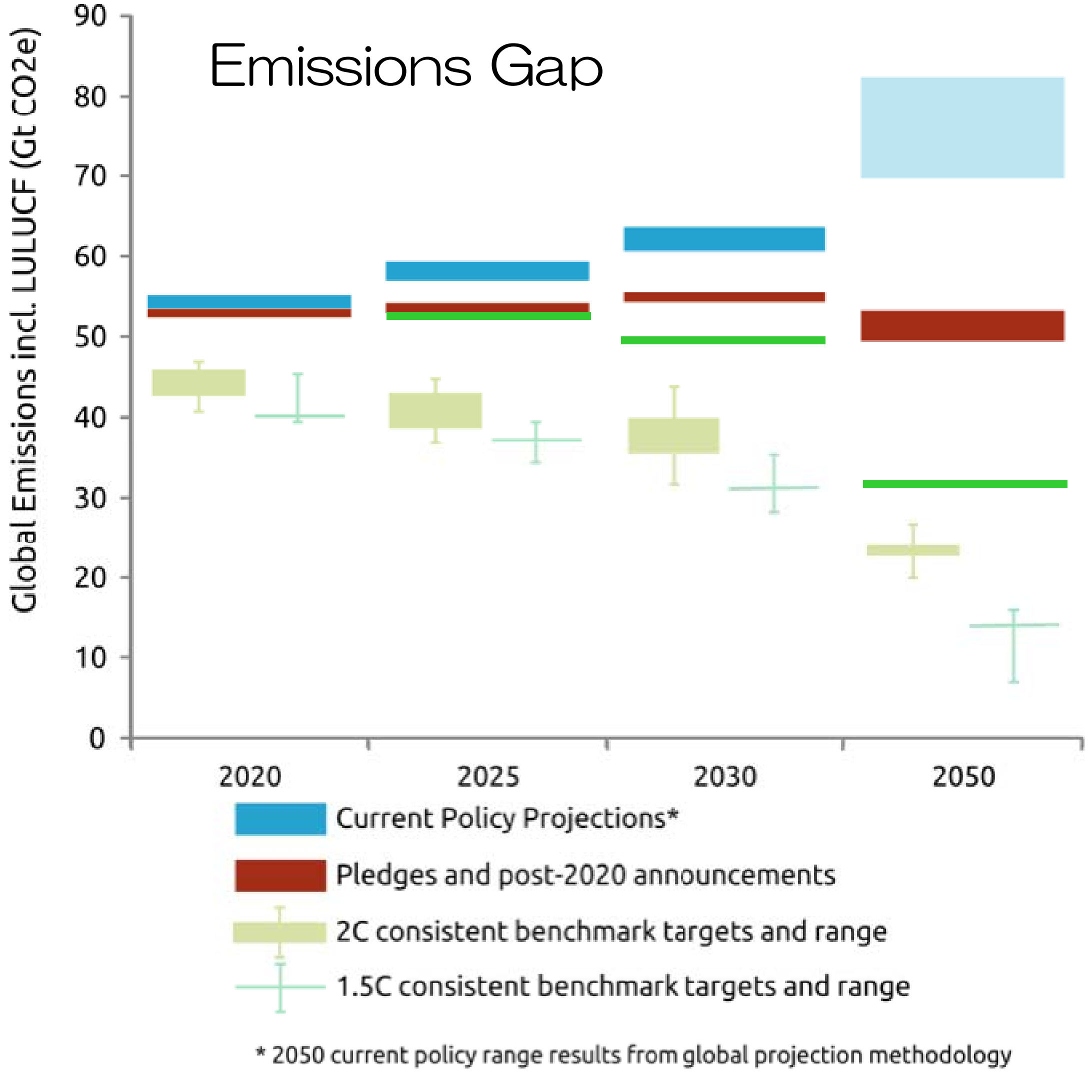
Summary

The simulated regional emission curves reflect the differences of financial and technical capability among areas, which provide useful information for global harmony.

A global energy vision that is globally effective while regionally feasible was obtained, and the numerical experiments indicate that the low carbon technology deployment and transfer is the key to achieve it.

Within a technology oriented international scheme, trilateral cooperation between Japan, US, and China, those have complementary relationships for CO2 emission reduction, can play essential role.

Some issues on COP21 and INDCs



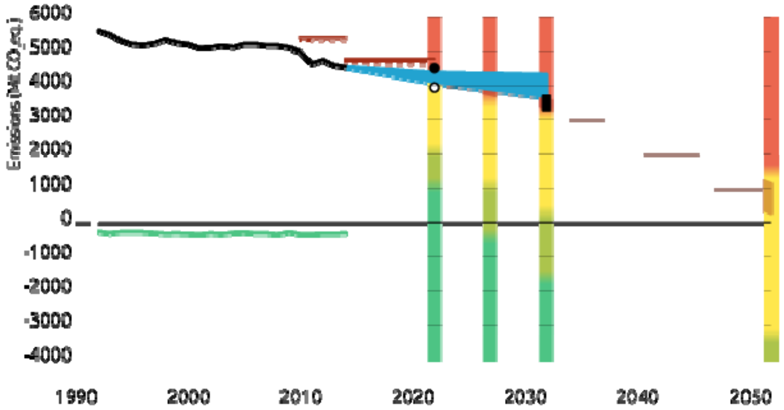
GHG emissions (GtCO2e)

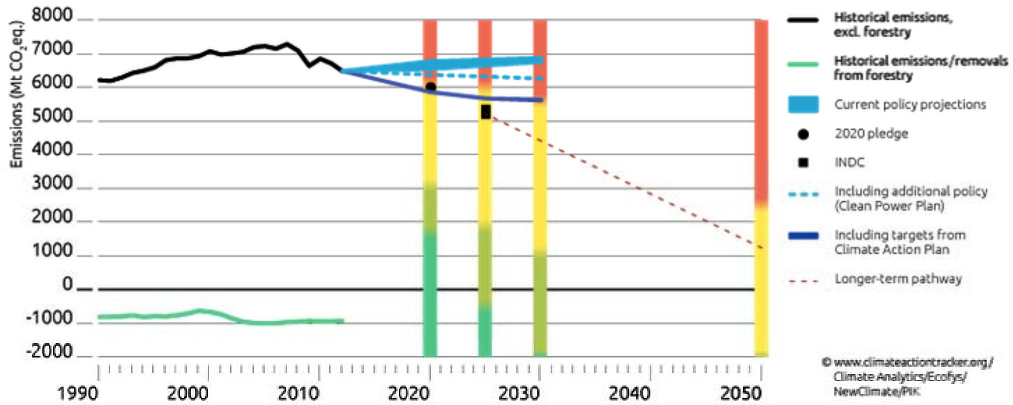
	2025	2030	2050
CP	57-59	61-64	
INDC	53-54	54-56	50-53
450ppm	39-43	36-40	23-24
Z650	52	49	31

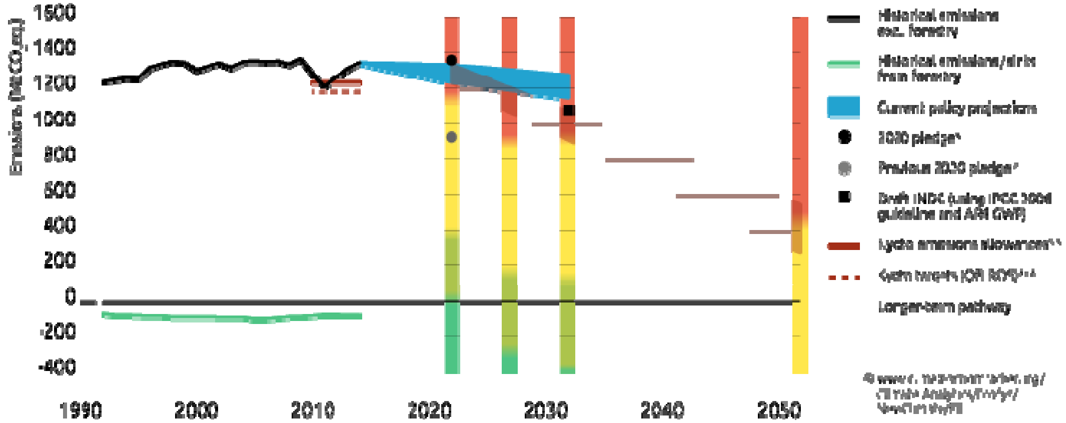
(Climate Action Tracker)

Some issues on COP21 and INDCs

Fill in the gap in developed countries?



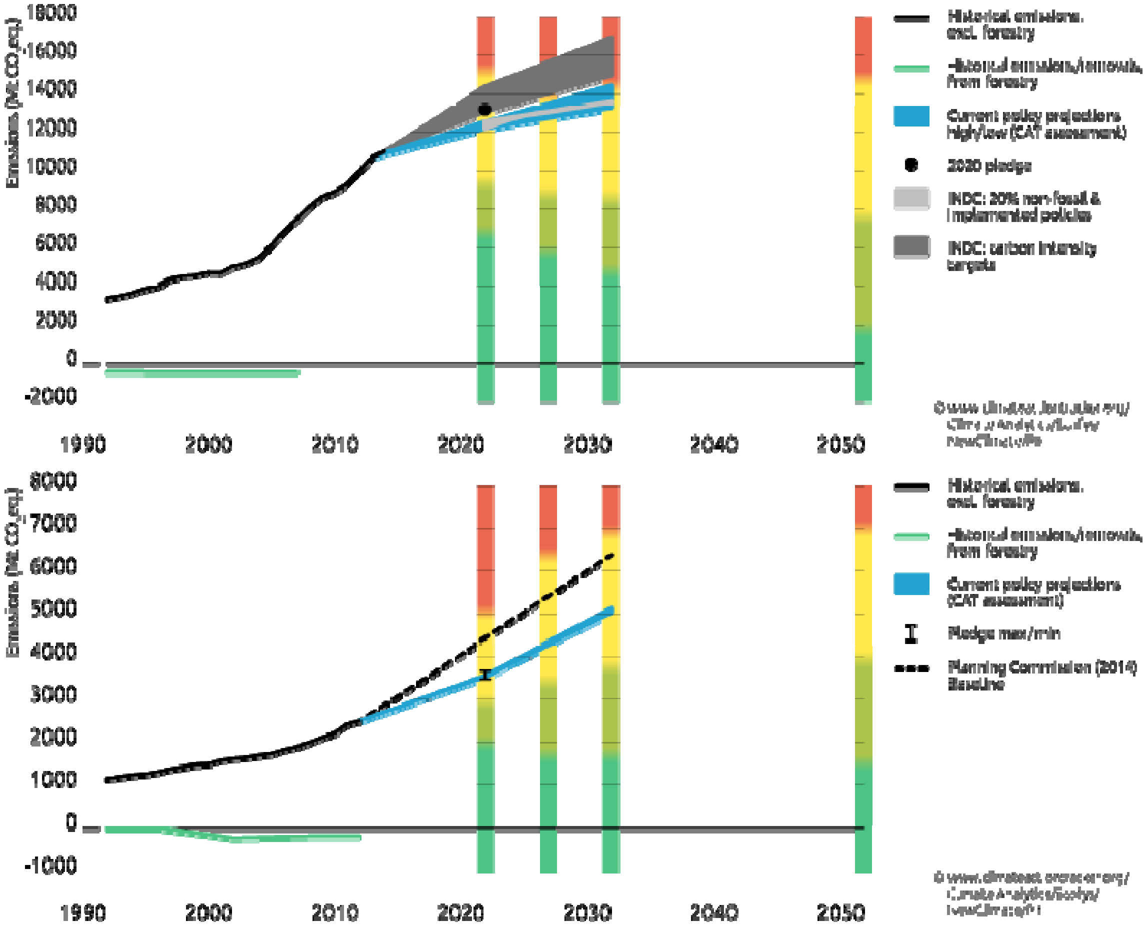


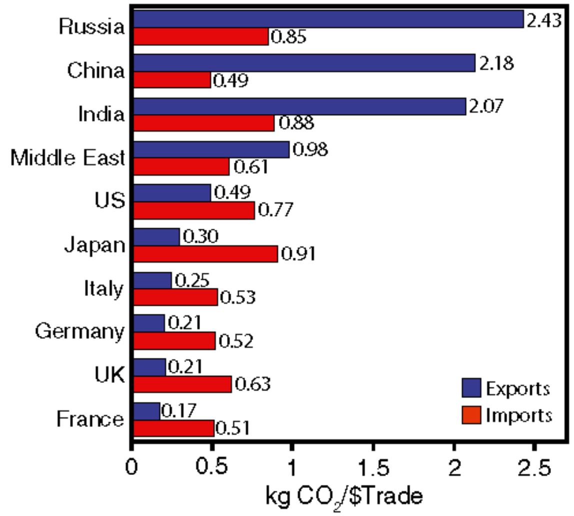


(Climate Action Tracker)

Some issues on COP21 and INDCs

Fill in the gap through international cooperation and cleaning the global industry up





(S. J. Davis and K. Calderira, 2010)

(Climate Action Tracker)

Thank You Very Much
For Your Attention!