Japan-China Expert Meeting on Climate Chage , 2014.11.15

Keynote: Issues and Topics

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Recent trends on energy policy

1. Cabinet Adoption of Basic Energy Plan of Japan

Defining the nuclear power and coal fired as base load, natural gas fired as middle load, and renewable energy (solar, wind, etc.) as peak load.

2. Publish of IPCC AR5

Cumulative emissions, overshoot scenario, the importance of CCS and nuclear, negative assessment of Kyoto Protocol, serious impacts of global warming

3. Changes of the energy policy of US

No new coal fired power plant, 30% reduction of the CO2 emission from power generation

4. EU: to reduce CO2 emission in 2030 by 40% relative to 1990 levels

5. China: trend to set total reduction target rather than CO2 intensity of GDP

6. Decrease of natural gas price, decrease of coal price and increase of coal fired plant in EU, decrease of oil price due to shale gas revolution

7. Establishment of Pledge and Review process to determine post 2020 global emission reduction framework, preparing to COP21 in Paris in 2015

Issues of this workshop

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 CO2 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 Japan-China 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 Japan? Is it enough to be the model of future industrial society?

CIGS

「Sharable global vision of GHG emission and long term energy mix against global warming」

1. Contents of the proposal: a. new emission pathway; b. national energy mix and emission pathway based on global optimization; c. development of low carbon technologies and the deployment scheme

2. Contents:

a. To set total global GHG emission (the energy related CO2 as main)

from “450 ppm concentration stabilization” to “overshoot and zero emission scenario”

→within 2℃, 650GtC, 25% reduction in 2050 relative to 2005

b. Globally cost minimum optimized energy mix and the obtained emissions of each countries to achieve the global pathway

→50% reduction for industrialized countries and 10% increase for developing countries in 2050 relative to 2005

c. To maintain the balance between additional investment and energy saving benefit of the energy mix

d. The deployment scheme for low carbon energy technologies

→technology transfer to aid development countries, removal of the additionality and speculation in current Kyoto Mechanism

Common understanding

- Support for feasible greenhouse gas emission scenarios based on climate change science while taking the overshoot scenario into account.
- Need to pursue a long-term global energy vision based on global optimization of the mitigation cost for energy related carbon dioxide emissions for a low carbon dioxide emission scenario and to welcome an energy vision balanced between required additional investments and fuel saving benefits.
- Promotion of deployment of low carbon technologies through international cooperation based on open, fair and efficient international mechanisms and working to implement an energy vision in which economic growth and global warming control co-exist.
- Sharing the vision through international discussions.

提案：地球温暖化抑制のために世界で共有すべき排出制約と低炭素産業社会へ向けたビジョン

Outline

-Energy related CO2 emission pathway
　latest achievement of climate science
　engineering approach of emission estimation

-Optimal way to achieve the scientific request
　analysis based on global energy model

-Practical approaches to the proposal
　technological and economic prospective

-Enhancement of international cooperation instead of Cap&Trade and CDM in Kyoto Protocol

概要

⑴温室効果ガス（主としてエネルギー起源二酸化炭素）の総排出量と排出曲線設定　Z650

⑵この制約下で世界全体で最適化するエネルギー構成と排出分担

⑶このエネルギー構成に対する追加削減費用と省エネメリットのバランス（投資と省エネメリットによる回収）

⑷国際協力による低炭素エネルギー技術普及のメカニズム

Global Emission Pathway

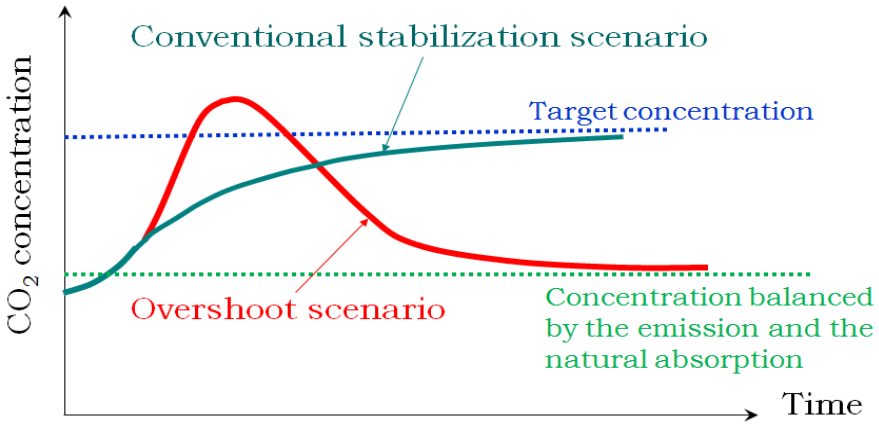
Scientific analysis based on

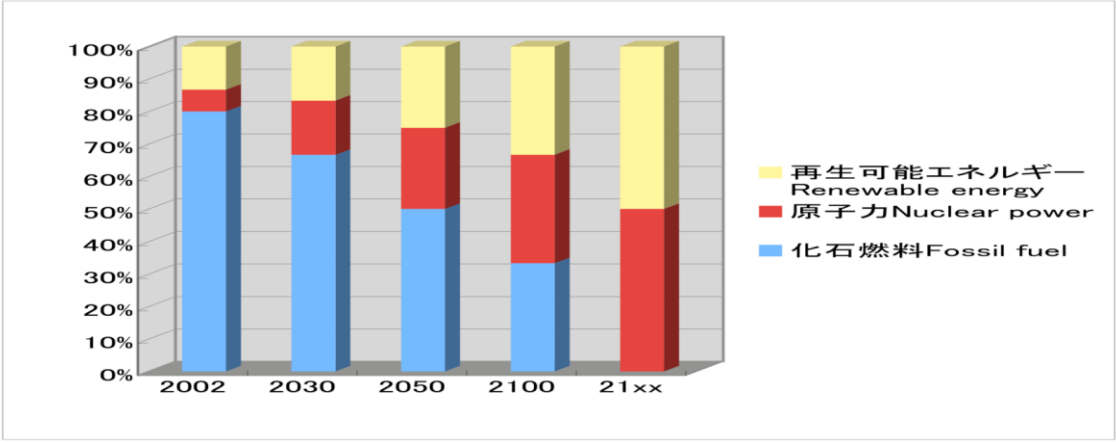
--- target of global mean temperature rise

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

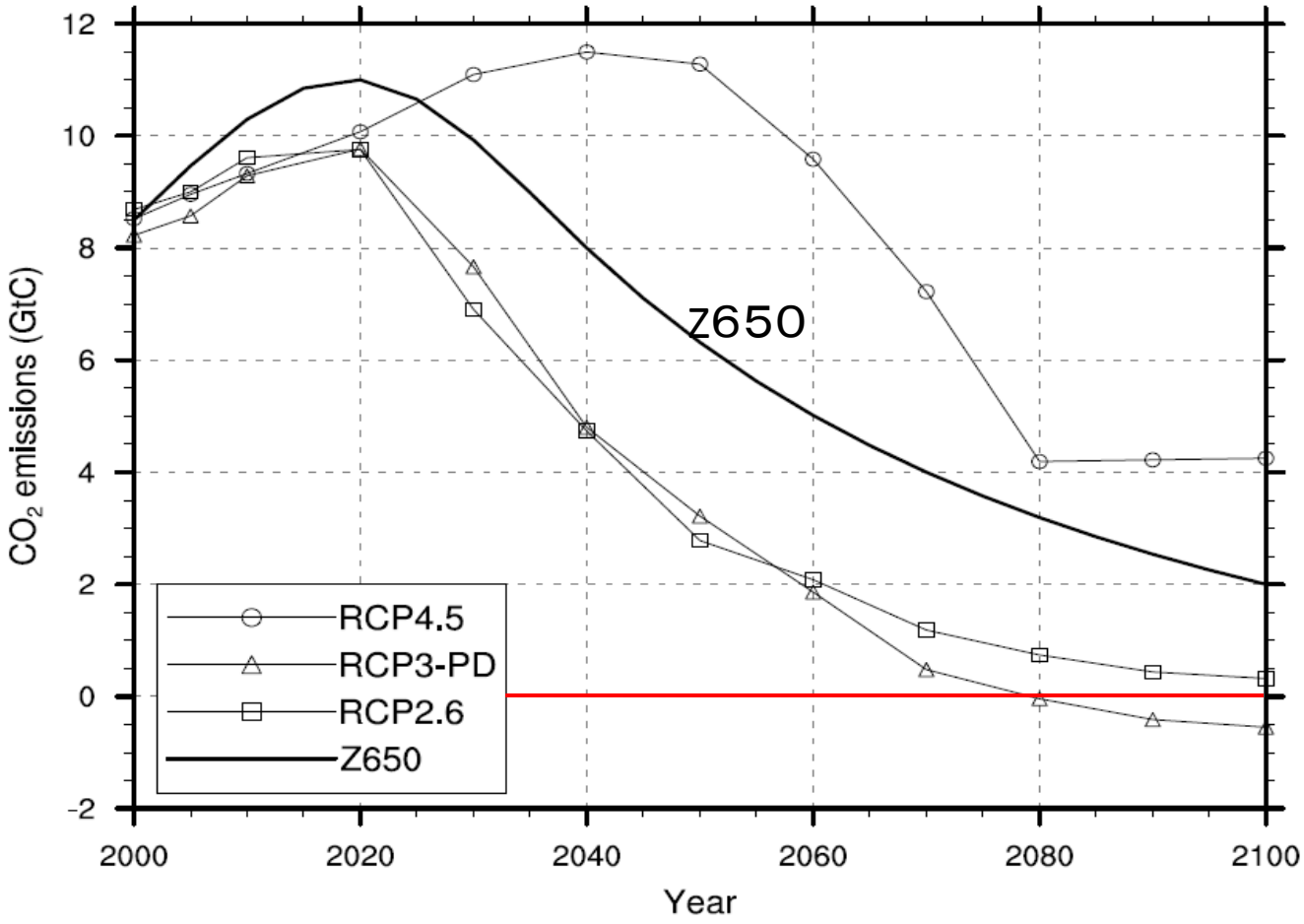
to peak at 2020 (11GtC) according to the trend of recent years

with approximate 2% 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

Comparison between Z650 and RCP Scenarios for AR5

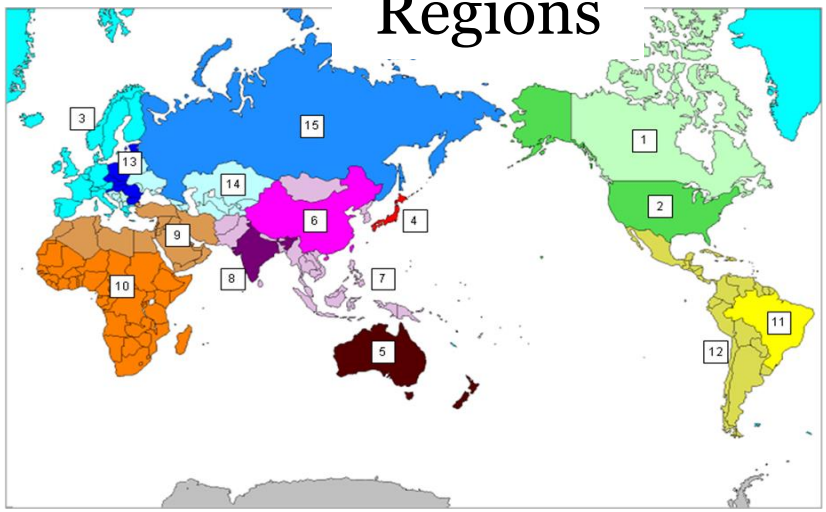


Source: Matsuno et al., "Stabilization of the CO2 concentration via zero-emission in the next century", presented at the CIGS Symposium on Oct. 27, 2009

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.

Simulation conditions - general

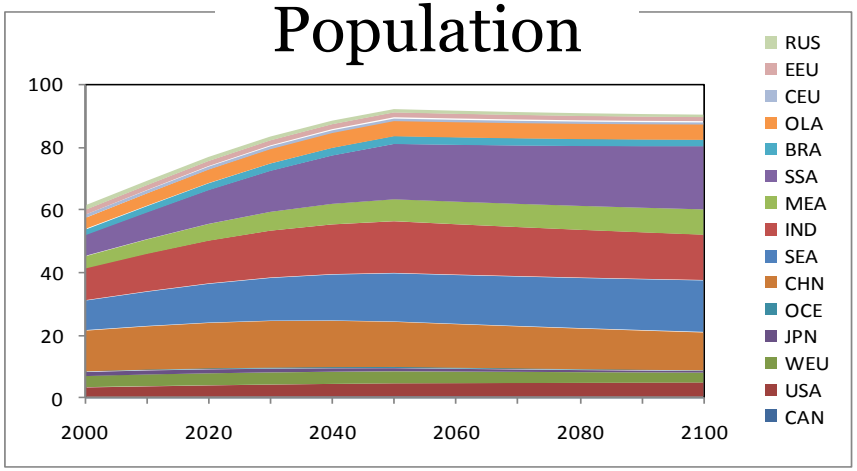
Regions



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

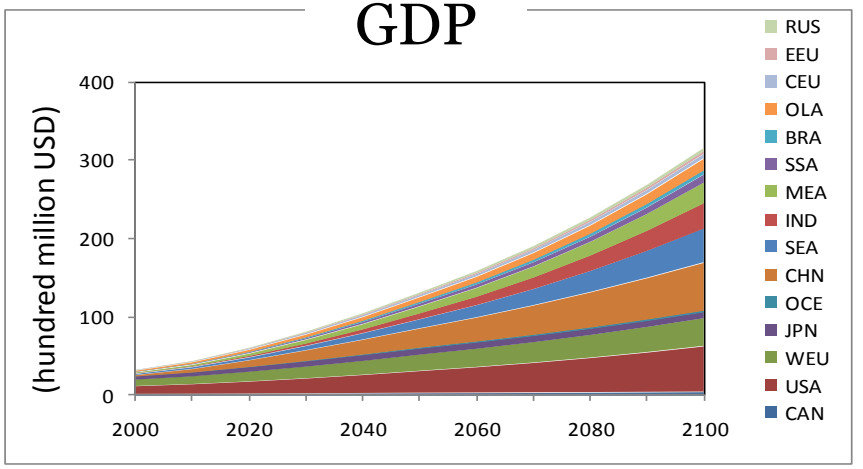
Developing countries
- China, India, ASEAN, Brazil, Latin, MENA, Sub-Sahara

Population



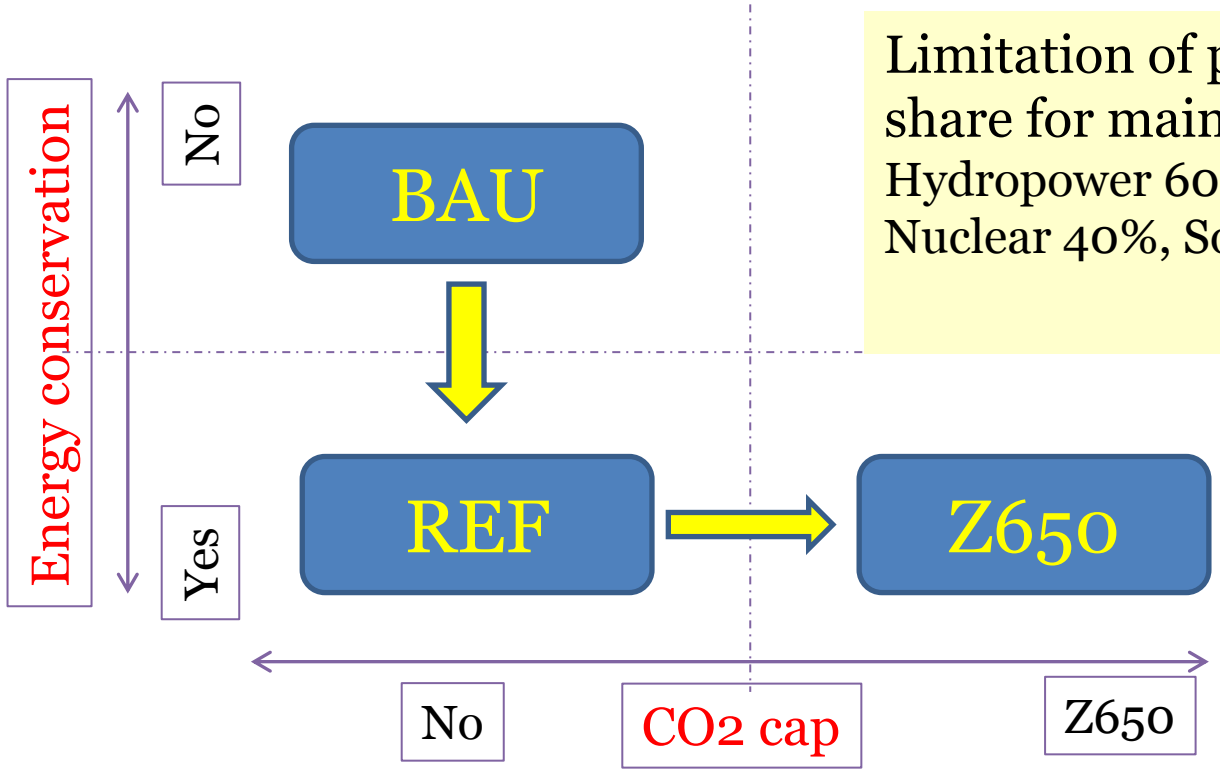
Based on UN medium level projection

GDP



Referred to IEA and IMF estimate

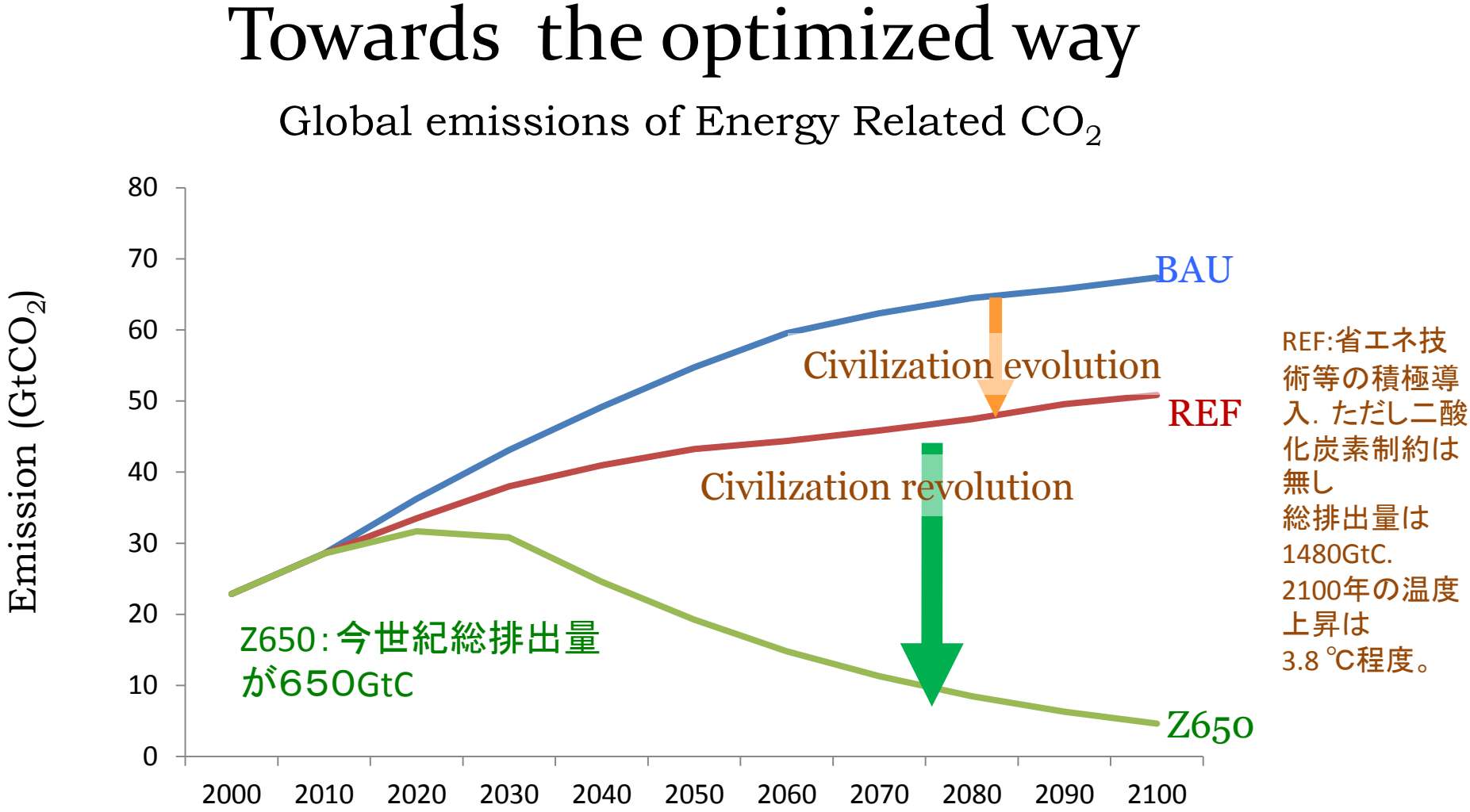
Scenarios for the analysis



Limitation of power generation share for main clean energy:
Hydropower 60%, Biomass 70%, Nuclear 40%, Solar 30%, Wind 25%

Based on the energy conservation and CO2 emission cap, three scenarios were designed and analyzed.

Towards the optimized way



REF:省エネ技術等の積極導入．ただし二酸化炭素制約は無し
総排出量は1480GtC.
2100年の温度上昇は3.8 ℃程度。

Continuance of fossil fuel dependent society without CO2 policy

- CO2 emission

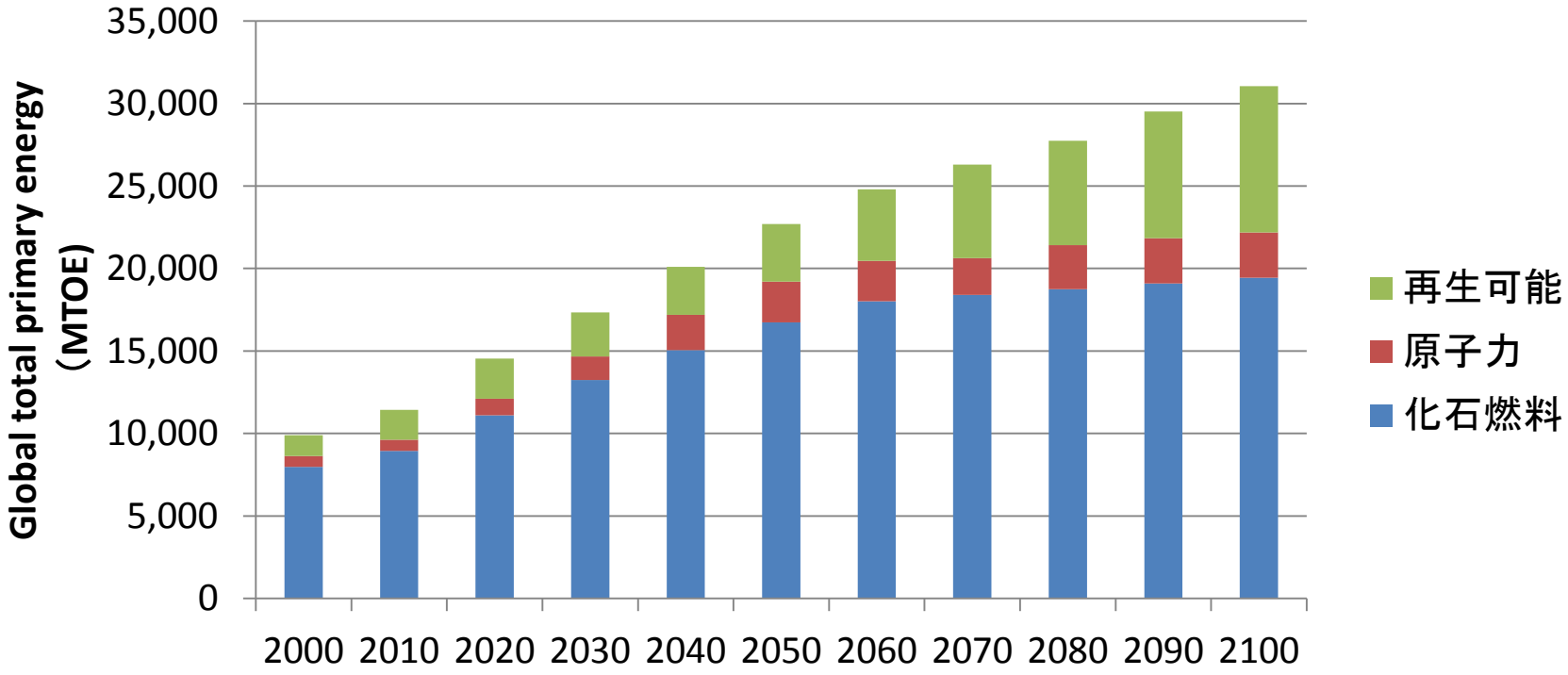
  2050: 54Gt（2.5 times of 1990）

  Cumulative emission：630GtC till 2050, 1480GtC till 2100

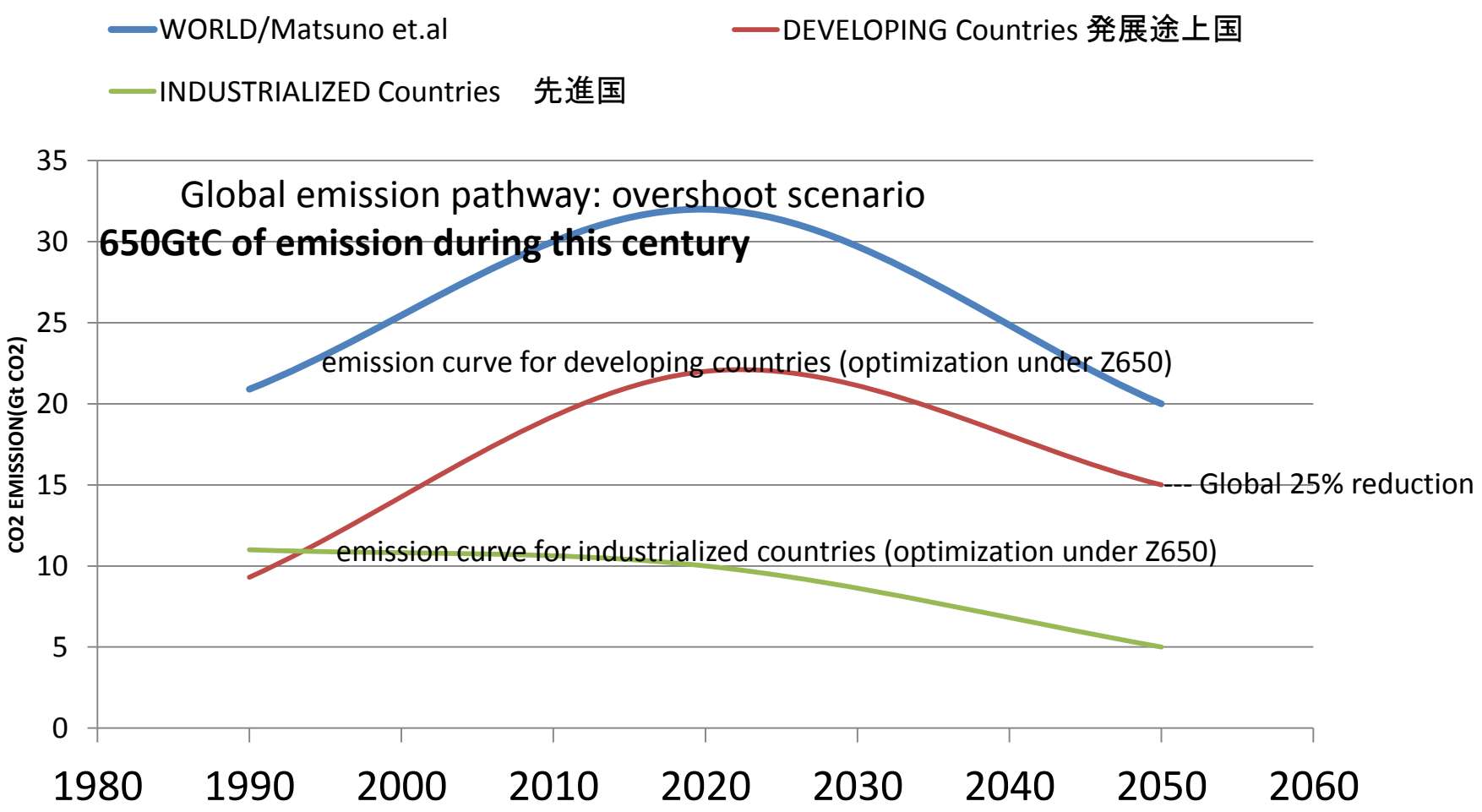
- Resources limitation

  Enough supply of fossil fuel during this century

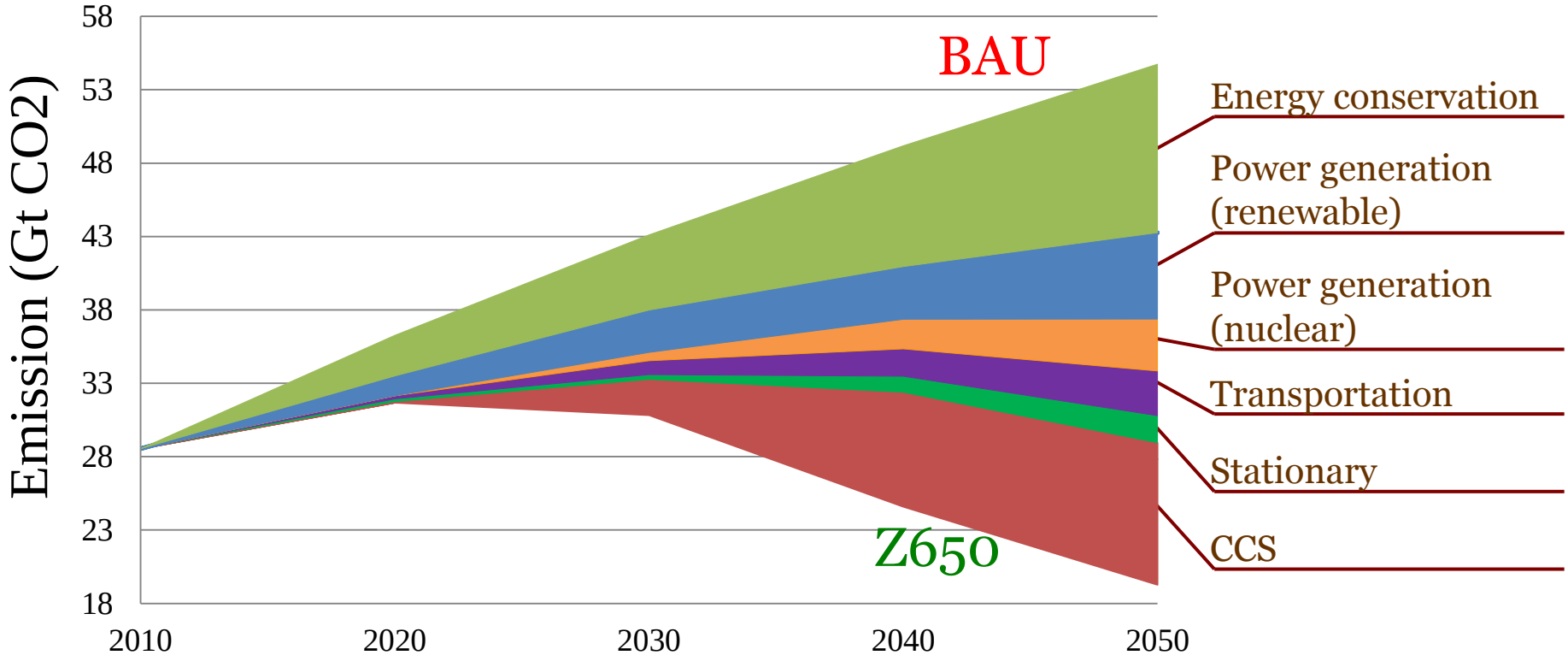
  However, 50 to 70% of the total resources will be used till 2150



「sharable global scenario　Z650」



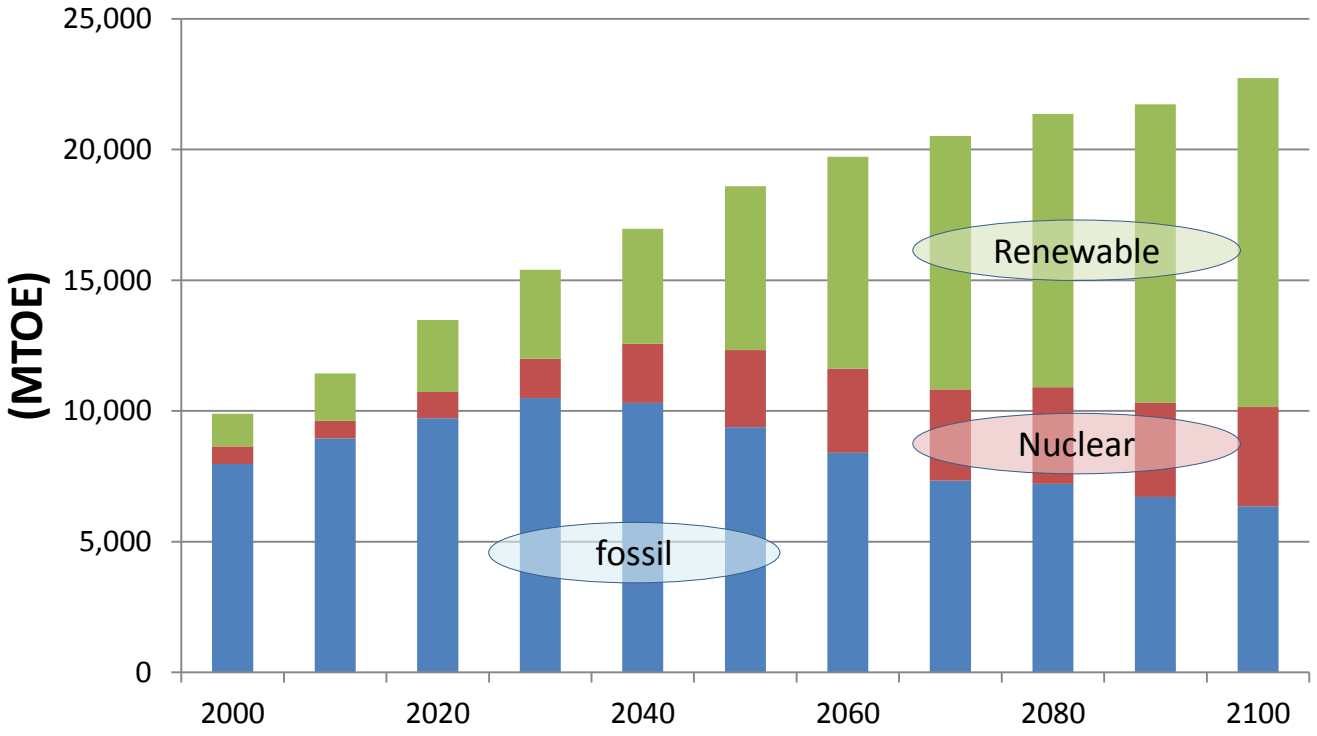
CO2 emission reductions by sector



Energy saving and renewable energy play an important role during the whole period, while nuclear, transportation and CCS play an increasing role during the later stage.

Global Long term Energy Mix

Fossil : Nucl : Renew = 5 : 2 : 3 (2050)
3 : 2 : 5 (2100)



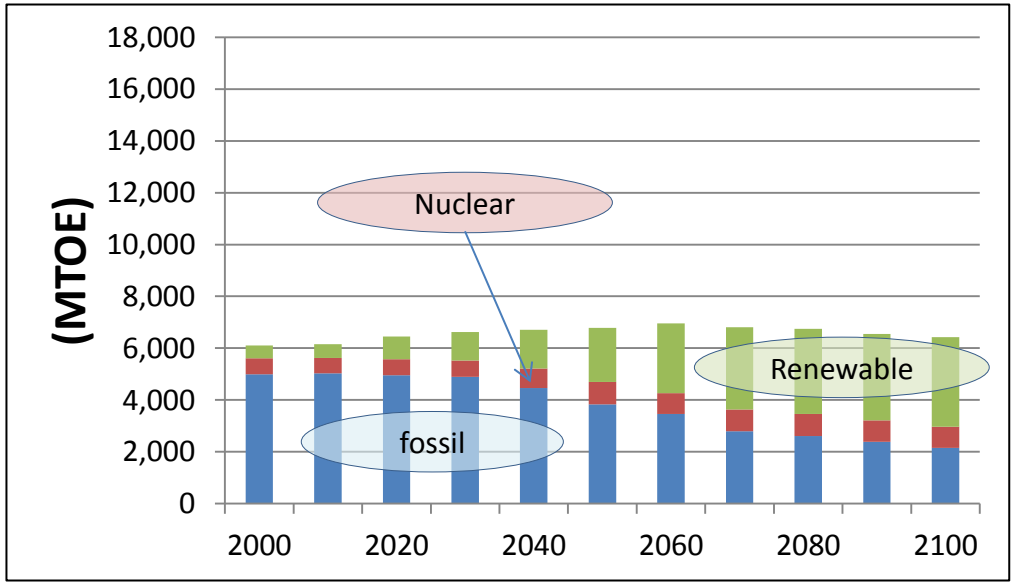
Region Total Primary Energy for Z650

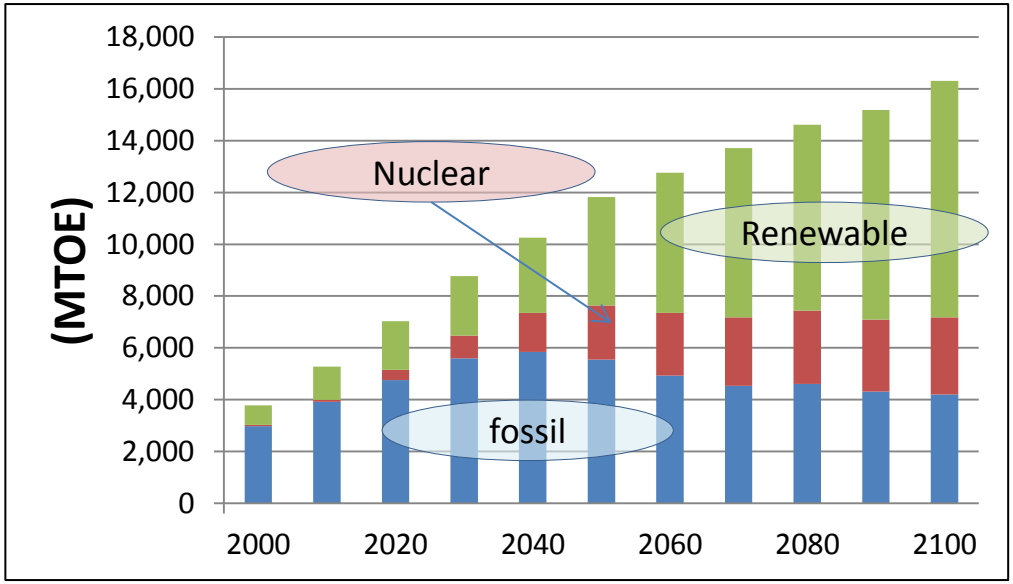
Industrialized countries

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

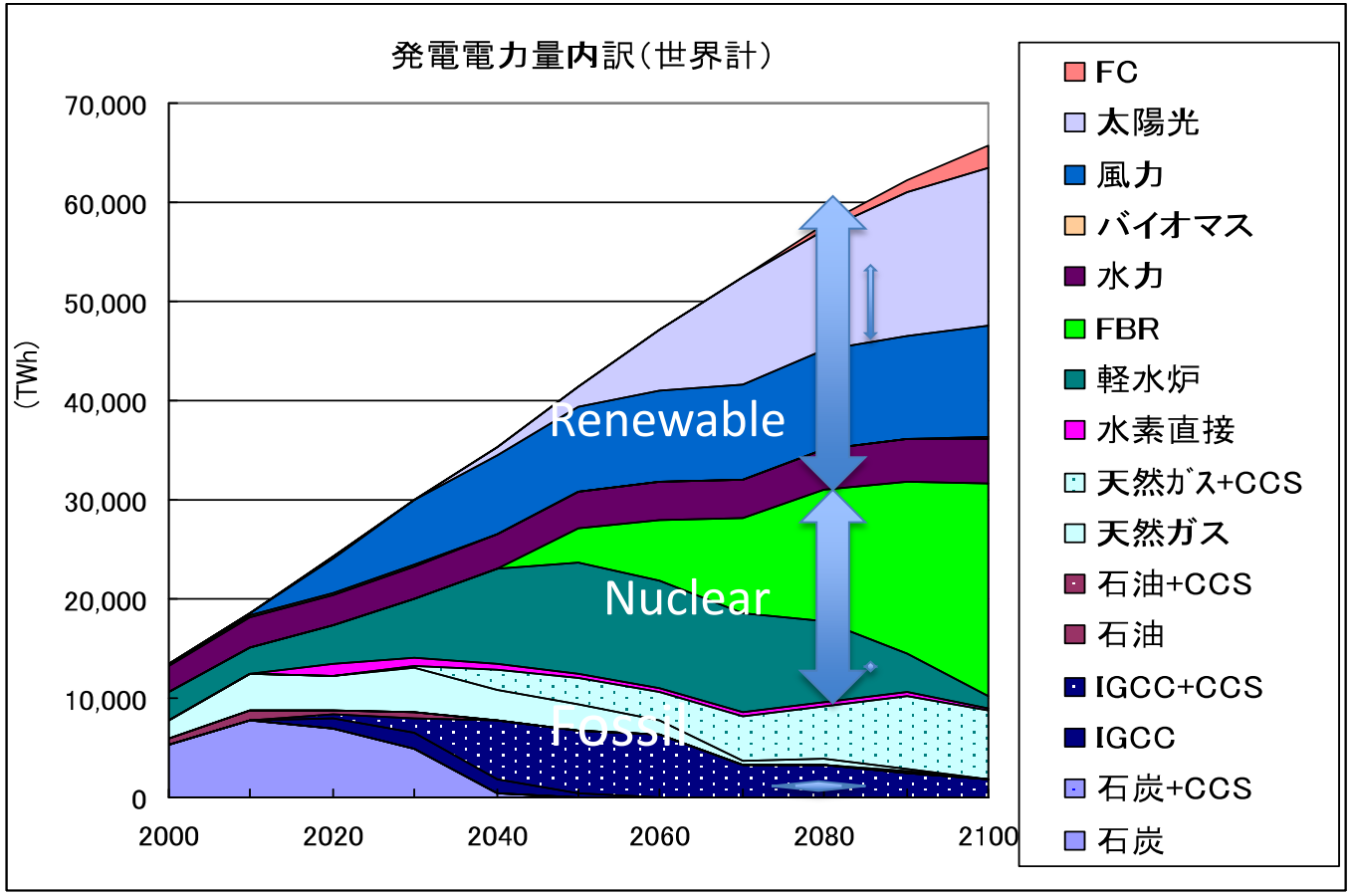
Developing countries

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



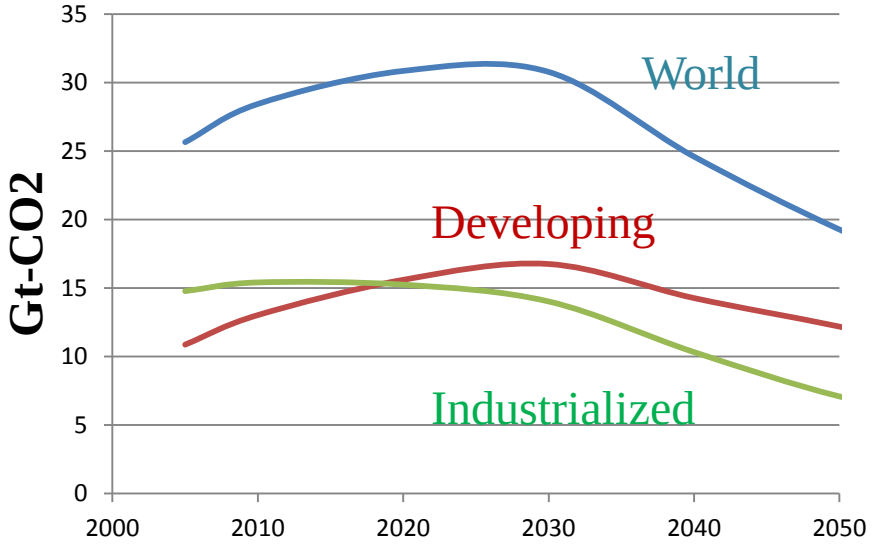


Energy mixture in electricity generation of the world

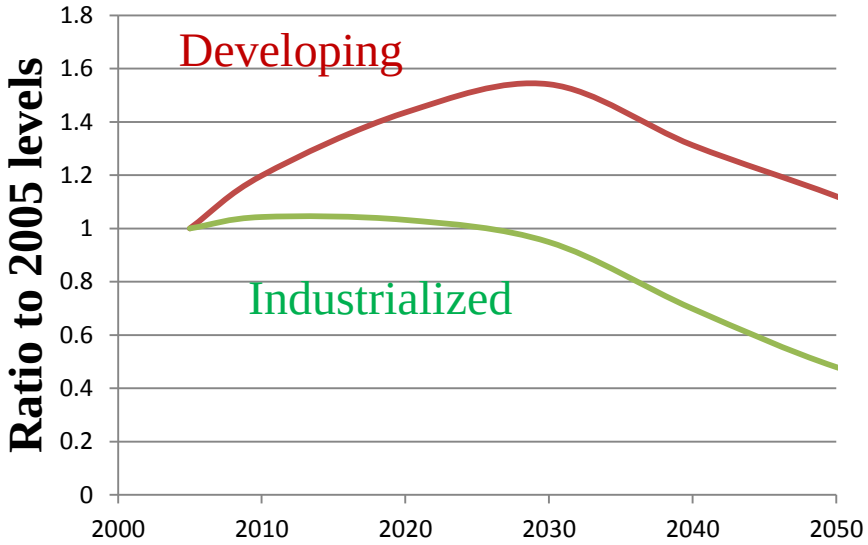


z650

CO2 emissions of Z650 scenario



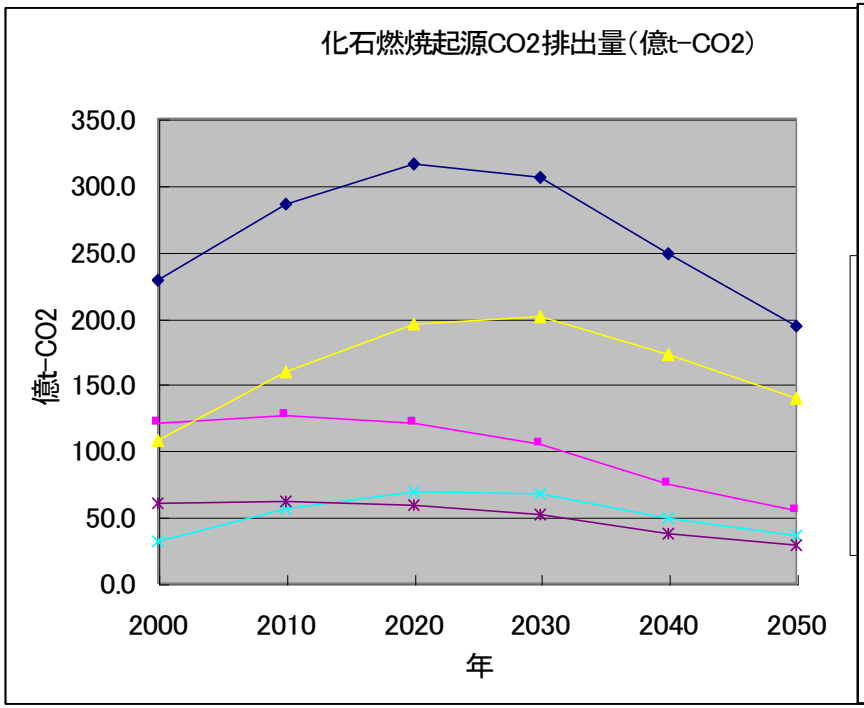
Amount of CO2 emission

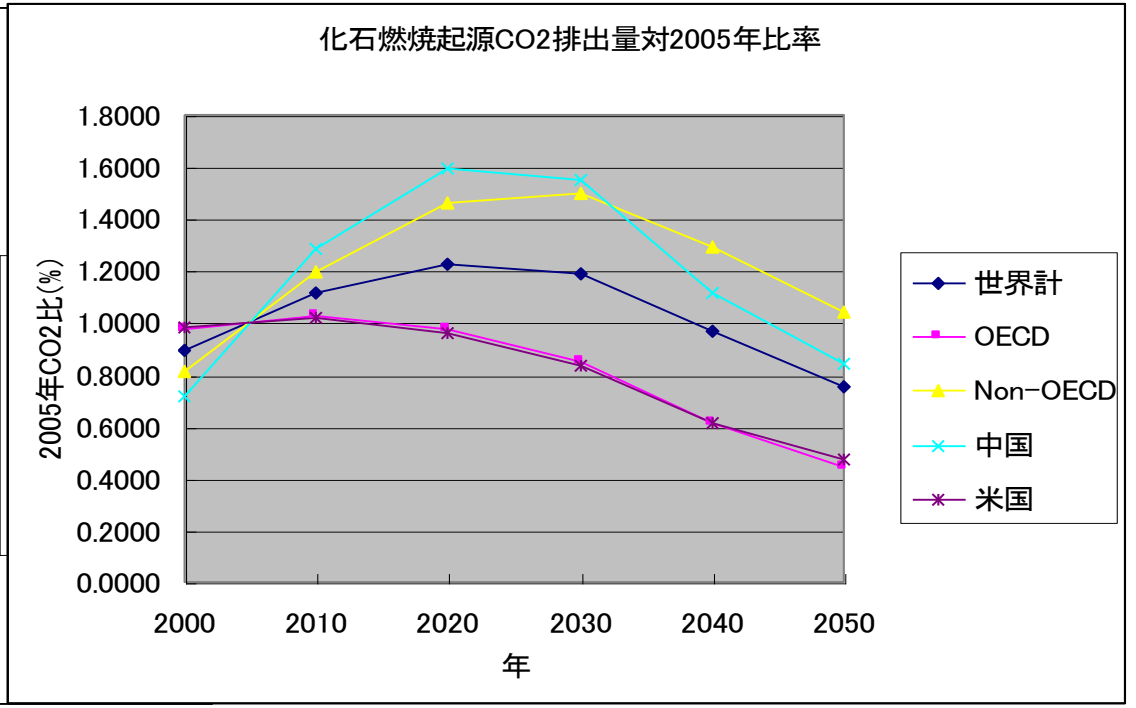


Ratio to 2005 levels

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.

CO2 emissions till 2050
-Global, OECD, Non-OECD, China and USA





To limit the share of nuclear in total power generation less than 60%

エネルギー起源二酸化炭素の排出比 (2005 年を 1.0)

	2030 年	2050 年
世界	1.2	0.75
先進国	0.9	0.5
US	0.9	0.4
EU	0.85	0.5
日本	0.8	0.4
途上国	1.6	1.1
中国	1.6	0.9
インド	1.9	1.7

Result of Global Optimization

Global and regional CO_2 Emissions

Ratios to 2005 levels		2005	2030	2050
REF	World	1.0	1.5	1.6
Z650	World	1.0	1.2	0.75
	Industrialized countries	1.0	1.0	0.5
	US		1.0	0.5
	EU15		0.9	0.4
	Japan		0.8	0.5
	Developing countries	1.0	1.5	1.1
	China		1.5	0.8
	India		1.9	1.6

Different reduction rates are needed depending on economic levels

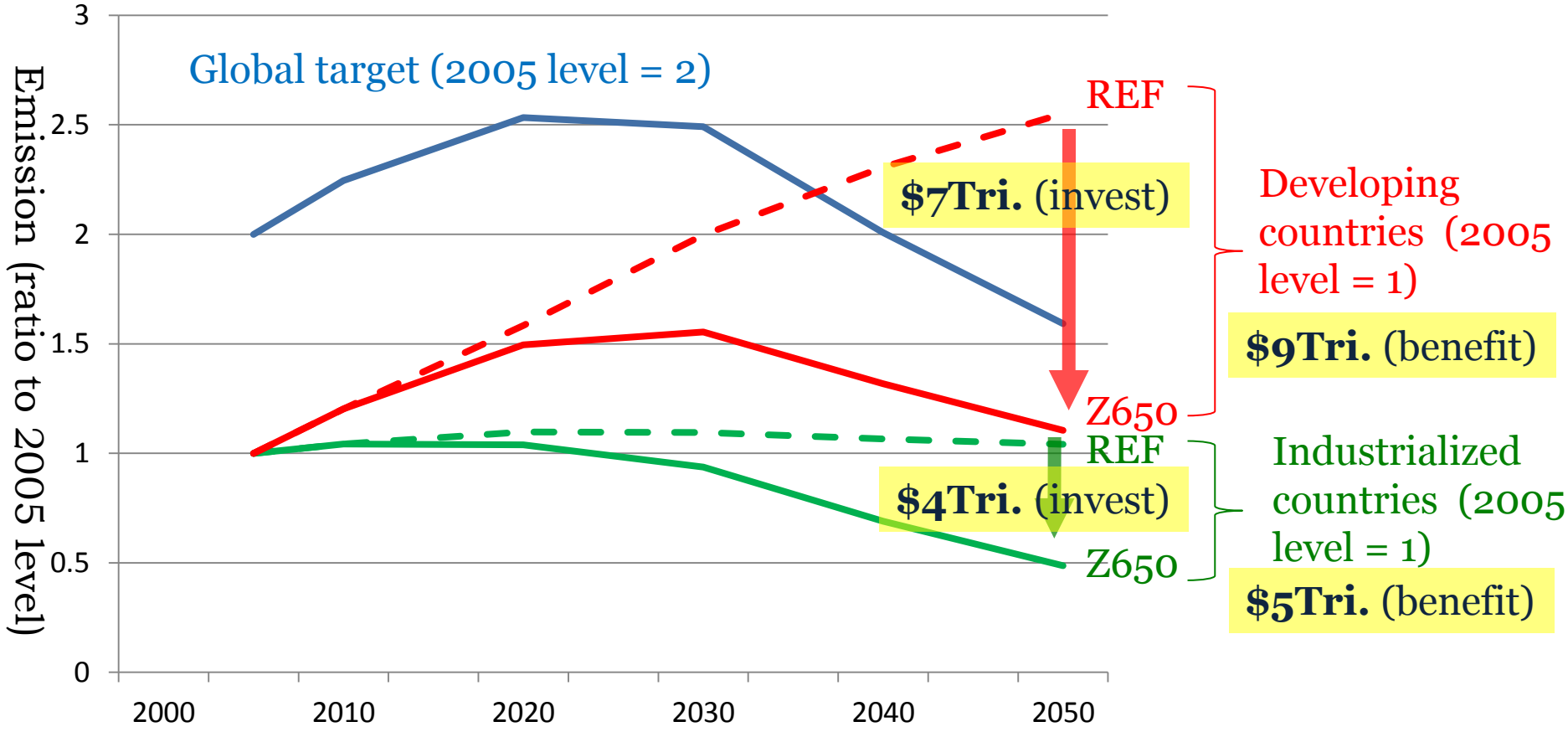
Regional Equitability

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

Additional Investments vs. Fuel Saving Benefits

Global and regional emissions of Energy Related CO_2

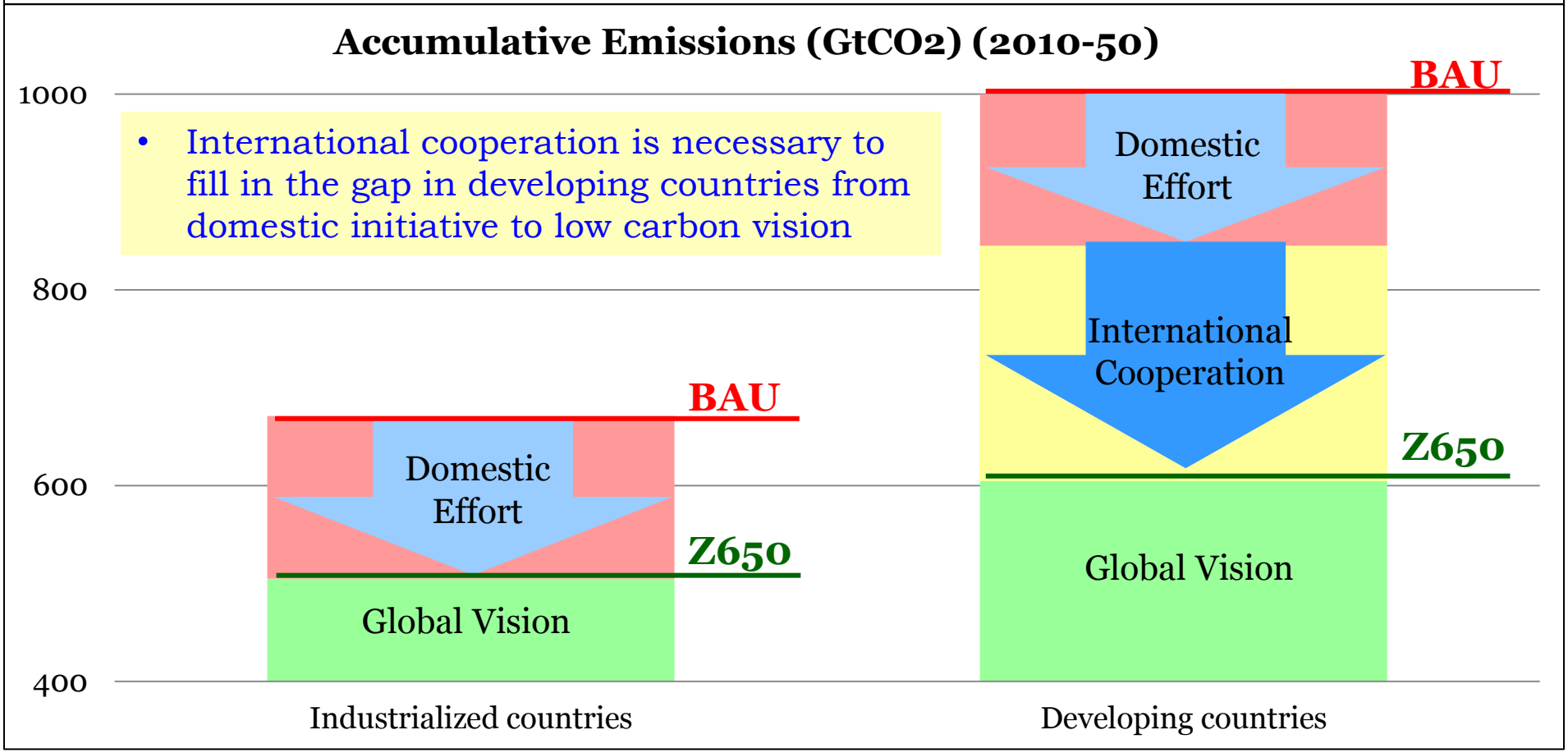


Economic assessment of global optimization

Comparison between cumulative additional investment and energy saving benefit within 2010–50（Trillion USD）

		Add. Invest.	Energy saving	Total benefit
Global optimization	World	11	14	3
	A1	4	5	1
	Non A1	7	9	2
80% reduction in industrialized countries	World	42	10	−32
	A1	37	10	−27
	Non A1	5	0	−5

CIGS Proposal
Practice approach



BAU: traditional development **REF:** energy conservation **Z650:** Low carbon vision

Necessity of Enhancement to the current mechanism (CDM)

--- Contribution to emission reduction(現在CDMで扱う削減量とは桁違いの削減量)

Too little (360MtCO2/yr) to meet the target (248GtCO2 during 40 years)

--- Business approach(追加性の規定を緩和してビジネス主体で)

Necessity of investment additionality not fit for business feasible actions

--- Transaction costs and bottlenecks(効率良い迅速な手続き)

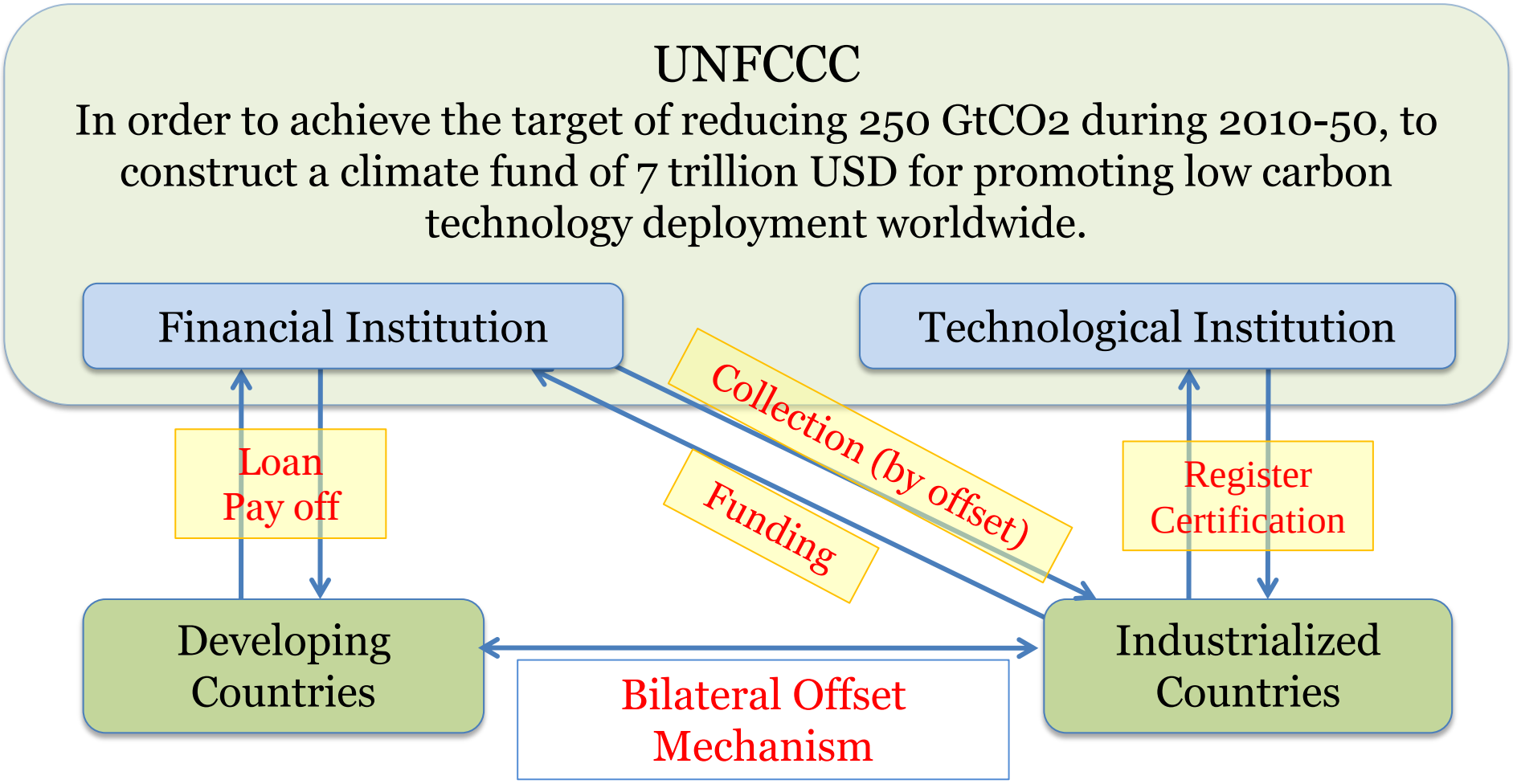
Large costs and complex governance procedures not fit for large scale and rapid applications

--- Financing mechanism(乱高下したカーボン市場、投機性を排除するシステム)

Credit trading system creates speculation

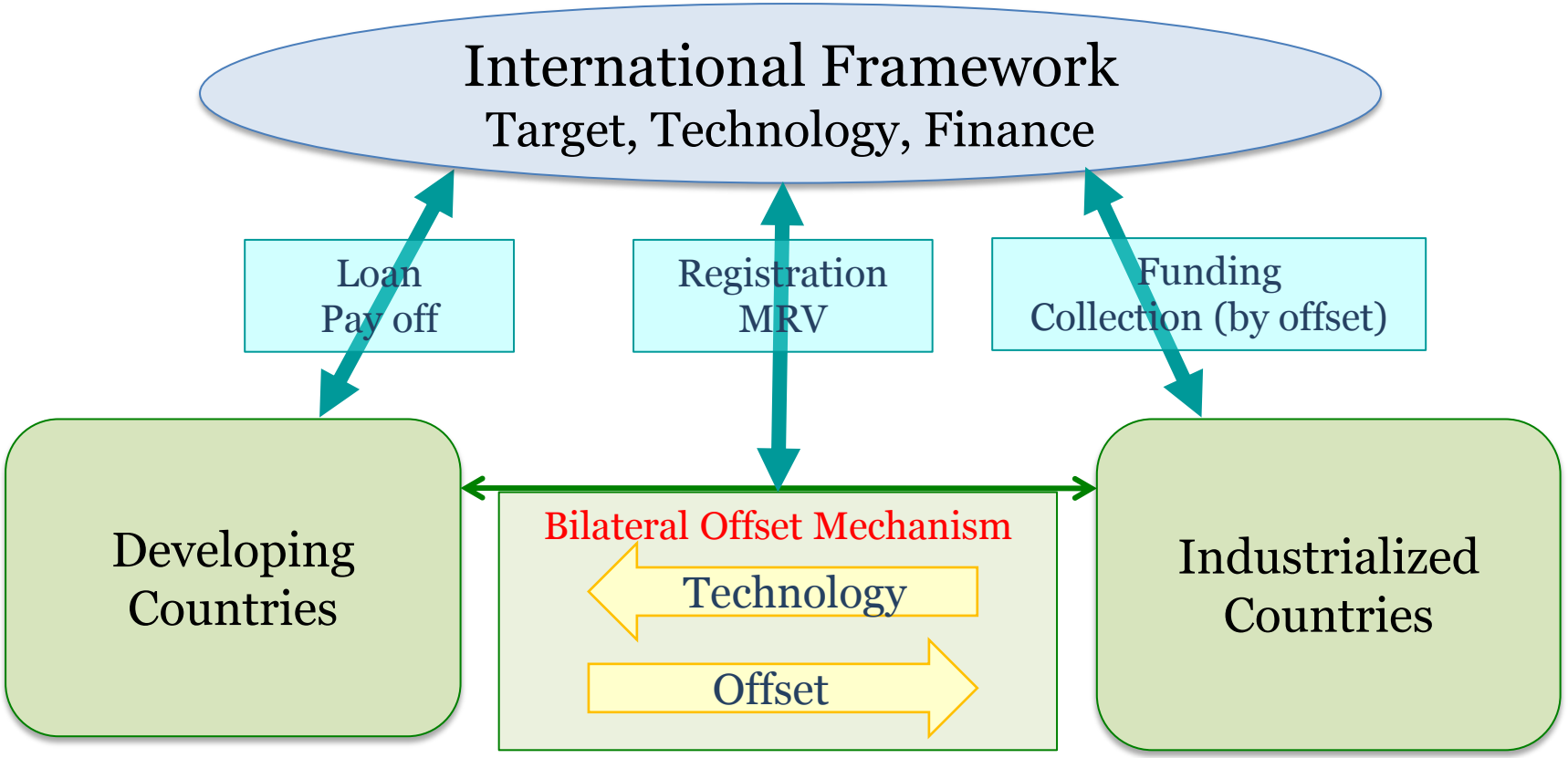
Enhanced international Mechanism

Based on the enforcement of CDM and bilateral offset mechanism
To ensure the incentive to technology



Enhanced international Mechanism

国際協力による低炭素技術の普及、認証認定



To promote the low carbon technology deployment

To provide incentive to low carbon technology development

二国間でのオフセットと技術移転。有償の融資とロイヤリティの確保（トップランナー低炭素技術の認定とライセンスフィーの尊重）、 透明性ある削減実績の認証

20 Innovative energy technology

(promotion of high efficiency fossil fuel utilization)

1. Deployment of IGCC
2. Efficiency improvement of NG fired power generation (combined and triple cycle)
3. Industrial utilization of CCS(membrane, cost reduction of transport and storage)
4. Production technologies of deep sea oil and gas, methane hydrate

(nuclear technology innovation post Fukushima)

5. Deployment of next generation reactor(LWR, FBR)
6. Development of multi purpose HTGR(inherent safety)and process heat supply
7. Treatment of high level nuclear waste

20 Innovative energy technology

(efficiency improvement and stabilization of renewable energy)

8. High efficiency PV and solar thermal power generation
9. Ocean renewable energy (offshore wind・current・tide・wave・OPT)
10. Geothermal

(battery revolution)

11. High performance storage technology (long life and low cost), independent house and building or smart grid
12. Diffusion of FC for automobile
13. High performance Li battery for EV

20 Innovative energy technology

(toward hydrogen society)

14. Hydrogen production using renewable energy
15. Hydrogen storage and transportation technology（82MPa－CFRP compressed tank）

(energy saving of process heat)

16. Direct reduction steel making
17. Innovative production process of cement

(advanced energy saving technologies)

18. AV transmission, superconductive transmission of electricity
19. Innovative device (SiC)
20. LED, organic EL

10 next generation technologies implementing before 2030 and deploying before 2050

1. Olefin synthesis by artificial photosynthesis
2. Thermal power generation using hot dry rock
3. Deployment or solid battery and air-metal battery
4. Next generation solar such as Quantum dot
5. Biomass fuel by micro algae
6. Annihilation of high level nuclear waste using ADS
7. Ocean CCS
8. Superconductive transmission of electricity (Cable)
9. Carbon fixation by vegetation (gene recombination)
10. Next generation power electronics

Summary

Z650 Scenario is proposed by scientific analysis as a shared global emission pathway.

Global energy system optimization suggests a regionally equitable low carbon vision to achieve the Z650 Scenario.
The energy related CO2 emissions of world, industrialized countries and developing countries will be 1.2, 0.95 and 1.54 in 2030, 0.75, 0.48 and 1.12 in 2050, compared with the 2005 levels, respectively.

The low carbon vision is technologically feasible and economically rational.
Additional investments could be covered by the benefits of fuel saving.

Gap between the current national mitigation plans and the low carbon vision occurs in developing countries.
Approach with large scale international cooperation for promoting low carbon technology deployment is necessary.

Current CDM system is not enough to achieve the global low carbon vision.
Enhanced technology-oriented mechanism based on bilateral offset scheme is proposed.

まとめ

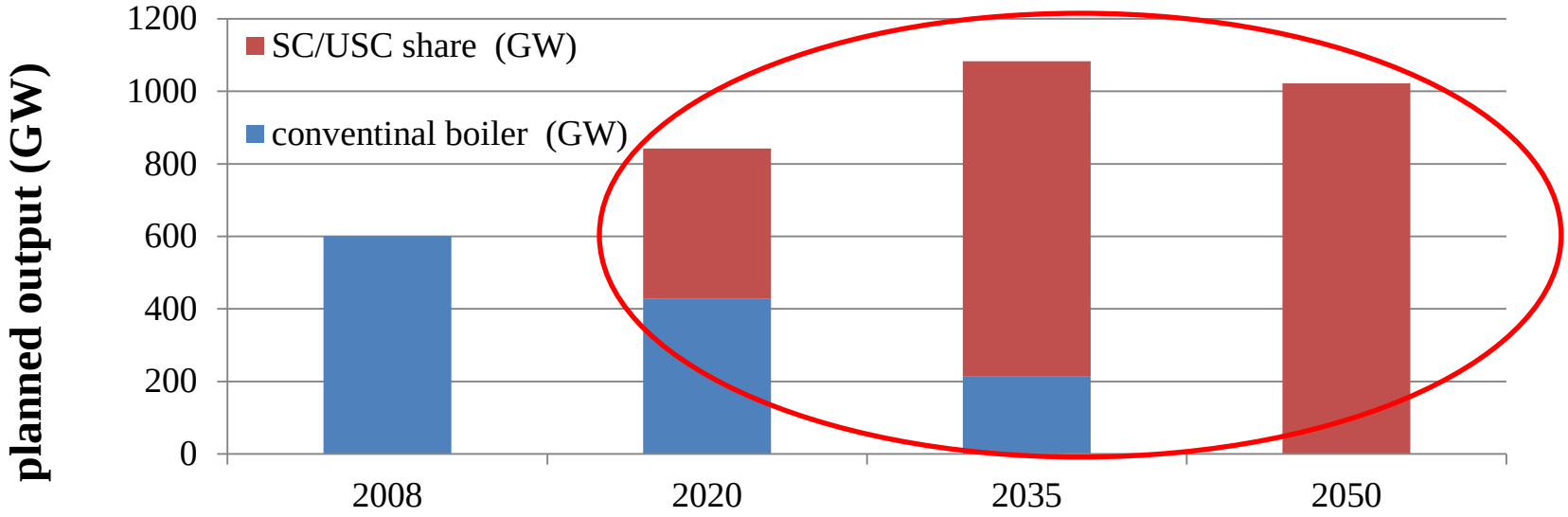
1. 気候変動による深刻な影響を共有し、今世紀温度上昇2℃以内に維持するため，温室効果ガスの実現可能な排出計画（パスウェイ）を共有する。
2. 　オーバーシュートシナリオも考慮し、ゼロエミッションを目指し、今世紀の累積排出量制限を含む世界全体の排出パスウェイを共有する。
3. 世界全体最適化（コストミニマム）により長期エネルギー構成を共有し、公平な役割分担によって達成する。
4. 発展途上国の成長と環境保全を両立させる長期エネルギー構成の実現には先進国の技術的・資金的支援の新しい仕組みが必要である。

Case study: replacing a planned SC/USC with IGCC in China

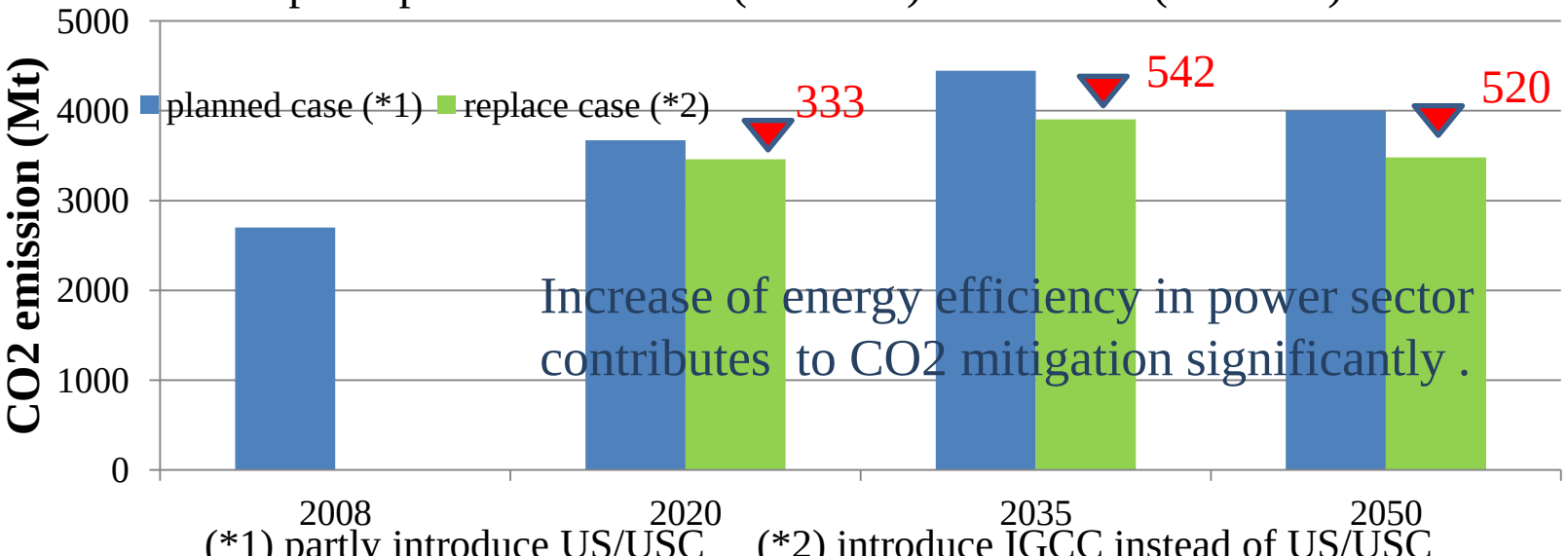
	2008	2020	2035	2050	Remarks
a. Planned electricity TWh	2790	4040	5091	4700	1
b. Total output GW	601	842	1083	1022	
c. Average power generation efficiency %	35.2	37.5	39	40	2
d. Coal consumption Mtoe	681.6	927.6	1122.6	1010	From a and c
e. CO2 emissions Mt	2699	3673	4445	4000	d*3.96
f. Planned share of SC/USC GW		413	868	1022	
g. Replace SC/USC with IGCC GW		413	868	1022	d and e
h. CO2 reduction Mt		333	542	520	Reduction from e

1：Based on the EEI scenario in "China's Low Carbon Development Pathways by 2050"
2：The final target of coal fire plant in EEI scenario is the USC and SC, the thermal efficiency is assumed to be 40%
3：It is assumed that all of the current plant in 2008 will be scraped and rebuilt by 2050 with the same speed
4：The efficiency of IGCC is assumed to be 46% according to the data from Nakoso, Japan
5：The capacity is calculated based on the same operating ratio of dust coal fire plant (about 53%).

Replacing SC/USC with IGCC



Replace planned SC/USC (eff. 40%) with IGCC (eff. 46%)

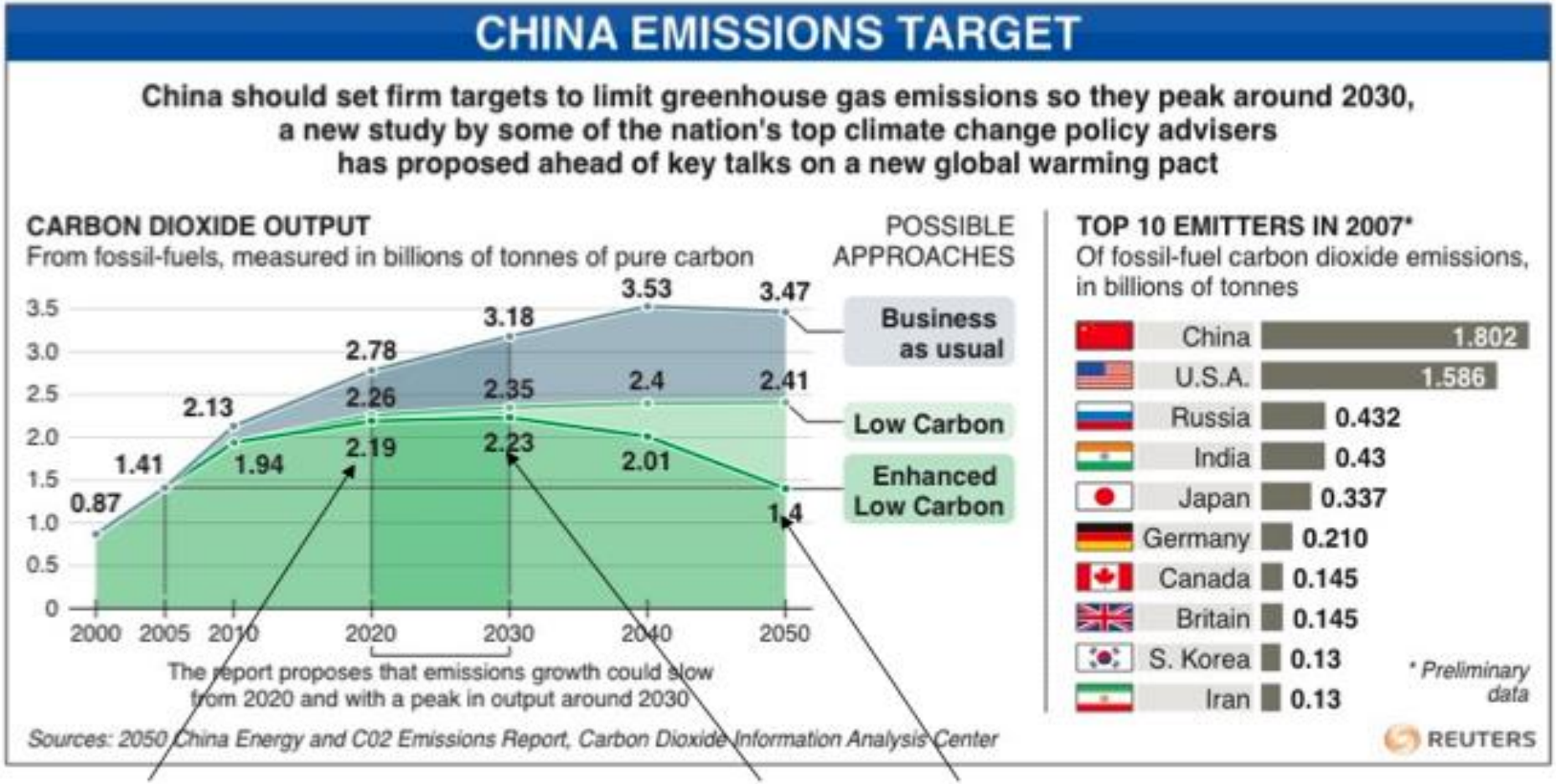


Increase of energy efficiency in power sector contributes to CO2 mitigation significantly .

(*1) partly introduce US/USC (*2) introduce IGCC instead of US/USC

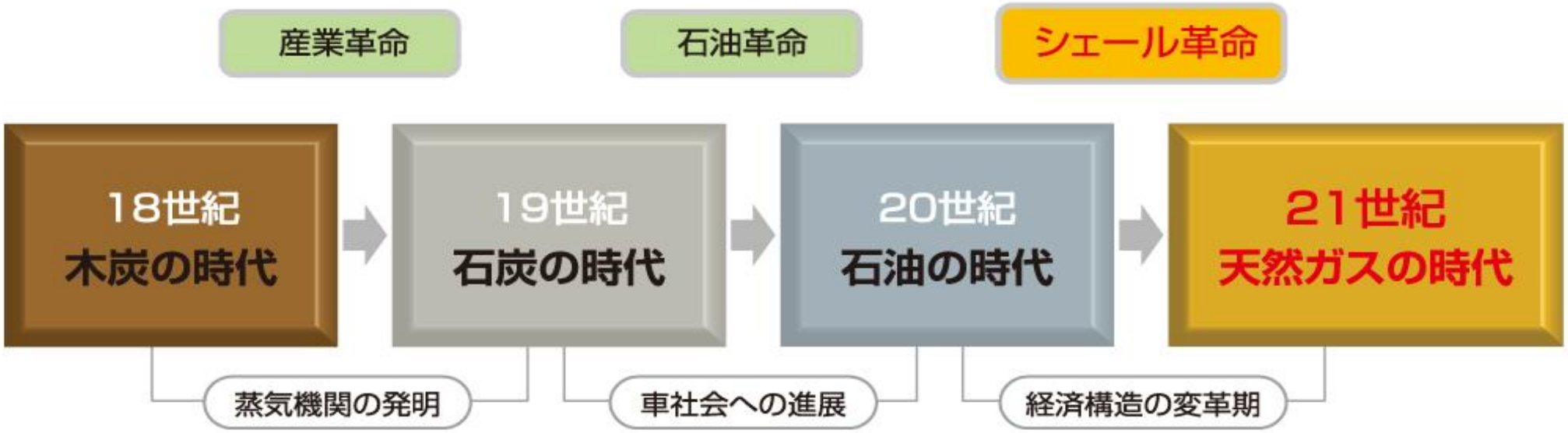
Resent study of reduction target in China 15 August 2009

Emissions in Enhanced Low Carbon scenario are very similar to Z650 case under 60%-80% reductions by Annex I countries.

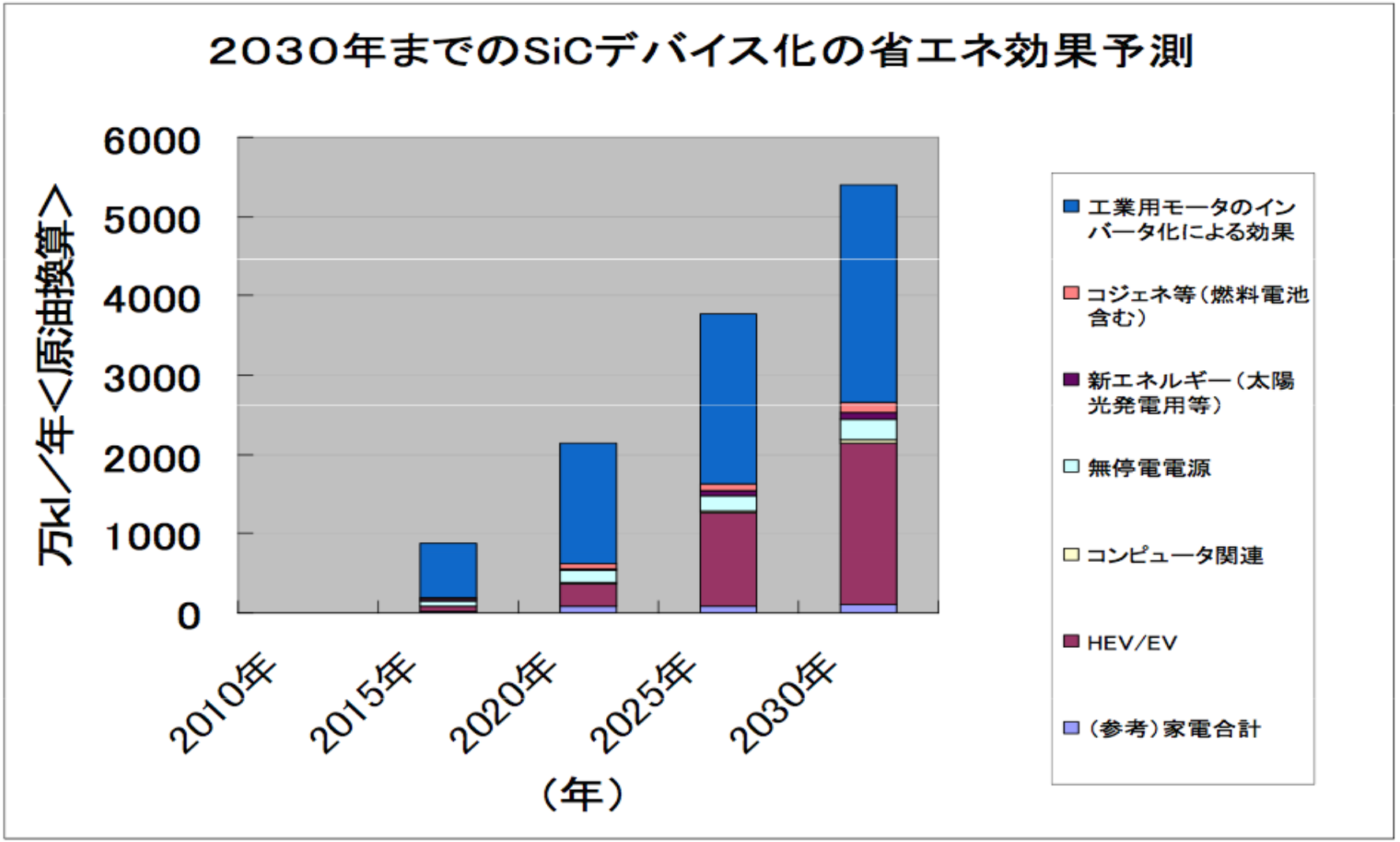


Increase ratio is1.55 in 2020 from 2005 level. 1.58 in 2030 „0.99 in 2050

Koki Maruyama "Policy Implication of Z520, Z650 emission pathways


産業革命
石油革命
シェール革命
18世紀
木炭の時代
19世紀
石炭の時代
20世紀
石油の時代
21世紀
天然ガスの時代
蒸気機関の発明
車社会への進展
経済構造の変革期

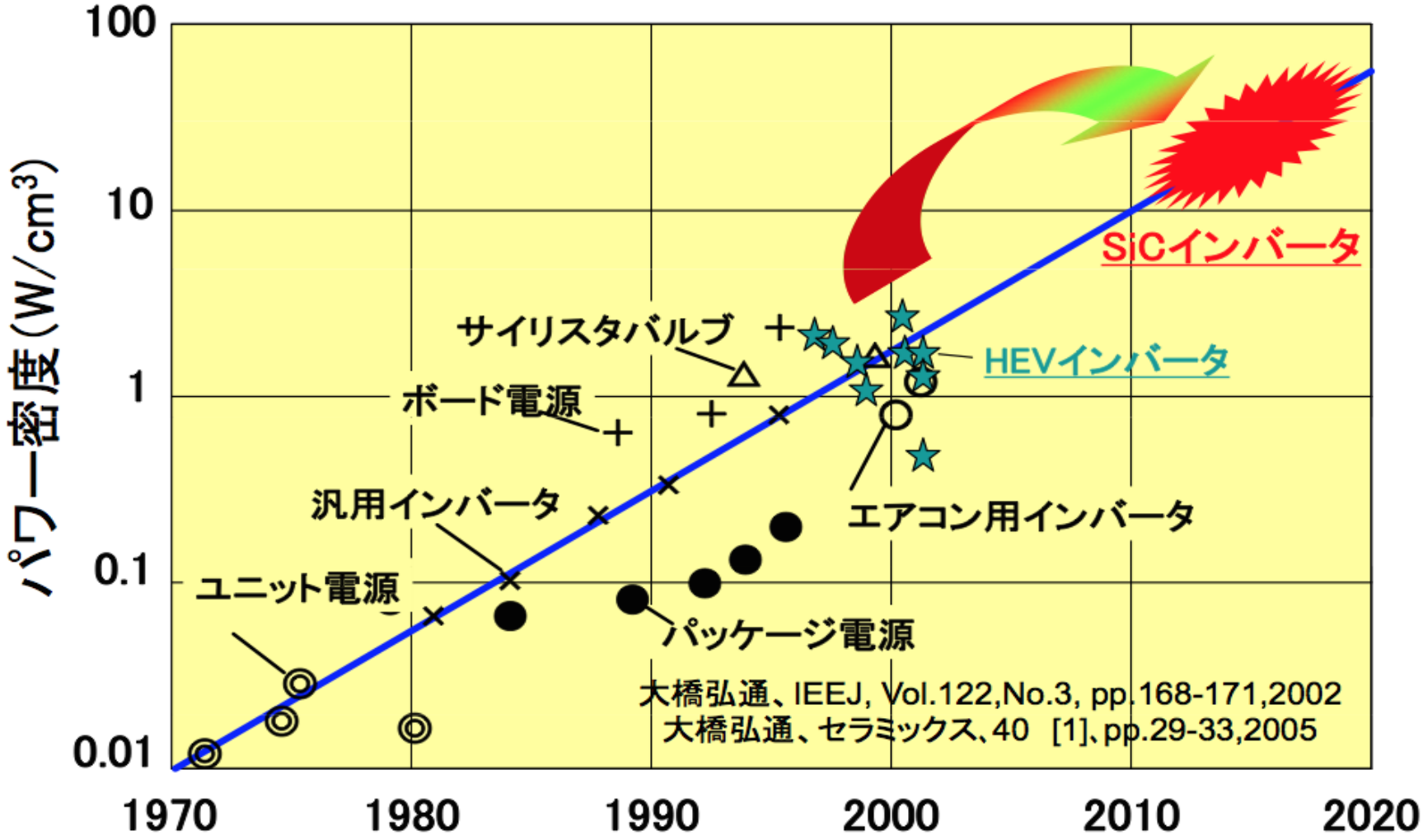
2030年までのSiCデバイス適用による省エネ効果予測



（汎用インバータによるインバータ化効果を入れた場合）

≪次世代省エネデバイス≫（NEDO省エネローリングのFED再委託調査）

電力変換器のパワー密度のロードマップ



電力変換器のパワー密度（大きさの指標）はこの30年で2桁向上した。
変換器のコストパフォーマンスの指標ともいえる。

政策

平成26年6月24日資源エネルギー庁

「水素・燃料電池戦略ロードマップ」をとりまとめ

①家庭用燃料電池や燃料電池自動車等、足下で実現しつつある燃料電池技術の活用を拡大し、大幅な省エネの実現や世界市場の獲得を目指す。（現在～）

②供給側においては海外の未利用エネルギーを用いた水素供給システムを確立するとともに、需要側では水素発電の本格導入も視野に入れ、エネルギーセキュリティの向上を目指す。（2020年代後半の実現を目指す）

③再生可能エネルギー等を用いたCO2フリーの水素供給システムの確立を目指す。（2040年頃の実現を目指す）

乗用車の将来（IEAの予測）