Global Vision against Climate Change

-Keynote Presentation at Japan China Workshop-

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There has been much movement related to climate change and energy policy during the past year. First, IPCC working groups 1 to 3 released the results of the 5th Assessment Report (IPCC AR5) from September of last year to April of this year. Last week the Synthesis Report was released that starkly presented the serious impacts of climate change and documented the relationship between the cumulative emissions of greenhouse gases and rising temperature. The probability of overshoot scenarios was acknowledged and the importance of CCS and nuclear power for achieving these scenarios was stressed. Furthermore, the Kyoto Protocol was negatively evaluated as an international framework for controlling climate change.

Next, the shale gas revolution (also shale oil) has impacted international energy supply by driving reduction in natural gas prices and leading to declines in the price of coal and oil. One consequence was the increase in coal fired power generation in the EU (maybe temporary as UK coal fired plants are shutting down as a result of the Large Combustion Source Directive and Germany may be temporary as well). Also, the negotiations on a new framework for international measures to address climate change for adoption at COP21 in 2015 in Paris has reached agreement on the new Pledge and Review approach for voluntary setting and reporting on emission reduction plans from 2020. Major countries and regions have announced new action plans. The EU has set a new target for 2030 of a 40% reduction relative to 1990 while the United States has prohibited the construction of new coal fired power plants (perhaps announced new emissions standards that effectively prohibit the construction of new coal fired power plants without CCS) and announced a 30% reduction target for power plant carbon dioxide emissions by 2030. China has gone beyond its previous announcement of reduction of emissions relative to unit GDP by announcing that it would move towards setting a target for reduction of total emissions (perhaps "announcing it will reach peak CO2 emissions by 2030". A new Basic Energy Plan for Japan has received cabinet approval with nuclear power and coal fired power for base load, LNG for mid-load and renewable energy (wind, solar, etc.) for peak load.

Based on these global and national movements, the issues for today's workshop are as follows:

1) What are appropriate shared constraints and pathways for long-term emissions of greenhouse gases for controlling climate change?
2) Given constraints on emissions, what are the best approaches for carbon dioxide emissions plans for (our?) countries based on long-term energy supply structures?
3) What is the (appropriate?) balance between cumulative investments for energy infrastructure and merits?
4) What are the innovative technologies that low carbon societies should use in the long term for implementing their energy infrastructures and mechanisms for deployment?
5) Based on the IPCC AR5 assessment report, is it possible for Japan and China to share and collaborate on implementation of medium to long-term energy visions?
6) Can Japan and China support growth and environmental protection for Asia based on a shared vision?

7) Can Japan's medium to long-term energy infrastructure provide a model for industrial societies?

Here, I will introduce one example of an approach to 1) to 4) investigated by the Canon Institute for Global Studies (CIGS) Energy 2050 Working Group, "Globally Sharable Long Term Vision against Global Warming". This vision statement is based on an alternative to conventional emissions pathways in combination with globally optimized energy infrastructure, development of low carbon technologies and a platform for deployment.

The vision is based on a global greenhouse gases emission pathway that constrains total carbon dioxide emissions to 650 GtC during this century while allowing overshoot followed by zero emissions as shown in Figure 1. Meteorological analysis based on the latest findings from IPCC AR5 has confirmed that this scenario has the potential for keeping temperature rise within 2ºC in the long term.

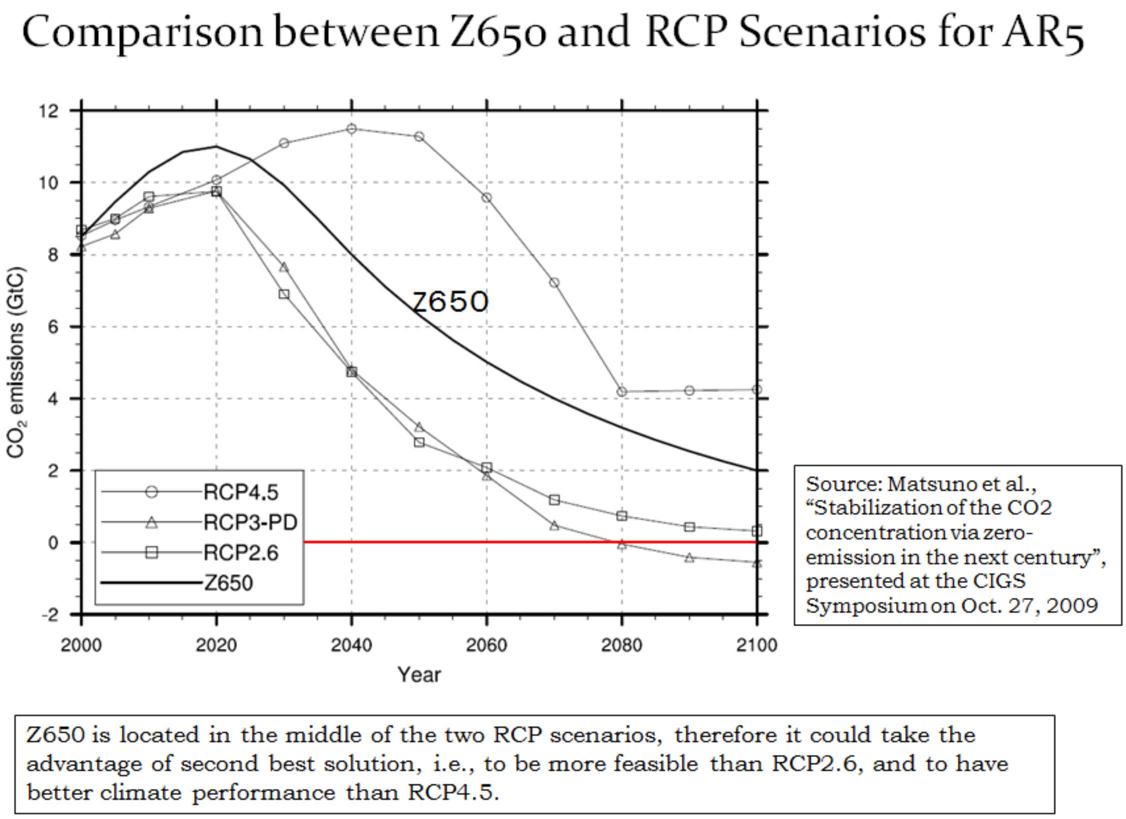

Figure 1 Z650 global emissions pathway

Based on the emission constraint conditions of the Z650 scenario, the emissions of energy related CO2 (Figure 2) that comprise most of the anthropogenic greenhouse gas are reduced and a long term energy vision was developed based on a global energy system optimized for total cost minimization.

The results of the analysis showed that in contrast to the BAU case without measures to control climate change as shown in Figure 3 where fossil fuel continues to play a central role, industrialized countries will maintain primary energy consumption levels while gradually shifting from a fossil fuel dominated energy mix to renewable energy. Developing nations will continue to greatly increase energy consumption with the increase being supplied primarily by renewable energy and nuclear power (Figure 4). Global primary energy proportions for fossil, nuclear and renewable energy will shift from 7:1:2 in 2030 to 5:2:3 in 2050 and 3:2:5 in 2100 showing a shift towards low carbon (Figure 5).

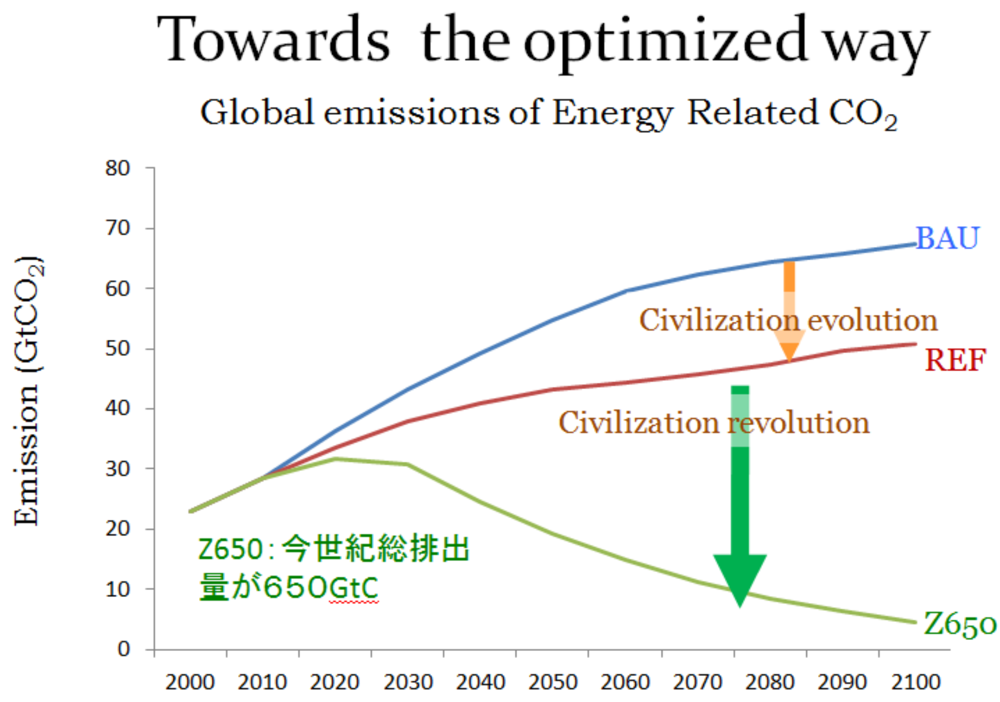

Figure 2 Emissions scenario for energy related CO2
(Z650: Total emissions during this century of 650GtC)

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

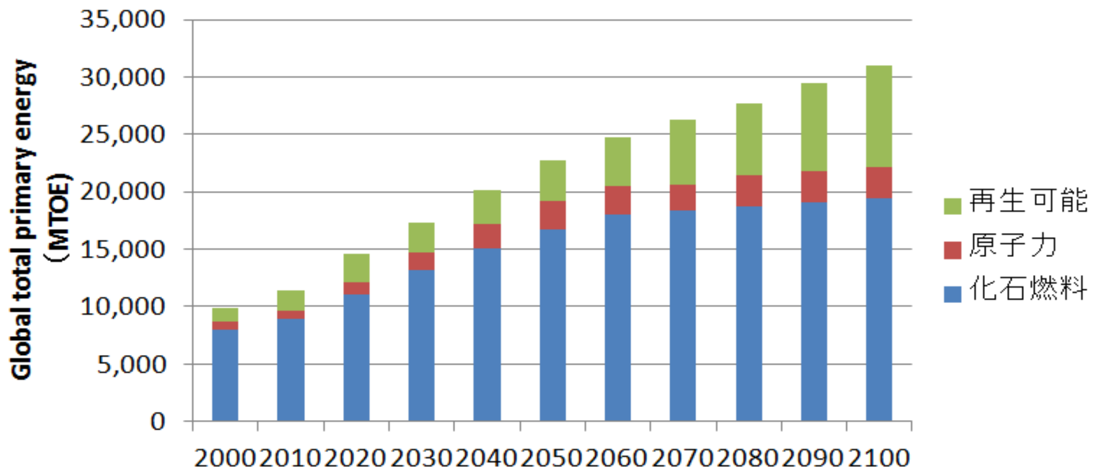

Figure 3 Global energy mix for BAU scenario

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

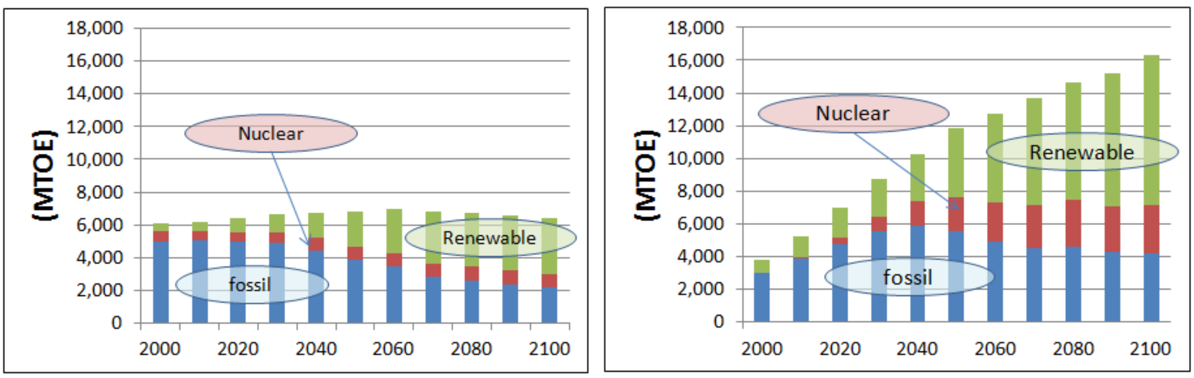

Figure 4 Regional energy mix for Z650 scenario

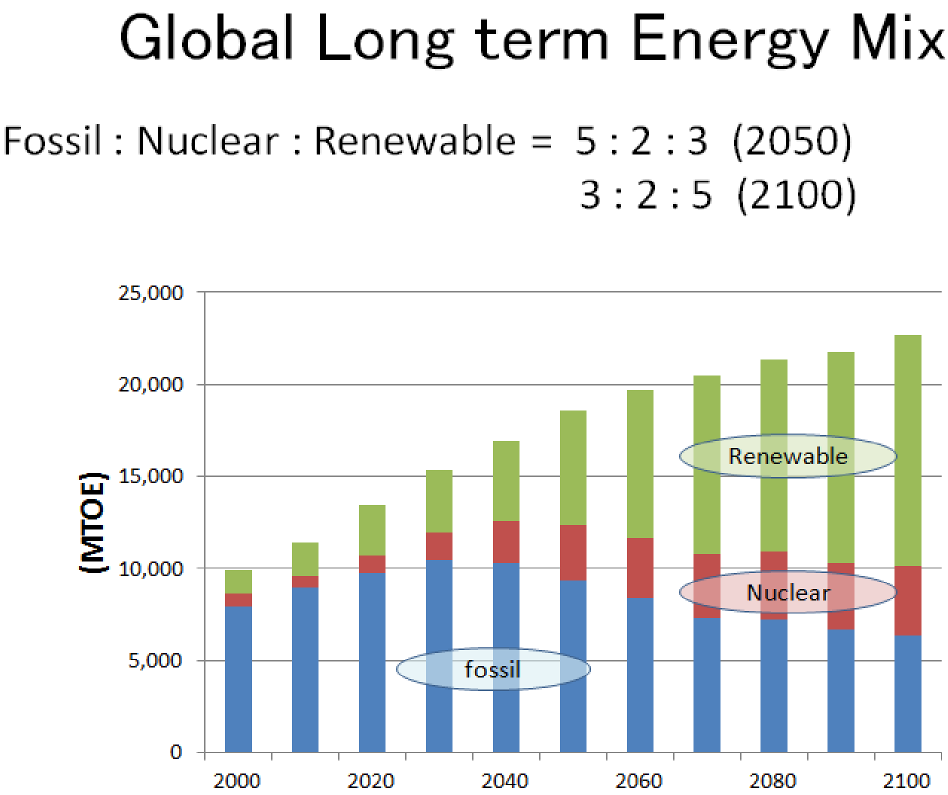

Figure 5 Global energy mix for Z650 scenario

Assuming achievement of the globally optimized energy vision, emissions of energy related CO2 for global, industrial nations and developing nations in 2030 would be 1.2, 0.95 and 1.54 times 2005 levels and in 2050 would be 0.75, 0.48 and 1.12 times 2005 levels (Figure 6) with emission pathways (Figure 7) for each country/region based on the stage of economic development. Balance between regions would be maintained.

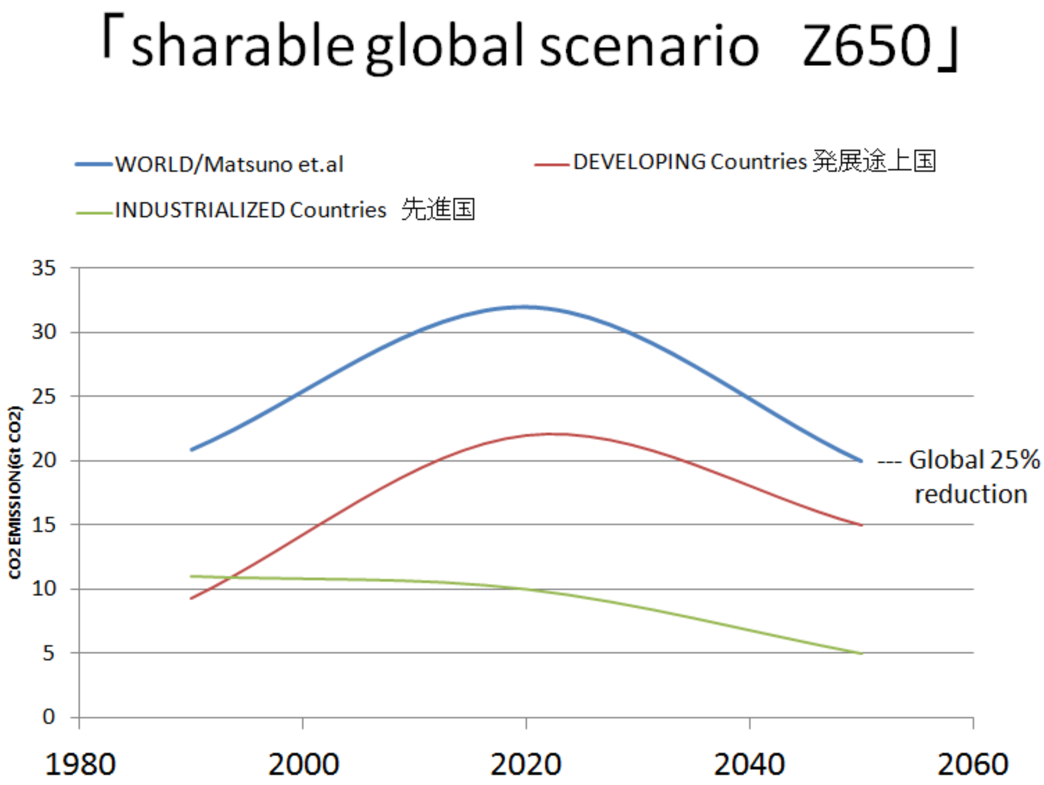

Figure 6 Global and regional emission pathways for Z650

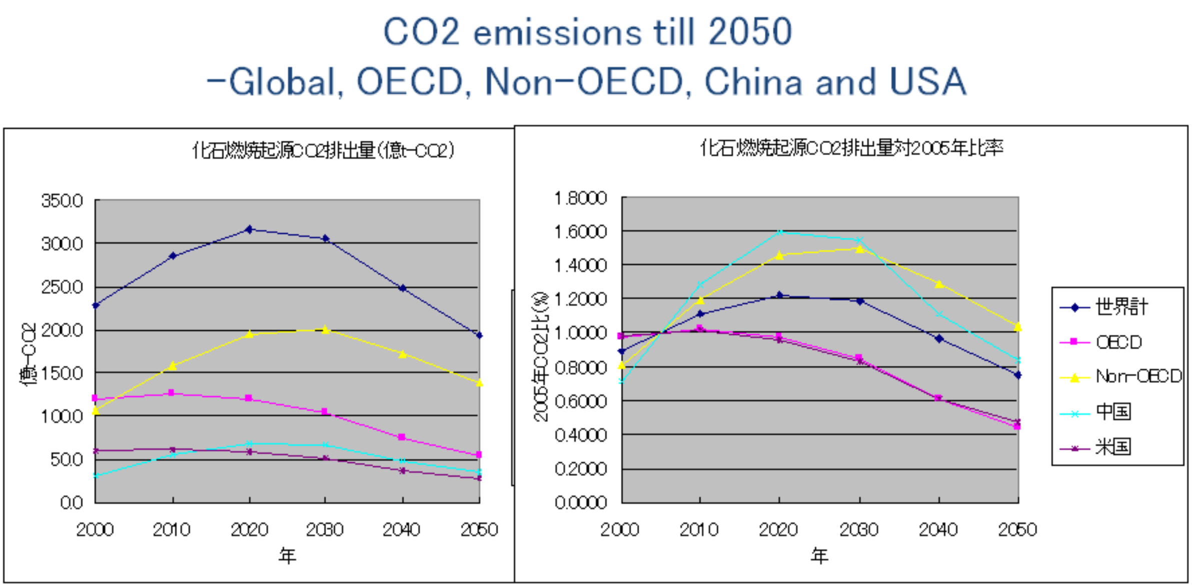

Figure 7 Key national and regional emission pathways for Z650

(Left: Fossil fuel combustion CO2 emissions (100 million tons), Right: Fossil fuel combustion CO2 emissions relative to 2005 levels)

Achievement of this low carbon vision compared to the scenario without CO2 emission constraints for industrialized and developing nations would require additional investments that would be covered by the energy conservation benefits from reducing fossil fuel consumption (Figure 8). Table 1 shows the results for analysis of 80% emission reduction in 2050 relative to 2005 for industrialized nations. The benefits exceed the cost and show the economic feasibility of the vision.

Table 1 Economic assessment of global optimization and regional optimization

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
	Annex 1	4	5	1
	Non Annex1	7	9	2
80% reduction in industrialized countries	World	42	10	-32
	Annex 1	37	10	-27
	Non Annex1	5	0	-5

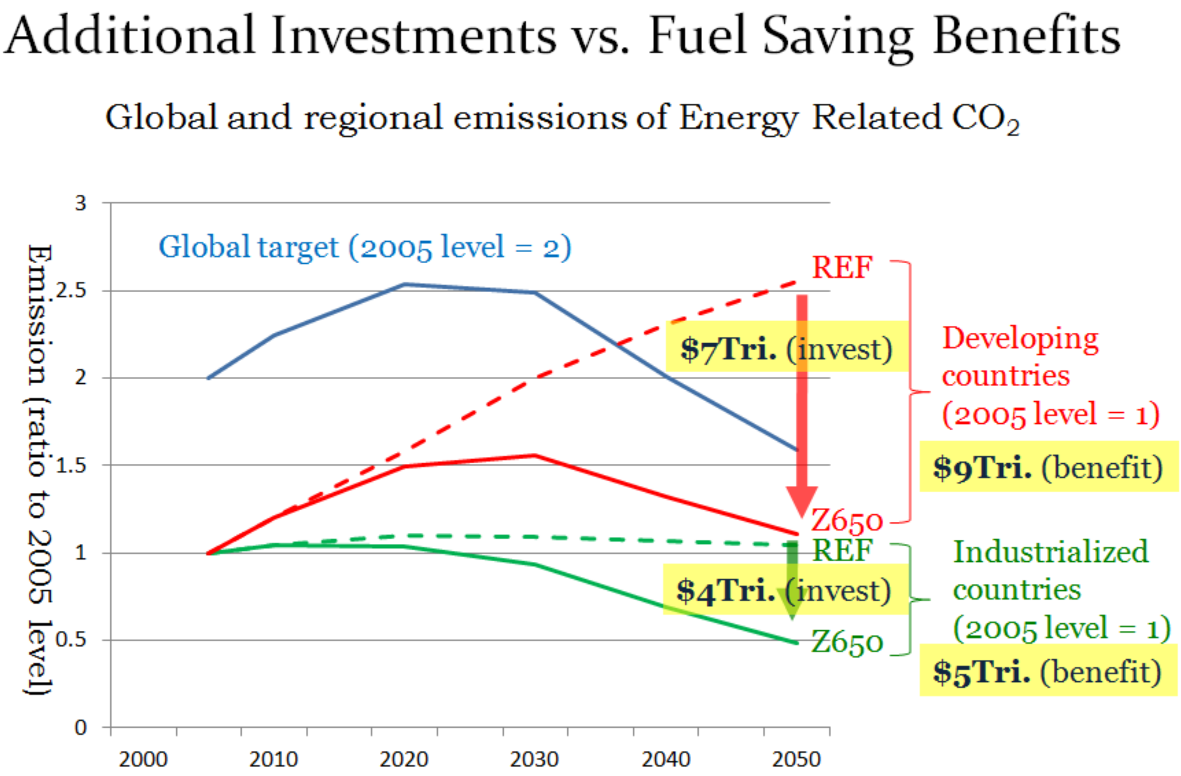

Figure 8 Economic benefits of Z650 approach from global optimization.

In order to achieve the low carbon vision based on optimization of the global energy system based on the efforts of industrialized and developing nations, international cooperation for development and deployment of low carbon technologies will be necessary (Figure 9). In order to drive this, the additionally and speculative aspects of the current CDM system need to be eliminated while complex requirements and procedures should be simplified. Building an international cooperation mechanism that is transparent, fair and efficient (Figure 10) based on bilateral offset mechanisms would be desirable.

A common understanding was reached on this Canon proposal with international and domestic specialists through discussion at international symposiums (in 2011 and 2013.

1) To support a feasible scenario for greenhouse gas emissions on the basis of the climate change science while taking into account over shoot scenarios.
2) To pursue the long-term global energy vision by the global optimization of mitigation costs of carbon dioxide under the energy related low carbon dioxide emission scenario. To welcome a vision that is balanced between additional investments and fuel saving benefits.
3) To promote the deployment of low carbon technologies through international cooperation based on an open, fair and efficient international mechanism. To share the will for realizing an energy vision in which economic growth and global warming control would co-exist.
4) The vision is to be shared through international discussions.

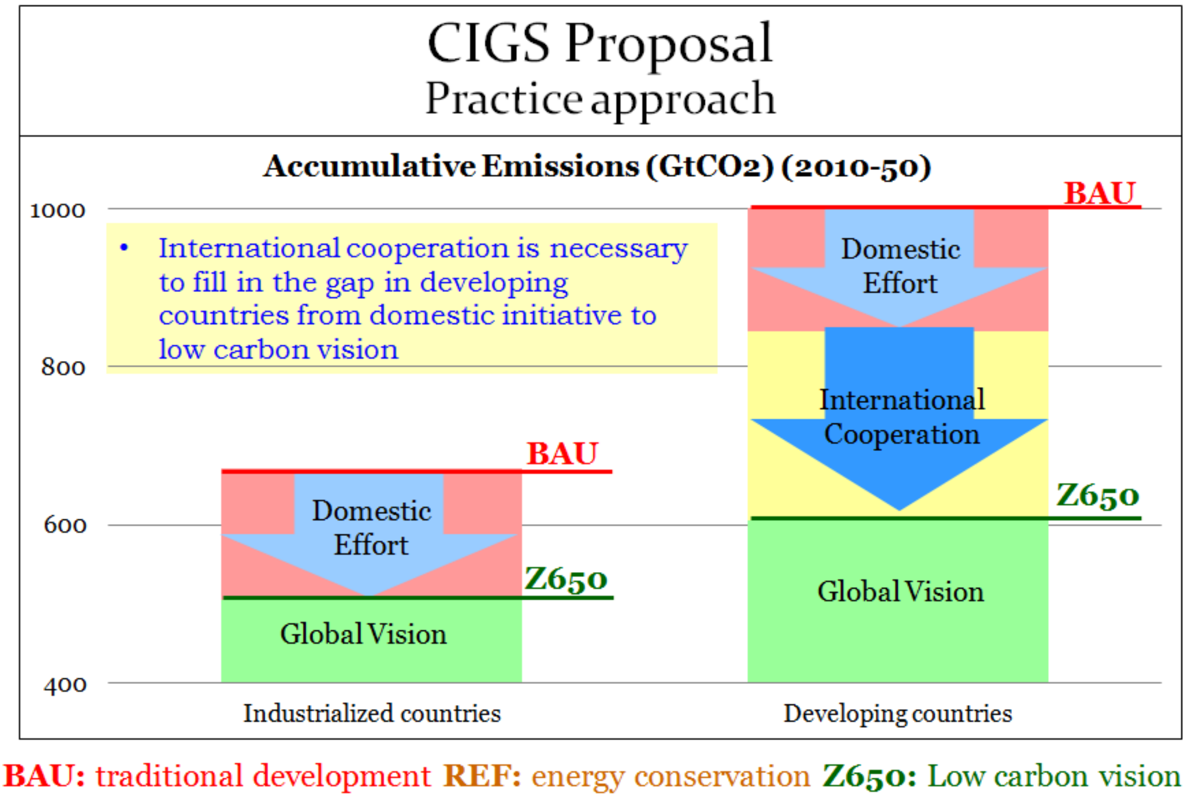

Figure 9 Conceptual diagram to achieve Z650 vision

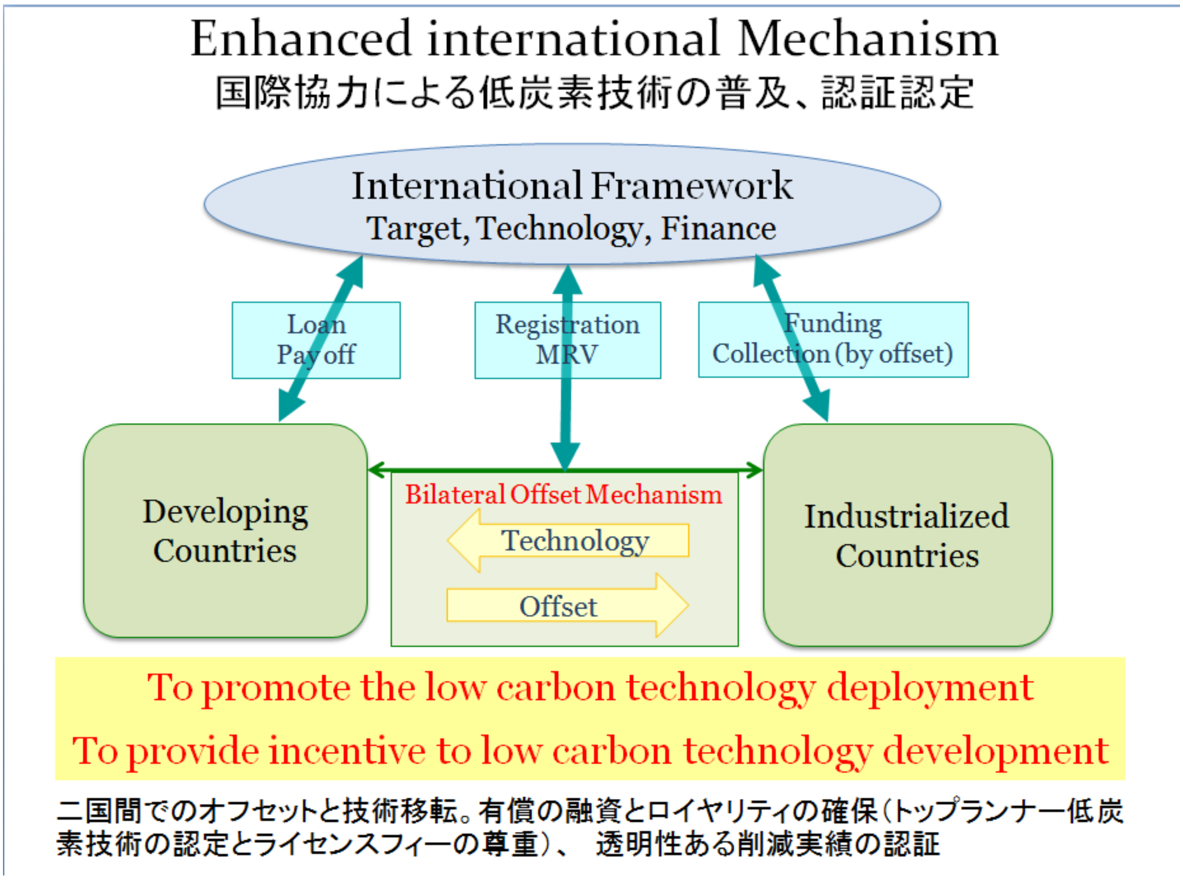

Figure 10 Conceptual diagram of proposed international mechanism

In order to achieve this global vision, innovative energy technologies in various fields will need to be commercialized and deployed. High efficiency fossil fuel utilization technologies include 1) deployment of coal gasification combined cycle (IGCC), 2) higher efficiency gas fired power generation (promotion of double and triple cycles), 3) commercialization of technologies for carbon capture and storage (CCS) including high temperature gas separation membranes, reduction of transport and 4) development and production technologies for deep sea oil and gas fields and commercialization of methane hydrate development. Nuclear power technologies include 1) deployment of next generation nuclear power generation (light water reactors, fast breeder reactors), 2) multiple purpose high temperature gas reactors (inherently safe) for power generation and industrial process heat supply, 3) technologies for volume reduction, separation and reducing level of MA (minor actinides?) in high level radioactive waste. Technologies for raising efficiency and stability of renewable energy sources include 1) commercialization of high efficiency solar photovoltaic cells and solar thermal generation, 2) commercialization of marine renewable energy (offshore wind, ocean current, tidal current, wave and ocean thermal energy conversion, 3) deployment of geothermal power generation and ground source heat pumps will be important. Innovations in battery technology (electrochemical technologies for storage and energy conversion?) will lead to 1) high performance electric power storage (increased service life, lower cost) and contribute to home/building energy self-sufficiency and smart grids, 2) commercialization and deployment of automobile fuel cells and 3) deployment of high performance lithium ion and other battery technologies for electric vehicles. In order to move towards the hydrogen society 1) hydrogen production using renewable energy (wind, solar, biomass, photo catalysts), 2) hydrogen storage and transport technologies (82 MPa CFRP tank for compressed hydrogen) need to be commercialized.

With regard to energy conservation for industry and end users 1) commercialization of direct reduction iron production (this is already commercial), 2) commercialization of innovative cement production processes, 3) deployment of DC power supply and superconducting transmission, 4) innovative devices using power electronics technologies including SiC and 5) organic electroluminescence lighting technology is expected to play a leading role with LEDs in raising light emission efficiency. Other promising technologies for the future include artificial photosynthesis, hot dry rock geothermal generation, solid electrolyte batteries, quantum dot solar photovoltaic power generation, microalgal fuel production, accelerator driven subcritical reactor, deep seabed CO2 storage, superconducting transmission, GMO trees and next generation power electronics.

In order to control climate change, scientists and engineers need to share a common understanding of the severity of the impacts of climate change. To maintain global temperature rise within 2ºC during this century, it will be important for the world to share a common understanding of feasible emissions pathways including limits on cumulative emissions and work to achieve a scenario with zero emissions after overshoot. The world needs to find a way to achieve a long-term energy mix based on global optimization (cost minimization) while fairly allocating the necessary roles. Industrialized countries need to build a new framework for technological and financial support to allow developing countries to achieve a long-term energy mix that is compatible with growth and environmental protection.