IEEJ's Asia/World Energy Outlook 2015

By Yukari Niwa Yamashita

ENERGY SITUATION IN ASIA

To better understand the conclusions reached in IEEJ's *Outlook*, it is important to understand that the *Outlook* is comprised of a few different scenarios, each providing a different point of view on future energy and environment policies. The *Reference Scenario*, for example, represents the core scenario for the *Outlook* and serves as the basis for comparison with the other scenarios. In the *Reference Scenario*, the future is developed according to past policies currently in place. The scenario incorporates traditional and conventional policies and rejects any assumptions for aggressive energy conservation or low-carbon policies.

In terms of economic expansion, all scenarios assume that Asia and Africa are projected to grow at 4.3% per year, while the Middle-East and Latin America are expected to grow at 2.7% per year, slightly less than the world average assumed at 2.9%. Accordingly, IEEJ's *Reference Scenario* suggests that world energy demand will increase from about 13,600 Mtoe in 2013 to 19,000 Mtoe in 2040, an increase close to 40% in 27 years. Projections for Europe, North America and Oceania show energy demand in those regions to remain relatively unchanged during the period. On the other hand, annual demand increases at slightly more than1.8% in Asia, Africa, the Middle-East and Latin America. Given that Asia's demand in 2013 was about 6,000 Mtoe (almost one third of world demand), 1.8% per year means that 60% of the global increase (5,500 Mtoe) will be accounted for in Asia and the rest of the increase will occur in the other 3 non-OECD regions.

Using the same economic growths, an *Advanced Technologies Scenario* is developed where the world strongly implements energy and environment policies, contributing to a secure and stable energy supply and enhancing climate change measures. The projection is based on the assumption that the best technologies for both the supply and demand sides will be introduced where possible. The policies' effects are, therefore, maximised.

In such scenario, the transportation sector lowers its oil requirements by more than 10% relative to the *Reference Scenario* with more stringent regulations or switching to clean energy vehicles. With regard to electricity, demand is substantially reduced with the adoption of policies and measures on energy efficiency while, from a supply perspective, the introduction and support for more renewables and nuclear energies lowers the need for fossil fuels (mainly coal) generation. Although coal use would remain the number 'one' fuel in Asia, its consumption could be reduced by about 30% under this scenario, either due to more efficient generating technologies or the fuel switch to less or non- emitting fuels such as natural gas or renewables.

The fuel choice is often related to domestic availability and a price advantage. For Asia, coal

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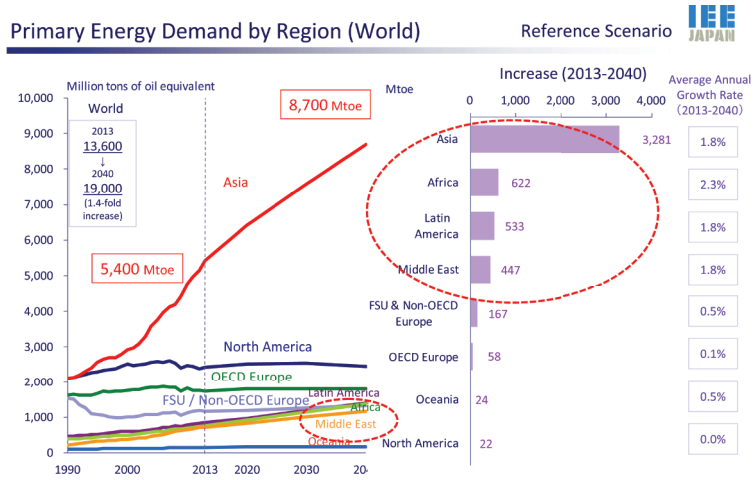
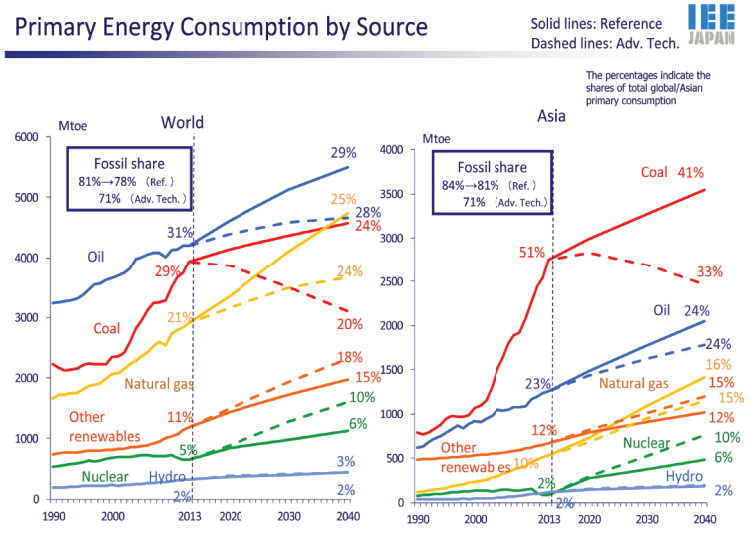


Source: IEEJ, Asia/ World Energy Outlook 2015



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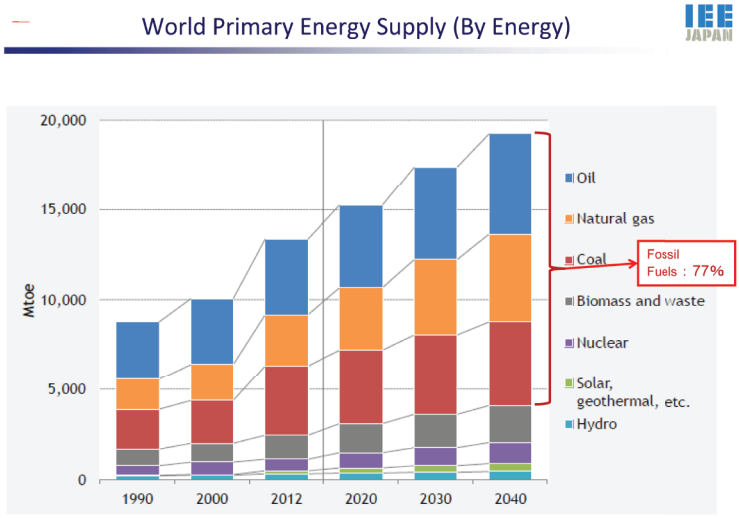


Source: Institute of Energy Economics, Japan, Asia/World Energy Outlook 2015

is chosen because of its availability within the region; with a self-sufficiency rate of about 90%. The self-sufficiency rate for natural gas is 60% and for oil around 18%. Both China and India follow the same pattern.

In the *Reference Scenario*, with the absence of stringent energy and environmental policies, fossil fuels are expected to fulfill slightly below 80% of the world energy mix by 2040. Despite all the talk on the benefits of renewables and push for carbon-free societies, which were incorporated into the *Advanced Technologies Scenario*, the need for fossil fuels by 2040 drops only slightly to reach 71% in the world as well as in Asia.

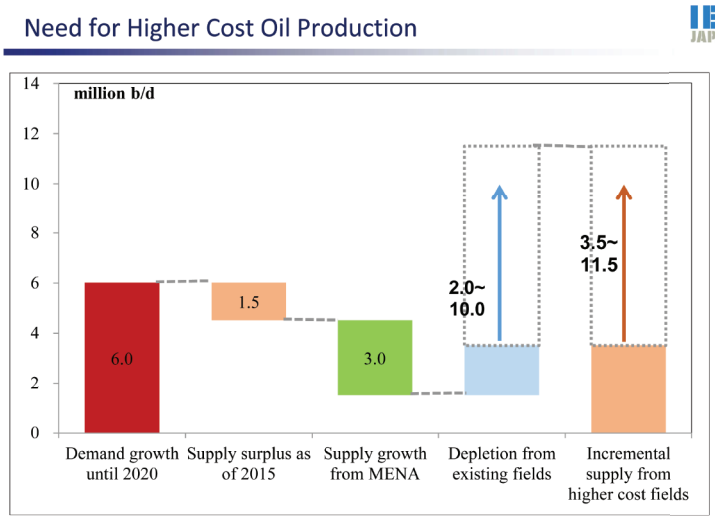
The reality is that the world will depend on fossil fuels for many years to come with strong implications regarding greenhouse gas emissions.

LOWER PRICES FOR ENERGY

In any market (including futures market), prices are based on expectations among market participants in regard to four factors – demand, supply, risks, and finance. This means that in the oil market, factors other than pure supply and demand can play important roles in forming oil prices.

For example, geopolitical related risks generally influence upward swings in oil prices. Some of the current risks include militants operating in Iraq and Syria, the Ukraine-Russia conflict, or even the return of Iran to the international oil market scene. In addition there are financial and speculative factors that have been growing more important over recent years with open interest for crude futures. Such an increase indicates that crude oil futures are viewed as an investment "commodities" in the world's financial markets. Unlike geopolitical risks, the financial and speculative factors effects on prices are difficult to predict.

Our estimation indicates that the spiking in oil prices in 2011 responded more to geopolitical or speculative factors rather than those related to supply and demand fundamentals. Of course, those risk factors continue to exert upward pressures on current prices but to a much lower extent; the abundant supply relative to demand is more than counter-balancing. In a way, the current reading of the market is back to basics with supply by far exceeding demand. It is believed that the shale revolution has brought more supplies than required to the international oil market where demand was weakened by slower economic growth in China and a stagnant EU economy creating a supply surplus position of more than 1 Mb/d.



Source: Prepared by IEEJ based on IEA data and others

Lower prices have been observed in the past. During the 80s, prices dropped in response to an overall demand decrease while supplies from non-OPEC sources were on the rise (the result of a prior period of high prices). The price plunge was not induced by demand but by supply as traditional oil suppliers, especially OPEC countries, competed for market shares and over supply continued. The other two cases of 'supply exceeded demand' were induced by lower demand caused by economic shocks, namely, the Asian financial crisis and the Lehman Brothers shock.

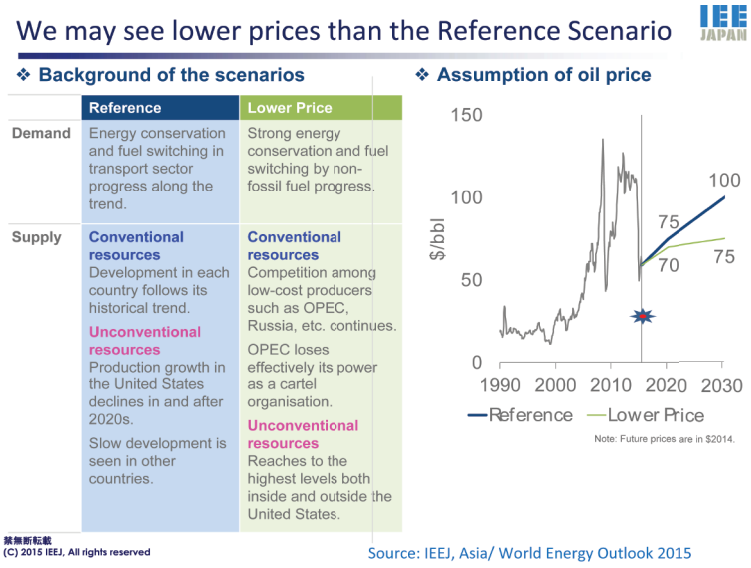
In previous *Outlooks*, the projection of future oil prices was done under the assumption that oil prices will follow an upward trend over a medium to long term because global oil demand is generally expected to continue growing in the future. Higher-cost oilfield development will, therefore, have to be implemented to make up for a decline in production from currently operating oilfields and secure

new oil supply sources to satisfy the increasing demand.

If global oil demand increases at an annual average pace of 1.2 million barrels per day (Mb/d), the cumulative demand expansion through 2020 will be 6 Mb/d. At present, the international oil market's surplus is estimated as exceeding 1.0 Mb/d. Consequently, even with expected additional production from MENA, some higher-cost oil production will soon be required to fulfil the emerging gap. It is IEEJ's estimate that oil prices should be expected to rise to $75/bbl in 2020. In and after 2020, a continued expansion in demand and relevant investment (including investment in higher-cost oil production) could continue to exert upward pressure on oil prices, leading oil prices to exceed $100/bbl in 2030.

In the *Lower Price Scenario* where the current situation is reflected, the oil price will reach $75 only by 2030.

On the demand side for the *Lower Price Scenario*, efficiency and productivity will continue to improve while U.S. shale oil output will reach 5.5 Mb/d in 2020 despite lower prices. In the meantime, with technology advancement, shale oil development will spread widely in other countries, leading global shale oil output to rise to 8.9 Mb/d in 2030. Due to a possible escalation of rivalry among OPEC members, the cartel may no longer work effectively and OPEC's influence on the crude oil market will remain very limited. Later, upstream oil development investment will expand in African oil producing countries, further increasing global supply.



Source: IEEJ, Asia/ World Energy Outlook 2015

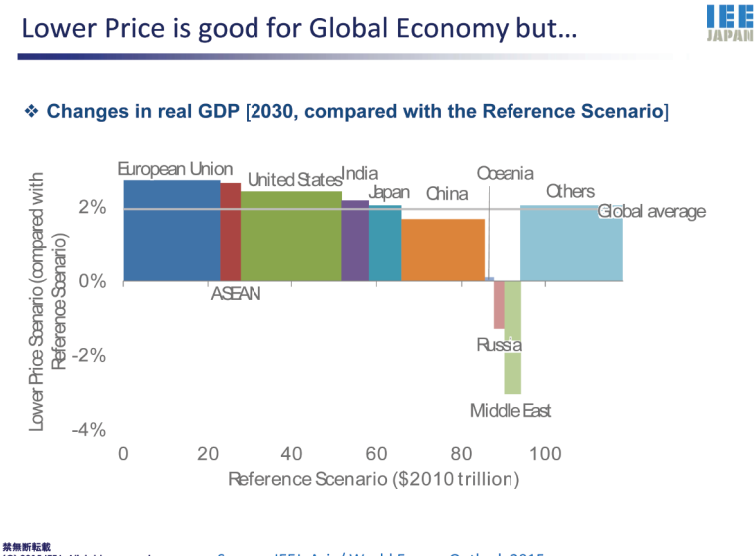
Based on the above, the supply-demand balance will stay structurally loose and risk factors will exert less influence in the crude oil market. The background to this scenario is slack demand combined with a substantial expansion in crude oil production; progress in the shale revolution as well as growth in production from Iraq, Iran and other members of OPEC. Consequently, in the *Lower Price Scenario*, prices will be limited to $75/bbl in 2030 with the next question related to prices for the medium and long term.

As oil demand is restricted and as real crude oil prices are set at 25% lower than in the *Reference Scenario*, the net value of crude oil imports and exports in the *Lower Price Scenario* will be far less than in the *Reference Scenario*. An oil price fall will directly invigorate net oil-importing economies by reducing their income outflow and raising their real purchasing power. On the other hand, such an oil price drop will work to shrink net oil-exporting economies.

China will benefit the most from a decline in crude oil import costs. The drop in import costs from the *Reference Scenario* in 2030 will be $217 billion. Lower energy prices, fuel switching to natural gas and lower domestic demand are contributing to the decline in the cost of China's crude oil imports. The United States is the second largest beneficiary from a drop in the value of crude oil imports. For most of the other crude oil importers, the lower levels of prices capture the greatest share of the drop in the cost of crude oil imports.

Meanwhile, by 2030, Middle Eastern oil producing countries' net exports are valued at $457 billion less than in the *Reference Scenario*. The decline will become a major economic downside factor for oil producing countries. The net value of crude oil exports will be $148 billion less for Russia and $115 billion less for Africa.

Nevertheless, the oil price fall will serve to expand the world economy. In the *Lower Price Scenario*, the world's real GDP for 2030 will increase



Source: IEEJ, Asia/ World Energy Outlook 2015

by 1.9% from the *Reference Scenario*.

Asia, heavily dependent on energy imports, for example, will greatly benefit from lower energy prices. The ASEAN economy will expand by 2.6% from the *Reference Scenario* in 2030. Real GDP will increase by 2.2% for India and by 1.7% for China. The EU and the U.S. economy will benefit as well.

Meanwhile, the Middle East's real GDP in 2030 will decline by 3.1% from the R*eference Scenario*. The global growth in unconventional resources development will further weaken the Middle East's presence as producers. Russia will also suffer from contraction of its real GDP by 1.3% from the *Reference Scenario.*

From IPCC 5th Assessment Report (AR5)

Scenarios in IPCC AR5 WG3

	Concentration of CO_2-eq in 2100, ppm CO_2-eq	Sub-category	Change in GHG emissions from 2010 to 2050, %	2100 temperature change relative to 1850-1900 (°C)*	
RCP2.6	450 (430-480)	Overshoot (vast majority)	-72 to -41	1.5 - 1.7	
	500 (480-530)	No overshoot	-57 to -42	1.7 - 1.9	2 °C
		Overshoot	-55 to -25	1.8 - 2.0	
	550 (530-580)	No overshoot	-49 to -19	2.0 - 2.2	
		Overshoot	-16 to +7	2.1 - 2.3	
RCP4.5	(580-650)		-38 to +24	2.3 - 2.6	
	(650-720)		-11 to +17	2.6 - 2.9	
RCP6.0	(720-1000)		+18 to +54	3.1 - 3.7	BAU

Temperatures in parentheses include carbon cycle and climate system uncertainties.

CLIMATE CHANGE

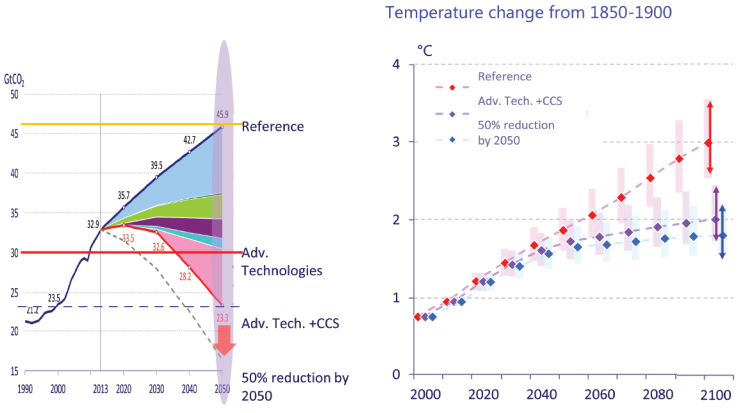
Although the issue of climate change and global warming are more and more present in the public mind, it is not becoming any easier to understand the mixed messages on how to combat climate change. The IPCC 5th Assessment Report (AR5) compiled a table that clearly showed that a concentration equivalent to 450 ppm CO_2-equivalent would be the ideal scenario for keeping the temperature rise below 2 degrees Celsius by 2100. Both the 500 and 550 ppm scenarios are included as possibly achieving a similar objective until the end of this century.

For the Representative Concentration Pathway (RCP 2.6), which is the typical scenario for the "450 ppm" category, the CO_2-eq concentration is expected to temporarily overshoot 450 ppm before declining to the objective level by the end of the century. This scenario assumes reductions of emissions by two-thirds from 2010 levels by 2050, and the need for negative emissions after 2070. At the G7 in 2015, a reduction of GHG emissions in the range of 41% to 72% were announced as agreed targets which make such a scenario more ambitious than the "50% reduction by 2050" target.

IEEJ's *Reference Scenario* discussed earlier corresponds very well with the worst of the scenarios presented in the table above (RCP 6.0). Another way to present the same information would be to graphically plot the related energy-related CO_2 emissions that correspond to selected scenarios from IPCC. The 450 ppm scenario would be the lowest curve with the need for negative emission beyond 2070.

The emissions results from IEEJ's Energy Outlook 2015 *Reference* and *Advanced Technologies Scenarios* are plotted against those of IPCC. As shown by the red arrow, the use of advanced technologies combined with CCS would not even be enough to reach the so-called "50% reduction by 2050" target which is indicated by dotted line.

How Much is Temperature Change ?



The results of the *Reference Scenario* correspond to a level of concentration in the atmosphere in 2100 in the range of 760-860 ppm[1] (CO_2-eq.), with an average temperature rise of about 3.0°C the same year. On the other hand, the *Advanced Technologies Scenario* is comparable to concentrations in 2100 of 540-600 ppm (CO_2-eq.), with the average rise in temperature between 1.7 and 2.4°C. This is lower than 2.5°C and possibly lower than 2°C by 2100.

Prior to the United Nations Climate Change Conference (COP21) in Nov. 2015, many participating countries submitted their Intended Nationally Determined Contributions (INDCs) presenting their respective post-2020 climate actions. By October 1st, 117 countries and regions (totaling 144 countries) had submitted their INDCs.

IEEJ analyzed the pledges of the top 8 major countries that cover 65% of global GHG emissions

in 2010, (49.8 Gt). At first sight, the reduction targets of those countries are quite impressive, ranging between 25 to 65%. But as one looks closer, the base years and the target years on which the targets apply are different for each participant. Of more interest is the fact that the EU, USA, Russia, Japan and Brazil are setting their targets in absolute value of GHG emissions while China and India are setting their target in terms of GDP intensity. Indonesia sets its target of 29% as a reduction from its BAU case.

From the information provided above, it is possible to construct a comparison of the emissions before and after the application of the target using IEEJ's model results for each country under the *Reference* and the *Advanced Technologies Scenarios*. It is more difficult to assess properly the impact of a GDP intensity target as it is highly dependent on prospects for economic growth.

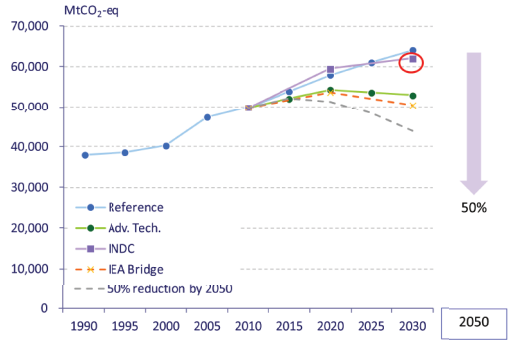
Intended Nationally Determined Contributions (INDCs)
Major Countries

Party	Date of submission	Target type	Reduction target	Base year	Target year	Coverage
EU	Mar 6	Absolute emissions	40%	1990	2030	GHG
United States	Mar 31	Absolute emissions	26～28%	2005	2025	GHG including LULUCF
Russia	Apr 1	Absolute emissions	25～30%	1990	2030	GHG
China	Jun 30	GDP intensity	60～65%	2005	2030	CO_2
Japan	Jul 17	Absolute emissions	26%	2013	2030	GHG
Indonesia	Sep 24	Reduction from BAU	29%	BAU	2030	GHG
Brazil	Sep 30	Absolute emissions	37% (43% for 2030)	2005	2025	GHG
India	Oct 1	GDP intensity	33～35%	2005	2030	GHG

The targets of the United States and Japan are as ambitious as the *Advanced Technologies Scenario* while the target for the EU is positioned close to that scenario. The targets of China and India are interesting as they exceed IEEJ's CO_2/GHG emissions expectations under the *Reference Scenario*.

When combined the evolution of the emissions suggested by the INDCs of the 8 parties follows a similar path to that of IEEJ's *Reference Scenario* for those parties. The climate actions based on the current INDCs are far from reaching the *Advanced Technologies Scenario*, which in turn is far behind the target of "50% reduction by 2050", and not even close to the 450 ppm scenario

Comparison of INDCs with the Reference/Adv. Tech. Scenarios

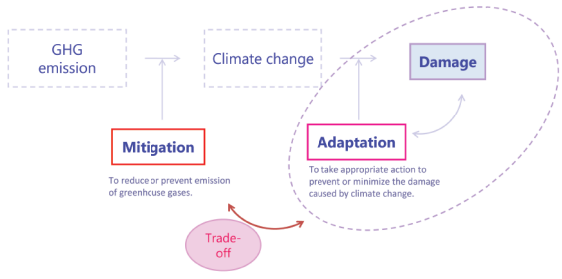


While it clearly appears that the INDCs are far from enough, should we keep on aiming at reaching the 50% target or even further down to the reduction level which 450ppm scenario suggests?

The 450ppm target (2.0°C) is clearly the minimum any planet doctors could ask for. The planet would be better at half that temperature rise and yet it is not what the planet used to look like a century ago. The 450ppm target is only the best next ideal as we cannot yet turn the clock back. Unfortunately the 450 ppm is out of reach for the moment. It may be better to temporarily lower expectations and be pragmatic.

There exists trade-offs between mitigation, adaptation and it would seem appropriate to aim at balancing the costs of adaptation with mitigation. Minimizing the overall costs of mitigation and adaptation would be an optimal way to tackle the climate change challenge in a more pragmatic manner.

Mitigation and Adaptation Costs



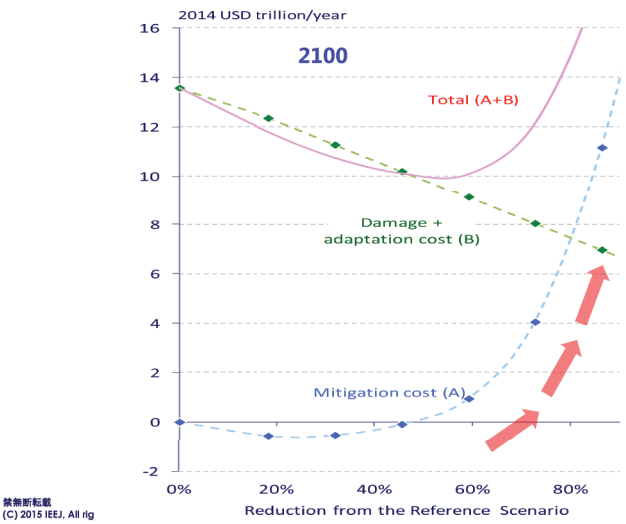
There is a trade-off relationship among the mitigation, adaptation and damage costs. it is impossible to reduce all three costs at the same time.

It would be realistic to expect a balance among the three, while minimizing the total cost.

Based on the limited number of models that have been published to project climate change damage and adaptation costs, IEEJ constructed the Mitigation-Adaptation Costs chart. It is a simple representation that trade-offs exist between actions directed at lowering emissions and actions aimed at lowering the impact of climate change. The more spent on mitigation, the less will be required for adaptation.

As the reduction ratio exceeds that of the *Advanced Technologies Scenario* (40%), the mitigation cost increases enormously. Consequently, based on the information available, it may be advantageous to concentrate on adaptation and damage costs in order to minimize overall costs. It is also important to speed up the reduction of the mitigation costs with innovative technologies and flatten the mitigation cost curve. A long-term perspective is indispensable to address the problem of climate change. And it

Mitigation vs. Adaptation Costs in 2100



may still be possible to optimize.

Of course, the optimum emission path differs widely depending on assumptions. Even if mitigation costs and damage were determined accurately, the path cannot be determined uniquely. At least, however, estimates indicate that the case in which the world would fail to halve emissions by 2050 and pursue greater emission cuts later would still be more economically rational and most probably closer to the optimal path.

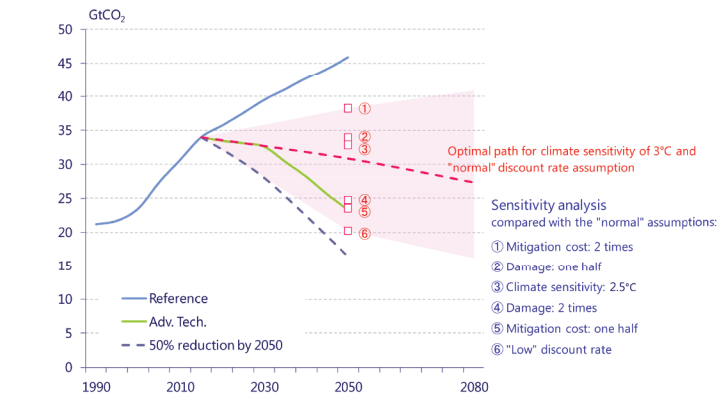
Should we keep aiming at meeting a "mitigation" target only?

Should we consider minimizing costs of "mitigation" and "adaptation"?

Before considering answering those questions, it is important to note that there remain many uncertainties regarding the climate change issues. There are huge variations with regard to future costs of mitigation, adaptation and damages. Part of that big uncertainty (and subject to huge debates) induces the discussions on an appropriate discount rate to use for cost estimations.

The most complicated uncertainty is related to the 'obvious' link between atmospheric concentration and temperature rise. The "Equilibrium Climate Sensitivity" seems not to stand the scientific tests for accuracy for commitments. IPCC recently reported that some (new) studies suggest that the "sensitivity" may be lower than previous reported. If it were to be the case, a lower climate sensitivity means that damage costs become smaller and that the future mitigation path can be less ambitious and yet optimal.

Example of the calculation of the long-term optimal path



CONCLUSION

The current lower energy prices may look good for energy consuming Asia but the world will remain dependent on fossil fuels until 2040 and more costly energy may be required beyond 2020. For growing Asia, it will continue to be essential to pursue improvement of energy efficiency and productivity. Moreover, lower prices with less export volume will cause a reduction in income and lower economic growth for traditional energy producers. This can be considered as an encouragement to diversify their economies from being heavily dependent on resource exports. Thus both consumers and producers need to avoid microscopic actions and are required to adopt strategies with longer-term perspectives. Climate change also requires long-term strategies, especially in development of innovative technologies. Rather than aiming only at meeting 450 ppm target, speeding up the technology development while optimizing the total costs of mitigation and adaptation need to be considered.

Footnote

[1]The "CO_2-equivalent concentration" includes the forcing of all GHGs, as well as aerosols and albedo change.