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What constitutes meaningful participation from China?
- An analysis of the Chinese intensity targets -

Jusen Asuka[1], Li Zhi Dong[2], and Lu Xiang Chun[3] **November 2010**

Note: This is slightly-modified version of the original article which was written prior to COP 15, 2009.

Abstract:

On 22 September 2009, Chinese President Hu Jintao spoke at the UN Climate Change Summit that "(China is) to significantly reduce CO_2 emissions per GDP (CO_2 intensity) from 2005 level by 2020". Around the same time, a government-related think tank in China published scenario analysis report that provided actual numbers to support such CO_2 intensity target. These were the messages from China to the international community that could be recognised as the Chinese commitment for international climate negotiation.

The "low-carbon scenario" discussed in the above scenario analysis report is to reduce intensity by 57% in 2020, and to peak emissions in 2035, then to decline thereafter. This scenario can be interpreted, in terms of absolute value, as a 22% emission reduction from BAU scenario in 2020, which can fulfill what EU requested to China (16% reduction from BAU by 2020) in order to control the global temperature increase to 2 degrees C from the level before the industrial revolution. If China is to reduce its emissions by just 16% from BAU in 2020, the necessary reduction in terms of CO_2 intensity will be a 53% reduction from the level of 2005.

The "low-carbon scenario" presumes that China will control CO_2 emissions mainly by iron and steel production adjustment and power system structural reform up to 2020, and by rapid and large scale introduction of advanced technologies including IGCC (Integrated Coal Gasification Combined Cycle power generation) and CCS (Carbon Capture and Storage) after 2030. Moreover, it presumes that China's per capita GDP will reach the 2005 level of developed countries by 2050, while its per capita energy consumption, CO_2 emissions, power usage, and production and stock of iron and cement in 2050 will be lower than the 2005 level of developed countries.

Today, China is rapidly adopting energy-related taxation, making the end prices of coal for power generation and electric power for industry use at the same or higher level than those of developed countries in 2006. For iron and steel products and cement products, China has implemented voluntary export control by imposing export taxes equivalent to the level of border tax adjustment or carbon pricing under the European Union Emission Trading Scheme (EU ETS).

Nevertheless, if China is to further promote low-carbonisation of the economy in the future and is to act as a political/economical superpower in the international society, it is essential to further strengthen existing

[1] Tohoku University/IGES, asuka@cneas.tohoku.ac.jp
[2] Nagaoka University of Technology, zhidong@kjs.nagaokaut.ac.jp
[3] Tohoku University, luxch@cneas.tohoku.ac.jp

regulations and to provide economic incentives, in addition to cooperating with the international community. At the same time, China and the international community need to further deepen thorough communication.

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1. Introduction

China's "ambitious commitment" is the prerequisite for several developed countries, including the Japanese Government's commitment for a post-2012 framework. However, the number of officials who can envisage what will constitute "ambitious," or can provide a logical and quantitative explanation on "why China needs to make what commitment," seems to be almost non-existent.

While such an incomprehensible situation continued, two significant events took place in September 2009: 1) National Development and Reform Commission Energy Research Institute Taskforce published the report titled "China's path of low-carbon development to 2050: Energy demand and supply and CO_2 emission scenarios" (NDRC ERI taskforce 2009, hereinafter referred to "Scenario Report") and the report by Development Research Center of the State Council, National Development and Reform Commission Energy Research Institute, and Tsinhua University, titled "China's energy and CO_2 emissions in 2050"[4] (DRC SC and Tshinhua University 2009, hereinafter referred to as Energy and CO_2 Emission Report) (on 16 September); and 2） China's President Hu Jintao's announcement of four targets at the UN Climate Change Summit (on 22 September). Immediately before these events, the Standing Committee of China's National People's Congress adopted a "Resolution for Active Responses to Climate Change" in August 2009, while the Chinese Government announced their plan for international climate negotiation in May 2009.

President Hu Jintao's speech at the UN Climate Change Summit on 22 September 2009, was not widely reported by the Japanese mass media, as they were more intent on reporting Japanese Prime Minister Hatoyama's speech at the same UN Summit. However, most of the media in Europe and the US reported President Hu's speech favourably. For example, the Times of the US described Japan and China as "new green team" on their Internet publication of 23 September 2009.

Nonetheless, this speech of President Hu's and the aforementioned Scenario Report are considered as the introduction of Chinese Government's commitment. To lead to the success of international climate negotiation, it is necessary to thoroughly understand what is contained in the "ball" that China is throwing to us.

In this report, we shall explain the four targets President Hu describes in section 2, and introduce the history of Chinese discussion on energy consumption per GDP (energy intensity) and CO_2 intensity in section 3. Section 4 describes the major conclusions of the Scenario Report, especially about actual quantified targets. Section 5 presents simple international comparison of quantified targets, while section 6 summarises the conclusion.

2. China's targets announced by President Hu Jintao at the UN Climate Change Summit

At the UN Climate Change Summit in New York, President Hu Jintao of China announced his country's four targets on climate change issue: 1) to significantly reduce CO_2 intensity by 2020 from 2005 levels; 2) to expand the share of non-fossil fuels in primary energy to 15%; 3) to increase forestry area to 40 million Km^2, and forestry storage to 1.3 billion m^3 by 2020; and 4) to pursue a low-carbon economy, and promote technology development and dissemination. It was the first time China's president announced the actual contents of global warming measures including concrete figures at the official forum of the UN.

Until then, the Chinese Government had not announced any concrete quantified figures that directly included CO_2 as an index, other than indicating individual targets on energy-saving, low-carbon energy development, afforestation, etc. Moreover, it evaded stating a choice of index in

[4] These two reports were published at the same time with some of authors being the same. "China's energy and CO_2 emission report for 2050" has a volume of about 900 pages. The "Scenario Report" can be considered as the extract of scenario analysis part of the aforementioned report, as the State Development Plan Committee Energy Research Institute was mainly responsible to write that part. In regards to the issue of China's participation, refer to Asuka (2008), Li (2009a, 2009b), also.

developing action targets at the forum of international negotiation on post-2012 framework, although expressing its intention to take "appropriate mitigation actions." President Hu's announcement, therefore, finally revealed the actual image of China's "participation."

We must note, however, that these targets are considered a part of China's Nationally Appropriate Mitigation Action (NAMA), stipulated in the Bali Action Plan adopted at COP 13. NAMA is recognised not only by the Chinese Government but also by the governments of other developing countries, as "voluntary actions taken under technological and financial supports of developed countries." [5]

Still, the aforementioned events are a practical declaration of China's commitment. From this time, what constitutes "significantly" or what is the scope of CO_2 intensity reduction became extremely important points in negotiations and diplomacy.

3. Past history of climate discussion in China

China has a fairly long history of discussions and research activities on energy intensities and/or CO_2 intensities. Despite fewer reports in the mass media, Chinese and Japanese newspapers have reported some comments by government officials on this subject in the past. The following points summarise such reports.

1)February, 2007: on page 378 of "Climate Change State Assessment Report" published by the Climate Change State Assessment Report Editing Committee, the quantified target was described as "50% reduction of CO_2 emissions per GDP by 2020 from 2000 level, and 85% reduction by 2050."

2)August, 2008: Zai Yande, Vice President of the Energy Research Institute of China National Development and Reform Commission, with other authors published a report entitled "Paths and measures to realize the reduction target of energy consumption per unit GDP" from the China Measurement Publisher. The report is voluminous with about 400 pages, and provides quantitative discussion on actual policies and measures and their feasibility in each industry sector and region.

3) 5 March 2009: Article on Xin Hua Press; "2009 Report on China's Sustainable Development Strategy" published by Chinese Academy of Social Science on 5 March 2009, presented the strategic targets of China toward low-carbon economy, and stated that carbon dioxide emissions shall be reduced by around 50 % per CNY 10,000 of GDP by 2020."

4) 31 May 2009: Article in Nihon Keizai Shimbun; "Chinese Government began the review of their energy efficiency improvement target, assuming the period of 10 years or longer, in preparation for the international negotiation on global warming framework after 2012 (post-Kyoto framework. Actual measure is likely to be based on 40% reduction of energy consumption used to produce a certain amount of Gross Domestic Products (GDP) by 2020 from 2010 level". China has already set the energy efficiency improvement target of 20% by 2010 from 2006 level. Gan Qing Tai, Special Representative for Climate Change negotiation at Chinese Ministry of Foreign Affairs told Nihon Keizai Shimbun that "academic experts are reviewing the actual measures for the future. China will continue the efforts to improve efficiency."

As these media reports indicated that there have been many reports and studies on energy intensities and CO_2 intensities in China, with extensive discussion of actual numbers ongoing within the Chinese Government. In other words, the Scenario Report and President Hu Jintao's statement discussed earlier had been sufficiently backed by numerous studies and discussions based on quantitative analysis.

[5] Bali Action Plan described the actions to be taken by developing countries as follows: "nationally appropriate mitigation actions by developing countries in the context of sustainable development, supported and enabled by technology, financing and capacity building, in a measurable, reportable and verifiable manner. （Advance unedited version, Decision -/CP.13: Bali Action Plan）

4. Details of the Scenario Report

1)Four scenarios

The Scenario Report analysed the following four scenarios.

a. Reference scenario

This is so-called baseline or BAU (Business as usual) and presumes that by 2050, 1) per capital GDP will reach middle developed county level; 2) per capital energy consumption will be 4 tce; 3) energy efficiency will be 10% below the global top level of today; and 4) energy consumption will be 7.8 billion tce.

b. Energy-saving scenario[6]

Under this scenario, China shall further pursue existing measure of prioritising energy-saving. It will not implement high-cost climate change measures, such as Carbon Capture and Storage (CCS).

c. Low-carbon scenario

This is a scenario to pursue low-carbon society, and presumes the introduction of carbon tax, CCS and Integrated Coal Gasification Combined Cycle Combustion (IGCC) by 2020-2030.

d. Enhanced low-carbon scenario

This scenario considers technological and financial support from developed countries and China's contribution to the international community, and presumes the introduction of carbon tax as well as the early dissemination of CCS and IGCC technologies.

Tables 1 and 2 below indicate the presumptions, and necessary policies and measures of each scenario.

[6] The relationship between this energy-saving scenario and reference scenario is not clear in the Scenario Report. Considering the numerals given and other references (Hu et al., 2009) of the same authors (researchers at the State Development Plan Committee Energy Research Institute), energy-saving scenario seems to be fairly close to the reference scenario.

Table 1. Contents and presumptions of each scenario (outline)

Scenario	Contents
Reference scenario	Per capita energy consumption to reach middle developed country level of today by 2050. Energy efficiency shall be 10% lower than that of world's top level as of 2005. Industrialisation further advances and energy use efficiency will improve to a certain level by technological development but overall energy consumption will reach 7.8 billion tce.
Energy saving scenario	Government will not implement measures specifically targeting the climate change issue, although considerable attention will be given to energy-saving and emissions reduction. Economic growth method may change, and for short to mid-term, production of high efficiency products will increase, leading to a certain growth in energy-saving equipment manufacturing, nuclear power generation, and renewable energy sectors. However, the situation continues for: 1) under-development of public transportation system as the public emphasises speed and comfort in transportation; 2) innovative energy-saving technology and emissions reduction technology will not be developed, while CCS will not disseminate; and 3) energy-saving life style will not disseminate, and the public retains the notion of "first pollution, then fixation."
Low carbon scenario	Comprehensively integrate the considerations of sustainable development, energy security, international competitiveness, energy saving, emission reduction potentials, etc. Shift in production and consumption patterns and technology development help advances low-carbon society. Accelerate the development of energy saving equipment manufacturing, nuclear power generation, renewable energy industry, etc. CCS technology is disseminated in power industry. Expand investment for low-carbon economic development. Disseminate energy-saving production and life style.
Enhanced low carbon scenario	Realise sophisticated low-carbon society under international cooperation. Progress in the cooperation between developed and developing countries. New technology development. Cost reduction in existing technologies. Dissemination of low-carbon technologies. Research and development and capital investment to support low-carbon society. Advanced energy diversification. Chinese Government to expand investment on low-carbon economy. Significant dissemination of clean coal technology and CCS.

Table 2. Contents and presumption of each scenario in details

Item	Energy-saving scenario	Low-carbon scenario	Enhanced low-carbon scenario
GDP growth rate	Realise the State "three phase" target: Average growth in 2005-20: 8.8%, in 2020-35: 6%, and in 2035-50: 4.4%	Same as Energy saving scenario	Same as Energy-saving scenario
Population growth	Peaked in 2030-40 at about 1.47 billion, and 1.46 billion in 2050	Same as Energy saving scenario	Same as Energy-saving scenario
Per capita GDP	CNY 200,000 in 2050 (USD 25,000 at 2005 fixed rate)	Same as Energy saving scenario	Same as Energy-saving scenario
Industrial structure	Drastic growth of tertiary industry after 2030, but heavy industry continues to play a key role.	Industrial structure will become equivalent to those of developed countries today. Accelerated industrialisation and tertiary industry development. Information industry to share important position.	Industrial structure will become equivalent to those of developed countries today. Accelerated industrialisation and tertiary industry development. Information industry to share important position.
Urbanisation rate	72% in 2030, and 79% in 2050	Same as Energy-saving scenario	Same as Energy-saving scenario
Export / Import	By 2030, primary industry products gradually lose international competitiveness. Energy consuming products are solely for domestic market.	By 2020, primary industry products gradually lose international competitiveness. Energy consuming products are solely for domestic market. Significant growth in the export of high-value-added products and services.	By 2020, primary industry products gradually lose international competitiveness. Energy consuming products are solely for domestic market. Significant growth in the export of high-value-added products and services.
Natural environment of the nation	Improved, but the notion of "first pollution, then improvement" will not change. First phase of Kuznets Curve.	Improved. Peak value of Kuznets curve is lowered.	Improved. Peak value of Kuznets curve is lowered.
Energy technology	Dissemination of advanced energy technology by 2040, making China the world technology leader in this field. Technology efficiency will be 40% higher than today.	Dissemination of advanced energy technology by 2030, making China the world technology leader in this field. Technology efficiency will be 40% higher than today.	Dissemination of advanced energy technology by 2030, making China the world technology leader in this field. Technology efficiency will be 40% higher than today.
Unconventional Energy resources	After 2040, need to explore unconventional gas and coal.	After 2040, need to explore unconventional gas and oil.	No need to explore unconventional gas or oil resources.
Solar power wind power	Power generation unit price of solar power will be CNY0.39 / /kWh in 2050. Land-based wind power will be disseminated.	Power generation unit price of solar power will be CNY 0.27 / /kWh in 2050. Dissemination of land-based wind power and large scale development of off-shore wind power.	Power generation unit price of solar power will be CNY 0.27 / /kWh in 2050. Dissemination of land-based wind power and large scale development of off-shore wind power.

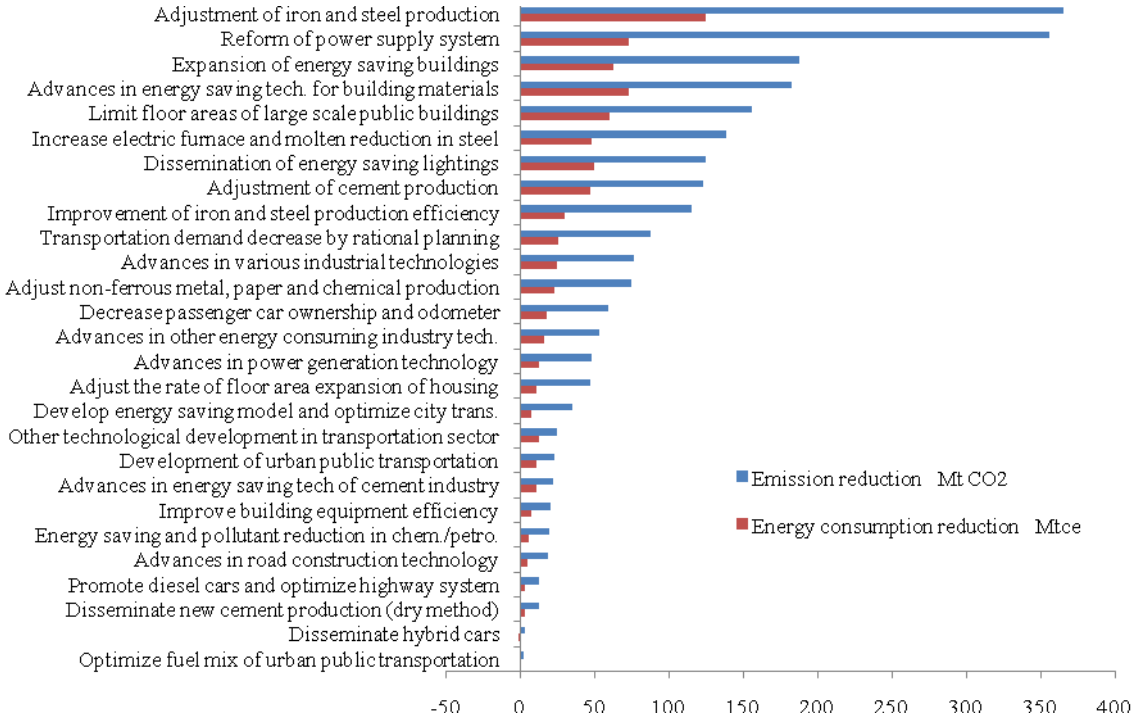
Table 2. Contents and presumption of each scenario in details (continued)

	Energy-saving scenario	Low-carbon scenario	Enhanced low-carbon scenario
Nuclear power	Total capacity of nuclear power generation to be 300 million kW by 2050. Unit price of power generation to be lowered from CNY 0.33 /kWh in 2005 to CNY 0.24 /kWh in 2050.	Total capacity of nuclear power generation to be 350 million kW by 2050. Unit price of power generation to be lowered from CNY 0.33 /kWh in 2005 to CNY 0.22 /kWh in 2050. Major shift to large scale development of the fourth generation nuclear power plant after 2030.	Total capacity of nuclear power generation to be 400 million kW by 2050. Unit price of power generation to be lowered from CNY 0.33 /kWh in 2005 to CNY 0.20 /kWh in 2050. Major shift to large scale development of the fourth generation nuclear power plant after 2030.
Coal thermal power generation	Main stream technologies include super-critical state power generation and ultra-super critical state power generation.	Main stream technologies include super-critical state power generation and ultra-super critical state power generation until 2030. Afterward IGCC will be the main stream technology.	IGCC will be the main stream technology after 2020.
CCS	Will not be introduced.	Pilot project to start from 2020. All new IGCC power plants to introduce IGCC after 2050.	CCS to be introduced to all new IGCC power plants. At the same time, CCS technology to be introduced to industrial sectors of iron and steel, cement, aluminum, ammonia, ethylene, etc. Disseminate technology after 2030.
Hydro power	Power capacity to reach 400 million kW by 2050. Actual power generation to exceed 1320 billion kWh.	Power capacity to reach 450 million kW by 2050. Actual power generation to exceed 1485 billion kWh.	Power capacity to reach 470 million kW by 2050. Actual power generation to exceed 1551 billion kWh.
Biomass	100 million tce biomass usage by 2050. Average cost will be less than CNY 430 /tce.	260 million tce biomass usage by 2050. Average cost will be less than CNY 370 /tce.	270 million tce biomass usage by 2050. Average cost will be less than CNY 370 /tce.
Residential sector	Dissemination of energy saving appliances, commercialisation of renewable energy (for example biomass) supply to villages	Dissemination of energy saving thermal insular housing	Dissemination of energy saving thermal insular housing
Transportation	Dissemination of public transportation. Development of rail transportation in big cities	Development of environmental-friendly rail transportation	Development of public transportation in big cities with population of more than one million. Non-automobile accesses from mid-size cities to villages.
Automobiles	Fuel cost efficiency to increase by 30%.	Fuel cost efficiency to increase by 60%.	Fuel cost efficiency to increase by 60%.

Source: Scenario Report p.44 Table 3-3

The following Figure 1 indicates energy consumption reduction and CO_2 emission reduction by specific measures up to 2020 under a low-carbon scenario.

Figure 1. Energy consumption reduction and CO_2 emission reduction up to 2020 under low-carbon scenario

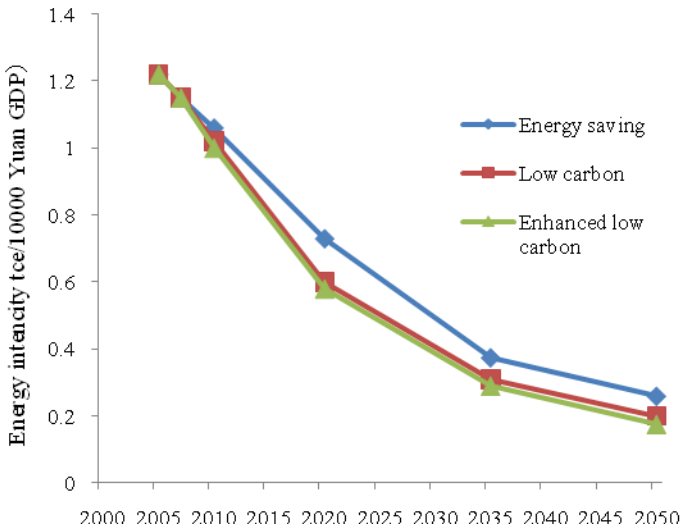


From the above, we find that two factors of production adjustment in the iron and steel industry and reforms in the power supply system (reform in power source mix and efficiency improvement in power generation technology) will contribute significantly to emissions reduction until 2020. The "Energy and CO_2 Emissions report" introduced in section 1 argues that China needs to review the introduction of more cost-efficient measures such as carbon tax and emissions trading system to minimise the cost required to achieve the targets, in addition to enhancing current policies (such as closure of inefficient production sites, provision of subsidies and imposing energy tax).

2) Energy intensity

Figure 2 shows the trends of energy intensities (energy consumption per CNY 10,000 GDP) for each scenario given in the Scenario Report.

Figure 2. Changes in energy intensities under each scenario



Source: Scenario Report p.84 Figure 3-28

Table 3 indicates the ratio of changes in each period under the scenarios.

Table 3. Energy intensity reduction rates (%) of each scenario

Scenario	2005-2010	2010-2020	2005-2020	2020-2035	2035-2050
Energy-saving	2.7	3.7	3.4 (40.5 % reduction)	4.4	3.4
Low-carbon	3.6	5.0	4.6 (50.7 % reduction)	4.4	3.4
Enhanced low-carbon	3.9	5.1	4.7 (51.5% reduction)	4.5	3.7

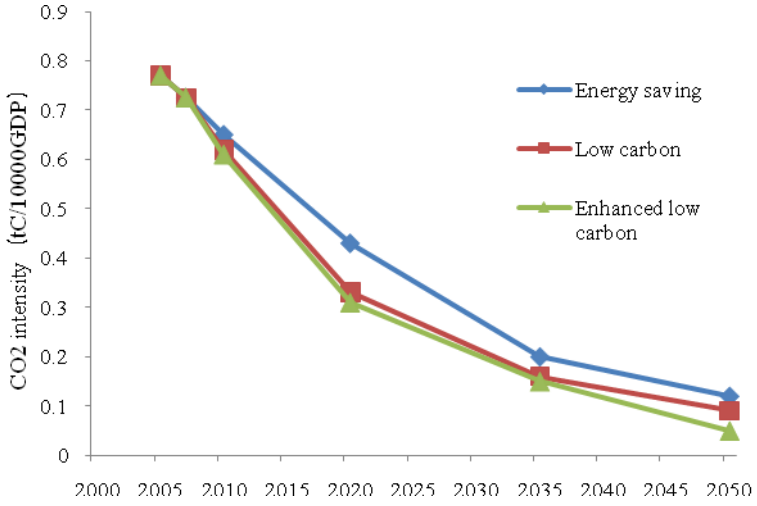
Source: Scenario Report p.85 Table 3-59

According to the Scenario Report, the energy intensity reduction rate during the 11th five-year plan period (2005-2010) will be about 16-17%. This is below the national target of 20% reduction.

3) CO_2 intensity

Figure 3 indicates the changes in CO_2 intensities (carbon emissions per 10000 Yuan GDP)

Figure 3. Changes in CO_2 emissions under each scenario



Source: Scenario Report p.86 Figure 3-30

Table 4 is prepared by authors based on Figure 3, showing the changes in CO_2 intensities under each of the scenarios.

Table 4. Fossil-fuel origin CO_2 intensities under each scenario (CO_2 emissions per 10000 Yuan GDP)

Scenario	2005	2010	2020	2035	2050
Energy-saving	0.77	0.65	0.43 (44% reduction)	0.20	0.12
Low-carbon	0.77	0.62	0.33 (57% reduction)	0.16	0.09
Enhanced low-carbon	0.77	0.61	0.31 (60% reduction)	0.15	0.05

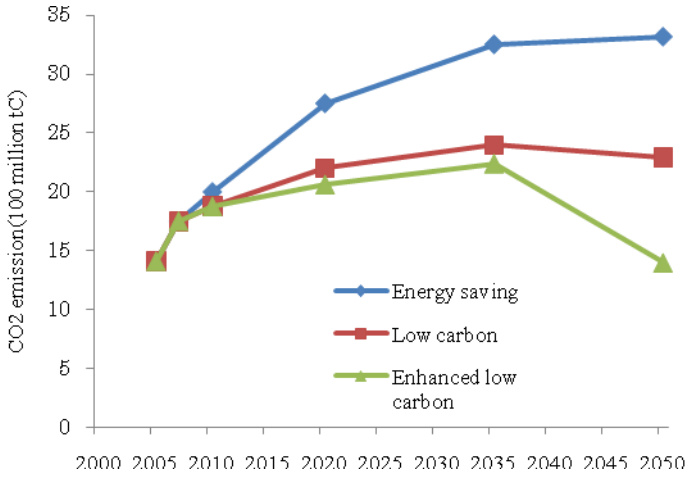
Note: As the values were read from Figure 3, error range can be ±0.01.

Figure 3 and Table 4 indicate that CO_2 intensity will be reduced by 44% from 2005 level by 2020 under the energy-saving scenario, and 57% under the low-carbon scenario. These values are consistent with the results of other studies in China mentioned in section 3, as well as the statements given by government officials in the past.

3) CO_2 emissions

Figure 4 indicates the changes of CO_2 emissions under each scenario.

Figure 4. Changes in CO_2 emissions under each scenario



Source: Scenario Report p.86 Figure 3-29

Table 5 is prepared by authors based on Figure 4, and indicates the changes in CO_2 emissions under each scenario.

Table 5. Fossil-fuel origin CO_2 emissions under each scenario (100 million tC)

Scenario	2005	2010	2020	2035	2050
Energy-saving	14.09	20.00	27.50	32.50	33.15
Low-carbon	14.09	18.76	22.00	23.98	22.90
Enhanced low-carbon	14.09	18.75	20.60	22.37	13.95

Above Figure 4 and Table 5 clearly show the following two findings.

First, the low-carbon scenario projects CO_2 emissions to peak out around 2035. Peak-out time is drawing attention in international negotiations as one of the short to mid-term reduction targets, and an actual "requirement item" of China. Therefore, it is quite significant that China officially disclosed a scenario that identifies peak-out time, even though

the disclosure is made in a form of publishing a report.

Secondly, the scale of emissions reduction from the reference scenario (BAU) is large enough to satisfy EU's request to China. The EU commission requests developing countries as a whole to reduce emissions by 15-30% from BAU scenario by 2020, in order to limit temperature increase within 2 degrees C above the pre-industrial level, and asks China, especially, to make 16% emission reduction in its stuff working document, which is calculated from certain differentiating standards. [7] Although China's Scenario Report does not provide the emissions under a BAU scenario in 2020, we use the EU Commission's projection [8] on China's emission volume (6 billion tCO_2 in 2005→BAU: 12 billion tCO_2 in 2020), to estimate their BAU in 2020 as two times the value of 1.409 billion tC in 2005 or 2.818 billion tC. In that case, reduction from BAU scenario will be 2.41%, 21.93%, and 26.90% for energy-saving scenario, low-carbon scenario and enhanced low-carbon scenario, respectively. The quantity of reduction for each scenario will be 68 million tC, 618 million tC, 758 million tC, respectively. This means that the projected reduction under the low-carbon scenario will fully satisfy the EU's request to China. Furthermore, if China is to achieve 16% emission reduction, they need to reduce CO_2 intensity by 53% from BAU.[9]

4) Iron and steel industry's intensity target

The Scenario Report indicates actual target for each industry. These targets are so-called sector-specific targets, which developed countries such as EU and Japan have been asking China to commit itself to for the last several years.

Table 6 indicates the target values of energy intensity in the iron and steel industry as well as the dissemination rates of their technologies.

Table 6. Technology dissemination rates and energy consumption in iron and steel industry (Low-carbon scenario)

Index	2005	2020	2035	2050
Cokes Dry Quenching (CDQ) dissemination rate (%)		60	80	100
Ratio of smelting reduction method introduction (%)		5	15	50
Pulverized coal injection to blast furnace (kg/t iron)		200	220	230
Top pressure Recovery Turbine (TRT) dissemination rate (%)		95	100	100
Converter gas recovery volume (m3/t steel)		90	100	100
Weight of electric furnace steel (%)		25	45	60
Ratio of iron and steel (%)		0.75	0.65	0.60
Rolling advanced technology dissemination rate (%)		70	80	100
Energy intensity[1] (kgce/t)	760	650	564	525
Comparison with international level	To attain internationally highest level efficiency by 2030			

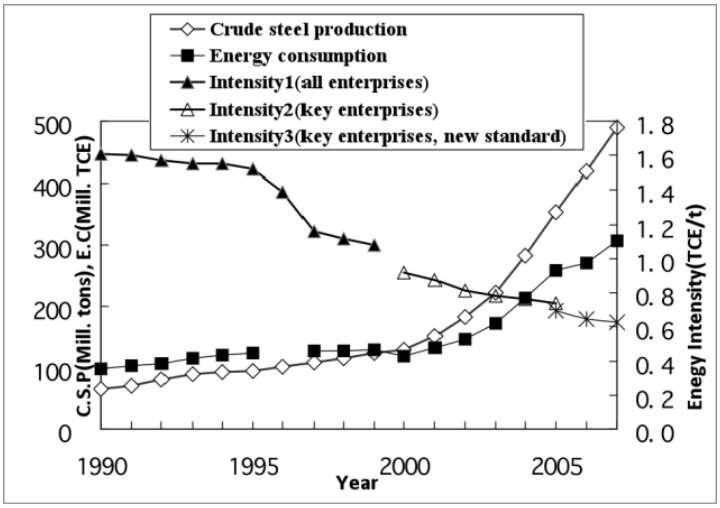
Source: Scenario Report p.151 Table 5-3

[7] EU Commission (2009a, p.77). The value was obtained by applying the quantified targets differentiating indexes on three factors of per capita GDP, per capita GHG emissions, and the population increase.
[8] EU Commission (2009b, p.57)
[9] According to the Scenario Report p.46 Table 3-4, CO_2 intensity in 2020 should be 0.365 (tC/ CNY 10000 GDP), assuming their GDP to reach CNY 65 trillion by 2020. This CO_2 intensity is 53% reduction from 2005 level.

For reference, the following point outlines the current situation and future challenges of the iron and steel industry in China.

Figure 5 indicates the changes of energy consumption and energy intensity (energy consumption volume per unit crude steel production) of iron and steel industry in China. As seen here, energy consumption in China has been increasing as their production quantity expands, but the energy intensity has actually decreased.

Figure 5. Energy consumption and energy intensity of iron and steel industry in China



Source: Kawabata and Chao 2009

As seen here, in energy-saving activities in the iron and steel industry of China, large to mid-scale firms have been playing a certain role. Table 7 compares energy intensities of Japanese and Chinese industries as of year 2004.

From this table, we find that: 1) energy efficiency of the highest level iron works in China is better than the average efficiency of Japanese iron works; 2) The Bao Shan Iron Works, which is at the highest level in China, has reached the level of the most advanced iron works in the world, and the difference between major Chinese iron works and China's highest level iron works has shrunk to 10-15%; 3) considering that the major competitor of Japanese corporations are the highest level iron works in China (that are manufacturing high tech iron and steel products equivalent to Japanese products), their production increase does not necessarily lead to significant carbon leakage[10].

In the background of such a trend is the rapid introduction and nationalisation of energy-saving technologies. For example, the most typical energy saving devise in iron and steel field, Cokes Dry Quenching (CDQ), has been installed or is to be installed in 45 % or more of coke ovens in Chinese iron and steel corporations. (Dan 2008) As shown in Figure 6, the result shows an internationally high dissemination rate.

[10] There is a concern about carbon leakage where emissions reduction in one country leads to emissions increase in another. In the case of high tech steel discussed in this section, however, there is not much difference in energy consumption per unit production. Therefore, the global emissions increase will not be so large, if we do not consider the differences in emission intensities of power generation industries.

Table 7. Comparison of energy intensities between Japanese and Chinese iron and steel industry

（MJ/ton, Year 2004）

		Energy consumption intensity	Cokes production process	Sintering steel production process	Pig iron production process	Converter steel production process	Roll formed process
1	Major Chinese companies	20.64	4.16	1.94	13.65	0.99	2.72
2	Smaller Chinese companies	30.59	6.71	3.18	17.32	2.20	8.40
3	The highest level in China	17.45	2.58 （Bao Shan）	1.52 (Hang Zhou)	11.57 （Bao Shan）	-0.11 (Wu Han)	1.57
4	Average in Japan	19.20	2.78	1.55	11.59	-0.08	1.81
Difference within China	2 - 1	9.95	2.54	1.24	3.68	1.21	5.68
	2 - 3	13.14	4.13	1.65	5.75	2.31	6.83
	1 - 3	3.19	1.58	0.42	2.07	1.10	1.15
Difference between China and Japan	1 - 4	1.43	1.38	0.39	2.05	1.07	0.90
	2 - 4	11.39	3.93	1.63	5.73	2.28	6.58
	3 - 4	-1.76	-0.20	-0.03	-0.02	-0.03	-0.24

Source: Ning Ya-Dong, Yutaka Tonooka, 2008

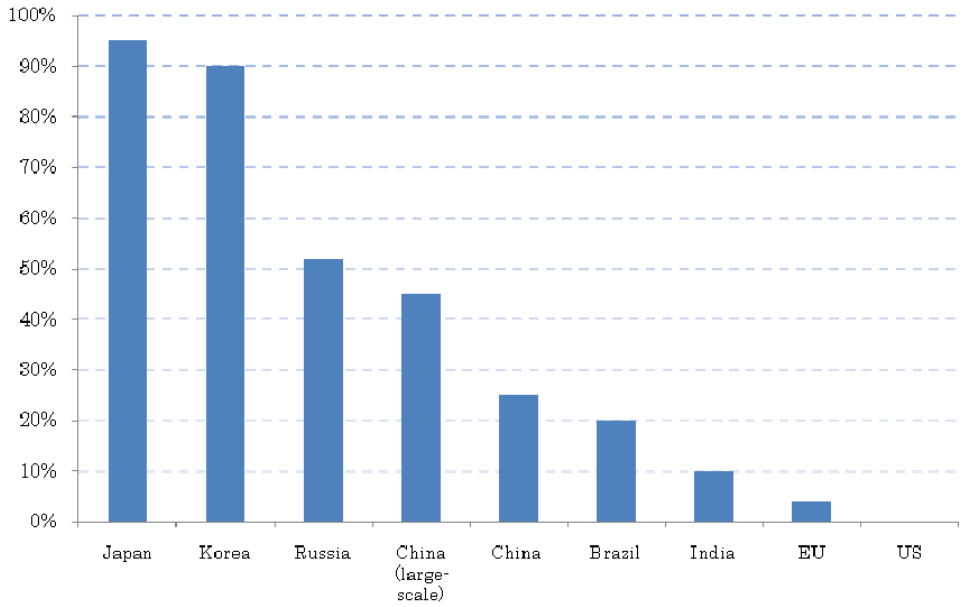
In other words, we find that, with regards to CDQ: 1) its installation is more advanced in China than EU, the US, or other developing countries[11]; and 2) 60% CDQ installation rate in 2020 means that China is to double its current 30% rate in 15 years.

In regards to another typical energy-saving technology in iron and steel industry, Top-pressure Recovery Turbine (TRT) for blast furnaces, 49 out of 56 blast furnaces in China have TRT installed presently. (Dan 2008).

Therefore, the remaining challenges Chinese iron and steel industry faces in terms of energy saving activities are: 1) strong growth of market demands for iron and steel products; 2) dominance of smaller scale blast furnaces; 3) higher ratio of converter processes, and even electric furnaces use greater amount of pig iron raw materials. (Kawabata and Zhao 2009)

[11] CDQ is the technology to recover sensible heat from cokes to generate power. As it was originally invented in Russia, its dissemination rate is quite high in Russia. The reason of lower dissemination in Europe and the US can be varied, but the major reason is their lower energy prices.

Figure 6. International comparison of Cokes Dry Quenching (CDQ) dissemination rates in iron and steel works (Year 2006)



Source: IEA 2006

To overcome such challenges, options may include demand restraints, unification and abolition of small scale blast furnaces, increased use of scrap irons, etc., but in China, as other countries in the world, it is essential to avoid options that may lead to unemployment and hence to social instability. Having said that, it is also true that there have been massive abolition of small scale blast furnaces by the Chinese government[12] In addition, it will take to time to accumulate proper amount of scrap irons will take time. What China needs for the future is the introduction of advanced technology that has not been commercialised or thoroughly disseminated even in Japan (such as molten reduction process or CCS). Therefore, the Chinese situation is not so simple as stating that "everything will be resolved if Japan transfers its technologies."

5) "Potential" CO_2 emissions in major countries in 2050

The Scenario Report actually contained the following numerical points and discussions of interests, as seen in Table 8, based on the IPCC scenario to cap atmospheric concentration of 550ppm (CO_2eq) that aimed to limit temperature increase within 3 degrees C rather than 2 degrees C from the pre-industrial level. The table was prepared by the National Development and Reform Commission Energy Research Institute Taskforce. In the Scenario Report, the task force argued that "considering the tardy pace of developed countries' responses, stabilisation at 500-550 ppm (i.e. 2.8 to 3.2 degrees C temperature increase since pre-industrial) will be more realistic."

[12] It can be said that ambitious efforts to merge, abolish, and close plants and corporations of energy consuming industry are ongoing in China. According to the Chinese Government, for example, thermal power plants closed between January and May of 2008 were 868 units with combined capacity of 5.79 million KWh. Among them, 133 units (4.49 million KWh) was coal fired plants, 681 units (0.83 million KWh) petroleum fired plants with average capacity of 6700 KWh per unit. Average capacity of closed coal power plants was 34000 KWh. Total asset of closed thermal power plants was CNY11.7 billion (or about JPY175.5 billion Yen), with debt amount of CNY6.7 billion Yuan (or about JPY100.5 billion Yen). Number of people affected by the closures is 56000, and 39000 among them are employees. Closure of small scale thermal power plants was implemented in 18 provinces and autonomies. In view of regional distribution of plant closures, the ratio was much higher among private companies in remote regions with the total of 3.69 million KWh capacity closed, which shared 64% of the total (China Information Agency SearChina, July 1, 2008)

Table 8. CO_2 emissions potential for major countries in 2050 (assuming 550ppm CO_2)

	EU (100 million tCO_2)	Annex 1countries (100 million tCO_2)	China (100 million tCO_2)
1990	40.05	171.48	36.5
1994	38.80	162.67	56
2020	28 - 32	120 -137	91.39 (Note)
2050	8 - 16	34 - 69	Reduction
2020 (from 1990 level)	20% - 30% reduction		60% increase
2050 (from 1990 level)	60% - 80% reduction		Reduction

Note: This number is in between the one for energy saving scenario (10.08 billion tCO_2) and the one for low-carbon scenario (8.067 billion tCO_2).

Source: Scenario Report p.130

5. International comparison of commitments

In the case of international comparison of "participation" or "efforts" for the international framework on global warming, key points will be whether national commitments are fair or not, i.e. whether nations are differentiated on the basis of equal criteria. Among researchers, at least, there is a consensus that the differentiation criteria need to involve the following three elements: 1) accountability (for example: per capita emissions; 2) capability (for example: per capita GDP); and 3) potentials (for example marginal reduction costs or cost vs. GDP).[13]

Let us look at these three elements of accountability, capability and potential in relation to China's quantified target. First of all, in terms of accountability and capability, China's per capita emissions are about a half of those in developed countries at present, while per capita GDP is less than one-tenth. (Considering the historical accumulation of emissions, the gap between China and developed countries becomes even wider.) About the potential, the Scenario Report has no reference to the number of marginal reduction cost in China. Whether this number is available or not, however, it is difficult to use marginal reduction cost alone as the differentiation criteria to differentiate developed and developing countries, considering the large difference in their per capita GDP and disposable income.

Let us now consider domestic energy prices. For the last several years, China saw a drastic rise in domestic energy prices. For example, Shanxi Province, which is considered as the energy base of China, implemented various new taxes or tax increases in 2007 to 2008 that included: 1) the establishment of a trade market; 2) a new tax of CNY15 /ton imposed as the reserve fund for Maintenance Cost Fund; 3) resource tax was raised by CNY 2.5 to 3.2 /ton; 4) the resource compensation cost was raised from 1% of sales revenue to 3-6%; 5) payment per ton of mining right establishment was auctioned off (CNY 6 /ton of reserve on average); 6) new tax was imposed as the contribution for Coal Sustainability and Development Fund, which was CNY 14 /ton for ordinary coal, CNY 18 /ton for anthracite, and CNY 20 /ton for coking coal; 7) a new tax of CNY 10 /ton

[13] The Mid-term Target Review Committee of Japan held in 2008 and 2009 addressed such emission reduction potential as a sole differentiation criteria. This was because: 1) the Review Committee's main task was to make international comparison of potentials among developed countries, such as EU and the US; and 2) in the calculation of reduction potential, Japan had comparatively smaller reduction requirement than other developed countries. However, the Committee's work was undoubtedly insufficient in determining reduction target, as it over-emphasized the comparison of cost burdens, while failing to address the issues of accountability and institution. In regards to the comparability of reduction targets of developed countries, refer to Elzen et al. (2009) and Asuka (2009).

was imposed as environmental cost; and 8) a new tax of CNY 5 /ton was imposed as a Coal Industry Conversion Fund. Because of these new taxes and tax increases, it was estimated that the production cost of coal rose by CNY 70-80 /ton. (Horii 2008) After July 2008, China implemented further drastic price increases, such as a 16.7% price increase for gasoline, 18.1% for light oil, and CNY 0.25 /kWh in average electric power prices (about a 4.7% increase).

Because of these tax burdens, today's domestic energy prices in China are not lower but higher than those of developed countries in many cases. According to the data given in the Scenario Report, for example, the end price of coal for power stations as of 2006 was USD62.3 /ton for China, while those for the US and Japan were lower than China at USD 38.6/ton and USD 51.5/ton, respectively.([14] the exchange rate of USD 1 = CNY7.979). In addition, the electric power price for industrial use as of 2006 was USD 0.065 /KWh for China, USD 0.061/KWh for the US, USD 0.051/KWh for France, and USD 0.065 /KWh for Republic of Korea.

Furthermore, the Chinese Government has already implemented voluntary export control for energy consuming industry and their products. To be specific, their measures include: 1) from July 2007, 2831 items from energy consuming industries were excluded from export promotion tax rebate system; 2) from August 2007, the taxes on lead, zinc, copper, tungsten, etc, were increased by three to sixteen times; 3) from July 2007, 15% export tax was imposed on certain aluminum products; 4) from January 2008, export tax on semi-products of iron and steel industry, such as steel rods, reinforcing rods, thin plates, etc. was increased by 15%; and 5) from January 2008, export tax on iron and steel products, ferrous alloy, cokes, steel billet, etc was increased by 25%.

Actually, trade friction has already occurred between China and the US over iron and steel products. [15] According to Chen (2008), the number of anti-dumping lawsuits in the US against China was largest in iron and steel products and their industry, with 23 cases from 1990 to 2006. (As a single country, China received the largest number of anti-dumping lawsuits.) As a way to avoid trade frictions, China's iron and steel industry is exploring new markets other than the US, and China's share in the iron and steel imports to the US declined from 11% in 1998 to 7% in 2005.

Nevertheless, the Chinese Government adopted the above measures to reinforce export control over energy consuming and less value-added products, while avoiding their trade partners imposing trade restriction against China. [16] These measures are as effective as having the EU and the US imposing border tax adjustment to Chinese products, which is what the EU and US are reviewing to adopt as a measure to address the issue of losing international competitiveness due to international asymmetry in global warming measures. [17] In fact, the implementation of such export restriction measures introduced by the Chinese Government has led to an actual decrease in the amount of Chinese exports. [18] Wang and Voituries (2009) estimated that "the voluntary export control China implemented from 2006 to 2008 in the form of new tax and tax increase would be equivalent to 30-40 Euro/t-CO_2 of national border tax adjustment implemented by importers for iron and steel products, and 18-26 Euro/t-CO_2 for aluminum products." In other words, these Chinese export products already have their carbon priced at the level equivalent to EU ETS prices.

[14] Calculated at an exchange rate of USD1 = CNY7.979, which is approximate to the current exchange rate. In regards to the international comparison of energy prices, Hoshino et al., (2009) noted the low energy prices in the US.

[15] It was often said that trade friction between US and China transferred from the fiber industry to the steel industry.

[16] The purposes of introducing these measures include not only climate change measures and air pollution prevention measures, but also tax revenue increase for an exporter country. Since the purposes and effects will differ depending on price elasticity and market situation (for example: price determinant or price follower?), it is difficult to determine what is the primary purpose. It must be determined case by case. In the case of China, however, the primary purpose is likely be energy saving.

[17] Muller and Sharma (2005) identified the significance of voluntary export control introduced by developing countries as a form of their commitment.

[18] However, following global economic crisis started in 2008, China has reviewed the exceptions to the rebate system. Drogue (2009) indicated that "China's voluntary export control is a practical carbon constraining measure, but the problem is that the measure is not permanent and not transparent."

Considering the above discussion as well as the equity in the international community, it is not easy to justify singling out China and requiring it to commit to quantified targets, without any stringent commitments from more advanced economies. China is a developing country and has already imposed policies that practically restrict carbon emissions. Of course, China is also a political/economical superpower and there is pressure and expectation from the international community that China will act as a superpower. Therefore China itself seems to be stepping up to the announcement of quantified commitment, in today's dynamics of international politics.

For reference, Table 9 shows an international comparison of today and year 2050 in various indices given by the Scenario Report.

Table 9. Comparison of China in 2050 and Japan and the US of today

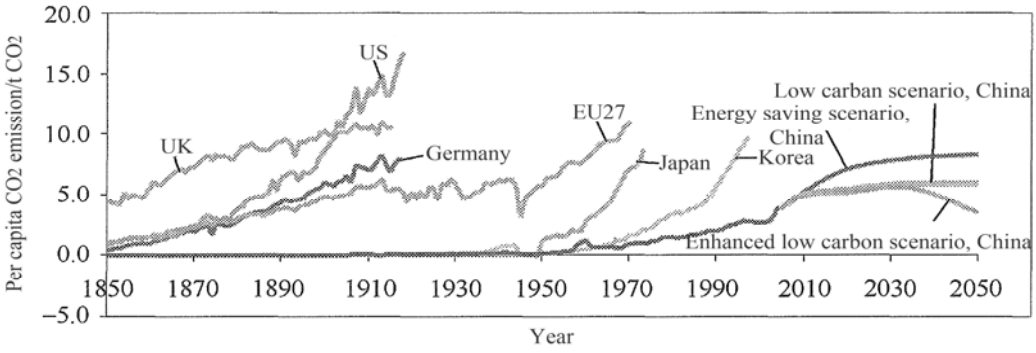
	US (2006)	Japan (2007)	Chinese scenario		
			2008	Energy-saving scenario (2050)	Low-carbon scenario (2050)
GDP/cap (US$)	37842	39748	3236	24921	24921
Energy consumption/cap （tce）	7.75	4.38	1.50	3.21	2.67
Power usage/cap (kWh)	14295**	8520*	2463	7305	6751
Residential power usage/cap (kWh)	4598*	2688**	161	1209	874
CO_2 emissions /cap (t CO_2)	19.3	9.7	4.3**	8.3	6.0
CO_2 storage/cap (t CO_2)	1110*	335*	71	383	310
Iron and steel production/cap (t)	0.33	0.95	0.4	0.29	0.21
Cement production/cap (t)	0.32	0.52	1.1	0.68	0.48
Iron and steel stock/cap (t)	22.5	36.5	3.7	22.0	18.0
Cement production stock/cap (t)	15.3	27.4	10.9	52.1	42.8
Passenger cars per 1000 persons	808	440	38.4	415	382

Source: Scenario Report p.147

Note: For calculating GDP in 2050, CNY/USD exchange rate used was 1:8.2. For calculating GDP in 2005, it was 1:7.

* - Value for year 2005, **- value for year 2006, and ***- value for year 2007.

Figure 8. Trends of CO_2 emissions per capital in various countries



Source: Scenario Report p.86 Figure 3-29

Figure 9 (a). Per capita CO_2 accumulation various countries

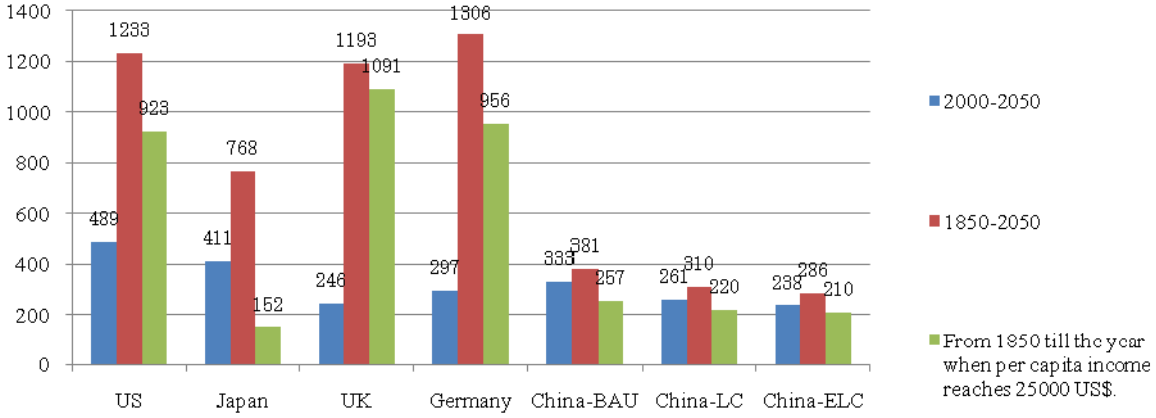
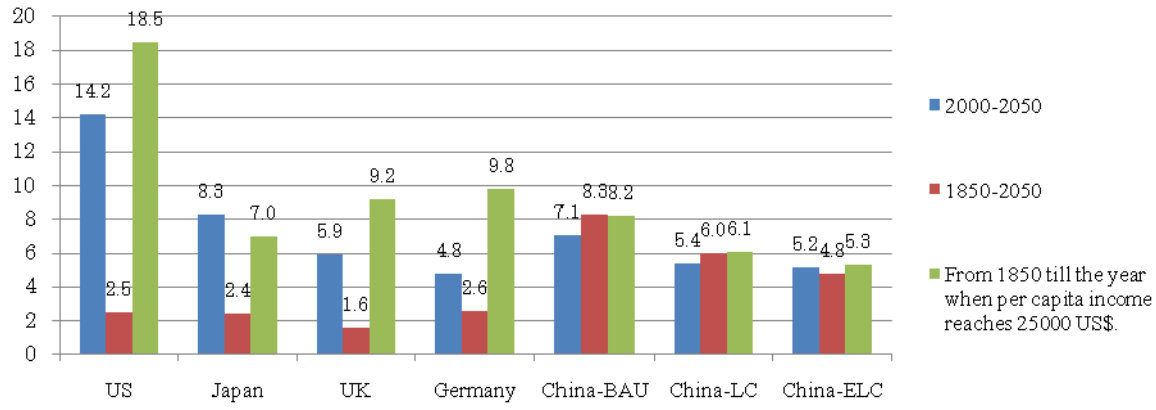


Figure 9 (b). Per capita CO_2 emissions of various countries



Source: Scenario Report p.140 Figure 4-62

Values and numbers discussed hereunder can be interpreted in various ways. First of all, it is difficult to estimate how fast technology advances, or how the world will change in several decades' time.

After interviewing several policy-makers in China, what the people of the developing world including China feel could be summarised in the following way: "It will take us 50 years to catch up with today's developed countries in terms of per capita GDP. Yet, we are asked to make the commitment that our per capita energy consumption, CO_2 emissions, electric power usage, and production and stock of iron and cement of 50 years from now will be lower than the current level of those in developed countries. We are the ones to suffer the most from global warming. (In the case of China, even a population control measure has been implemented.) Commitments made by developed countries today are far below the level required to limit temperature increase to less than 2 degrees C from the pre-industrial level (i.e. emissions reduction target of 20-45% from 1990). Moreover, developed countries have not fully met their existing commitments on financial and technological support. Considering these facts, it is totally unfair to us".

Of course, whether the amount of iron and cement production can correlate to the degree of affluent living or development of civilization is another matter. There is no easy answer to it. In addition, commitments made by developed countries differ significantly from one nation to another, so that one cannot make a generalised criticism of these countries. According to Figure 9, China's per capita CO_2 emissions in 2050 will be more than those of developed countries, if these countries are to drastically reduce their emissions by 80% from 1990 level, reaching twice as much as the global average. The authors of the Scenario Report were fully aware of such a fact, and argued that "the pressure to China will even increase by then, so China needs to make further reduction after 2050." Nonetheless, these are difficult issues linked to value judgments of individuals, such as "what is prosperity", and "what is fair."

6. Conclusion and future prospects

As discussed here, China has long carried out extensive discussions on the issue of CO_2 intensity at the researcher and policy-maker levels. Moreover, President Hu Jintao proposed four targets in his speech at the UN, which were in accordance with "basic elements of the commitment the US is asking China to adopt" proposed at the US-China negotiator dialogue held several times since the inauguration of the Obama administration.[19] Considering these developments, therefore, it was anticipated that China would very likely announce an actual number for its commitment in the form of statement by Chinese top officials at a certain time and this actually happened just before COP 15[20]. The fact that the Chinese Government announced these numbers despite the risk of "stand alone" at this juncture, three months before COP 15, can be construed as the Chinese Government forestalling the negotiation trump card before developed countries, in particular the US, could show their cards.

The authors believe that the Chinese Government judged that the merit of sending out a positive message depicting an actual commitment number would surpass any risks of having their target and number go out of control. This is similar to the situation in which Japanese Prime Minister Hatoyama sent out a message to the international community that he would take the initiative on this issue, by drastically changing the commitment made by the past administrations.

Still, the Scenario Report discussed in this report is merely a calculated result based on a certain assumption. Whatever its number would be, the introduction of various technologies and policies and measures is a must and essential. China cannot "achieve anything by not doing anything."

In any case, what can be expected is the further acceleration of the dynamics of international politics in a positive direction, and the deepening of

[19] From the author's interview of Chinese government official.
[20] As for the commitment announced just before COP15, refer to Asuka and Lu (2009).

communication between China and the international community.

Reference

Asuka, Jusen. 2008. Considering the issue of Chinese "participation in the international framework of global warming measures, *Environmental Research*, 2008, no.150:26-37.

Asuka, Jusen. 2009. Comparability of developed countries' reduction targets (efforts), presentations at the WWF Japan School's "Copenhagen 2009", a series of study meetings for the new framework agreement on climate change after 2013, held on April 24, 2009. http://www.cneas.tohoku.ac.jp/labs/china/asuka/

Asuka Jusen and Lu Xiangchun 2010. Quantified emissions reduction target of China-Assessing the Chinese target of 40-45% reduction in CO2 intensity, IGES Working paper, IGES, Hayama, Japan.

Droge S.2009. Tackling Leakage in a World of Unequal Carbon Prices, *Climate Strategies,* 1 September 2009.

den Elzen MGJ, N. Hohne, J. van Vliet and C. Ellermann.2009. Exploring comparable post-2012 reduction efforts for Annex I countries. Netherlands Environmental Assessment Agency report 500102019. http://www.pbl.nl/en/publications/2009/Exploring-comparable-post-2012-reduction-efforts-for-Annex-I-countries.html

EU Commission. 2009a. COMMISSION STAFF WORKING DOCUMENT Towards a comprehensive climate change agreement in Copenhagen- Extensive background information and analysis-PART 1-{COM(2009) 39 final}{SEC(2009) 102} http://ec.europa.eu/environment/climat/future_action.htm

EU Commission. 2009b. COMMISSION STAFF WORKING DOCUMENT Towards a comprehensive climate change agreement in Copenhagen- Extensive background information and analysis-PART2-{COM(2009) 39 final}{SEC(2009) 102} http://ec.europa.eu/environment/climat/future_action.htm

Hoshino, Y., D. Sugiyama, and T. Ueno. 2009. International comparison of energy prices – from the viewpoint of global warming mitigation measures. report of Central Research Institute of Electric Power Industry Y08027.

Horii, N. 2008. Is coal still a bottleneck? – Direction of fundamental reform in the 11th five-year plan, East Asia, March 2008, no. 489:24-38.

IEA (International Energy Agency) 2007. Tracking Industrial Energy Efficiency and CO_2 Emissions, 2007.

Jiang, KJ, Hu, XL, Zhuang, X, Liu, Q. 2009. China's Low Carbon Scenario for 2050 and Pathway for Low Carbon Development. *Energy of China and World, 2009,* vol. 6: p1-7. http://www.eri.org.cn/manage/upload/uploadimages/eri20090630132954.pdf

Kawabata, N. and Zhao Y. 2009. Energy consumption and CO2 emissions of Iron and Steel Industry in China. Report Reference Paper submitted for the Autumn Annual Meeting of the Iron and Steel Institute of Japan, September 15, 2009.

Development Research Center of the State Council, National Development and Reform Commission Energy Research Institute, and Tsinhua University. 2009. *China's energy and CO_2emissions in 2050*, *Science Press.*

Muller, B and A.Sharma. 2005. Trade Tactic Could Unlock Climate Negotiations. *SciDev.Net*.

National Development and Reform Commission Energy Research Institute Taskforce. 2009. *China's path of low carbon development to 2050: Energy demand and supply and CO_2 emission scenarios, Science Press.*

Ning, Ya Dong, Y. Tonooka. 2008. Production Forms and Energy Consumption Structures of Chinese Iron and Steel Industry. *Energy Resources*, 2008, vol.29, no.5:313-318.

Dan, Shang Hua. 2008. Promoting energy saving and emission reduction to build green iron and steel industry. *Chinese Iron and Steel Industry*, June 2008, vol. 57. Chinese Iron and Steel Industry Association.

Chen, You Jun (2008), "US's anti-dumping measure against China: Case of iron and steel industry", *Asian Studies*, Vol.54, No.3, p.19-34, April 2008, Asian Political and Economic Academy.

Li, Zhi Dong. 2009a. China to aim for 'fruits' rather than 'theory', web site of Asahi Shimbun: http://www.asahi.com/eco/forum2009/news/j/TKY200909140076.html、2009/9/14.

Li, Zhi Dong. 2009b. *Trend of China's global warming measures with the Congress taking actions*. Japan Energy Economy Research Institute, http://eneken.ieej.or.jp/ 2009/9/16.

Wang Xin and Voituriez Tancrede. 2009. Can unilateral trade measures significantly reduce leakage and competitiveness pressures on EU-ETS-constrained industries?: The case of China export taxes and VAT rebates. Climate Strategies Working paper, Jan.21, 2009.

CONTACT **Institute for Global Environmental Strategies**
2108-11 Kamiyamaguchi, Hayama, Kanagawa, Japan 240-0115
Tel: 81-46-855-3860 Fax: 81-46-855-3809
URL: http://www.iges.or.jp
Email: cc-info@iges.or.jp