An Analysis of China's INDC

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On 30 June 2015, the Chinese government submitted its Intended Nationally Determined Contribution (INDC), detailing its commitment to climate change mitigation and adaptation for the post-2020 period. Highlights of the INDC include specific goals such as:

- To achieve peak carbon dioxide emissions by approximately 2030, or sooner as best efforts allow;
- To lower carbon dioxide emissions per unit of GDP by 60% to 65% from 2005 levels;
- To increase the share of non-fossil fuels in the primary energy mix to approximately 20%;
- To increase the volume of forest stock by approximately 4.5 billion cubic meters over 2005 levels; and
- Continue to proactively adapt to climate change through: enhanced mechanism- and capacity-building; the effective management of climate change risks in sectors such as agriculture, forestry, and water resources and in regions including urban, coastal, and ecologically vulnerable areas; improved early warning and emergency response systems and disaster prevention and mitigation mechanisms.

This article offers an analysis of China's INDC in terms of its basic assumptions and considerations, the ambition and fairness of the intended contributions, and the obstacles and challenges facing China in achieving these goals.

1. Basic Assumptions and Considerations

The recent IPCC Fifth Assessment Report further confirmed the imminence of climate change based on science and observed facts. The international community is faced with a serious challenge in addressing climate change and achieving its target of capping the increase in the average global temperature at 2°C. Low-carbon development has emerged as a mainstream trend of development worldwide, and is indeed a necessary condition for achieving sustainable development. In this context, the INDCs proposed by each country should be motivated by an interest in containing the risks of climate change and actualizing equitable opportunities to achieve sustainable, low-carbon development.

Even though China has become the largest carbon emitter and the second-largest economy in the world, its main development indicators and the ongoing bifurcation of rural and urban economic structures demonstrate the fact that China is still a developing country. This implies significant differences between China and developed countries in terms of their respective stages of development, development needs, historical responsibilities, and over capacity. China’s foremost strategic priorities continues to focus on poverty alleviation, increasing incomes, bolstering social security, expanding coverage of public services (including infrastructure), and generally raising the standard of living. Meanwhile, China's traditional input-heavy growth model is no longer sustainable. Constrained by limited resources and environmental pressures, China risks falling into the “middle-income trap.” China must therefore seek an innovative new path of development and upgrade its growth model to a “new normal”: shifting the drivers of growth from the quantity of input to the efficiency of input; reducing dependence on energy, resources, and environmental inputs; cultivating new growth points and competitive advantages; and adopting a low-carbon, efficiency-focused path of development.

The system of indicators underlying China’s INDCs reflects the need for transformation and innovation in China's model of development; these indicators include an intended time target for peak emissions and quantitative indicators designed to evaluate carbon efficiency (including targets for carbon intensity, share of non-fossil fuels, and carbon sinks). China is committed to changing its path of development; exploring innovative, sustainable and low-carbon models that differ from the traditional development pathways of both the US and the EU; and creating the technological, financial, and other conditions necessary to achieve this transformation.

China’s INDC also contains a range of implementation measures and policies designed to mitigate existing climate change risk and fulfill the INDC's mandate across mitigation, adaptation, financing, technology development and transfer, capacity building, and transparency. China's INDC also calls for broadening and deepening south-south cooperation on climate change, including the establishment of a fund for south-south climate cooperation.

2. Ambition and Fairness of Contributions

On the whole, the INDC demonstrates China's overall determination to take serious action on climate change, control greenhouse gas emissions, strengthen adaptation capacity, and actively engage in global governance, including the acceptance of reasonable international commitments.

A. The implementation of China's INDC will promote economic decoupling from carbon emissions.

As can be seen from Table 1 and Figure 1, economic growth is the major contributor to the increase in China's carbon dioxide emissions. Relative to 2005, China's GDP per capita will grow 3.2x, 5.2x and 11x by 2020, 2030, and 2050, respectively. Implementation of the INDC can contain the increase of China's energy-related CO_2 emissions over the same time period to 1.8x, 2x and 0.84x, respectively. This indicates a decoupling between China's economic growth and carbon emissions; that is, the economy's dependence on carbon will be reduced, creating more favorable conditions for the transition toward a low-carbon path of development.

The major reason for the decoupling will be the decrease in energy intensity per unit of GDP (which in turn will benefit from industrial restructuring and improved energy efficiency) and the decarbonization of China's energy mix. By 2030 and 2050, China's energy intensity per unit of GDP will drop roughly 57% and 82%, respectively, relative to 2005 levels, while its carbon intensity per unit of energy will drop by 20% and 61%, respectively.

In particular, during the period of 2005 to 2020 and the period of 2020 to 2030, the contribution from decreasing energy intensity will be more significant than the decarbonization of the energy mix. From 2030 onward, the contribution from the decarbonization of energy will become more pronounced.

Table 1 Major factors in implementation of China's INDC (2005=100)

	2005	2010	2015	2020	2030	2040	2050
Population	100	103	105	108	112	112	111
GDP per capita	100	166	235	321	517	783	1103
Energy intensity per unit of GDP	100	81	68	59	43	29	18
Carbon intensity per unit of energy consumption	100	98	94	89	80	63	39
Energy related CO_2 emissions	100	135	158	182	201	158	84

Sources: Data for 2005 and 2010 is from *China Statistical Yearbook*, *China Energy Statistical Yearbook* and China's official review of target completion. Data after 2015 is developed based on INDC scenario study results calculated by the PECE model of NCSC and Renmin University of China.

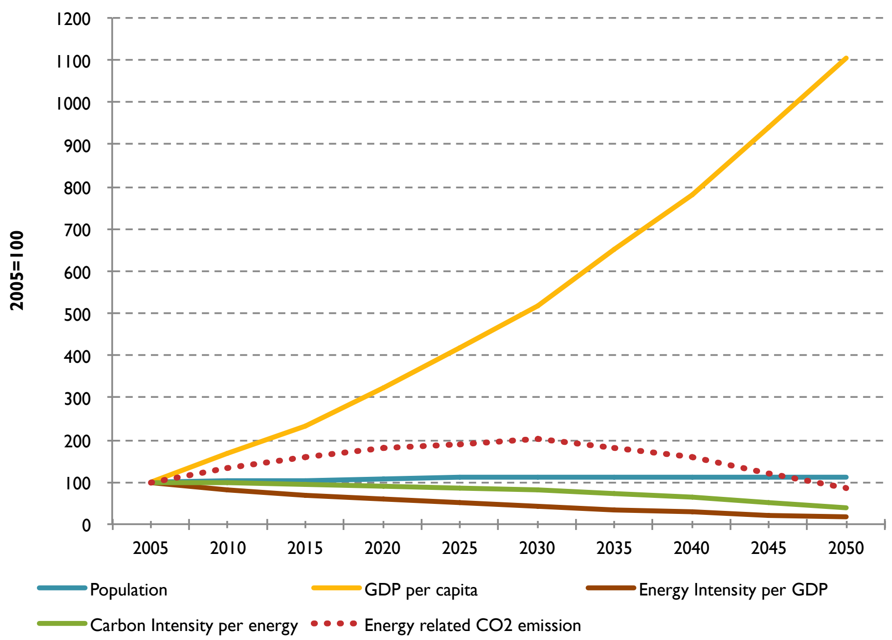

Figure 1-1 Change of major driving factors after the implementation of INDC in China (2005 = 100)

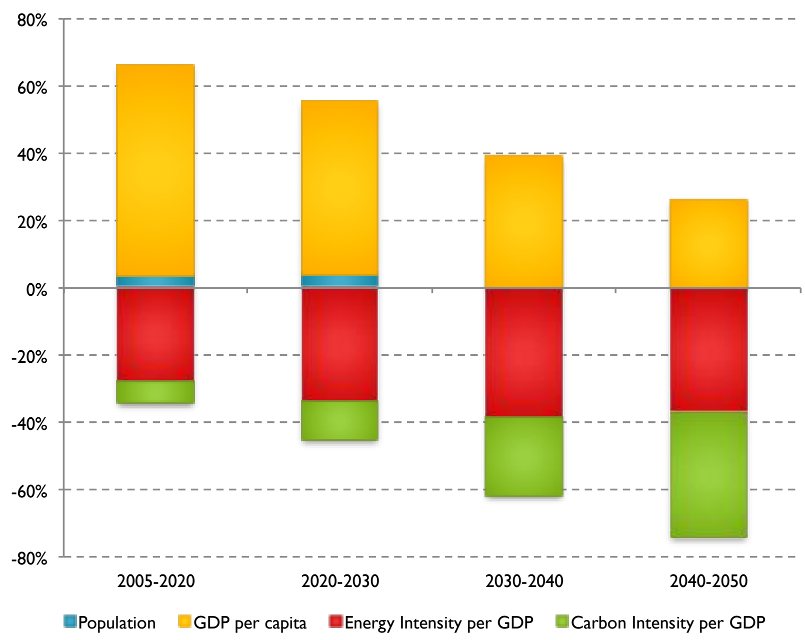

Figure 1-2 Decomposition of the change in China's energy–related CO2 emissions

Sources: Data of 2005 and 2010 are from *China Statistical Yearbook*, *China Energy Statistical Yearbook* and the China's official review of target completion. Data after 2015 is developed based on INDC scenario study results calculated by the PECE model of NCSC and Renmin University of China.

B. China's emission reduction efforts after 2020 will be further strengthened compared to its 2020 commitments

Table 2 demonstrates that by the period of 2020-2030, the annual rate of decline of China's CO_2 emissions per unit of GDP will be further enhanced from 3.9% in the 2005-2020 period to 4.4%, with the potential to reach 6.3% in the 2030-2040 period and 9.2% in the 2040-2050 period. Meanwhile, China will speed up the deployment and construction of non-fossil energy projects, promoting an increase in the growth rate of non-fossil energy sources. By 2030, China's installed capacity of non-fossil power is expected to increase by approximately another 900 gigawatts from the 2014 level, roughly equivalent to the country's installed thermal power capacity in 2014, and much higher than U.S. and European levels over the same period (see Figure 2). Average annual installation of non-fossil power generation capacity will increase from 41.5 gigawatts in the period of 2005-2020 to 62.8 gigawatts during 2020-2030, and to 90 gigawatts in the 2040-2050 period.

Table 2 China's action in reducing carbon intensity and developing non-fossil energy

	2005-20	2020-30	2030-40	2040-50
Annual average rate of decrease of CO2 intensity per unit of GDP	3.9%	4.4%	6.3%	9.2%
Annual average newly installed non-fossil power generation capacity (GW), among which	41.5	62.8	79.6	90.1
Wind power (GW)	13.9	23.0	31.0	35.0
Solar power (GW)	7.0	24.5	33.0	40.8
Nuclear power (GW)	3.4	9.0	9.3	10.5

Sources: Developed based on INDC scenario study results calculated by the PECE model of NCSC and Renmin University of China. The carbon intensity and non-fossil target in 2020 are calculated as 45% and 15%, and in 2030 as 65% and 20%, respectively.

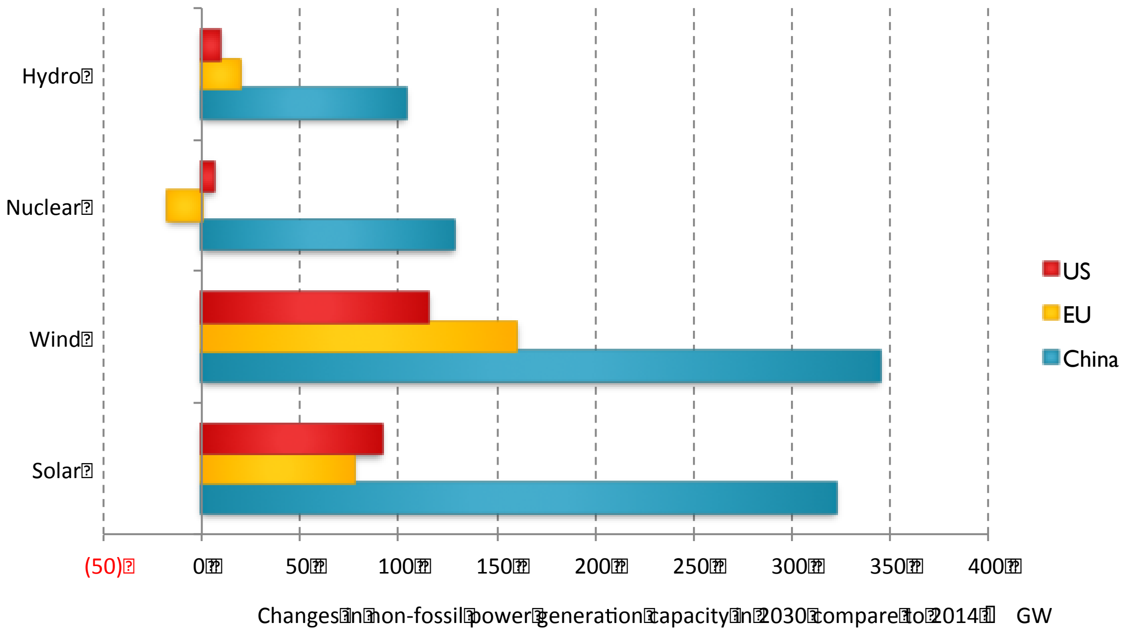

Figure 2 Change in non-fossil generation capacity in 2030 compared to 2014 (GW)

Source: Developed based on INDC scenario study results calculated by the PECE model of NCSC and Renmin University of China. U.S. and EU data are from *World Energy Outlook 2015 Special Report* by IEA, covering the change by 2030 over 2013.

C. As a country starting late in its development, China has the potential to achieve the following transformation through implementation of its INDC targets, and to achieve an innovative development pathway that will be less carbon-intensive and peak lower and earlier, with lower income levels than other developed countries

Seen from the historical CO_2 emissions trajectory of major economies, there exists a Kuznets curve (an inverted 'U' curve) relation between economic development levels and CO_2 emissions per capita, i.e., along with the increase of GDP per capita, the level of CO_2 emissions per capita will experience continual growth until reaching a peak and then dropping. Although the level of emissions peaks vary, until today, no economy has avoided this trend of "dropping after growing".

For major developed countries, their CO_2 emissions per capita peaked at around 10-22 tons when their GDP per capita reached around 20,000-25,000 US dollars per annum (in 2010 price levels). Yet according to China's targets set in the INDC, it is possible that China's CO_2 emissions per capita will peak at around 8 tons when its GDP per capita reaches around 14,000 US dollars. This is a major feature of China's innovative development pathway as a country starting late in its development. If taking consideration of China's position as the "world's factory" and its abundant coal resources, it is likely that the peak values of consumption-based emissions and energy use will be lower than those of developed countries.

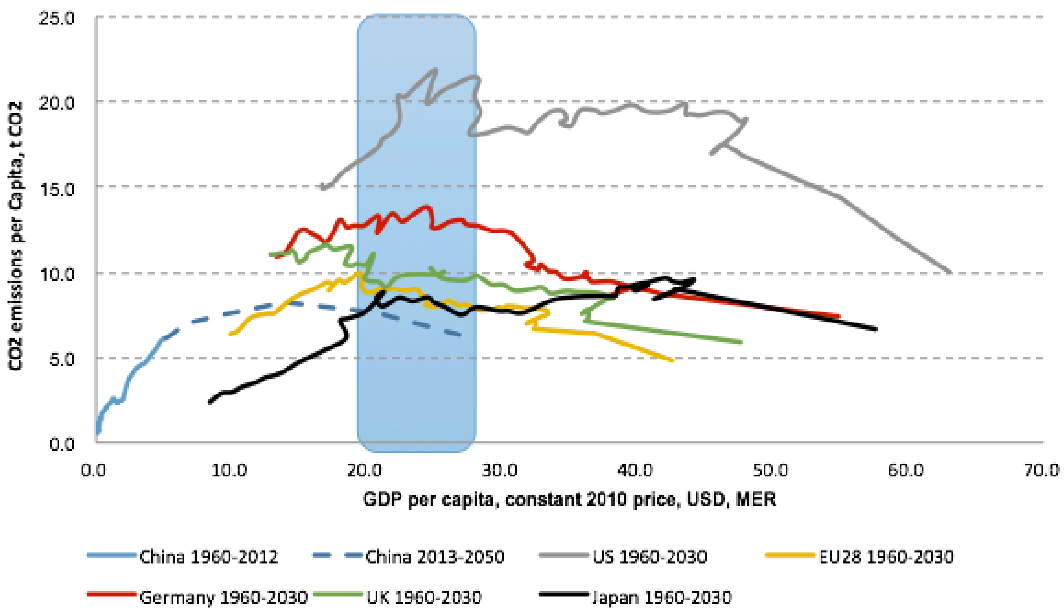

Figure 3 Trajectory of GDP and CO_2 emissions per capita of major economies

Data sources: only contains energy related CO_2 emissions. Data of historical CO_2 emissions from 1960 to 2012 is quoted from CDIAC. Population and GDP information are cited from the

World Bank. Data after 2012 is calculated based on INDC targets of each economy.

D. If China can realize its 2030 targets proposed in the INDC, it will lay a solid foundation for China to further transform its development pathway to achieve the global goal of limiting warming within 2°C

According to multiple scenarios with more than 50% probability to achieve the 2°C target in the IPCC's Fifth Assessment Report which are consistent with China's actual situation, the emission reduction requirement for China by 2030 is almost coherent with the emission reduction target China sets in its INDC. However, the key focus is on whether China could accelerate the pace of decarbonization after peaking in 2030. That is to say, if China could decarbonize at a faster rate after achieving its 2030 goals, it is possible that China's long-term development pathway will meet the international goal of holding the increase in global average temperature below 2°C. As demonstrated in Figure 4, the dotted lines, standing for the simulated emission footprints under the INDC scenario (before and after energy data readjustment), fall right into the range (in purple shade) of multiple IPCC AR5 scenarios which are coherent with the 2°C temperature goal, in line with China's actual situation. Since China's INDC contains practical arrangements in technology, finance, policy mechanisms and capacity building geared towards an innovate development pathway, and it is committed to avoiding the lock-in effect of urbanization, infrastructure construction and high-carbon industry through scientific planning (urban spatial layout) and administrative orders (limiting increases in high-energy consumption industry), it is safe to conclude that through implementation of the INDC, China will build up its development philosophy, public opinion, policy and institutional reserve, technological reserve system, innovation capacity, capital stocks and flows, comprehensive and specialized capabilities, laying a solid foundation for transformation at a faster rate after 2030.

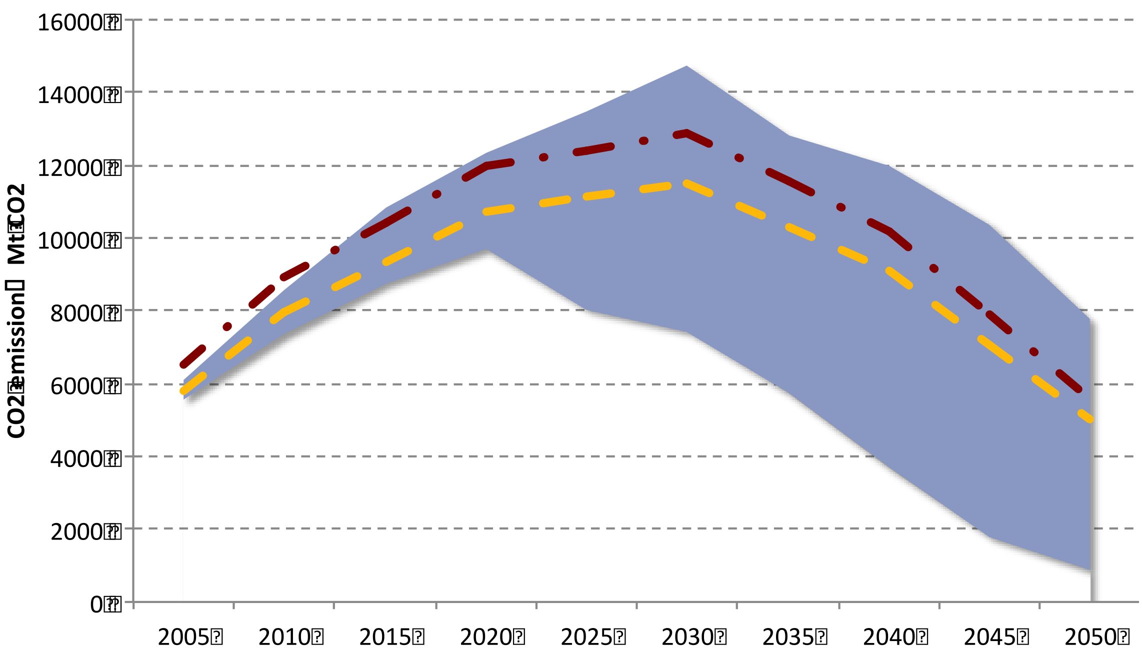

Figure 4 Relations between China's INDC scenario and IPCC 2°C Scenario

Note and sources: the purple shade stands for a range of multiple possible scenarios from the IPCC AR5 scenario database (more than 50% probability to achieve 2°C goal) that meets China's actual situation, including scenarios developed by global models like GCAM, IMAGE, MERGE, MESSAGE, POLES, REMIND, TIAM-ECN, WITCH, etc. Scenarios with 2010 and 2015 emission levels which were very different to China's actual emissions were removed. The yellow dotted line stands for China's emissions trend when implementing INDC targets (without consideration of Chinese energy data adjustment in 2014), calculated with the PECE model developed by NCSC and Renmin University of China. The red line describes a rough trend taking into consideration the Chinese energy data adjustment in 2014. To make the data comparable with global data, the CO_2 emissions include energy-related CO_2 emissions plus CO_2 emissions from cement production.

E. Through Implementation of its INDC, China's cumulative emission level by 2030 will stay lower than the US and EU levels

The IPCC Fifth Assessment Report confirmed the approximate linear relation between global warming and cumulative emissions. As demonstrated in Figure 5, for developed countries, the peaking period of their GHG emissions occurred throughout 1850 until 1990. During that period, their process of industrialization was marked by large amounts of GHG emissions. In China, CO_2 emissions grew sharply since the mid-20th century, in particular from the rapid industrialization during the period of 'reform and opening up', which started around 1980. Under the INDC targets and through its innovate development pathway, China will be sure to maintain its cumulative energy-related CO_2 emissions by 2030 lower than those of the US and the EU (at that time, the ratio of cumulative energy-related CO_2 emissions among US, EU and China will be 1.4:1.2:1.0), even lower than the current (1751-2012) cumulative emission level of US and EU. China's cumulative emissions per capita from 1751 to 2030 are projected to be much lower than the US and EU (18% and 30% respectively).

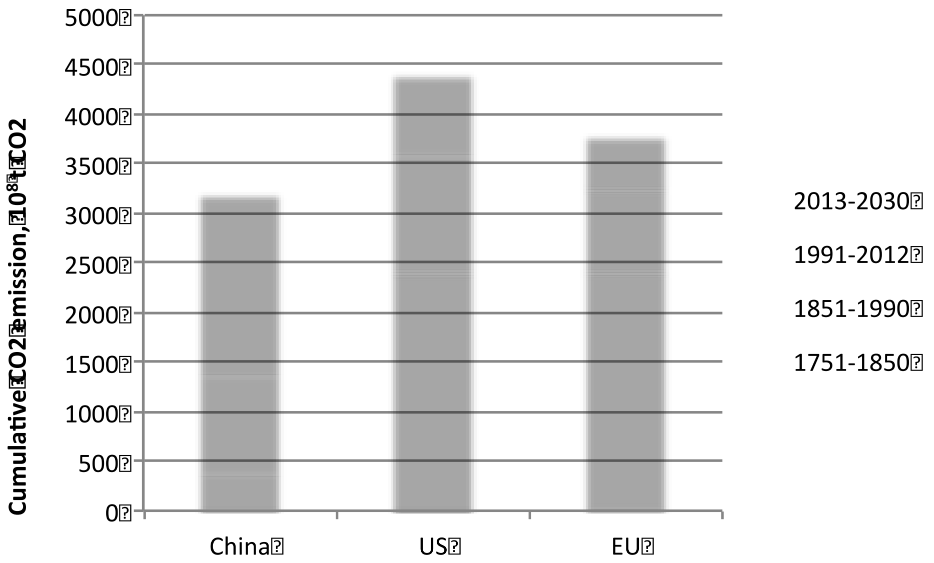

Figure 5-1 Cumulative CO_2 emissions comparing China, US, and EU

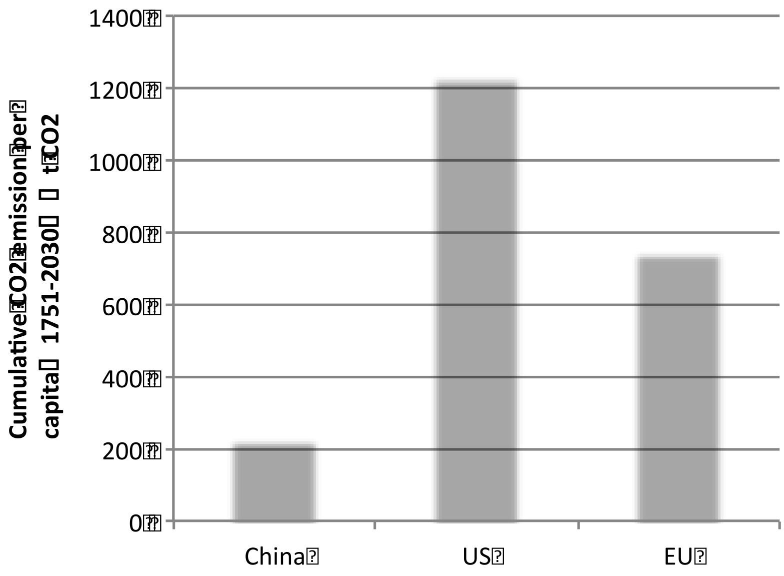

Figure 5-2 Cumulative CO_2 emissions per capita comparing China, US, and EU

Sources: only contains energy-related CO_2 emissions. Data of historical CO_2 emissions from 1960 to 2012 is quoted from CDIAC. Population and GDP information are cited from the World Bank. Data after 2012 is calculated based on INDC targets of each country.

F. China will provide demonstration and reference for future developing countries,

and will transfer experience and provide support for developing countries through means such as south-south cooperation

As the largest developing country in the world, China is taken as an example for many other developing countries seeking growth. Through its innovative development pathway, China will become a demonstration model which other developing countries can follow in pursuing sustainable development. Learning from China's experience, other developing countries can avoid reliance on the traditional high-carbon development pathway and the lock-in effect, enabling them to take on a new development pathway that is efficient and innovative with low pollution and emissions. At the same time, China will promote global transformation by fulfilling its commitment, contributing to the reshaping of the global development pathway.

3. Difficulties and challenges facing China in achieving INDC targets

Although it is clear that low-carbon growth is inevitable for China's future development, China will face a number of challenges in achieving its INDC targets, including limitations brought by China's stage of economic and social development, economic structure, natural reserves of energy resources, energy efficiency, technological capacity, institutional policy basis, the international political and economic structure it faces, etc.

1. Accessibility to natural resources will increase the risk of failing the INDC targets. For example, clean energy such as natural gas is needed to replace coal consumption to meet the targets. A huge challenge in this process is how to ensure a sufficient and reliable supply of resources and guarantee national energy security while controlling costs.

2. As China is still in the process of industrialization and urbanization, heavy industry sectors such as machinery manufacturing, iron and steel, construction materials and chemical industry still form a large share of the economy. Together with rapid urbanization, which comes with large scale infrastructure construction, this implies a constant increase of energy consumption and carbon emissions. Even though the Chinese government has committed to adjustment of economic structure and transformation of economic growth, it is no overnight process. Furthermore, potential downward economic pressure would present a great challenge.

3. With the ratio of middle class population rising every year, the emissions from transportation and buildings will increase accordingly, surpassing that of the manufacturing industry in mid-long term. To realize the targets set in the INDC, it

will be vital to cultivate the young generation to adopt a low-carbon consumption model and lifestyle.

4. Reliability and uncertainty of technology is another major challenge facing China in achieving its INDC objectives. For instance, China needs to address issues such as how to ensure renewable energy generation and reliability of the power grid, how to manage environmental impacts of hydropower and safety of nuclear power, and how to reduce the uncertainty of carbon capture and storage (CCS) technology.

5. As a developing country, China's overall technological level lags behind, with limited R&D capacity of key technologies, especially in low-carbon and adaptation technology. How to ensure access to technologies through effective international cooperation is one of the key issues in implementing the INDC targets.

6. To achieve mitigation and adaptation targets requires huge investment and construction costs. Some of the incremental investments bring about economic returns, while a majority of them are just huge economic costs, for example, the application of technologies like CCS. Besides economic costs, China may face social costs in the process such as structural unemployment caused by the closure of outdated production facilities, requiring measures to mitigate these social impacts.

7. Competencies and capacities of key stakeholders in climate change are generally still limited, bringing about the heavy task of raising social awareness, and improving institutional and social mechanisms. China lacks macro management capacities to address climate change and its legislative and policy system in this area is incomplete. At present, China still lacks a sound statistical and accounting system for GHG emissions and is comparatively weak in monitoring, regulation, and calculation of GHG emissions, as well as in law enforcement capacity. All of these shortcomings present challenges for China to realize its INDC targets.