

Communication

## On the Chinese Carbon Reduction Target

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**Abstract:** In November 2009, China pledged a 40–45% decrease in CO<sub>2</sub> emissions per GDP by 2020, as compared with the 2005 level. Although carbon intensity (emission) targets by nature are ambiguous, this study demonstrates that China's pledge is consistent with the current Chinese domestic agenda that simultaneously pursues economic growth and energy security. The target numbers in the pledge seem reasonable, given the technological feasibility and measures, considered along with the assumption that moderate economic growth will occur. However, the study also argues that financial and institutional constraints exist as potential obstacles to achieving the target if the trend of the current economic tendencies continues.

**Keywords:** climate change; China's pledge; carbon intensity

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### 1. Introduction

International pressure on China to take collaborative action on curbing CO<sub>2</sub> emissions has been growing ever since it became the world's largest CO<sub>2</sub> emitter, with its emissions expected to continue to increase. In November 2009, just before the United Nations Climate Change Conference in Copenhagen (COP 15), China officially pledged internationally that it would reduce its per GDP CO<sub>2</sub>

emissions (carbon intensity) by 40–45% by 2020, as compared with the 2005 levels. This pledge is probably a cornerstone for global collaboration, as it is the first announcement to target a reduction in the emerging and developing economies. In fact, India, among others, followed China, by setting its own reduction target.

However, China's pledge is a reflection of the situations and challenges that China currently faces; therefore, evaluating the pledge from multiple viewpoints is of significance. China, still a developing country, with a population of 1.3 billion, must simultaneously pursue further economic growth and energy security in the coming years. In this sense, the reduction of per GDP CO<sub>2</sub> emissions is essentially in line with Chinese domestic issues. At the domestic level, China already has specific goals for improving energy efficiency. For example, the 11th Five Year Plan of China aims to improve energy intensity (the inverse of energy efficiency) by 20% between 2005 and 2010. China has also set an official mid-term goal of energy efficiency: quadrupling GDP by 2020, but only doubling energy consumption, compared with the base year 2000. This mid-term goal means an improvement of 50% in energy intensity and is roughly equivalent to the target of 40–45% CO<sub>2</sub> emission reduction per GDP. Yet, the reality does not match China's expectations. Data as of March 2010, show that energy intensity in China had improved by only 6.7% between 2005 and 2008, and, likewise, energy consumption had already doubled its 2000 level by 2008 [1], suggesting the difficulties in achieving the targets set in the 11th Five Year Plan. Perhaps it is not incidental that China has started investigating a road map toward a low carbon society in the mid term. In September 2009, the Energy Research Institute of China documented the report "Low Carbon Scenario for China 2050" [2]. Taken together, these actions clearly indicate that the pledge is not merely coincidental, but strategic.

## 2. Intensity Measure against Climate Change

Carbon intensity is by definition a subtle target. A 40–45% reduction does not mean a net reduction of CO<sub>2</sub> emissions in 2020. A 45% improvement in carbon intensity will result in a net carbon emission increase if China's annual economic growth rate exceeds 4% between 2005 and 2020. The evaluation of the carbon intensity target also depends on which type of GDP is used for the calculation. Table 1 presents the carbon intensity of China, Japan, and the US in 2005, using constant price GDP, and power purchase parity (PPP). Constant price GDP is likely to appear lower than PPP for developing countries, which are countries with relatively low prices. Hence, the difference in carbon intensity level becomes larger in both absolute and relative terms when carbon intensity is calculated on the basis of GDP. For example, Chinese carbon intensity is 10-times larger than that of Japan when calculated with GDP at constant prices, but only three times larger than that of Japan when PPP is used. Technologically speaking, it seems challenging to achieve the goal under PPP because catching up with developed countries must occur within a decade. This argument also means that the currency exchange rate substantially affects the interpretation of the realized intensity.

Furthermore, any interpretation of the intensity target depends on the future GDP growth of China. To understand this, consider two possible cases of CO<sub>2</sub> emissions for China in 2020, 8.4 gigatons (Gt) and 9.6 Gt. According to the International Energy Agency (IEA) [5], China must limit its CO<sub>2</sub> emissions to 8.4 Gt in 2020 in order to attain (global) 450 parts per million (ppm) carbon concentration in the long term. On the other hand, 9.6 Gt CO<sub>2</sub> emissions is the emission level under the currently

implemented Chinese policies and measures. Thus, if the CO<sub>2</sub> emissions achieved are below 8.4 Gt, this will be appreciated in terms of global collaboration because an emission reduction from the world's largest emitter yields substantial impacts.

**Table 1.** 2005 Carbon Intensity and GDP base for China, Japan, and the United States.

	2005 GDP (US\$ 2000 Price)	2005 PPP (US\$ 2005 Price)
China	2.93	1.04
Japan	0.25	0.32
United States	0.53	0.47

Data: CO<sub>2</sub> emissions and GDP data are obtained from [3] and [4], respectively.

Given China's CO<sub>2</sub> emissions of 5.5 Gt in 2005, we estimate CO<sub>2</sub> emissions in 2020 using 7% and 8% annual average GDP growth rates in this period. Table 2 shows how GDP growth and carbon intensity improvement affect Chinese CO<sub>2</sub> emissions in 2020. First, the results show that higher GDP growth by definition generates larger emissions, other things being equal.

Second, the results are close to the CO<sub>2</sub> emissions from IEA scenarios. Specifically, if the annual growth rate is 7% and the intensity improvement rate is 45%, China's CO<sub>2</sub> emissions in 2020 will be 8.4 Gt—the level that the 450 Scenario assumes. Interestingly, if the GDP growth rate is 8%, CO<sub>2</sub> emissions become similar to the level estimated in the Reference Scenario if carbon intensity improves by 45%. These observations explain why the international society has different opinions about the Chinese pledge. If the *ex-ante* evaluation of the intensity target figure alone is ambiguous, an investigation of China's situation is of particular benefit.

**Table 2.** Intensity improvement, GDP growth, and CO<sub>2</sub> emission.

Carbon Intensity	GDP Growth Rate	CO <sub>2</sub> emission
IEA Reference Scenario	8%	9.6 Gt
IEA 450 Scenario	8%	8.4 Gt
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40% Improvement	7%	9.2 Gt
<b>45% Improvement</b>	<b>7%</b>	<b>8.4 Gt</b>
40% Improvement	8%	10.6 Gt
45% Improvement	8%	9.7 Gt

Note: The IEA Reference Scenario assumes that the currently implemented policies and other trends (technological advancement and social changes) will be maintained. On the other hand, IEA presumes that China has to limit its CO<sub>2</sub> emissions to 8.4 Gt in 2020 so that the earth's average temperature will be stabilized within a two-degree increase from that in the industrial revolution age.

### 3. The Real Meaning of China's Pledge

The specific question of interest is how difficult it is for China to achieve the intensity target. Technologically speaking, measures and policies to achieve low carbon emission targets with reduction potentials have been examined and proposed [2,6,7]. These include the promotion of nuclear power and renewable energy, technology advancement and the setting of regulations/standards in the

industrial sector, and the improvement of energy efficiency in the transport and building sectors; these measures are technologically available. Nuclear power plants are already operating in China; domestic companies in the field of renewable energy are emerging. Evidence also exists that diffusing available technologies can substantially increase energy efficiency and reduce CO<sub>2</sub> emissions per production in the steel and cement industries in China [8,9].

However, both the financial and institutional feasibilities are uncertain, given the current rapid economic growth. The more rapidly the economy grows, the larger the emission reductions necessary to meet the target become, thereby incurring larger costs and institutional burdens. Specifically, the sharp increase in demand for energy and materials (e.g., steel and cement), owing to economic growth, along with urbanization, will make these already expensive measures even more expensive. Promoting nuclear power and renewable energy are both particularly expensive measures. The IEA [5] estimated that additional investment, up to 2020, in the energy generation sector alone necessary to achieve the 450 Scenario is estimated to be US\$ 797 billion. Also, diffusing efficient technologies among state-owned small-scale plants in the cement and steel industries is both institutionally and financially difficult. It is extensively documented that the barrier to reducing energy use in the Chinese cement industry is not the lack of feasible technology, but the lack of a mechanism to finance it [9]. Furthermore, energy conservation in such rapidly growing sectors as transport and building is a considerable challenge. Specific strategies with a reliable and certain financial foundation must be employed to implement these proposed measures. Besides an industrial structural change, a shift from a heavy industry to a service sector oriented economy is imperative, given that the recent increase in energy intensity in China has been due to the rapid expansion in heavy industries, including steel and cement [10].

What is, therefore, the real meaning of the Chinese pledge? Domestically, it is an attempt to decouple rapid development and environmental degradation. We demonstrated that China possesses technological feasibility as a necessary condition to meet the goal, but this is not sufficient; China has to overcome the financial and institutional barriers as well. In this line, setting a specific carbon reduction target as an international pledge facilitates the promotion of specific measures for environmental protection and energy security. These include the introduction of a market in CO<sub>2</sub> emissions and carbon taxes that has the potential to induce investment in environmental technologies and substantially reduce the cost of this reduction. China already has open carbon emission markets in Beijing, Shanghai, and Tianjin; others will open in additional major cities. At the COP 15 in Copenhagen, China released its first standard on voluntary CO<sub>2</sub> emission abatement, the so-called "Panda Standard", which attempts to regulate all aspects of emission abatement through a perfect market mechanism [11]. The Panda Standard also establishes China's position in the international market, and demonstrates China's resolve regarding the future.

#### 4. Conclusions

This study has evaluated China's pledge regarding CO<sub>2</sub> emission reduction per GDP by 2020. In general, an intensity target as a measure against climate change remains unclear until all the elements of it are clarified. How this pledge contributes to the global challenge against climate change depends on the choice of GDP units and the rate of GDP growth. The study has demonstrated that this pledge

by China, along with its domestic agenda, including economic development and energy security, is intended to maintain consistency across its target numbers. Given the feasible technologies and appropriate measures, the target numbers in the pledge appear reasonable under the desired conditions (e.g., moderate economic growth). However, looking into the situations China faces shows that institutional and financial difficulties are domestically present. Attaining the target numbers could be quite a challenge if the current economic trends continue in the coming decade. There is still a possibility that China will have to make an extraordinary effort, along with help from the international community, to reach the promised emission reduction goal.

## References

1. National Bureau of Statistics of China. *China Statistical Yearbook 2009*; China Statistical Press: Beijing, China, 2009.
2. *Scenario for Low Carbon Society 2009*; China Energy Research Institute, National Development and Reform Commission: Beijing, China, 2009.
3. Earth Trend. Available online: <http://earthtrends.wri.org> (accessed on 4 February 2010).
4. *World Development Indicators 2009*; World Bank: New York, NY, USA, 2009.
5. *World Energy Outlook 2009*; International Energy Agency (IEA): Paris, France, 2009; pp. 195-219.
6. Lin, J.; Zhou, N.; Levine, M.D.; Fridley, D. *Achieving China's Target for Energy Intensity Reduction in 2010: An Exploration of Recent Trends and Possible Future Scenarios*; Lawrence Berkeley National Laboratory: Berkeley, CA, USA, 2006; Available online: <http://china.lbl.gov/publications> (accessed on 4 February 2010).
7. Tanaka, K. Assessment of energy efficiency performance measures in industry and their application for policy. *Energ. Policy* **2008**, *36*, 2887-2902.
8. Wang, K.; Wang, C.; Ku, X.; Chen, J. Scenario analysis on CO<sub>2</sub> emissions reduction potential in China's iron and steel industry. *Energ. Policy* **2007**, *35*, 2320-2335.
9. Price, L.; Galitsky C. *Opportunities for Improving Energy and Environmental Performance of China's Cement Kilns*; Lawrence Berkeley National Laboratory: Berkeley, CA, USA, 2006; Available online: <http://china.lbl.gov/publications> (accessed on 4 February 2010).
10. Ma, C.; Stern, D. China's changing energy intensity trend: A decomposition analysis. *Energ. Econ.* **2008**, *30*, 1037-1053.
11. China Panda Standard. Available online: <http://www.pandastandard.org/> (accessed on 31 March 2010).