Chapter 19

Sustainable Development: Challenges, Opportunities and Implications for Sino-U.S. Cooperation

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Executive Summary

Thirty years ago, 'development' was the key word in China's politics, economy and society. Deng Xiaoping – the chief architect behind China's economic modernization – emphasized that development was of overriding importance. Indeed, development – which can be understood to be the means to improving the lives of a population – has been the guiding principle of all major policies and actions of the Chinese government since the era of 'opening up'. But today, the watchword and the social ethos have changed to *sustainable* development. In a poignant signal of this shift, the Chinese Communist Party officially incorporated the "Scientific Outlook of Development" (Scientific Outlook) as one of the fundamental principles of the party's constitution in November 2012. The Scientific Outlook requires development to be comprehensive, balanced, and sustainable, and all policies must "put the people first".

In his address to the 18th Congress of the Chinese Communist Party, then President Hu Jintao added his key components by urging political reform and economic, social and cultural development to achieve modernization and the revival of the Chinese nation. He also put emphasis on the cultivation of a 'harmonious society'.

Now, more than ever, environmental protection, natural resource conservation and ecological progress have been highlighted as core principles of national development. Former Premier Wen Jiabo, in his address at the sixth National Conference on Environmental Protection in April 2006, stressed that "we must be fully aware of the severity and complexity of our country's environmental situation and the importance and urgency of increasing environmental protection. Protecting the environment is to protect the homes we live in and the foundations for the development of the Chinese nation. We should not use up resources left by our forefathers without leaving any to our offspring. China should be on high alert to fight against worsening environmental pollution and ecological deterioration in some regions, and environmental protection should be given a higher priority in the drive for national modernization."

The new administration of President Xi Jinping and Premier Li Keqiang have reaffirmed this commitment to sustainable development. Indeed, earlier this year, the concept of "ecological civilization" - meaning a society that balances socioeconomic and environmental wellbeing - was written into the ruling party constitution. This high-level endorsement signals China's seriousness in dealing with its own as well as global environmental challenges. There have also been productive developments in the practical, policy-making dimension. The ongoing 12th Five-Year Plan (FYP) extends and expands the energy-saving and ecological conservation goals of the successful 11th FYP. These positive developments form a strong foundation for realizing future national objectives, as well as for greater collaboration with the United States in sustainable development.

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China's Sustainability Challenge

China has achieved impressive economic growth, averaging a double-digit annual growth in the last three decades. However, the cost of natural resource depletion and environmental degradation has been equally significant. China's gross domestic product (GDP) was about one tenth of global GDP in 2011, but consumed nearly half of the world's annual production of coal, iron and steel, and more than half of its cement. Resource productivity is much lower than that of developed countries and even many other developing countries. Taken together, these represent serious obstacles to achieving anything that can be legitimately called 'sustainability'.

Resource exploitation, in particular, has caused severe environmental problems. China consumed 3.35 billion tons of coal in 2011. Coal burning alone emits 80% of CO_2 emissions in China, and causes myriad environmental problems at local and global scales – most notably, climate change. Coal mining directly results in thousands of deaths every year, and often results in severe land despoliation and the consequent displacement of communities. At the Huainan Coal Mine, for instance, thousands of hectares were flooded by water and the residents were forced to abandon their homes and farmland. Groundwater suffers from coal excavation, as mining damages important aquifers. In 2007, the external cost of coal mining and transport reached RMB1.7tr, or 7.1% of national GDP (Mao, et al. , 2008).

China now produces 610 million tons of steel annually, corresponding to 44.53% of the world total. Hebei Province, which surrounds the sprawling metropolises of Beijing and Tianjin, produces one third of that amount alone. A notable – and lamentable – consequence of the coal burning for the iron and steel industry in this area is a deleterious level of PM2.5 – a pollutant confirmed by the Chinese Academy of Sciences to be particularly harmful to the human respiratory system. In January, 2013, seven major cities in Hebei Province were listed among the 10 most polluted cities in China[1].

In January 2013, Beijing's air was saturated with heavy smog for a staggering 26 days. During the smoggy days, PM2.5 levels ranged from 200-700 mg per cubic meter, with select days afflicted by levels as high as 1,000 mg per cubic meter. The World Health Organization has warned that if a 24-hour average exceeds 25 mg per cubic meter, a hazardous threshold has been reached. Beijing is not the only place in China dealing with this toxic phenomenon, as it is not even the most polluted city in China. Although featured less prominently in the international media, Shijiazhuang, the capital city of Hebei, suffered even higher levels of the smog. In fact, as much as 1.4 million square kilometers of eastern China – where heavy and chemical industries are concentrated – were impacted by the pollution. Dr Zhong Nanshan, a well-respected medical scientist who played a critical role in addressing the SARS outbreak a decade ago, warned that the heavy smog is even more dangerous than that infamous epidemic.

Another topic of serious concern, but which may not receive significant attention in the global press, is the issue of soil pollution. In January 2013, *People's Daily* – a widely circulated periodical within China – cited an important finding by the Ministry of Environmental Protection about soil pollu-

1 http://www.cnemc.cn/, accessed March 9, 2013

tion. According to a recent survey, an astounding 10 million hectares of farmland have been polluted in China. Furthermore, an additional two million hectares are under irrigation with polluted water, and 130,000 hectares have been destroyed or are covered by solid waste. Thus, a total of more than 10% of the country's farmland is affected by environmental degradation. Each year, as much as 12 million tons of grain are wasted due to heavy metal pollution in the soil (State Environmental Protection Administration, 2006). In fact, a recent survey sampling 300,000 hectares of basic farmland reserves showed heavy metal pollution for every eight hectares on average.

Pollution has gone beyond the land surface and severely affected groundwater, especially in cities. A recent China Central Television (CCTV) program reported that 55% of urban groundwater is poor or extremely low in quality[2]. A Peking University study based on multi-year, continuous monitoring of water quality in 118 cities showed that nearly two-thirds had been severely polluted, and one-third lightly polluted, with only a small proportion rated as more-or-less clean[3]. Experts warn that groundwater pollution, caused by surface water pollution, poses a serious threat to human health, as it is considered a key factor in the rapid growth of cancer. A recent Google map rendering highlighted the geographical distribution of 247 so-called 'cancer villages'[4].

These resource and environmental problems are so severe that they jeopardize the sustainability of the national economy. These problems not only undermine the resource endowment of future generations, but are hurting the wellbeing of the present generation. These problems also pose a serious challenge to the legitimacy of the political leadership and the ruling party.

Policy Responses

Despite this spate of environmental challenges, many of which seem barely surmountable, China has maintained a vigilant stance and marshaled an earnest array of policy actions. Since the 1980s, the Chinese government and policy experts have reminded themselves of the lessons from the 'treatment-after-pollution' model that occurred in the early industrialized countries. Despite this, the level of pollution has become equally bad, if not worse. Unfortunately, China has not been able to escape the treatment-after-pollution model, and is now even replicating the experience from its economically advanced coastal region to the less industrialized western parts. The inability to adopt a more anticipatory approach has taken much of the country on a long struggle toward a sustainable balance between economic growth and environmental protection.

However, it would be a mistake to conclude that no serious action has been undertaken in recent decades. Indeed, policies in environmental protection and natural resource conservation have been adopted throughout China during the recent decades. China's policy action on environmental protection began at the 1972 United Nations (UN) Conference on Human Environment in Stockholm, Sweden. Shortly after the conference, China's State Council set up the influential Environmental Protection Committee. The first Environmental Protection Law was enacted in 1979, and since then about 30 laws have been adopted in environmental and natural resource protection.

China officially made sustainable development a major development strategy following the 1992 UN Conference on Environment and Development (UNCED). In response to the call of the UN conference, China was the first country in the world to complete its national Agenda 21, implementing

2 CCTV News 1+1, 21 February 2013
3 http://www.foodmate.net/special/anquan/90.html
4 (*Global Times* microblog, 22 February 2013)

sustainable development strategy[5]. The document highlighted various national programs, and outlined initiatives on environmental challenges going forward. Over the last three decades, China has made a handful of so-called basic national policies – which are at the core of the centralized decision-making process – and nearly all of them have been about environmental protection, population control and natural resource conservation. This wide-ranging strategy has also changed environmental governance in China. In the early 1990s, the State Council set up the China Council for International Cooperation on Environment and Development (CCICED), consisting of 32 Chinese members and 25 international members, led by the vice premier. This committee commissions task forces every year on major issues of sustainable development and submits policy recommendations to the Central Government for consideration. This organization is notable for being China's only sustained and substantial nexus for international policy cooperation.

Although it must be admitted that vigorous efforts at environmental control have not kept up with environmental degradation – a besetting issue that afflicts many other large economies – a number of salient achievements thus far offer optimism for China's potential to achieve sustainability. We review them in the following sections.

Achievements

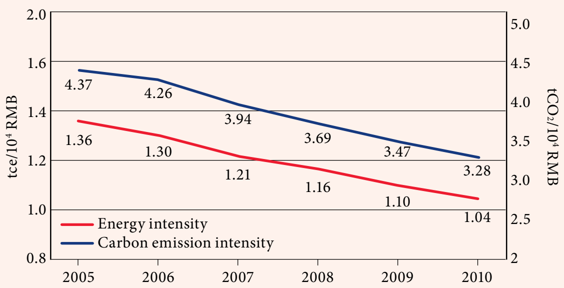
Increase in economic productivity and resource use efficiency

Since 2004, China's grain production has consistently exceeded 500 million tons, a 25% increase over yields prior to the 1992 UNCED. Grain yield per hectare has exceeded four tons, reaching a level considered to be highly productive. The enhanced grain production has been critical for the food security of the world's most populous nation, especially considering the land and water resource limitation. China's per capita arable land is only 40% of the world average, and per capita freshwater availability is only 28%. China's enhanced agricultural productivity has, in large part, been achieved through infrastructure construction and technological improvement. 'Green' and low-carbon farming has been on the rise. The coal equivalent of 37 million tons – accounting for about 1.14% of the total end-use energy consumption – was consumed by agriculture and forestry in 2010, while contributing to 9.4% of the national GDP. Among all of China's industries, agriculture is the only one that stabilized its energy consumption in the 11th Five Year Plan (FYP), about 35.0-37 Mtc per year. Energy intensity showed a sharp decrease of 17.4% from 2005 to 2010. It is notable, however, that the embedded carbon emissions associated with agricultural production has increased. In 2009, the embedded carbon emissions in agriculture production materials were 325 Mt CO_2-eq, or 2.6 times as much as the direct emissions in agriculture. Fertilizer was a major source of embedded carbon emissions, accounting for about 86% of all sources. Need-based fertilization was an effective measure to reduce the total fertilizer use and thus to reduce the embedded carbon emissions in agriculture. China's agriculture shows strong low carbon features compared to many other countries. Compared to the agricultural energy consumption in some Organization of Economic Cooperation and Development (OECD) countries in 2006 (measured by the purchasing power parity (PPP) method (IEA, 2009)), China's level was only 19.0% of the average level of the developed nations' group. More specifically, it was 24.4% of Australia's, 22.1% of the U.S.' and 36.5% of Japan's level.

In the two decades since the first UNCED, otherwise referred to as the Rio Conference, China transformed from an agriculture-dominated economy to the world's manufacturing hub. As a percentage

5 The UN developed Agenda 21, which was agreed upon by the participating parties at the Rio Conference in 1992. The Conference called for each country to develop its own Agenda 21 to implement the sustainable development strategy. China responded with the completion of the first national Agenda 21.

Figure 1: Energy Intensity and CO_2 Emission Intensity of the Manufacturing Industry, 2005-10



Source: Qi, 2011.

of GDP, China's exports rose from 11% in 1980 to as high as 39% in 2006 (World Bank). To enhance the sustainability of China's industry, the government has focused on restructuring initiatives that reduce the share of energy and resource-intensive sectors, closing down production facilities with low resource and energy efficiency, and adopting more sustainable technology.

Energy savings in the manufacturing industry are of particular importance. In 2010, energy consumption by the manufacturing industry was about 1.83 Gtce, accounting for 60% of end-use energy consumption, or 56% of total national energy consumption; CO_2 emissions were 4.30 Gt, accounting for 59% of national total energy-related emissions. During the 11th FYP, total energy consumption and CO_2 emissions increased in the manufacturing industry, but the energy intensity and carbon emissions intensity experienced a rapid decrease.

Energy efficiency in the manufacturing industry can be measured by two indicators – the energy consumption per unit of value-added, which reflects the overall energy intensity in one industry, and the energy consumption per unit of an industrial product. From 2005 to 2010, energy consumption per unit value-added in the manufacturing industry decreased by 23.2%, an annual decrease of 5.14% on average. This was 20% faster than the national average of 4.15%. This also translated into total energy savings of 329 Mtce, accounting for 52.5% of the national total. Carbon dioxide emissions per RMB10,000 value-added decreased from 4.37 tons in 2005 to 3.28 tons in 2010, a decrease of 25.1%, or an annual decrease of 5.6% on average (see Figure 1). Cumulative CO_2 emission reductions were 1.16 Gt, accounting for 74.8% of total national reductions.

Energy consumption per unit of product decreased for all 16 major products in six energy-intensive industries. The manufacturing industry achieved total energy savings of 311 Mtce through unit product energy efficiency improvement, accounting for 94.6% of total savings by the manufacturing industry, or 49.6% of total national energy savings.

This major success was largely due to technological improvement and structural optimization. Technological improvement included innovation, phasing out inefficient technologies and scaling up the deployment of advanced technologies, adopting energy efficient equipment and increasing investment in research and development. From 2006 to 2010, the so-called "Top-1000 Enterprises Energy Efficiency Program"[6] yielded energy savings of 150 Mtce (NDRC, 2011a), the "Ten Key Industry Energy Saving Program"[7] yielded 340 Mtce (NDRC, 2011b), and the "Phasing-out Obsolete Capacity Program" yielded over 110 Mtce (Qi, 2011). These three programs successfully met, and even surpassed, energy savings targets. With the deployment of more efficient technologies, overall energy consumption per ton of steel dropped by 12.1% from 2006 to 2010 (NBS, 2011c). At the same time, the deployment rates for all major new technologies went up. The medium and large steel companies achieved better performance than their Japanese peers, who

6 Approximately 1,000 of the largest energy-consuming enterprises were selected as primary focus of the industrial energy-saving program. This program was called the "Top 1000 Enterprises Program", a key program in the 11th Five-Year Plan. This program has been scaled up in the 12th Five-Year Plan to the "Top 10 Thousand Program", to cover a much wider range of enterprises.

7 "The Ten Key Industry Energy Saving Program" identified ten major areas of industry for national support for energy saving.

were rated as world leaders according to numerous industry indicators. Comprehensive energy consumption intensity in the cement industry achieved a decrease of 28.6% through the large-scale deployment of new dry processes and residue heat-to-electricity technologies, and through increasing the bulk cement rate (NBS, 2011c). There was also energy efficiency success in the non-ferrous metal industry. By scaling up pre-baked cell production, AC electricity consumption in aluminum ingot production has dropped by 12% (NBS, 2011c). The overall electricity consumption intensity in copper smelting dropped by 35.9% (NBS, 2011c), the largest decrease achieved among all industries between 2006 and 2010.

In terms of structural changes, the heavy-industry-oriented industrialization trend in the first three years during 2006-10 continued, but the rate slowed down. Meanwhile, the structure of the manufacturing industry started a transition to a more energy efficient mode, with a decreasing share of high energy-intensive industries and an increasing share of less energy-intensive products. In addition, the share of the services industry increased from 39% to 43.2% in the first decade of the 21st century. This change alone helped create 65 million jobs and moved the economy down a significantly more energy and resource efficient path.

Poverty alleviation and balanced regional development

According to the previous poverty line set by the Chinese government, from 2000 to 2010, the number of people living in poverty shrank from 94.22 million to 16.88 million, or from 10.2% to 2.8% of the overall population. There are several reasons for this. One reason is the significant improvement in infrastructure in the most poverty-stricken regions. Hard-surfaced roads, electricity, telecommunications and television connections are now available in most places. These improvements have lowered transportation and transaction costs, provided information and communication networks, and therefore facilitated new income and employment opportunities, and boosted the 'social capital' of previously marginal communities. Additionally, due to growing outlays and the government focus on education, the illiteracy rate in impoverished regions has declined to about 10% of the population.

Poverty alleviation at the national scale has benefited from more balanced regional development. The current pattern of more advanced economic development in the eastern, coastal provinces and less in the western regions is being adjusted. Since 2007, the rate of economic growth in the west has broadly exceeded that of the east, and this change seems to be a long-term trend of the Chinese economy. Even with overall GDP expansion currently slowing down, western China is still maintaining double-digit growth.

The Chinese government has put forward a strategic vision of promoting the construction of development priority zones since 2006. In 2010, China released an official outline of the "National Planning for Development Priority Zones". Based on different regions' resources and environmental bearing capacities and their current development intensity and potential, the Chinese government is comprehensively planning corresponding population distributions, economic layout, and land use and urbanization patterns. Land space is divided into four categories: optimized development zones, key development zones, restricted development zones and prohibited development zones. The main functions of different regions have been determined, and accordingly, their development orientations have been specified, development policies improved, development intensity controlled and development order regulated. The strategy strives to facilitate new national land development patterns that accommodate population, economy, resources and the environment. This strategy is meant to achieve a national balance between natural conservation and socioeconomic enhancement.

vironment.

Urbanization and infrastructure improvement
Urbanization is a major macro-trend of China's social and economic development. Each year more than 10 million rural residents move to cities and towns. In 2011, for the first time in Chinese history, more people lived in cities and towns than in rural villages. This change was driven by greater economic opportunities that are largely absent in rural areas, and has made it possible for many more people to enjoy the better living standards afforded by urban infrastructure and built environment. In 2010, urban fountain water coverage reached 96.7% of the population, and natural gas supply 92% – as compared to 2000, when these figures were only 63.9% and 50.1% respectively. District heating coverage has increased three-fold, buses 1.2-fold and urban green areas 1.55-fold. Processed urban waste water and garbage facilities increased to 82.3% and 77.9%, respectively. Urbanization has become a very important factor in development, improving the standard of living for hundreds of millions of people in China in recent decades.

Meanwhile, the energy efficiency of buildings and transportation in cities has advanced significantly. Energy consumption and CO_2 emissions in the building sector continuously increased in the 11th FYP as a result of urbanization and the growing standard of living, but the annual growth rate decreased notably compared to that of the 10th FYP. Almost one quarter of the buildings now meet the national energy-saving standards. From 2005 to 2010, energy consumption per unit area increased by 19.7%, or an annual rate of 3.7% on average. At the same time, CO_2 emissions per unit area increased by 17.9% overall, or 3.3% annually on average. At present, China's CO_2 emissions per unit of building area are far lower than developed countries levels and less than one-third that of the U.S. level. These achievements have made China, despite being a still relatively low-income economy, one of the world leaders in the field of sustainable built environment.

Four categories can be identified in building energy consumption. Centralized district heating system in northern cities achieved the greatest progress in energy efficiency. Energy consumption per unit area in central heating systems in northern cities continuously dropped from 17.78 kgce per square meter in 2005 to 16.28 kgce per square meter in 2010, a decrease of 8.41%. At the same time, the associated CO_2 emissions per unit area also decreased from 47.48 kg CO_2 per square meter in 2005 to 43.87 kg CO_2 per square meter in 2010, a decrease of 7.6%. As a result, the growth rate of total energy consumption and CO_2 emissions related to northern cities' central heating system has slowed down, which accounted for about 25% of total building energy consumption in the whole country in 2010.

Through the transformation of the envelope structure of buildings, the institutional reform of the centralized district heating system and the scaling up of energy-saving lighting and energy standards for home appliances, the building sector has achieved an energy-saving capability of 67.50 Mtce, equivalent to an accumulative emissions reduction capability of 185 Mt CO_2 from 2006 to 2010.

China's transportation sector has experienced rapid growth in roads, vehicles and traffic, all leading to growth in energy consumption. Energy consumption in the transportation sector amounted to 230 Mtce in 2005 and 300 Mtce in 2009, an increase of more than 30% over four years, higher than the average growth rate in other sectors, although it was lower than that of the previous FYP. Energy efficiency improved significantly in the sector. Energy consumption per ton-km in railway transportation decreased from 6.48 tce/Mton-km equivalent in 2005 to 4.94 tce/Mton-km equivalent in 2010, a decrease of 23.8% (MOR, 2011). Fuel oil consumption per unit ton-km in aviation transportation decreased from 0.336 kg/ton-km in 2005 to 0.298 kg/ton-km in 2010, a decrease of 11.3% (CAA, 2011).

Answering the growing demands of an increasingly mobile urban population, the Chinese government has encouraged the development of mass transportation. There has been a continued increase in the share of public transportation in resident trips. Take Beijing as an example: the share of public transportation reached 39.3% in the first half of 2010 (*Beijing Daily*, 2010), an increase of nearly 7% compared to 2005. In railway transportation, the government developed an overall plan and implemented an express railway network with priorities. It is expected that the express railway network will provide alternatives to carbon-intensive modes of transport such as airplanes and cars in the long run.

And in response to the proliferation of private vehicles, the government has increased fuel economy standards to encourage the production of more efficient cars and imposed a gas tax in 2008. It has also adopted a progressive tax schedule on cars with higher fuel consumption to incentivize the purchase of more efficient cars. In 2005, small-displacement cars of 1.6 liters or less accounted for two-thirds of the total ordinary passenger cars in China (CATRC, 2009). The ratio increased to 68.77% in 2010 (CAMA, 2011). The government has also provided a much-needed fillip to the alternative fuels automobile market. In 2009, the Ministry of Science and Technologies and the Ministry of Industries and Information Technology jointly launched a pilot program of 1,000 new energy cars in 10 cities to promote the mass production of these vehicles and reduce their cost to consumers. The two ministries developed the "New Energy Vehicle Development Plan", which drew a roadmap for technology development.

Reforestation, resource conservation and environmental protection

Shortly after the floods in the Yangtze River Basin in 1998, the Chinese government implemented a universal ban on the logging of primary forest. Since then, the government has funded six major afforestation and reforestation programs aimed at increasing forest coverage and ecosystem conservation. Over 43 million hectares of forest were planted in the last decade, almost a quarter increase over the previous 10 years time. The national forest coverage has increased to 20.36%, as compared to 16.55% a decade ago. Meanwhile, natural conservation efforts have also included ecosystem restoration of grasslands and wetlands. The government has sponsored and funded numerous programs. In the conservation of wetlands, 70,000 hectares of wetland have been restored and 550 wetland reserves have been established, including 41 international key wetlands and 213 wetland national parks. These have bolstered the extensive nature reserve system. By 2010, a total of 2,588 nature reserves were established, putting 149 million hectares under official conservation programs. The total area of nature reserves is now 25% greater than the total area for food production in China.

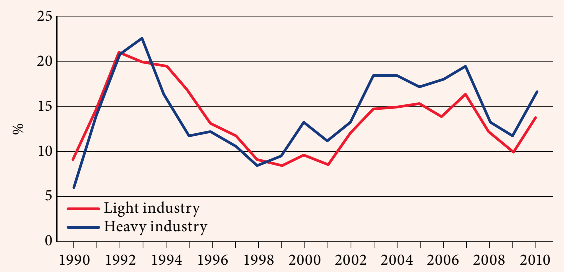
Water conservation is of particular importance and therefore has been given great attention over the last two decades. According to the "National Report on Sustainable Development" released before the Rio+20 Conference on Sustainable Development in 2012, China has, since 2001, established 300 pilot projects for building a water-saving society and raised the technological standards for water conservation in agriculture, industry and cities. As a result, water consumption for every thousand RMB of industrial value-added dropped from 28.5 cubic meters in 2000 to 124 cubic meters in 2010, and water consumption per thousand RMB of GDP fell from 554 cubic meters in 2000 to 225 cubic meters in 2010 (The People's Republic of China, 2012).

Climate change mitigation

China's climate change policies focus on mitigation rather than adaptation. The efforts at mitigation include both energy saving and renewable energy development.

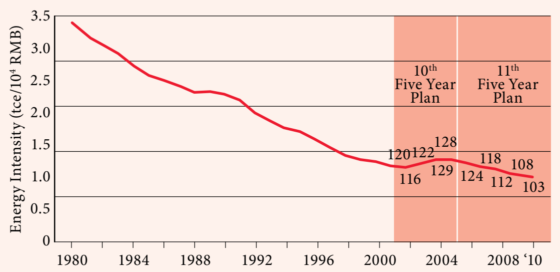
From 1980 to 2000, China's GDP increased by a factor of 6.15, but the energy consumption grew

Figure 2: **Growth Rate of Light Industry and Heavy Industry, 1990-2010**



Source: "The Statistics Bulletin of the National Economic and Social Development of the People's Republic of China", 1990-2010

Figure 3: **Change of Energy Intensity in China, 1980-2010**



Source: China Statistics Yearbook 2011 (NBS, 2011a); Energy intensity is calculated at 2005 prices

only by a factor of 2.14. The energy intensity was cut by 63.3%. As the nation entered the new century, accelerated industrialization posed new challenges to energy use, and the share of energy-intensive heavy industry increased quickly (see Figure 2). The overall energy intensity reversed from a decreasing trend to a sharp increase. Measured by energy consumption per unit GDP, intensity increased by 4.8% in 2003 and by 5.5% in 2004. In 2005 the energy intensity went back down to the 1999 level. The two consecutive years of increase canceled out the achievement in energy intensity reduction from 1999 to 2005. GDP in 2005 increased by 70% compared to that of 1999. With such a high growth rate continuing into the future, energy consumption and carbon emissions will increase dramatically if effective controls are not in place, posing a severe challenge to energy supply, environmental quality and climate change impacts for China as well as for the world.

The 11th FYP, covering the period from 2006-2010, set an explicit target of reducing the energy intensity by 20%. In addition, a few major industrial sectors were identified as priority areas under the energy saving policy. The 11th FYP defined the target as 'mandatory' and required all government departments and local governments to ensure the delivery of the target with maximum effort and the greatest measure of resources that could be allocated.

According to data from the National Development and Reform Commission, by the end of 2010, energy intensity in China had decreased by 19.1% compared to the 2005 level, virtually achieving the target set by the 11th FYP. On a year-to-year basis, the reduction was 2.72% in 2006, 5.01% in 2007, 5.23% in 2008, 3.62% in 2009 and 4.10% in 2010 (NDRC and NBS, 2011). By 2008 energy intensity had dropped to the 2002 level (see Figure 3). The rapidly increasing trend of energy intensity during the 10th FYP period (2000-2005) was replaced with a sharp decrease of an annual rate of 4.3%. As a comparison, energy intensity in the U.S. decreased by 1.2% annually on average (BEA, 2011; EIA, 2010). In 2011, the first year of the 12th FYP, the energy intensity of the Chinese economy was further cut by 2.01%, contributing to the overall five-year target of 16%.

The key to low-carbon development is the decarbonization of the economy. This is achieved by decreasing fossil fuel consumption per unit of production and consumption. During the 11th FYP, China successfully curbed its increasing energy intensity, moving towards a low-carbon development path. This helped to alleviate the pressure on the energy supply, where shortages were once rampant across the country, and slowed down the increase in greenhouse gas emissions, despite maintaining high economic growth.

Large-scale reforestation in China has contributed to ecological carbon sequestration. In 2009 forest coverage reached 20.4%, achieving the 11th FYP target. A nationwide general survey of forest stock from 2004 to 2009 showed that China's forestry carbon sink amounted to 22,290 $MtCO_2$, a total increase of 10.4% compared to the previous survey period (1998-2003), an annual increase of 420 $MtCO_2$ on average. The IFO Institute – Center for Economic Studies – a German government think-tank – reported that China had developed 73% of total new forest land (Xinhua News Agency, 2010), despite a massive global deforestation rate of 20,000 hectares per day. China's continuing efforts in reforestation will ensure a steady increase of forestland, greatly contributing to China's low-carbon development and global CO_2 emissions reduction efforts.

Obstacles to China's Sustainable Development

Vulnerabilities of the physical environment and limitations of the resource endowment

China's vast, beautiful and diverse territory shows the complexity of the nation's geography, geology and geomorphology. Although China may be a naturalist's dream, it may not be the beau ideal for the farmer or factory owner. Most of the country's land area is considered unsuitable for agricultural and industrial production as well as for human habitation: more than 20% of the land is located atop the frigid Qinghai-Tibetan Plateau, with the highest altitude in the world; another 10% in the mountainous karst area of southern China, which has exceptionally poor soil quality; and more than half of the land is under arid and semi-arid climate. Per capita freshwater availability is only 28% of the world average and arable land is 40% of the world average. Per capita mineral resource is also limited. The natural capital endowment is a tight constraint for China's sustainable development, given the rising demand of a broadening consumer class. It takes much more effort – and much more stress on the domestic natural environment – for China to achieve the standard of living long enjoyed in the U.S. In fact, some believe that it is unlikely that China will ever achieve a similar standard of living under current resource availabilities and the foreseeable future of ameliorative technological progress. Additionally, due to its climate as well as human and physical geography, China is extremely susceptible to different kinds of natural disasters of many kinds. The high population density makes seaborne disturbances such as typhoons particularly damaging, and the impact on the economy – which is anchored by the large coastal cities – tends to be very high. It is estimated that weather-related disasters are close to 10 times that of the U.S.

Pressure for greater development

If sustainable development is about balancing environment and development, China faces a particular challenge because economic growth is so badly needed. Despite the rapid expansion of the Chinese economy, most regions in China are still in the early stages of industrialization and urbanization. There is still a large population under the poverty line. According to the 2011 poverty standard – per-capita annual income under RMB2,300 in rural areas – 122 million people were still living in impoverished conditions (UNICEF China). Although China has exceeded Japan in national GDP and is now the second largest economy in the world, the number of people living in poverty is about the same size as the total population of Japan. Most of the impoverished regions suffer from adverse environmental conditions and thus economic development is particularly difficult. China is still under huge pressure to provide employment opportunities, particularly for the tens of millions of rural workers who are eager to enter cities, and the millions of college graduates flooding into the job market every year. Compounding this difficulty is the rapid aging of the population – a dilemma commonly encapsulated by the question, "Will China grow old before she grows rich?" – which poses a huge burden on future social resources. So far, China is the only country in the world with more than 100 million senior citizens. The provisioning of social security and healthcare to an aging population thus demands continued, vigorous economic growth.

Prospect for Sino-U.S. Cooperation

The complementarity of the Chinese and American economies, and the common necessity to address global environmental problems, creates a convincing case for bilateral cooperation on sustainable development. First, the U.S. is abundant in natural resources. The arable land area in the U.S. is 197 million hectares, two thirds more than that of China; and the per capita arable land area in the U.S. is eight times greater than China's. Contrasts of freshwater and other natural resource availabilities are equally impressive. The complementarity in food production, in particular, could have significant implications for the environment, as it already does for trade.

The U.S. has long been the world leader in technological innovation. The U.S. holds a leading global edge in information and communications technology (ICT), as well as clean energy advancement. These advantages would not only put the U.S. in a leading position in the so-called 'Third Industrial Revolution', but could benefit other countries in their transition to sustainable development. Bilateral cooperation would help China immensely, accelerating the transition to low-carbon growth against the fast-moving timeline of climate change. But the relationship goes both ways: the U.S. can also learn much from China, particularly about consumption. China has developed ways of living with limited resource availability for thousands of years, while maintaining a sustainable relationship with the natural environment. Indeed, traditional Taoist philosophy has influenced countless generations to 'live in harmony with the environment', and impressed on Chinese culture the concept of 'unity of man and nature'. This relationship with nature has been an underlying force in Chinese culture until recent decades, up until the impact of economic globalization and the modern profit-driven ethos undermined the traditional socio-ecological balance. Nonetheless, the widespread efforts by high-level policymakers, as well as growing segments of the public, to embrace resource-use efficiency and conservation – as documented in earlier sections – offer encouraging signals of a shift back to the earlier, sustainable attitude. Both the U.S. and China – the two largest countries on the planet – can benefit from such traditional wisdoms.

In this vein of mutual understanding and common cause, the two countries have made important agreements on climate change and clean energy in recent years. Sino-U.S. cooperation on sustainability reached a breakthrough in April 2013, when Secretary of State John Kerry arrived in Beijing for high-level negotiations to discuss a climate change action plan that was officially added to the influential Strategic and Economic Dialogue. The two countries – the world's two largest economies as well as its two largest carbon emitters – then released a joint statement that will likely represent a landmark in global environmental statecraft. The declaration called for "forceful, nationally appropriate action by the United States and China – including large-scale cooperative action", further stating that "such action is crucial both to contain climate change and to set the kind of powerful example that can inspire the world." The statement, and other discussions and agreements surrounding Secretary Kerry's visit, also highlighted the importance of promoting energy technology, environmental protection and resource conservation, all upon a platform of mutual trust and respect between China and the U.S.

The challenges of sustainable development can provide opportunities for close collaboration and the emergence of a geopolitical relationship that benefits not only China and the U.S., but the world at large. The encouraging developments in recent years certainly point in that direction. Sino-U.S. cooperation on climate change and energy can form a bridgehead to additional collaboration on other issues of mutual and global concern, from security to commerce. In this sense, engagement between the two countries on sustainable development is not only an achievement in and of itself, but an important step toward a broader relationship of goodwill. Indeed, informed opinion on both sides has consistently voiced a desire for comity. Dr Henry Kissinger has recently argued for the imperative of peaceful Sino-U.S. 'co-evolution' in the years ahead, and the need to find common projects to build cooperation (Kissinger, 2011). Although global environmental problems such as climate change are daunting, they present an opportunity to make common cause in a way that is historically novel.

However, there have also been antagonistic voices that postulate the inevitability of conflict and argue for the adoption of more aggressive postures. This would be a truly unfortunate outcome for the two large nations involved and the international community in which they are inextricably linked. Historians have noted that the relationship between the regnant power and the rising power is usually fraught with the potential for misunderstanding. Putting the Sino-U.S. dynamic on a robust foundation requires earnest and honest efforts by both sides to understand each other and align goals. Never before has the world faced such a demanding challenge as the great biophysical changes currently looming, and never has the need for cooperation between the world's two greatest powers been so necessary. Building upon recent achievements, let us hope China and the U.S. can strike the right balance and lead the world to a more sustainable future.

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