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Climate and Energy Impacts of China's Stimulus Package

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Preface

In November 2008, the State Council invested 4 trillion RMB into a national economic stimulus package designed to assist China's economy in weathering the global financial crisis. In terms of addressing an urgent situation and boosting economic recovery, the stimulus package has already achieved good results. Considering the influence of the stimulus investment on China's energy and transportation structure, as well as the increased attention paid by the Chinese government to energy conservation and emissions reduction, the stimulus package will surely have long term environmental benefits.

This report places China's stimulus package in an international comparative perspective, analyzing its short and long-term effects in terms of energy consumption and carbon emissions. It also examines the direct benefits garnered by energy efficient enterprises and alternative energy promotion, as well as the indirect benefits of changes to the country's economic structure for energy and emissions. On the basis of this analysis, policy recommendations are given for how to achieve development and environmental objectives at the same time.

There are several methodological items that the reader should take note of:

- Data in this report covers up to the end of 2009; data for 2010 and beyond is estimated.

- The term "emissions reduction" as used in this report refers to the reduction in carbon dioxide emissions unless otherwise specified, and therefore differs from the common concept of emissions reduction in China, which generally includes reduction in emissions and discharge of waste gas, waste water and solid waste.

- For the purpose of consistency, references to energy savings in this document refer to tons of standard coal saved, and each ton of coal contains 2.9306 x 107 KJ of energy. This treatment is also consistent with references in official Chinese documents to energy consumption and savings, which are given exclusively in terms of coal energy equivalents.

- The term ‘alternative energy’ used therein refers to newly developed technologies geared towards renewable sources of energy. This includes solar, wind, biomass, geothermal, wave, ocean currents, tidal and other non-conventional sources of energy. However, it does not include nuclear energy.

Glossary

A-Si	Amorphous silicon
BF	Blast Furnace
COD	Chemical oxygen demand
DSA	Dimensionally Stable Anode
EMCO	Energy Management Company
ESCO	Energy Service Company
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GW	Gigawatt
HSBC	Hong Kong and Shanghai Banking Corporation
IT	Information Technology
KA	Kiloampere
Kg	Kilogram
kgce/t	Kilogram of coal per ton
KJ	Kilojoule
KW	Kilowatt
Low-E	Low emittance
MW	Megawatt
OLED	Organic Light-Emitting Diode
PCI	Pulverized coal injection
PV	Photovoltaic
STIRPAT	Stochastic impacts by regression on population, affluence, and technology
TRT	Top-pressure recovery turbine
TARP	Troubled Asset Relief Program
WB	World Bank

Executive Summary

- ◆ The RMB 4 trillion stimulus package has led to a quick recovery of China's economy;
- ◆Most of the stimulus package has been directed towards infrastructure projects, thus increasing energy consumption in the short term;
- ◆The stimulus package has altered transportation patterns in China and will contribute greatly to long-term energy conservation;
- ◆China should adopt further measures to achieve its goal of reducing emissions per unit of GDP by 45% by 2020.

Impact of the RMB 4 Trillion Stimulus Package on China's Economy

The RMB 4 trillion stimulus package was launched in November 2008 in an attempt to tackle the impact of the global financial crisis, stimulate domestic demand and resume stable economic growth. The package includes a new investment of RMB 1.18 trillion from the central government and almost RMB 3 trillion of supporting investment from local governments and non-governmental sectors, which to a great extent comes from supporting loans provided by policy banks and commercial banks. The stimulus funds have been used mostly for construction projects, including infrastructure, post-earthquake reconstruction of Wenchuan County in Sichuan Province, government-subsidized housing and new rural construction. In addition, 19% of the stimulus funds have been devoted to energy conservation and emissions reduction, industrial restructuring and social welfare.

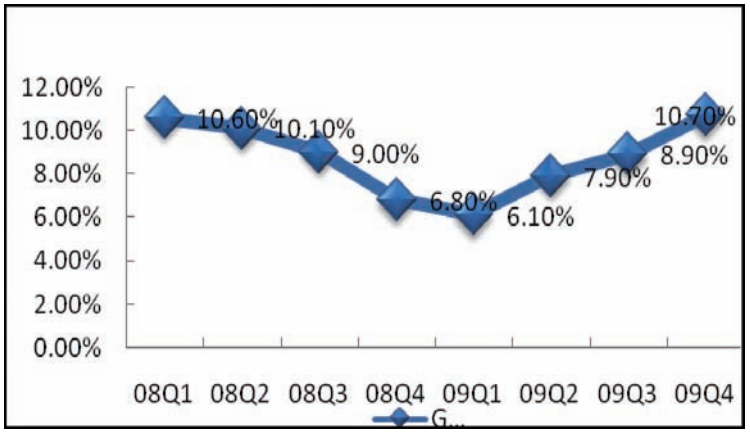


Figure 1. GDP growth rate from 2008-2009

The stimulus package has produced good results in terms of economic stimulus and growth recovery. In the first half of 2009, China's urban fixed-asset investment rose by 26.5%, up 0.4% from the previous year. From Q2 of 2009, China's GDP growth ceased its decline and resumed growth. In the first 3 quarters of 2009, China's GDP totaled RMB 21.78 trillion, with a monthly growth rate of 6.1%, 7.9% and 8.9% respectively. GDP growth in Q4 returned to the previous level of 10%.

Modeling analysis shows that the construction industry has been the first to benefit from the stimulus package, followed by the equipment manufacturing, iron & steel, nonferrous metals and cement industries. Increased energy demand will result from higher investment in major industries such as these. In the long run, agriculture will benefit most from the stimulus package, followed by the construction industry. On the whole, the RMB 4 trillion stimulus package will increase China's GDP by an estimated RMB 6.4 trillion in total over the next 7-8 years. The increase in GDP amounted to approximately RMB 838.2 billion in 2009, and will reach a peak of RMB 1.6 trillion in 2010.

Impact of the RMB 4 Trillion Stimulus Package on Energy Consumption in China

RMB 210 billion out of the RMB 4 trillion stimulus package has gone towards energy conservation, emissions reduction and environmental engineering projects. Estimates made based on the data of the first 6 months of the stimulus program show that some 20% of the funds will be directly invested in energy conservation, with an eventual total of RMB 40.8 billion focusing on 10 major energy conservation projects. Such direct investment is expected to save approximately 19 million tons of coal per year, accounting for roughly 14% of China's total energy conservation in 2010. In addition, RMB 80-100 billion of the RMB 4 trillion stimulus package will be channeled into nuclear power projects, which will save nearly 14 million tons of coal each year after their completion.

Though the stimulus funds are not being directly invested in alternative energy sources, its orientation towards energy conservation, emission reduction and industrial restructuring has nevertheless indirectly affected investment in alternative energy. Large-scale renewable energy power generation projects are underway, and investment in wind and solar power generation equipment manufacturing has increased

markedly. In addition, the alternative energy automobile industry represented by commercial charging stations has recently broken ground in Shenzhen.

Structurally, the stimulus package is weighted towards infrastructure and railways compared with previous fixed asset investments. Such infrastructure, railway and expressway projects - especially airports and subways - generally bring lower GDP returns in the following year than investment in other fixed assets. In the short term, therefore, China will face rising carbon intensity pressure.

Increased energy consumption as a result of the stimulus investment can be accounted for by the fact that 81% of these funds or RMB 3.25 trillion has been devoted to infrastructure projects, which will consume a large amount of iron & steel, nonferrous metals and cement. This will in turn lead to growth of energy intensive industries. As a result, for the next two years the stimulus package will increase total energy consumption by some 113 million tons of coal, equivalent to 260 million tons of carbon emissions, increasing annual emissions by 130 million tons.

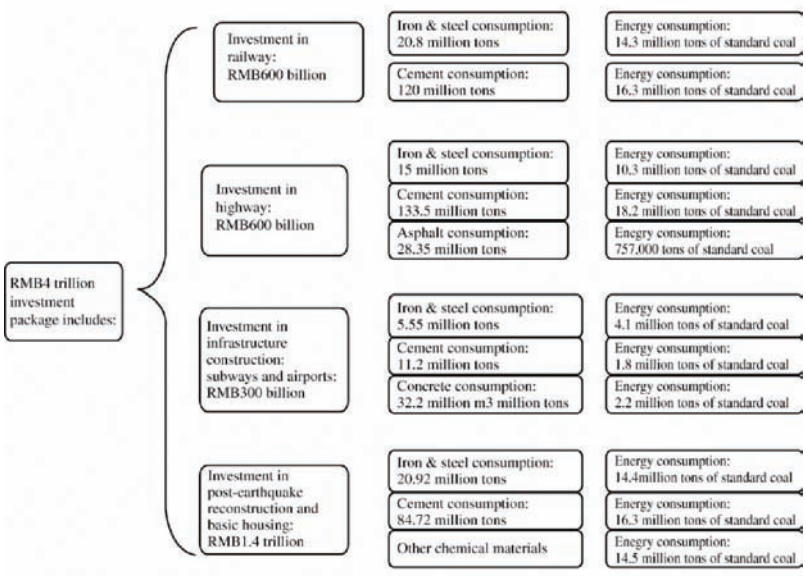


Figure 2. Preliminary Workflow for Calculation of Energy Consumption by Energy intensive Products Resulting from the Economic Stimulus Package

Empirical data show that after several months of sharp decline caused by the financial crisis, China's energy intensive industries have enjoyed a rapid recovery. In the first 8 months of 2009, China's total investment in railways, highways and urban public transport reached RMB 1.41 trillion, the highest level in the country's history. As a result, China's energy consumption started to grow quickly in Q2 of 2009. Beginning in June 2009, China's coal and power output both exceeded their highest levels in 2008.

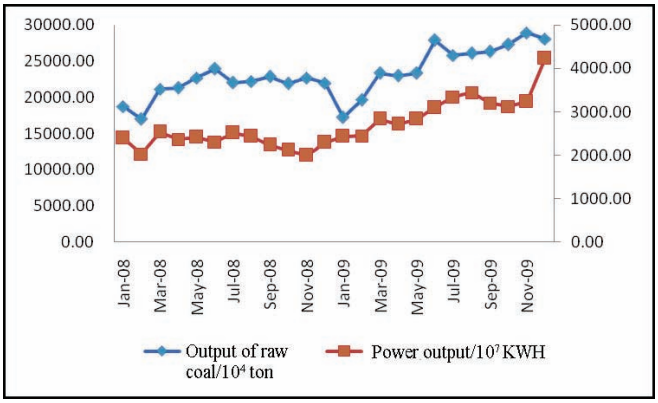


Figure 3. China's Output of Raw Coal and Electric Power over the Past 24 Months

The Effects of the Stimulus Package on Future Energy Conservation

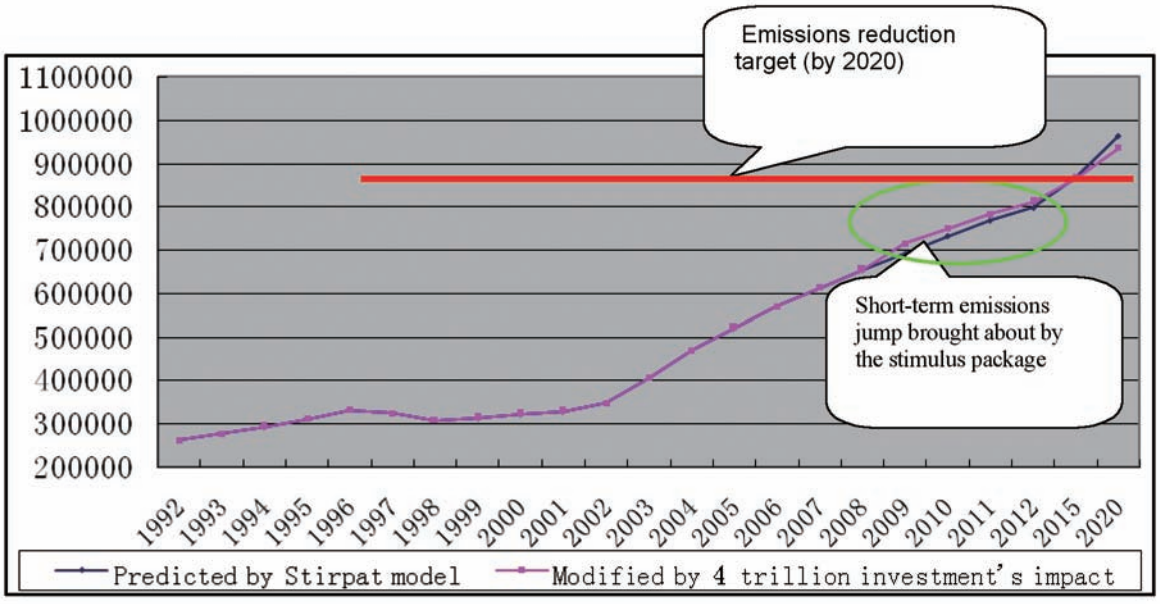


Figure 4. China's past and future CO2 emissions (Unit: million tons, without reference to the impact of policies after 2009)

In the short term, the stimulus package will increase China's annual energy consumption and will cause a jump in carbon emissions. In the long run however, the stimulus package is still expected to make positive contributions to China's energy conservation and emissions reduction. First, energy savings of around 20% are expected in the transportation sector by 2020 after the completion of rail transit networks like railways

and subway systems. This is equivalent to 220 million tons of carbon dioxide emissions. Second, energy conservation projects and nuclear power plants will begin to come on line starting from 2010. Because a high level of investment in energy intensive industries cannot be sustained, the impact of the stimulus package on energy consumption in China is expected to turn from negative to positive by 2014. Furthermore, it is anticipated that by 2020, this investment will bring about an annual emissions reduction of at least 270 million tons. This will bring China's carbon dioxide emissions down to 9.36 billion tons from the 9.63 billion tons predicted by the model used in this report. This figure still represents a big gap from the goal, which China pledged at the Copenhagen Climate Conference to reduce its emissions per unit GDP of 45% by 2020.

Policy Recommendations: Promote Low-Carbon Economic Development in China

First, continue to increase investment in the energy conservation field, and formulate strict energy conservation standards. Currently, China is in a peak period of marginal utility of technology-based energy conservation. Unit investment in energy conservation projects can bring about an annual amount of energy conservation equivalent to 4-5 tons of coal. Developing the energy conservation industry is therefore of great significance to China's energy conservation and emissions reduction. The 7 major industries of construction, iron & steel, nonferrous metals, construction materials, power generation, petrochemicals and chemicals, and transportation account for almost 90% of China's overall energy consumption. Therefore energy conservation measures should start from these industries. China needs to strengthen its efforts in this regard and launch energy conservation demonstration projects; at the same time, China needs to formulate better energy conservation standards and provide disincentives for inefficient, energy intensive enterprises.

Second, strongly support alternative energy industries. China abounds in wind, solar and other alternative energy reserves, which are sufficient to meet its energy demand well into the future. However, China has yet to fully tap potential in this field due to the following reasons: 1) it is weak in relevant R&D; 2) insufficient government support has resulted in the export of most products; and 3) it is lagging behind in grid construction e.g. smart grids. China must overcome these obstacles in order to effectively develop its alternative energy resources.

Third, speed up industrial restructuring and restrict the development of energy intensive industries. The RMB 4 trillion stimulus package is an interim economic policy. The flow of large amounts of capital into energy intensive industries will lead to surplus production capacity, causing considerable duplicate construction and waste of resources. This presents serious obstacles to China's efforts to build itself into a "Dual-Oriented (Resource and Environment) Society". China should therefore tighten its approval procedures for new industrial projects, especially in the 4 major industries of iron & steel, nonferrous metals, chemicals and cement. In addition, it is necessary to make full use of the existing production capacities of energy intensive industries for projects funded under the stimulus program. In such projects, priority should be given to the procurement of products from manufacturers that have completed energy conservation retrofits.

Fourth, funding should be prioritized for expanding and improving railways and other more sustainable modes of transport and types of infrastructure over highway construction. In the past 10 years, China has given priority to highway construction over rail transit construction. Currently, there are over 60,000 km of highways in China while railway coverage only grew from 68,700 km in 2000 to 80,000 km by the end of 2009, showing imbalanced development between these 2 modes of transport. This funding structure has been changed in the stimulus package, but not enough to fundamentally alter the current situation of insufficient rail transit (including railways, subways and light rail tracks) coverage in China. In the second phase of the stimulus package, therefore, more investment should be given to rail transit projects, while investment in highway construction should be curtailed. In addition, priority should be given to the promotion of electric cars, particularly in terms of car manufacturing and charging infrastructure.

Fifth, build platforms for low carbon economic growth, particularly smart grids and information highways. Given the vital importance of electricity as a secondary energy source, it is crucial to build intelligent and complete electrical grids. Only on this basis can electric automobiles and various alternative energy industries develop successfully and become mainstream industries. Meanwhile, as China shifts from a manufacturing economy to a services economy, IT and software, service outsourcing, film, TV, entertainment, media and finance industries will become increasingly important. This will generate a huge demand for information transmission. Currently, communication networks lag behind in China and cannot meet the development needs of the service industry. Therefore, the stimulus package should prioritize investments

in grid and communications infrastructure during its next stage. In terms of infrastructure, grid construction should receive a higher percentage of investment, while improvement of the internet nationwide should be a priority for those funds earmarked for restructuring.

Sixth, set up a government energy-efficiency guarantee fund and build a green financial platform. Due to poor investment and financing mechanisms for energy conservation and alternative energies, energy service enterprises have trouble acquiring sufficient financing. For a long time, China's energy conservation service industry has been in a small and dispersed state. From 2004 to 2009, the World Bank/Global Environment Facility implemented a WB/GEF China Energy Conservation Promotion Program II (loan guarantee program). This Program has proven effective during its five years of operation. Its approximately RMB 150 million in policy funds have brought about an investment of over RMB 800 million in private capital in the energy conservation industry, achieving a leverage ratio of around 6 times. Moreover, the guarantee principal basically remains in place. Meanwhile, the Program has made significant achievements in terms of energy conservation, emissions reduction and economic benefits.

The WB/GEF China Energy Conservation Promotion Program II is experimental in nature, and is not of sufficient scale to significantly upgrade energy service enterprises in China. To achieve its goals, the Project must rely on government policy support. In the United States, $8 billion out of its $787 billion economic stimulus package has been directly used as loan guarantees in the low carbon field. We therefore suggest that the government should allocate funds to set up a national energy efficiency loan guarantee fund to replace some direct government investment in the field of energy conservation and alternative energy. If the government can invest an accumulated total of RMB80 billion as a guarantee reserve fund in the next 10 years, based on a leverage ratio of 5, it may well open up an energy conservation and alternative energy market of RMB 400 billion.

I. An Overview of the 4 Trillion RMB Stimulus Package

The 4 trillion RMB (US$585.6 billion)[1] stimulus package was put forward in November 2008 with the goal of coping with the global economic crisis, boosting domestic demand, and ensuring economic stability. In this program, 1.18 trillion RMB (US$172.65 billion) constitutes new investment on the part of the central government, which is composed of budgetary funds, capital investment, other public investment, post-disaster reconstruction funds, etc. The remaining investment funds worth nearly 3 trillion RMB (US$438.94 billion) are financed from other sources such as local budgets, local government bonds issued by the central government, policy-related loans, and bank loans, among which 70 per cent are bank loans. The sources of the 4 trillion RMB in stimulus funds are illustrated in Figure 1.

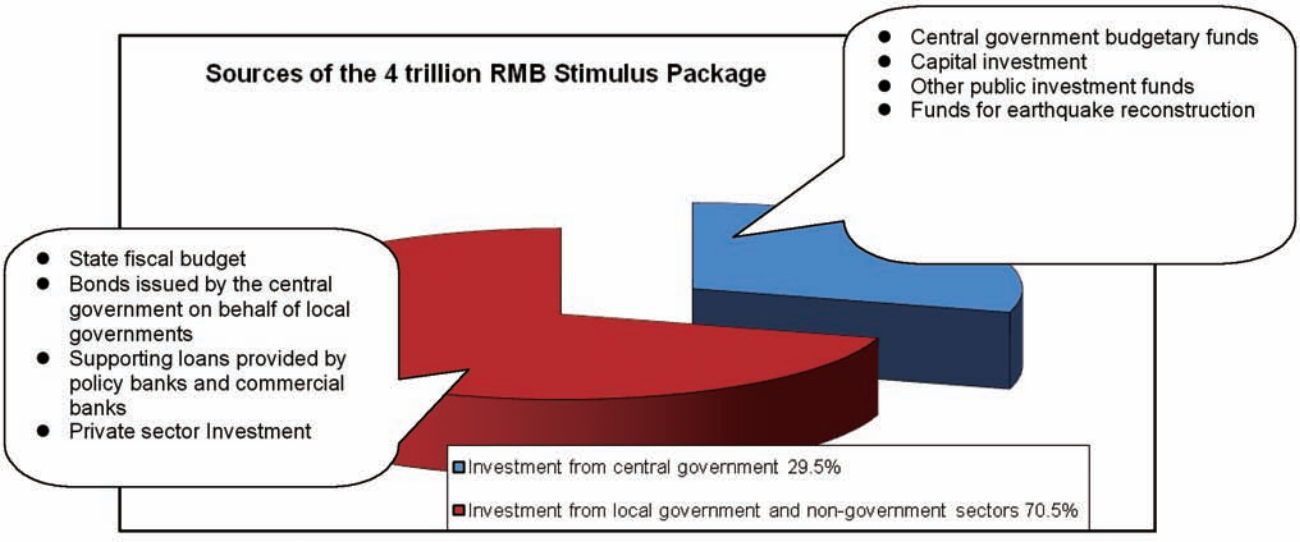


Figure 1. Sources of the 4 trillion RMB stimulus package

In order to help local governments and enterprises raise supportive funds and project capital, the central government has taken the following four steps: (1) help local governments raise funds for their share in the project, (2) issue policy-related loans, (3) expand the issuance of local corporate bonds, and (4) encourage active involvement of corporate, social, and private capital in projects related to infrastructure and technological innovation.

1 Equal to US$ 585.6 billion, according to the average exchange rate between Chinese Yuan RMB and US dollars in 2009,USD:RMB=6.83.

The Ministry of Finance issued 24 billion RMB in (US$3.51 billion) treasury bonds in November 2008, and in 2009 issued another 100 billion RMB worth (US$14.63 billion) of treasury bonds[2]. So far, the distribution of these bonds have been specified as follows: 10 billion RMB (US$1.46 billion) for government-subsidized housing projects, 34 billion RMB (US$4.97 billion) for the livelihood improvement program in rural areas and rural infrastructure construction, 25 billion RMB (US$3.65 billion) for major infrastructure projects such as the construction of railroads, highways, and airports, 13 billion RMB (US$1.9 billion) for social services such as health care and education, 12 billion RMB (US$1.75 billion) for energy conservation, emissions reduction, and environmental engineering projects, and the remaining 6 billion RMB (US$878.88 million) to support innovation and industrial restructuring. Though the 100 billion RMB amounts to only a tiny proportion of the 4 trillion RMB program, it is indicative of the policy direction of the central government: central leaders have attached great importance to energy conservation and emissions reduction, as well as livelihood improvement projects in rural areas.

As indicated by the economic data, the major channel for the implementation of the stimulus program is through the increased amount of loans issued by financial institutions. The investments that are not provided

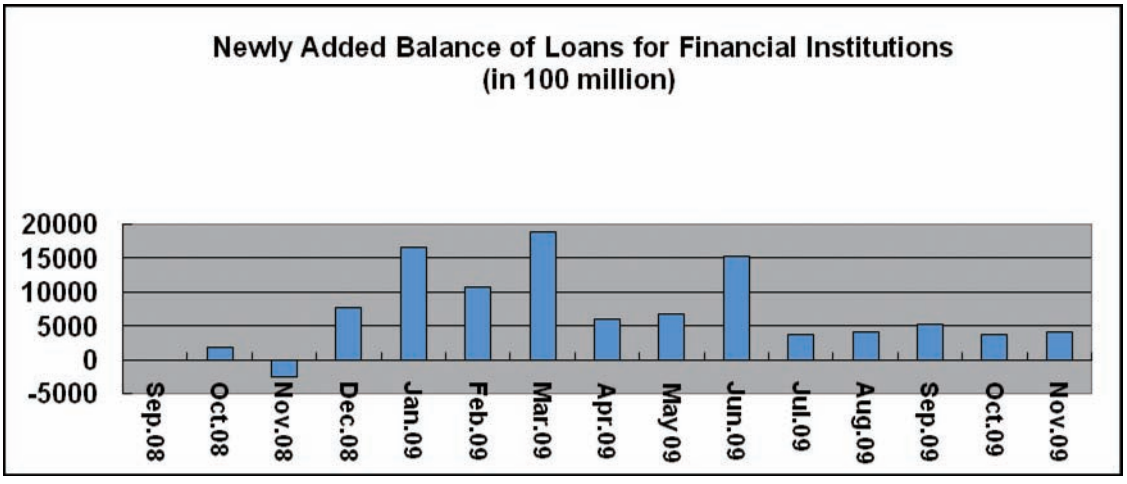


Figure 2. Newly added balance of loans for financial institutions in China[3]

2 Released from the Ministry of Finance of PRC at a press conference held by the State Council on November 14, 2008,. http://www.drcnet.com.cn/DRCnet.common.web/DocViewSummary.aspx?docId=1845437&leafId=15100&viewMode=content

3 Source: The People's Bank of China, http://www.pbc.gov.cn/diaochatongji/tongjishuju/gofile.asp?file=2009S01.htm

by the central government are to be financed by policy-related loans and loans issued by commercial banks. From December 2008 to June 2009, the loan portfolio of financial institutions has experienced a dramatic increase (See Figure 2). The majority of bank loans are being channeled to state owned enterprises and local government-subsidized enterprises, which are all mainly involved in the area of infrastructure development. In addition, the issuance of treasury bonds by local governments has provided capital guarantees for the large-scale implementation of infrastructure projects.

According to the information already released, the direction of stimulus fund investments include housing guarantees, rural construction, energy conservation and emissions reduction, infrastructure development, social services, industrial restructuring, and post-disaster reconstruction of Wenchuan, as illustrated in Figure 3.

The composition of the 4 trillion RMB stimulus package							
Housing guarantees	Rural construction	Energy conservation and emissions reduction	Infrastructure development	Social services	Industrial restructuring	Post-disaster reconstruction of Wenchuan	Total (RMB)
400 billion	370 billion	210 billion	1.5 trillion	150 billion	370 billion	1 trillion	4 trillion

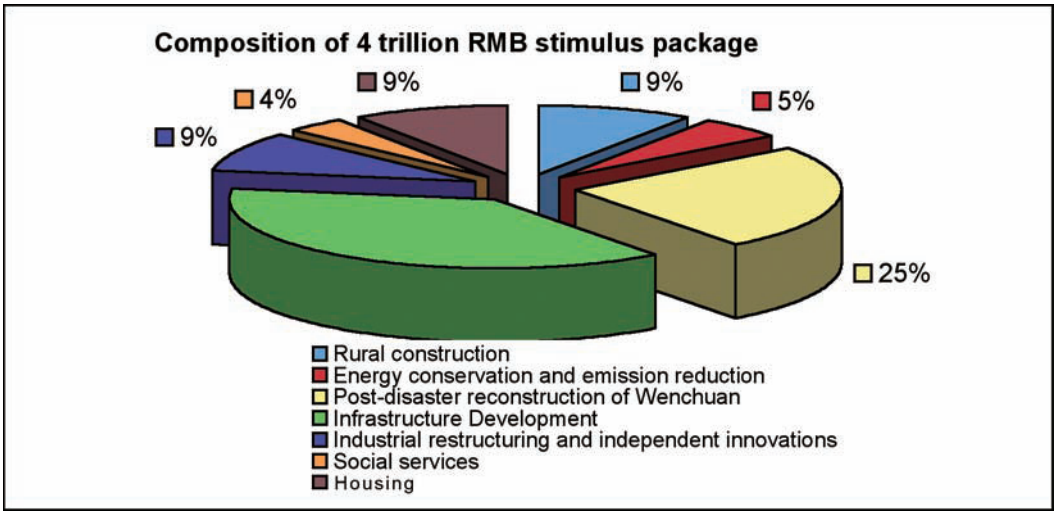


Figure 3. Composition of the 4 trillion RMB stimulus package[4]

4 These emission reductions not only include carbon emission reduction but also include the reduction of wastewater, solid waste and flue gas.

As illustrated, the stimulus program has two major components. One is infrastructure development such as the construction of railroads, highways, and urban transportation facilities. The other is post-disaster reconstruction and the livelihood improvement program, which includes affordable housing, a "new socialist countryside" project and the construction of housing and infrastructure in earthquake-affected areas. The investment in housing and infrastructure amounts to 3.27 trillion RMB (US$478.44 billion).

Funds directed towards industrial restructuring are being used to support emerging industrial sectors and to assist existing industries to improve efficiency and adapt to low carbon development. Some 80 billion RMB (US$11.7 billion) of funding is being used for the construction of nuclear stations in order to alleviate dependency on coal-fired power plants. Funds for social services are focused on culture, education, and health care. In addition, 210 billion RMB (US$30.72 billion) is being devoted to energy conservation, emissions reduction, and environmental engineering projects. As can be seen, the 4 trillion RMB stimulus funds are not being directly allocated to the construction of large-scale chemical factories, refineries, and steel plants. At the same time, only 58 billion RMB[5] out of the above mentioned 210 billion RMB directly address energy conservation and emissions reduction.

Notably, 370 billion RMB (US$54.13 billion) is being directed towards industrial innovations and restructuring. In addition to the 80-100 billion RMB (US$11.7-14.6 billion) that are being used to build nuclear power stations, funds will flow to high-tech areas such as information technology, equipment manufacturing, and biotechnology. These efforts will indirectly promote energy security and emissions reduction in China. According to officials of the National Development and Reform Commission, 176 projects in high-tech industrialization and 146 projects in industrial technology have been undertaken. The investment plans for the 222 projects assigned for 2009[6] – aimed at reviving and technologically restructuring the information technology industry – has already been decided.

5 Adopted from China central government web site, http://www.gov.cn/gzdt/2009-06/04/content_1332257.htm
6 From National Development and Reform Committee web site, http://tzs.ndrc.gov.cn/t20090521_286872.htm

Figure 4 is the monthly trend of investment in fixed assets for urban areas in China, which demonstrates that investments experienced a dramatic decrease in the first quarter of 2009 and began to increase steadily from the second quarter onward. The area inside the red triangle represents state investments, whereas the area below the baseline of the triangle represents private investments. As illustrated by Figure 4, during the first three quarters of this year, especially the first and second quarter, state investments played an important role. However, starting from the third quarter, especially after October, private investments experienced a substantial recovery and have become the main source of investment capital.

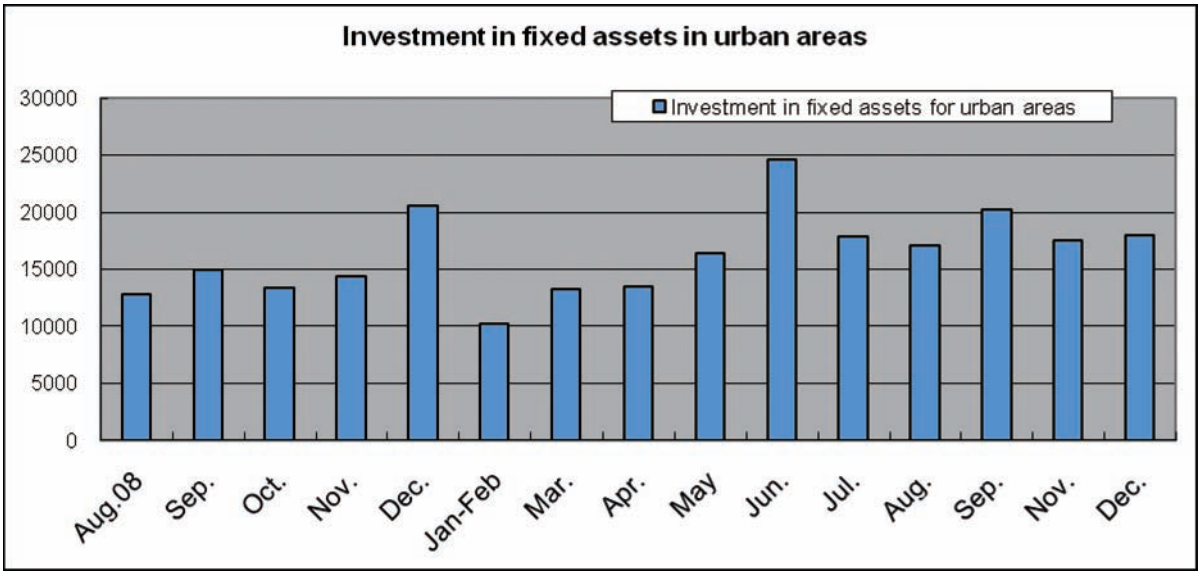


Figure 4. Monthly trend of investment in fixed assets in urban areas in China

In tandem with the stimulus program, the government has introduced a series of measures to stimulate consumption such as the “Car to the Countryside” and “Home Appliances to the Countryside” policies. These policies are intended to promote economic growth from both the investment and the consumption side. This year, the state raised subsidies for the trading of old motor vehicles to new ones from 1 billion RMB (US$146.4 million) to 5 billion RMB (US$732 million), and also allocated an additional fund worth 2 billion RMB (US$292 million) as subsidies for the "old for new" home appliances policy. The central government arranged 5 billion RMB in subsidies for the "Car to the Countryside" program[7]. It is estimated

7 Source: “Cars and Motorbikes to the Countryside Program” Announced by PRC Ministry of Finance, Ministry of Industry and Information etc. http://www.gov.cn/gzdt/2009-03/16/content_1260172.htm

that will contribute to the additional purchase of 1 million cars, worth some 50 billion RMB (US$7.315 billion). Despite the fact that none of the 4 trillion RMB stimulus funds are being directly devoted to stimulating consumption, farmers' purchasing power could still be enhanced because various infrastructure and earthquake reconstruction projects will provide extra income to them. They will also benefit from the "New Socialist Countryside" project. As a result, the stimulus program shall promote the smooth implementation of consumer stimulus policies like the "Car to the Countryside" program. These policies will enhance rural residents' demand for durable goods.

According to data released by the National Development and Reform Commission, by the end of August 2009, 505 billion RMB (US$73.88 billion) in central government investment had been allocated, making up 50.5 per cent of the total planned investment. Over 50 per cent of the 505 billion RMB has been spent on livelihood improvement projects. Of the funds that have already been allocated, investment in infrastructure is prominent. Of the planned investment in urban and rural housing, 73.4 per cent has already been completed, as has over 40 per cent of the investment in basic infrastructure and public services. In addition, investments in energy conservation and emissions reduction have resulted in an annual energy saving capacity of 6.69 million tons.

Before the opening of the 15th Conference of Parties to the United Nations Framework Convention on Climate Change, the Chinese government promised that by 2020, China's carbon emissions per unit of GDP will decline by 40-45 per cent compared with 2005 levels. As Premier Wen Jiabao pointed out in the conference, "China's objective of reducing the emission of greenhouse gases is both in accordance with the actual conditions of China, and will benefit the Chinese people and the whole human race. Whatever agreement is reached in the conference, China will strive unwaveringly to achieve and even surpass this objective." As a result, energy conservation and emissions reduction is both a necessity for coping with climate change and a prerequisite for China’s own economic development and industrial restructuring.

II. Analysis of Foreign Economic Stimulus Plans and their Energy Conservation & Emissions Reduction Components

2.1. The United States

Following the maelstrom of the international financial crisis, the United States faced enormous pressure to fight rising unemployment, revive economic activity and invest in long-term economic growth. Since President Barack Obama took office in 2009, he has launched a US$787 billion economic stimulus plan and a US$350 billion Troubled Asset Relief Program (TARP) funding program. TARP funds have been used to assist troubled financial institutions and for market stabilization; the US$787 billion in economic stimulus funds, just like China's 4 trillion RMB stimulus package, is intended for economic stimulus. Many provisions are aimed at stimulating and transforming the energy sector, focusing on the future, so that the U.S. can occupy a strong competitive position in developing a low carbon economy.

The US$787 billion economic stimulus plan signed by President Obama contains about US$288 billion for tax cuts, US$80 billion for unemployment relief and social welfare, US$60 billion for medical care, US$111 billion for the building of infrastructure including railways, more than US$40 billion for the improvement of energy efficiency, and nearly US$10 billion for education and scientific research, with the remaining funds for transfer payments to state governments.[8] The aim is to restore the spending power of U.S. citizens and achieve economic recovery through such measures as tax cuts and an increase in social welfare.

The over US$40 billion directed towards the energy sector includes US$11 billion in funding for a new electric smart grid, US$10 billion for state and local governments to make investments in energy efficiency and to increase energy efficiency in federal buildings, US$6 billion for renewable energy and electric transmission technologies loan guarantees, US$32 billion toward Energy Efficiency and Conservation Block Grants and many other investments aimed at reducing diesel fuel emissions and further developing electric vehicle technologies. The tax-cut plan also allocates US$20 billion to the field of renewable energy. As can

8 "Summary: American Recovery and Reinvestment". Committee on Appropriations. 13 February 2009

be seen in the economic stimulus plan, the U.S. federal government promotes energy conservation and emissions reductions through financial means rather than direct investment.

Apart from the US$787 billion economic stimulus plan, the United States has launched a number of associated development plans for low-carbon industry. In the field of new energy, President Obama proposed that the U.S. invest US$150 billion over the next 10 years in alternative sources of energy like wind power and solar power. While campaigning for the presidency, Barack Obama proposed to upgrade the power grid system, in order to promote energy efficiency and to establish a new energy economy. However, this proposition has not been enacted into law. The Obama administration's long-term goal is to eventually divert resources spent on the import of petroleum products to the construction of new U.S. solar, wind, and geothermal power plants, and to build a competitive alternative energy industry in the U.S. and increase green employment opportunities over the next 10-20 years.

As part of President Barack Obama's economic stimulus plan, which he laid out in a speech on January 8th 2009, he announced his long-term vision for U.S. energy policy[9], which includes the following goals:

1. Under the new energy strategy, substantially reduce the dependence on oil from the Middle East and Venezuela;
2. By 2012, to produce 10 per cent of electricity in the United States from renewable energy, and 25 per cent by 2025, and furthermore to promote the smart grid program;
3. In the area of energy technology, Obama plans to double the country's wind, solar, and geothermal power generation capacity in three years;
4. Undertake a large-scale transformation of federal government office buildings, including energy-saving system measures in the White House, and promote the replacement of old heating systems as well as energy-saving measures for schools and public buildings throughout the country;
5. For motor vehicles, spur the government and the private sector to invest heavily in hybrid vehicles, electric vehicles, and other new technologies to reduce U.S. oil consumption, and also to achieve 100 million hybrid car sales by 2015 through supporting vehicle manufacturers with US$4 billion in federal funds.

9 The Office of President-Elect 23, Feb. 2010, http://change.gov/agenda/energy_and_environment_agenda/

6. Fulfill the commitment of the federal government to reduce emissions by 28% by 2020.

For Obama's full vision to become a reality, many of these goals would have to be enacted into law and/or funded by the US Congress. While the current economic stimulus plan is aiding implementation of some of these goals, a stronger policy framework and more funding is required to achieve them. In addition to the measures mentioned above, the White House has committed to $8 billion in loan guarantees for nuclear energy; [10] and a 28% emissions reduction on the part of the federal government by 2020;[11]

2.2. Germany

The German recovery package is in fact the sum of two distinct sets of measures. The first one, called "Konjunkturpaket I" was decided on November 5th, 2008 and describes a set of measures for 2009 and 2010 totaling EUR 31 billion[12]. This was a reaction to the decline in growth and demand following the global financial crisis. The continuing financial crisis and its increasing effects on other sectors of the economy led to a second set of measures, also known as "Konjunkturpaket II" totaling around EUR 50 billion[13],[14]. The total stimulus plan is expected to reach EUR 81 billion.

The first set of measures concentrated on providing liquidity and credit to the economy.

The second economic stimulus plan includes additional investments in infrastructure, reduced income taxes and social security expenditures for private homes. The overarching concept is an increase in investments and the reduction of tax payments for households in order to stimulate overall demand. As part

10 The White House web site (Mar. 24, 2010) http://www.whitehouse.gov/the-press-office/obama-administration-announces-loan-guarantees-construct-new-nuclear-power-reactors
11 The White House web site (Mar. 24, 2010) http://www.whitehouse.gov/the-press-office/president-obama-sets-greenhouse-gas-emissions-reduction-target-federal-operations
12 Germany Social Democratic Party Parliament Group web site (in German, 20, Mar. 2010) http://www.spd-fraktion.de/cnt/rs/rs_datei/0,,10599,00.pdf
13 From Germany federal Ministry of economic and technology (in German, 20, Mar. 2010) http://www.bmwi.de/BMWi/Navigation/Wirtschaft/Konjunktur/konjunkturpaket-2.html
14 Germany Social Democratic Party Parliament Group web site (in German, 20, Mar. 2010) http://www.spd-fraktion.de/cnt/rs/rs_datei/0,,10599,00.pdf

of the public investment expenditure, about €17 [delete?]billion[15] (about US$ 19.11 billion) is being directed towards infrastructure and school construction. Another portion of about EUR 1.5 billion[16],[17] was allocated for automobile subsidies (Abwrackprämie), and the German parliament (Bundestag) put additional money to increase this amount to 5 billion Euro in April 2009. The remainder is for tax cuts. Germany's economic stimulus plan is mainly aimed at increasing consumption, while infrastructure development accounts for a relatively small proportion.

An analysis of the environmental sustainability of the budget measures conducted on behalf of WWF Germany by "Forum Ökologisch-Soziale Marktwirtschaft" [include English name? "Green Budget Germany"] (FÖS) concluded that 13% of the overall measures were ecologically sustainable, while 46% of the greenness of the measures would be defined depending on the implementation thereof. 33% of the measures were considered neutral in terms of ecological consequences while 8% were considered counterproductive.

In the area of energy policy, the new German government has announced the development of a new energy framework by October 2010. The Ministry of the Environment has made it clear that it will include the development of new energy sources and enhancing energy efficiency, with the ultimate goal for renewable energy to be the main contributor to the energy sector by 2050. Furthermore, the German Bundestag recently approved a total of €500 million[18],[19] (US$682 million) for an electric car R&D program. Three automobile manufacturers, including Mercedes-Benz, plan to achieve mass production of automotive lithium batteries by 2011. However it is still too early to assess these efforts.

2.3. South Korea

South Korea's US$32 billion economic stimulus plan includes US$28 billion in green funds, of which

15 Germany parliament web site (in German, 20, Mar. 2010) http://www.bundestag.de/presse/hib/2009_04/2009_114/07.html
16 Germany Social Democratic Party Parliament Group web site (in German, 20, Mar. 2010) http://www.spd-fraktion.de/cnt/rs/rs_datei/0,,10599,00.pdf
17 German Parliament [maybe use "Bundestag" instead?] web site (in German, 20, Mar. 2010) http://www.bundestag.de/dasparlament/2009/14/WirtschaftFinanzen/24026930.html
18 German Parliament [maybe use "Bundestag" instead?] web site (in German, 20, Mar. 2010) http://www.bundestag.de/dasparlament/2009/14/WirtschaftFinanzen/24026930.html
19 From German Federal Ministry of Economics and Technology (in German, 20, Mar. 2010) http://www.bmwi.de/Dateien/BMWi/PDF/nationaler-entwicklungsplan-elektromobilitaet-der-bundesregierung,property=pdf,bereich=bmwi,sprache=de,rwb=true.pdf

81 per cent will be invested in energy conservation and environmental protection projects. UnlikeEuropean and USA (meaning USA, Canada & Central America? Unclear.) other governments, the South Korean government's economic stimulus plan is focused on investment. Therefore, the government is taking a more prominent role and its investment in energy conservation and environmental protection is higher than any other country. Until the beginning of 2009, up to US$28 billion of green funds initialized by South Korea's Presidential Commission on Green Growth had been allocated to local administrative departments, of which US$23 billion had been put into actual use in 2009. The remaining 26% of the green economy stimulus investment will be invested in 2010, according to the Presidential Commission. As predicted by HSBC, actual investment in green industries will reach US$25 billion in 2010.[20] The South Korean government expects an annual growth of 52% in investment in green technologies in 2010, and guarantees an annual input of 2% of GDP to promote a green economy. In addition, a new research institute on global green growth will be established to promote cooperation with developing countries. [Changed from counties to countries. I assume this is countries. At present, 97 per cent of the energy used in South Korea is imported. The South Korean government has promised to construct millions of green homes and to increase the energy efficiency of more than one million homes. It will also invest heavily in low-carbon technology research and will put a large amount of money into high-speed rail and other types of low carbon transportation. Meanwhile, it plans to expand subway, train and tram use. Overall, it plans a 20 per cent reduction of greenhouse gas emissions in the area of transportation by 2020. In addition, South Korea also plans to increase the sequestration capacity of carbon sinks and to establish Korea's first biomass energy base.

In related policies, the South Korean government proposed a "low-carbon green growth" economic revitalization program in 2008, of which the development of nuclear energy is one important element. In 2009 it launched the "Third Phase of the Basic Plan on New Energy and Renewable Energy," a program which will focus on certain areas of industrialization, while developing the alternative and renewable energy export market. Meanwhile, the South Korean government plans to vigorously develop coastal tidal power projects and to invest in a new tidal power plant. Besides the Basic Plan, South Korea has also developed special programs such as the "100,000 Solar Roofs Plan," which proposes to install 100,000 sets of 3kW solar cell

20 Delivering the green stimulus, HSBC Global Research, 9 March 2010

power generation systems for civilians by 2012. In addition, the South Korean "National Energy Technology Development Plan (2006-2015)" sets four goals: an oil self-sufficiency rate reaching 18 per cent by 2013, reduction of energy consumption by 5 per cent, reduction of 17 million tons of carbon emissions, and alternative energy and renewable energy accounting for 5 per cent of national energy supply by 2011.

2.4. Brazil

Since its financial system is relatively stable and exports account for a small portion of its GDP, Brazil's economy has weathered the financial crisis fairly well. Even so, the Brazilian government has launched new economic stimulus measures to aid its economy. Under the direct leadership of the federal government and with the collaboration of various organizations, 1-1.5% of Brazil's GDP has been directed to economic recovery following the financial crisis. In order to stimulate financial markets by increasing liquidity, the Brazil Central Bank's benchmark interest rate was set at a record low of 8.75 per cent, with the entire program involving a total amount of 99.8 billion Real. At the same time, the Central Bank injected 42.2 billion Real into small financial institutions, provided exporters with US$24.4 billion in loans, and sold US$14.5 billion on the open market. The stimulus program aimed to bring Brazil's economic growth rate up to a relatively high level in 2009.

Brazil's economic stimulus package features both government investment and measures to boost consumption. To stimulate financial markets, the Brazilian government has lowered the taxes levied on some industrial products, including automobiles, building materials, and home appliances. According to government figures, 9 billion Real was put into this plan by April 2009. Meanwhile, the government has decreased the tax rate on financial transactions from 3% to 1.5% and lowered the individual income tax rate. As a result, US$8.75 million was exempted each month and the total tax relief plan reached 0.5% of GDP.[21]The remaining funds were mainly directed to energy, health, and infrastructure construction. Meanwhile, the Brazilian government has launched a stimulus plan for the real estate industry and injected about 34 billion Real into the industry through a series of measures.[22] Moreover, the Brazilian National Development Bank has lowered the long-term annual loan rate from 6.25% to a record low of 6%.[23]

21 http://www.brookings.edu/articles/2009/0323_latin_america_cardenas.aspx
22 http://www.minhacasaminhavida.gov.br/index.html
23 http://www1.folha.uol.com.br/folha/dinheiro/ult91u464961.shtml

The Brazilian government has also encouraged energy conservation and carbon emissions reduction. Without affecting its annual economic growth rate of 4 per cent, it plans to reduce greenhouse gas emissions by 36.1 - 38.9 per cent by 2020, of which agricultural emissions will be reduced by 6.1 per cent, energy industry emissions by 7.7 per cent, and iron and steel enterprise emissions by 0.4 per cent. If this goal is achieved, Brazil's greenhouse gas emissions in 2020 will be close to 1994 levels. This is equivalent to a 20 per cent reduction of 2005 levels.

2.5. China's Economic Stimulus Policies Compared With Other Countries

(1) Diversified Measures for Energy Conservation and Emissions Reduction

China's 4 trillion RMB (about US$585 billion) investment is the second largest stimulus package, second in size only to the United States' US$787 billion program. Out of the 4 trillion RMB package, 210 billion RMB (US$30.72 billion) will be used for energy conservation, emissions reduction and environmental engineering projects, accounting for 5.25 per cent of the total investment. In the United States' US$787 billion economic stimulus package, about US$68 billion or 8.6 per cent of the total investment will be devoted to clean energy and energy-saving measures.

President Obama has indicated that in the next 10 years, US$150 billion in investment will be used for research and development in solar, wind, biomass energy and other new energy projects[24]. Meanwhile, the European Union has established a medium-term plan for development of a globally competitive green economy, which includes €105 billion (US$143.38 billion) in financing from 2009 to 2013.

In terms of direct investment on energy conservation and emissions reduction, China's economic stimulus program is not very different from those of developed countries, excluding South Korea. The implementation plan associated with energy conservation and emissions reduction is highly directed and diversified.

24 The Office of President-Elect 23, Feb. 2010, http://change.gov/agenda/economy_agenda/

Government and large-scale state owned enterprises are investing in solar, nuclear and other alternative energy sources across the country. Experts report that China's installed capacity of wind and solar power will reach 100 GW and 20 GW[25] respectively by 2010. In addition, 80-100 billion RMB of the stimulus funds will be directly invested in nuclear power.

Table 1. A comparison of the economic stimulus plans and energy conservation and emissions reduction efforts in China and other countries[26]

Country	China	U.S.	Germany	South Korea	Brazil
Total amount of economic stimulus plan	About US$ 586 billion	US$787 billion	US$110 billion	About US$ 32 billion	US$17-25 billion
Energy conservation and emissions reduction investment	US$31 billion	US$68 billion		US$28 billion	-
Other energy conservation and emissions reduction measures	US$14 billion investment in nuclear power and alternative energy	US$150 billion investment in alternative energy over the next decade	-	Publish a series of special new energy application programs	Encourage large domestic enterprises to invest in renewable energy

(2) Government at all Levels Actively Support Energy Conservation and Emissions Reduction

Energy conservation and emissions reduction measures have tremendous potential throughout all processes of production, sales, consumption, use, disposal, recycling, resource recovery and reuse; each area has to comply with specific regulations. [awkward. unclear]Only by regulating the behavior of producers, consumers, users and re-users through legislative and administrative measures can progress be made.

To advance energy conservation and emissions reduction, U.S. and European countries have allowed market mechanisms to take the lead in implementing regulatory polices and incentive measures. In the

25 Announced by Mr. Shi Dinghuan, Counselor of the State Council, senior energy expert in Chian PV Summit Forum (Xi'an), 2009
26 Currency exchange rates are calculated according to average rates in 2009: EUR:USD=1.394, USD:RMB=6.83, Real:USD =1.993,http://www.oanda.com/currency/average

U.S., for example, US$39 billion out of the total US$787 billion economic stimulus plan was allocated to the establishment of public funds for energy efficiency (for issuance of low-interest or interest-free loans, etc.), and another US$8 billion was used for an energy efficiency guarantee program. Furthermore, capital flows to alternative energy industries have been encouraged through tax incentives. These measures have fully mobilized commercial capital to participate in low-carbon industry development. EU members have adopted fixed-price and fixed-production leverage to encourage electricity grid companies to purchase certain amounts or a certain percentage of alternative energy. Meanwhile, European countries and Japan vigorously promote the energy conservation (EMCO) industry, making use of market mechanisms to link energy-saving products and providers with customers.

China differs from Western countries in that the government at many levels is playing a leading role in supporting and creating unique mechanisms for energy conservation and emissions reductions. Legally, China has already issued a Renewable Energy Law and other relevant laws that will support energy conservation and emissions reduction. In terms of administrative regulations, China's government has issued the "Ten Key Energy Conservation Projects" [27] and other energy efficiency related policies and regulations. Finally, China's government is encouraging companies to upgrade their technology and invest in alternative energy; particularly state owned and controlled enterprises (currently the primary investors in this field).

Scientific and technological innovation can be a significant driver for energy conservation and emissions reduction, as these involve a great deal of cutting-edge technologies. For this reason, the government needs to promote research and development work. In the U.S., for example, President Obama announced in August 2009 that US$2.4 billion of the US$787 billion economic stimulus package would be focused on supporting the research and development of electric vehicles and batteries. Meanwhile, EU members have developed a variety of highly efficient new turbine generators that can make use of the surplus kinetic energy of factory boilers to generate power, resulting in energy efficiency gains of 30 per cent or more. Compared with these developed countries, China once favored new construction over research and development, (especially

27 The Top Ten Energy Saving Projects are: upgrading of inefficient coal-fired industrial boilers and furnaces, the regional cogeneration project, utilization of residual heat and pressure, petroleum conservation and substitution engineering, energy conservation in motor systems, optimization of energy systems (system conservation), energy-efficient buildings, green lighting project, energy conservation projects of government agencies, and energy saving monitoring and technology service system construction. The stimulus funds investment policy for energy-saving industries is being implemented in accordance with the framework of the "Top Ten Energy Saving Projects".

research and development associated with intellectual property rights). In the new stimulus package however, 370 billion RMB is to be invested in industry structural adjustments and independent innovation. This section of the investment will promote technology upgrades and encourage the reduction of carbon intensity in companies.

(3) Great Attention has been given by Senior Government Officials, and Follow-up Measures Should be Broader.

In the first three quarters of 2009, maintaining economic growth was the focus of government economic policy, which explains why the stimulus funds were directed primarily towards infrastructure development. The implementation of energy conservation and emissions reduction measures has been relatively slow. In the period following implementation of the stimulus package, there has been an obvious pick-up of economic growth, which has encouraged industrial restructuring. Improving the quality of economic growth has now become a major task. Energy conservation and emissions reduction, as the country's long-term strategy, will be given more prominence and exhibit the following characteristics:

First, the direction of the stimulus funds will be optimized continuously. During the economic work conference held in early December 2009, efforts were made to adjust the structure of the economy and improve the quality and efficiency of economic development. Scaling back outmoded production practices and promoting more competitive, innovative enterprises are the new focuses of state policy in 2010. Alternative energy, new materials, the information industry, pharmaceuticals, biotechnology, energy conservation, environmental protection and electric vehicles are the seven new strategic industries that will attract investment.

Second, supporting policies will favor energy conservation and emissions reduction. First of all, the central government has given strong incentives to local governments in this regard through public advocacy and promotional recognition. For instance, during the China Economic Forum held in December 26th 2009, 20 cities were selected for best energy conservation and emissions reduction efforts. Moreover, an energy conservation and emissions reduction index may be introduced in the performance evaluation system for

local government officials. Second, government purchases will give priority to energy efficient products. For instance, the Shanghai government included alternative energy vehicles in their government purchase list and have enlarged the yearly purchasing scale. In addition, the Chinese government has increased the preferential treatment for alternative energy through taxes and other incentives, and provides support through bank loans, equity financing, etc.

Third, state-owned enterprises have greatly increased their investments in alternative energy. From mid-2009, five major electric power companies, including China Guangdong Nuclear Power Group and China Three Gorges Project Corporation, have accelerated the construction of wind power plants. Large-scale wind power stations of more than 100 MW have begun construction in Jiuquan in Gansu Province, Bayin in Inner Mongolia, Yancheng, Xiangshu, and other locations. As for solar energy, construction of large-scale photovoltaic power plants in Wuhai in Inner Mongolia, Stone Forest in Yunnan, and other places have also begun. They are expected to drive the rapid growth of the domestic solar market. In addition, the South China Power Company constructed China's first commercial electric car charging station in Shenzhen, which will lay a solid foundation for the popularity of electric vehicles.

From the beginning of the fourth quarter of 2009, especially after the Copenhagen Climate Summit, energy conservation and emissions reduction efforts have garnered the full support of the Chinese government, at both the central and local level. Following the implementation of various policies to encourage the development of this sector, China's great capacity in the field of energy conservation and emissions reduction will be fully exploited with follow-up potential being much broader.

III. Impacts of the Stimulus Package on Energy Conservation and Alternative Energy Industries

3.1. The Current Status of China's Energy Conservation and Alternative Energy Industries

The energy conservation industry includes two major components: the energy services industry and energy efficient manufacturing. The Energy Service Company (ESCO) is a specialized enterprise that provides customers with advice on how to conserve energy and retrofits high energy-consuming equipment (such as blast furnaces), buildings, and other public services (electricity, transportation, etc.). China's energy services industries have been developing rapidly in recent years, with a 162.35 per cent[28] increase in industrial output (from 8.25 billion RMB [US$1.2 billion] in 2006 to 21.65 billion RMB [US$3.16 billion] in 2007). Energy efficient manufacturing includes two areas: the production of energy efficient equipment and associated supplies. The first area refers to the manufacturing and marketing of equipment and instruments used for saving energy. The second area includes various energy saving additives, catalysts, lubricants, thermal resistance (or heat-reflective materials), semiconductor materials and devices, and alternative energy sources, including key supplies and raw materials, used in manufacturing energy saving equipment or those used by energy services companies. Currently, in the field of energy manufacturing, China's efforts have already begun to take on an industrial scale, with an increase in independent research and development by a few leading industrial enterprises.

The term 'alternative energy' refers to newly developed technologies geared towards renewable sources of energy. This includes solar, wind, biomass, geothermal, wave, ocean currents, tidal and other non-conventional sources of energy. However, this does not include nuclear energy. Since the implementation of the Renewable Energy Law of the People's Republic of China, China has seen robust growth in the alternative energy industry with installed wind power capacity reaching 12.17 million kW at the end of 2008.

28 Quoted from 2007 Annual Development Report for Energy Conservation Service Industry in China, issued by Energy Conservation Service Industry Committee of China Energy Conservation Association (EMCA). http://news.xinhuanet.com/newscenter/2008-01/18/content_7462302.htm

Installed solar photovoltaic power generation capacity reached 300,000 kW, an increase of 150,000 kW over the previous year. Other energy sources have undergone significant improvement. For instance, there are currently more than 19 million household biogas digesters in use, producing more than 9 billion m^3 of biogas. However, other alternative energies such as biomass, have not yet been commercialized on a large scale.

3.2. Effects of the Stimulus Package on the Energy Conservation and Alternative Energy Industries

Although the stimulus package has only come on line for a little over a year, it has had significant effects in terms of conserving energy and reducing emissions. This progress can be seen in the following areas: the development of energy conservation and alternative energies, the growth of markets related to energy conservation, credits and investments for state-owned corporations, the development of new technologies as well as energy-saving industries and equipment, and the enhancement of long-term energy-saving industries.

First, the development of energy conservation and alternative energy industries has attracted broad attention. Of the 4 trillion RMB invested, 210 billion RMB (US$30.72 billion) has been put into energy conservation, emissions reduction, and ecological construction projects. From 2008, experts have put forward proposals that have propelled the advancement of energy saving technologies and alternative energy sources.

Second, markets for energy conservation and alternative energy have been expanding. As of 31 May 2009, the central government have issued a 27.8 billion RMB budget for public investment in energy conservation and emissions reduction, of which RMB 5.4 billion was used for key energy conservation projects[29]. The implementation of these projects has provided good opportunities for domestic energy-saving services. There is a large abundance and variety of energy saving equipment and supplies for the ten projects. The primary focus is on highly efficient boilers, blast furnace top-pressure recovery turbine (TRT) devices, dry coke quenching plants, furnace flue gas pre-heaters and radiation exhaust heat exchange

29 Source: http://www.gov.cn/gzdt/2009-06/04/content_1332257.htm, released by State Council Information Office of PRC

devices, waste heat power generation equipment, energy saving electric motors, rare earth permanent magnet motors, frequency control devices, computer automated control systems, semiconductor (LED) lamps and other equipment, as well as polyurethane, polystyrene, mineral wool, glass wool and other supplies. Due to the large number of orders, the markets for these products are expanding rapidly.

As for alternative energy sources, there is little available data at this time. Encouraging the development of alternative energy sources such as biomass in rural areas will increase demand for these energy sources. Meanwhile, 80 billion RMB (US$11.7 billion) of the 4 trillion RMB will be put into nuclear power projects, which will indirectly stimulate investment by 300-400 billion RMB (US$43-58 billion).

Third, the stimulus funds have increased the availability of credit and investment for energy efficient industries from state-owned (holding) corporations, with banks, financial institutions, and large state-owned enterprises as the mainstays. The Industrial and Commercial Bank of China[30] is one case in point; it is investing heavily in key energy-saving programs this year. The number of regional co-generation projects has reached 123, with a loan balance of 43.75 billion RMB (US$6.4 billion) (some of these programs are supported by the original 4 trillion RMB invested); the waste heat and waste pressure recovery technology in the cement, steel and other industries are used in 20 projects, with a loan balance of 5.3 billion RMB (US$775.46 million). There are 23 projects related to central heating or heating networks, with a loan balance of 1.92 billion RMB (US$282.23 million). Companies offering energy-saving services have gradually attracted investments. Led by national projects, including the ten key energy-saving projects, various financial institutions have continued to increase their investment in energy service companies, resulting in a total annual investment growth rate of nearly 50 per cent. Alternative energy industries are the most popular. Large-scale state-owned enterprises (including the national power grid), five power generation groups, three major oil groups, the Shenhua Group, Yangtze Power, and some upgraded energy companies have increased investment in alternative energy manufacturing industries. International energy equipment enterprises have also expanded in Chinese markets, (including the biggest global manufacturer of PV modules, First Solar, Inc.), and some have started building solar PV power plants in China. Meanwhile,

30 from the The Industrial and Commercial Bank of China web site, [this link is dead]

alternative energy enterprises in capital markets have been pursued by private equity funds and venture capital funds.

Fourth, investment has accelerated energy conservation and promoted the industrialization of new technologies. Supported by the stimulus package, new energy conservation and emissions reduction projects have appeared. In the steel industry, dry coke quenching and blast furnace TRT technologies have been widely applied. New large-scale sintering machines and coke ovens have been adopted in recent years. In the chemical industry, energy-saving technologies producing caustic soda, soda afterheat utilization, closed-type calcium carbide furnaces, and sulfuric acid, have been used widely.

Fifth, the development of energy-saving and alternative energy equipment manufacturing industries has increased. Driven by market demand and investment, the number of manufacturing enterprises producing energy-saving equipment and supplies has increased rapidly. In the field of energy efficient lighting, the number of LED lights will reach 1.4 million in 2009. Domestic demand is expected to grow by 79 per cent in 2010, reaching 2.5 million. Development in the field of alternative energy (without explicit state investment) is expected to attract private capital. For example, within the field of solar photovoltaic energy, experts estimate that by the end of 2009, China will have the capacity to produce 30 thousands tons of poly-silicon annually, with an output exceeding 10,000 tons. According to the Ministry of Industry and Information Technology, China produced 4GW of solar cells in 2009[31].

Sixth, the stimulus package will enhance the long-term development of energy saving industries. The stimulus funds invested in energy saving industries will not only influence short-term investment, but will also attract long-term investment. Not only will long-term investment increase the size, markets, and technological growth of energy-saving industries, it will ensure their momentum over time. The Chinese government has invested 12.6 billion RMB (US$1.84 billion) to enhance the implementation of ten key energy saving projects in 2007 and 2008, which in turn has increased private investment to about 150 billion RMB (US$21.95 billion). According to a rough estimate, every unit of central government fiscal expenditure on energy conservation

31 According to China Machinery Industry Federation, http://www.mei.gov.cn/industry/utility/news.jsp?cd=301508&edittime=2010-04-06

can stimulate a ten-fold increase in private investment. Among the 4 trillion RMB in stimulus funds that have already been allocated, 27.8 billion RMB (US$4.0685 billion) has been invested in energy conservation and emissions reduction, 5.4 billion RMB (US$.79 billion) of which has been used in the field of energy conservation. If the remaining stimulus funds are allocated as planned, 210 billion RMB (US$30.72 billion) will be used for energy conservation, emissions reduction, and eco-construction, of which the investment in energy conservation will be about 40.79 billion RMB (US$5.96 billion). If the aforementioned ten-fold ratio holds for the next few years, it should lead to private investment of 407 billion RMB (US$59 billion). These funds, which have been gradually invested in the market, will promote the long-term development of energy-saving industries.

3.3. Estimated Direct Effects of the Development of Energy Saving Industries

Because energy intensive industries, including the iron and steel industries, non-ferrous metallurgy, petrochemical and chemical industries, building materials, and housing construction (including lighting), are the main consumers of energy in China, they should be taken into consideration first when we analyze the effects brought about by the development of energy-saving industry. Figure 5 illustrates the energy consumption structure of China in 2007. This figure shows that the seven major energy intensive industries account for 89.63 percent of China's total energy consumption, with the building industry (including lighting, heating, and cooling) accounting for the largest percentage[32]. In addition, six other industries (excluding the transport sector), have made significant progress in technology-based energy conservation. Therefore, relatively small investments in these six industries can have major impacts.

Although an overall plan for the 4 trillion RMB stimulus fund had been made by November 2008, fund allocation needs to be changed according to actual conditions. Therefore, the effects of the stimulus package can be divided into two parts. One is the direct effect of the investment, e.g., fund allocation towards the "Ten Key Energy Saving Projects[33]. The other is policy-related investment. The government allocated

32 Prepared on the basis of data in China Statistics Yearbook 2008 , issued by the National Bureau of Statistics of China

33The Top Ten Energy Saving Projects are: upgrading of inefficient coal-fired industrial boilers and furnaces, the regional cogeneration project, utilization of residual heat and pressure, petroleum conservation and substitution engineering, energy conservation in motor systems, optimization of energy systems (system conservation), energy-efficient buildings, green lighting project, energy conservation projects of government agencies, and energy saving monitoring and technology service system construction. The stimulus funds investment policy for energy-saving industries is being implemented in accordance with the framework of the "Top Ten Energy Saving Projects".

210 billion RMB (US$30.725 billion) of the initial 4 trillion RMB investment to energy-saving and emission reduction projects. These investments will play an important role in guiding the allocation of private capital towards energy-saving and alternative energy industries. The following section will present the contribution of energy saving industries both in terms of each industry as well as the additional energy conservation and emissions reduction brought about by the stimulus package itself.

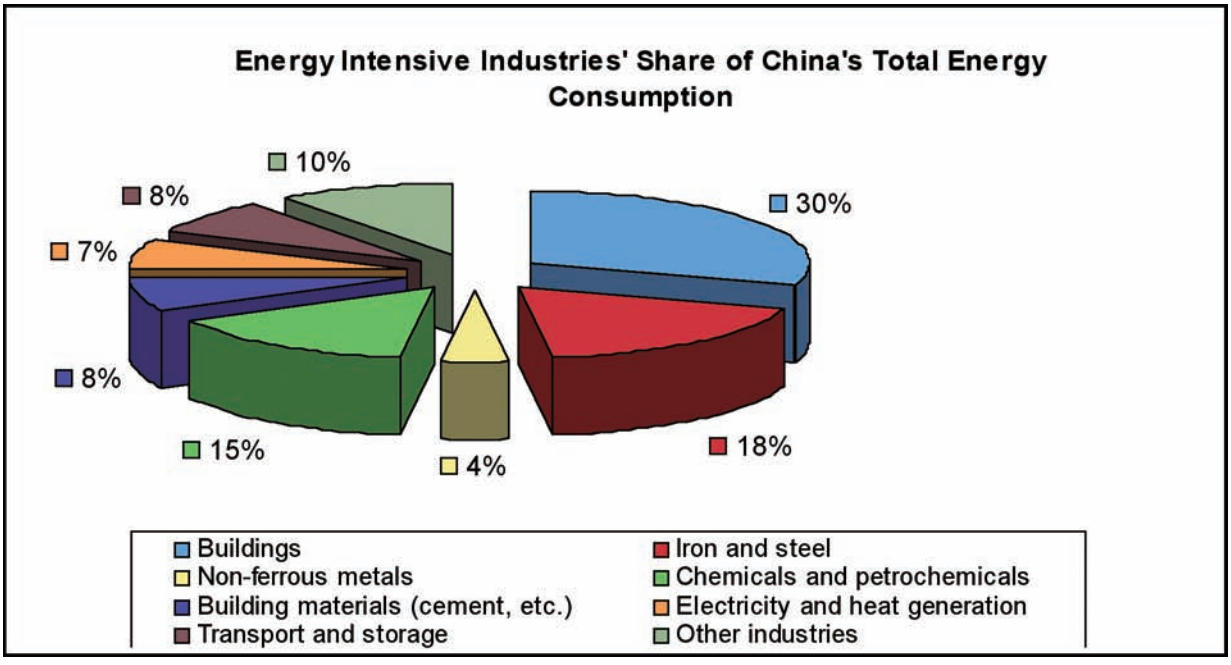


Figure 5. Energy intensive industries' share of China's total energy consumption (2007)

(1) Buildings

Buildings account for about 30 percent of China's total energy consumption. Energy conservation in buildings includes three elements : wall thermal insulation, energy efficient air conditioning and heating, and energy efficient lighting. Every 10,000 RMB (US$1,463) invested in efficiency improvements in buildings can save 3.8 tons of coal annually[34].

34 Data is derived from statistics of the World Bank/Global Environment Facility "China Energy Conservation Promotion Program Phase II"(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

In the areas of insulation, polyurethane and polystyrene, hollow concrete blocks, and other high-performance thermal insulation materials have gradually been substituted for traditional wall materials. Hollow, inflatable and LOW-E glass, plastic-steel section materials and tempered glass have also been widely used to substitute for traditional steel windows and aluminum alloy doors and windows. These new thermal insulation materials sharply reduce heating energy consumption. In 2008, the energy saved through thermal insulation was the equivalent of 22.3 million tons of coal. Assuming the growth rate in 2010 is the same as in previous years (16%), then energy saved through thermal insulation will reach the equivalent of 30 million tons of coal. In the area of lighting, the use of amalgam fluorescent lamps, LED and other energy-saving lights have been rapidly expanded in public places and have gradually been introduced in indoor lighting. The energy consumption of LED is only 10 per cent that of filament lamps and 30 per cent that of fluorescent lamps. China's annual electricity consumption from lighting already reached 390 billion kW in 2008, so there is enormous potential for energy savings in this area.

The amount of electricity saved from lighting in 2008 reached 50 billion kWh, equivalent to an estimated 5 million tons of coal annually. As the government is strengthening efforts to implement financial subsidies towards the Efficient Lighting Policy, it is estimated that the accumulated savings of electricity will reach 103.2 billion kWh, thereby saving 10 per cent of the electricity consumed by lighting, and reducing coal use by 10 million tons annually. Moreover, more efficient air conditioning and heating systems will reduce 10-20 per cent of the energy consumed by cooling and heating buildings. By the end of the 11th Five Year Plan, 560 million square meters of building space will utilize more efficient heating and cooling systems, saving an estimated 10 million tons of coal annually.

Considering all three aspects together– insulation, heating and cooling, and lighting – it is estimated that China’s nationwide energy conservation from buildings will reach the equivalent of 50 million tons of coal in 2010, amounting to carbon emissions reductions of 115.35 million tons.

By the end of June 2009, the total stimulus funds invested in green architecture projects, the green lighting project, and retrofitting government buildings was 1.5 billion RMB (US$219.5 million), bringing about a savings of 570,000 tons of coal each year. By the completion of the stimulus package, the direct energy

savings brought about the retrofitting of buildings will amount to the equivalent of 4.33 million tons of coal annually, thereby preventing 10 million tons of carbon emissions. This will account for 8.66 per cent of the total energy savings and emissions reduction from buildings in China during that period.

(2) Iron and Steel

In the iron and steel industry, every 10,000 RMB invested in energy conservation can save 4.8 tons of coal each year.[35] This saving is mainly reflected in two processes: sintering and iron-making. The amount of investment required and the energy savings from each process is large.

Through the recovery of waste heat, flue gas desulphurization, and other advanced energy-saving technologies, the total energy consumed by sintering processes in China's major steel enterprises during the first half of 2009 amounted to 55.23 kgce/t, a decline of 0.74kgce/t compared with the same period in 2008. The energy saved from this process alone amounted to 190,000 tons of coal. In iron production processes, the fuel ratio of BF in China's major enterprises fell to 518 kg/t by utilizing PCI technology in BF, TRT and other advanced technologies, a decrease of 14 kg/t compared with the same period in the previous year. This was the largest decline rate in the last ten years. Furthermore, the coke ratio of BF in China's major steel enterprises was 373 kg/t, a reduction of 23kg/t, and the lowest in China's history.

More efficient production processes will significantly reduce energy consumption per ton of steel. By 2010, China's energy consumption per ton of steel is expected to decline to 600 kg of coal compared with 630 kg currently. Based on an estimated annual output of 500 million tons of crude steel, energy savings in the iron and steel industry will reach 15 million tons of coal annually, equivalent to carbon emissions reductions of 34.55 million tons.

By the end of June 2009, 750 million RMB (US$109.7 million) in stimulus funds had been allocated towards boiler retrofitting, waste heat utilization and other energy conservation projects in the steel industry.

35 Data is derived from statistics of the World Bank/Global Environment Facility "China Energy Conservation Promotion Program Phase II"(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

This investment brought about a savings of 360,000 tons of coal. By the completion of the stimulus package, the direct energy savings brought about by efficiency improvements in steel production processes will be equal to 2.73 million tons of coal annually while saving 6.32 million tons of carbon emissions, which will account for 18.24 per cent of the total energy savings and emissions reduction in the iron and steel industry.

(3) Electric Power

In China's electric power industry, every 10,000 RMB invested in energy conservation can save 6.5 tons of coal per year[36]. Thermal power generation accounts for over 80 per cent of China's total power generation, so it is particularly important to improve its energy efficiency. In the power generation sector, oil gun gasification, plasma non-oil ignition and stable combustion at low load as well as other energy-saving technologies have developed rapidly and been applied widely due to the support of the Top Ten Energy-Saving Projects funded by the stimulus package. Moreover, application of aluminum conductor composite core wires, amorphous alloy transformer core, and other energy-saving technologies allow for substantial efficiency gains in electricity transmission and transformation.

The amount of coal used in China's electric power generation in 2008 was 346 g/kWh, representing a 9-g/kWh decrease compared to the previous year. The annual output of electric power generation was 3.43 trillion kWh. This was equivalent to saving 3,090 tons of coal. In addition, during the period from January-August 2009, the amount of coal used fell to 341 g/kWh, a decline of 6g/kWh over the same period compared to the previous year. According to this data, experts estimate that the amount of coal used in China's electricity generation will continue to decline to around 330 g/kWh in 2010, with an annual power output of 3.5 trillion kWh. This will save 38.5 million tons of coal and 88.65 million tons of carbon emissions annually.

By the end of June 2009, 800 million RMB (US$117 million) in stimulus funds will be put towards district cogeneration, petroleum conservation and substitution engineering, efficient motor systems, and other

36 Data is derived from statistics of the World Bank/Global Environment Facility "China Energy Conservation Promotion Program Phase II"(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

electricity conservation projects, which will bring about a savings of 520,000 tons of coal[37]. By the completion of the stimulus package, these projects will save 3.952 million tons of coal annually, which is equivalent to 9.15 million tons of carbon emissions and accounts for 10.3 per cent of the total energy savings in the electric power industry.

(4) Building Materials

The energy consumed in building materials production accounts for 9% of total national energy consumption, 13% of industrial energy consumption. The discharge of sulfur dioxide accounts for 14% of total emissions, and the discharge of dust and smoke accounts for 55% of total national discharge of such substances. Every 10,000 RMB invested in energy conservation in the building materials industry can save 5.1 tons of coal per year. The cement industry alone accounts for over 57 per cent of the total energy consumption in this sector[38]. Currently, waste heat generation is the key efficiency improvement in this industry, and is being promoted by a spare heat and pressure utilization project, which is one of the Ten Key Energy Conservation Projects under the 11th Five Year Plan. The basic principle of this technology is to recycle the great amount of heat discharged during industrial production processes through heat recovery devices. A waste heat boiler produces superheated steam, which pushes a steam turbine and thus drives an electric generator. The electrical energy generated from this process is very large: in 2008, 149 spare heat-generating production lines were put into operation and 106 electric generator sets were installed, resulting in an installed power generating capacity of 975.2 MW. In 2009, 232 waste heat power-generating units were planned, while 181 electric generator sets were installed, resulting in an installed power generating capacity of 1,677 MW. By 2010, the cement industry's installed power generating capacity from waste heat recovery will nearly reach the capacity of two Gezhouba Hydropower Stations. The electricity produced by waste heat recovery is equivalent to saved energy. With the increase in annual power generation, these efficiency gains will become more apparent. The energy saved from the cement industry was equal to about 16 million tons of coal in 2008. Producing one ton of cement consumes about 125 kg of coal. In 2010, this consumption can be reduced to 110 kg of coal, saving 21 million tons of coal given total annual cement production of 1.4 billion tons.

37 Data is derived from statistics of the World Bank/Global Environment Facility "China Energy Conservation Promotion Program Phase II"(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

38 China Building Material Federation, Information Center web site http://cbmia.cbminfo.com/Default.aspx?tabid=71&error=Object+reference+not+set+to+an+instance+of+an+object.&content=0

Other building materials industries, including plate glass, ceramics, wall materials, etc. can significantly decrease their respective per unit energy consumption by applying efficient furnaces and other techniques. Building materials industries other than the cement industry are expected to directly save energy equivalent to three million tons of coal. Including the cement industry, it is estimated that total energy savings in the building materials industry will be the equivalent of 24 million tons of coal in 2010.

As of June 2009, RMB 900 million (US$131.7 million) out of the 4 trillion investment package had been applied in energy conservation of building materials, including boiler transformation, waste heat and pressure utilization projects, regional cogeneration projects, oil conservation and substitution projects, and energy-efficient motor systems projects, thus saving energy equal to 459,000 tons of coal (based on the same investment ratio and energy efficiency above). According to this proportion, the direct total energy savings from the building materials industries due to the stimulus investment will be equal to 3.48 million tons of coal and 8.09 million tons of reduced carbon emissions, or 14.5 per cent of the total energy savings in the building materials industries.

(5) Chemicals

Every 10,000 RMB invested in energy conservation in the chemical industry can save 4.1 tons of coal per year[39]. The major energy consuming products of the chemical industry are synthetic ammonia, caustic soda, and sodium carbonate. The introduction of large, efficient ammonia plants makes it possible to introduce over 20 energy conservation techniques, leading to the upgrade of domestic large and medium-sized ammonia equipment. That, and the introduction of over 40 energy conservation techniques in small-sized ammonia plants have resulted in significant energy savings per unit of ammonia production. At present, the national energy consumption per ton of ammonia (from a weighted average of large, medium, and small-sized plants) is 1.6 tons of coal, with this amount expected to decrease to 1.57 tons in 2010. Thus 1.5 million tons of coal can be saved for every 50 million tons of ammonia produced.

39 Data is derived from statistics of the World Bank/Global Environment Facility “China Energy Conservation Promotion Program Phase II”(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

Energy consumption in the production of one ton of caustic soda (a weighted average of the diaphragm membrane and ion membrane processes) is expected to decrease from the current 1,435 kg to 1,400 kg of coal in 2010. The decrease will come about with the improvement of diaphragm membrane electrolysis and metal-anode diaphragm technology, and the widespread application of expansible metal anodes, modified diaphragm techniques, and three-effect uniflow-type forced-circle evaporator technology. Around 630,000 tons of coal can be saved based on the production of 18 million tons of caustic soda. The equipment in the sodium carbonate industry is continuously being improved and domestically developed technologies, equipment, and processes have been widely applied in old and new plants. The energy consumed in the production of one ton of sodium carbonate is expected to decrease from the current 400 kg to 380 kg of coal in 2010. Thus 400,000 tons of coal can be saved for every 20 million tons of sodium carbonate production. The energy saved from ammonia, caustic soda, and sodium carbonate production reached 2.1 million tons in 2008. In 2010, this amount is expected to reach 2.53 million tons of coal, reducing CO[40] emissions by 5.86 million tons.

As of June 2009, 500 million RMB (US$73.174 million) in stimulus funds have gone towards energy conservation in the chemical industry, including waste, heat and pressure utilization, oil conservation and substitution, and energy systems optimization. This investment has saved 205,000 tons of coal. Upon completion of the stimulus program, saved energy from the chemical industry will equal 1.55 million tons of coal and 3.61 million tons of reduced emissions, amounting to 61.6 per cent of total energy conservation in the chemical industry.

(6) Industrial Electricity (Nonferrous Metals)

Electricity consumed in industrial processes accounts for 50 to 60 percent of China's total electrical consumption[40]. The non-ferrous metallurgy industry consumes 25 percent of industrial electricity, and is the largest electricity-consuming sector. On average, every ten thousand RMB invested in energy conservation

40 Calculated according to "China Statistic Yearbook 2008", the electricity balance sheet, issued by National Bureau of Statistics of China
41 Data is derived from statistics of the World Bank/Global Environment Facility "China Energy Conservation Promotion Program Phase II"(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

in the nonferrous metal industry can save 4.3 tons of coal per year[41]. China's nonferrous metal industry hascreated a patented set of advanced energy saving technologies, significantly improving the technical level of equipment in this field. Electrolytic aluminum technology has developed the fastest, and the development of the 300 kA large-scale aluminum electro baths provided technical support for industrialization. In addition, Zhongfu Aluminum's large-scale aluminum electrolysis and Wanji Aluminum's application of graphotype cathode blocks have played an important role in energy conservation.

The China Nonferrous Metals Industry Association estimates that in 2008, electricity consumption from aluminum production decreased to 14,323 kWh per ton, 118 kWh per ton below 2007 levels, which resulted in electricity savings of 1.6 billion kWh. Energy consumption from copper smelting was 450 kilograms of coal per ton, down by 8.5 percent; in lead smelting, energy consumption was 505 kilograms of coal per ton, down by 5.6 percent; zinc production consumed 1700 kilograms of coal per ton, down by 17.2 percent. Energy consumption in other nonferrous metal industries also decreased.

Energy saved from the nonferrous metal industry due to efficiency gains equaled 1.1 million tons of coal in 2008. In 2010, this amount is expected to reach 1.3 million tons, leading to emissions reductions of 3.01 million tons. Four hundred million RMB has been invested in efficient motor systems, bringing about energy savings of 172,000 tons of coal by June 2009. By the completion of the stimulus package, the total amount of electricity savings in industry can reach the equivalent of 1.307 million tons of coal, of which energy saved from the nonferrous metal industry is expected to equal to 330,000 tons of coal, which is equivalent to 760,000 tons of reduced emissions, accounting for 25.2% of total energy conservation in the nonferrous metals industry.

(7) Other Industries

Other industries where energy conservation measures have been taken include agriculture, forestry, animal husbandry, water conservation, commerce, food and beverages, wholesale goods supply and storage. Assuming that every 10,000 RMB invested in energy conservation measures in these industries can

save about 4 tons of coal per year, [42] it is estimated that 4 million tons of coal were saved in 2008. In 2010, an estimated 5 million tons of coal can be saved, resulting in reduced emissions of 11.6 million tons.

As of June 2009, 550 million RMB (US$80.49million) of stimulus funds have been invested in these other industries and will bring about energy savings amounting to 220,000 tons of coal. By the completion of the stimulus package, energy savings in these industries are estimated at 1.67 million tons of coal, with corresponding emissions reductions of 3.88 million tons. Some 33.4 per cent of total energy conservation in these other industries will occur as a result of stimulus funds investment.

Table 1 Energy conservation in each industry as a result of stimulus funds investment

Industry	Buildings	Steel	Electricity Generation	Building Materials	Chemicals	Non-ferrous metals	Others	Total
Saved energy as of June 2009	57	36	52	45.9	20.5	17.2 (4.5)	22	230.6
Total energy saved due to stimulus funds investment	433.2	273.6	395.2	348.4	155.8	130.7 (33)	167.2	1904.1
Percentage of energy conservation generated from stimulus funds investment	8.66%	18.24%	10.3%	14.5%	61.6%	Accounts for 25.2% of non-ferrous metal industry	33.4%	13.97%

Unit: 10,000 tons of coal equivalent

42 Data is derived from statistics of the World Bank/Global Environment Facility “China Energy Conservation Promotion Program Phase II”(Unpublished internal information), which is based on a variety of real energy-saving projects in China between 2003-2009

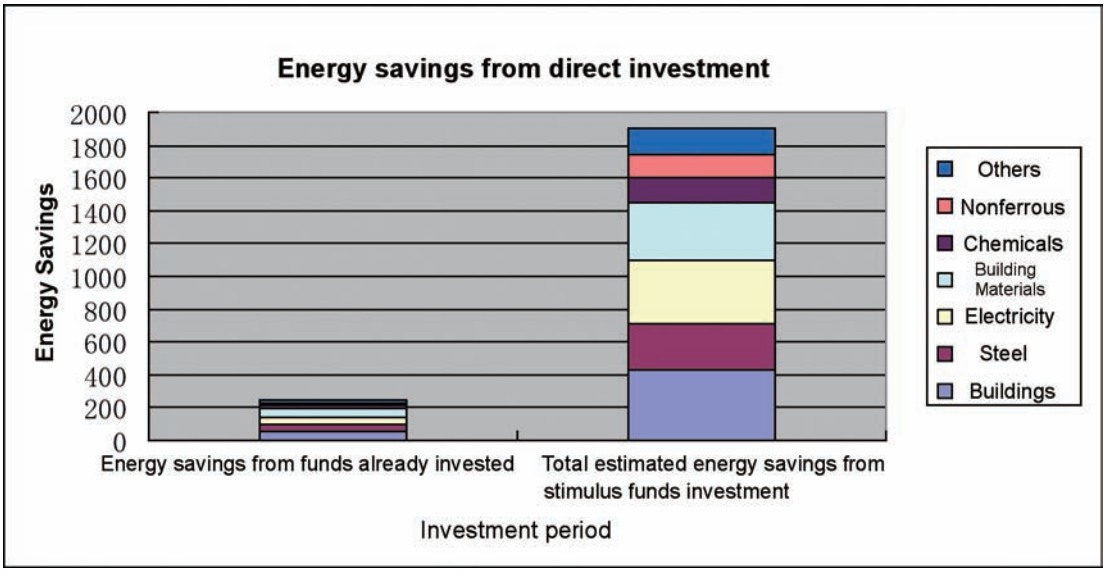


Figure 6. Diagram of direct energy savings generated by stimulus funds investment (Unit: 10,000 tons of coal equivalent)

Table 2. Energy Savings from Key Industries in 2008 and 2010

Industry	Buildings	Steel	Electricity generation	Building materials	Chemicals	Nonferrous metals	Others	Total
Energy saved in 2008	3,530	1,350	3,090	1,850	210	110	400	10,540
Energy saved in 2010	5,000	1,500	3,850	2,400	253	130	500	13,633

Unit: 10,000 tons of coal

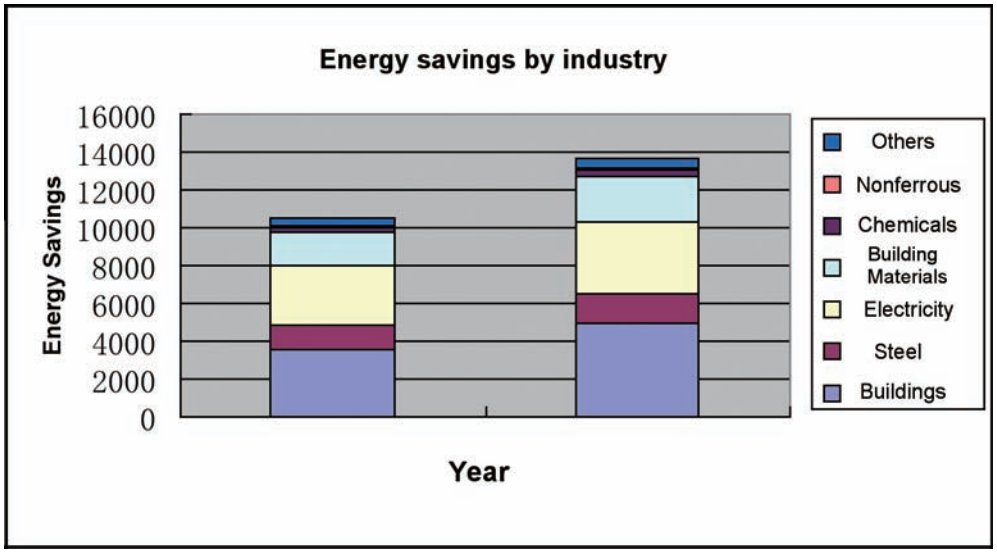


Figure 7. Energy savings by industry in 2008 and 2010

3.4. Effects of Energy Conservation from the Alternative Energy and Nuclear Power Industries

The alternative energy industry, as a strategic focus of future national economic development, has been growing rapidly in recent years. There are 18 provinces and 100 cities in China that have prioritized alternative energy as a pillar of future development. Both local government and private capital investment are being increasingly directed towards alternative energy industries like wind and solar energy. However, because of their pursuit of short-term profits, most enterprises have indiscriminately expanded their energy production, causing periodic surpluses in energy production (At present, electrical grid construction lags behind power generation in China. As a result, some wind-generated electricity has no access to the grid, causing temporary surpluses in energy production). Under these circumstances, stimulus funds have not been invested directly in the alternative energy sector. Nonetheless, there are high expectations for the development of alternative energy in China in light of the portion of the stimulus funds that have been devoted to energy conservation and greenhouse gas emissions reduction, as well as China's commitment during the Copenhagen Conference to decrease greenhouse gas emissions by 40-45 per cent per unit of GDP by 2020 compared to 2005 levels.

The Chinese government is strongly pushing the development of the nuclear industry at present, with the goal of making nuclear power account for 4 per cent of total electricity generation by 2020. Driven by this policy, a part of the stimulus funds has been invested directly into nuclear power. The following section will examine the development and energy conservation effects of the alternative energy and nuclear power industries.

(1) Alternative Energy

Of the global investment in the wind power industry, 15 per cent has been directed towards the Chinese market. The value of these investments reached 84 billion RMB (US$12.29 billion) in 2008 and 12.8 billion kWh of wind power were generated in that year, up 126.79 per cent from 2007. The production of wind turbines reached 4.27 million kW in the first half of 2009, up 135.7 per cent from the same period in 2008.

It is estimated that installed wind power-generating capacity will reach 10 GW in 2009. Assuming a cost of 6,500 RMB per kW, about 65 billion RMB (US$9.512 billion) were invested in the wind power industry in 2009. The annual addition of wind power generation capacity will likely stabilize between 10 and 15 GW over the next decade. In 2009, installed wind turbines generated 26.9 billion kWh, accounting for 1 per cent of total power generated in China while saving 9.106 million tons of coal, a 105.9% increase[43] compared to 2008. A conservative estimate is that wind power generation can reach 56.5 billion KWh in 2010 while saving the equivalent of 19 million tons of coal.

According to the Department of Information, Ministry of Industry and Information Technology, China produced 4GW of solar cells in 2009. Most solar cells use poly-silicon as a raw material and ninety per cent of these products were exported[44]. Domestic companies use reducing furnaces to produce poly-silicon, and the production of 1kg of it consumes 170 to 180 kWh of power. Assuming the production of poly-silicon in 2009 reached 10,000 tons, the electricity consumption therein was an estimated 1.7 to 1.8 billion kWh, which amounts to a rate of energy regeneration of 1:8[45]. Solar photovoltaic products presently used within China can only balance out the energy consumed in the manufacturing process, so the effects on energy conservation and emissions reduction are not clear. However, experts predict that by 2020, installed solar capacity in China will reach 20 million kW, far beyond the previously planned aim of 1.8 million kW. At that time, the energy conservation effect of China's photovoltaic industry will be given full play.

Other energy resources such as biomass, geothermal, tidal power, and ocean flow energy have potential for development if they are supported by government policy. But the above energy resources have not been commercialized or adopted on an industrial scale. Due to technical and cost considerations, their commercial viability is not nearly as good as that of wind and solar energy, so their development has lagged behind. Take biomass energy for example: electricity generated from biomass is supposed to reach 5.5 million kW by 2010 according to government plans, but the profitability of biomass energy power stations remains low. Their life

43 According to The State Grid web site http://www.sgcc.com.cn/xwzx/nyzx/2010/01/214684.shtml
44 According to the 2009-2012 China Polysilicion Industry Investment Analysis and Forecast Report issued by China Investment Consulting recently.
45 The rate of energy regeneration is defined as the ratio of energy consumption during manufacturing of power generation equipment to power generated within the life cycle. Generally the solar battery is calculated according to the operational life of 20 years.

cycles are short, so the energy production of biomass power stations remains to be seen. As small-scale farming by individual owners prevails in China, it is difficult to collect and extensively utilize the biomass. Besides, climatic conditions in China are not conducive to growing certain biofuels. Other alternative energy industries in China are also in their initial stages. Their large-scale application in the future depends on the support of government policy and financial subsidies. As to other alternative energy industries besides solar, wind and nuclear energy, the total energy savings amounted to 4.5 million tons of coal in 2008. This amount can reach an estimated 6 million tons of coal or 13.8 million tons of CO2 in 2010.

(2) Nuclear Power

The installed capacity of nuclear power and its amount of electricity generation in 2008 were 8.85 million kW and 68.4 billion kWh, respectively, saving the equivalent of 21.55 million tons of coal[46]. Twenty four nuclear reactors are currently under construction, mainly in coastal areas: two in the second phase extension project of Qinshan station, two in the Fang Jianshan Nuclear Program, two in the Guangdong Da Yawan station, four 1 MW-reactors in Liaoning, and six reactors each in and Fuqing. The total combined power generation capacity will reach over 25 million kW. The construction period of a nuclear power plant is rather long, usually requiring 58 months. Most projects will not be finished by 2010, and so nuclear power generation capacity in 2010 will remain at present levels. Thus the amount of indirectly saved energy will also not change greatly. By 2020, 13 nuclear power plants will have been constructed in China, and there will be 58 one million kW nuclear reactors. Installed capacity will reach 58 million kW, and electricity generation will exceed 260 billion kWh. By 2020, it is estimated that nuclear power will account for about 4 per cent of the nation’s total installed capacity, and over 6 per cent of electric power generation.

Over 80 billion RMB (US$11.7 billion) in stimulus funds from the portion allotted to industrial structural readjustment is being directly invested into the nuclear energy industry. The nuclear program is a case in point. This investment will yield 6 million kW in installed capacity, which can be converted to an annual power generation of 45 billion kWh. Based on past experience, investments by

46 According to statistics provided by the State Statistical Bureau, the average energy consumption for per kWh electricity is equal to 0.404 kg of coal and the proportion of thermal installed power is 78 per cent in China. This proportion is used below as well.

the central government in the nuclear energy will trigger corresponding investments by local governments and the private sector. It is estimated that this investment may stimulate 300-400 billion RMB (US$43.905-58.541 billion) of domestic investment that will lead to final installed capacity of 24-30 million kW, which can be converted into annual power generation of 180 billion kWh. Therefore, energy directly saved from the investment of stimulus funds in the nuclear industry will amount to 14.18 million tons of coal (based on a thermal power installed capacity of 78 per cent). This is equivalent to 32.61 million tons of reduced carbon emissions, and the indirectly saved energy can potentially exceed 56 million tons of coal per year. However, the energy conservation effects of the stimulus funds in this sector will not be apparent until after 2013 because of the long construction periods needed for nuclear power plants.

In any case, nuclear energy raises a number of other concerns, including radiation, safety issues, waste disposal, and the spread of nuclear weapons. In the development of nuclear plants, such risks must be seriously considered.

Table 3. Indirectly saved energy from alternative energy industry in 2008 and 2010

	Wind energy	Solar energy	Other alternative energy		Total
Saved energy in 2008	440.4	0	500		940.4
Saved energy in 2010	2000	0	600		2600

Unit: 10,000 tons of coal

IV. Effects of the Stimulus Package on China's Economic Structure and its Efficacy for Energy Conservation and Emissions Reduction

4.1. The Impact of the Stimulus Package on China's Economy

The stimulus package has positively impacted the Chinese economy and restored growth in the wake of the global financial crisis. During the first half of 2009, China's fixed asset urban investment continued its rapid growth at 26.5 per cent, a slight increase (0.4 percent) over the growth rate of 2008. Central government spending showed the biggest annual boost with a 40.3 percent increase in investment projects (a 25.4 per cent larger increase than 2008), and total investment on new national projects increased 87.5 per cent. Investment in railways rocketed 211.1 per cent, after relatively modest growth of 11.5 per cent in 2008.

The spike in government investment has made immediate impacts on the Chinese economy, which has shown signs of recovery over the past year. The national GDP growth rate stopped falling and began to ascend in the second quarter of 2009. The annual GDP for 2009 amounted to 33.53 trillion RMB (US$4.9 trillion), marking an 8.7 percent annual growth rate and a 1.6 per cent increase over the first half of the year. As shown in Figure 9, economic growth increased in each quarter of 2009 at a rate of 6.1, 7.9, 8.9 and 10.7 per cent, respectively.

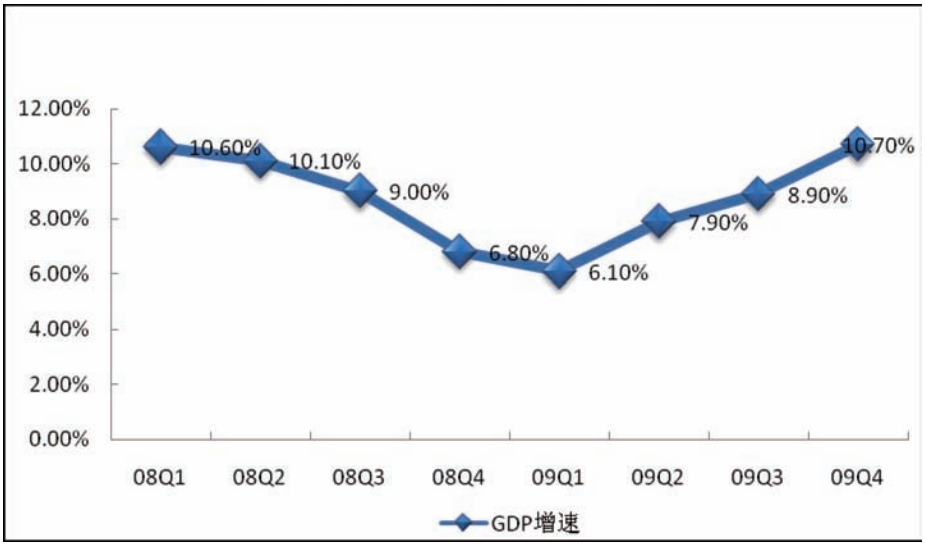


Figure 8. China's Quarterly Growth rates 2008-2009

As shown in table 4, the national economy hit its nadir in February 2009 with a coefficient index of 94. The economy began to recover quickly, however, rising several points over the next few months.

Table 4. Macroeconomic climate index (until December, 2009)

Date	Early warning index	Coincident index (=100 in 1996)	Leading index (=100 in 1996)	Lagging index (=100 in 1996)
2008.11	82.7	97.6	97.4	97.1
2008.12	78.7	95.5	97.9	95.6
2009.01	74.7	94.5	98.6	93.9
2009.02	73.3	94.0	99.0	92.7
2009.03	76.0	94.5	100.0	91.2
2009.04	78.0	95.0	101.1	90.7
2009.05	84.0	95.5	102.0	90.0
2009.06	86.7	96.0	102.7	89.5
2009.07	90.0	96.7	103.5	89.6
2009.08	96.7	97.3	104.2	90.0
2009.09	103.3	98.2	105.0	90.8
2009.10	103.3	99.4	105.8	91.9
2009.11	114.0	100.4	105.4	93.2
2009.12	120.7	101.3	104.8	94.4

Table 4 details China macroeconomic situation over 2008-2009 through four indices. The coincident index reflects current economic trends through an integrated analysis of four components: 1) industrial production, 2) employment, 3) social demand [47] (including investment, consumption and foreign trade), and 4) social income[48] (including national revenue, business profits and residential income). The leading index forecasts future economic trends through analysis of key indicators, including industrial production, issued building permits, unemployment insurance claims, money supply, inventory changes, and stock prices. The lagging (or concurrent) index reflects ups and downs in economic cycles and is obtained from the integration of indicators such as national GDP, unemployment rate, retail sales index, personal consumption, industrial production, etc.

47 Social demand is the sum of various items within possible consumption channels of total social purchase power. The formula used to calculate it is: Total social demand = total investment demand + total consumption demand + total foreign demand (within the analyzed time period.)
48 Social income is sometimes referred to as national income. Social income = taxes + enterprise profits + residents' income

Table 5. Macroeconomic index of China (January-December 2009)

Early Warning Signal Diagram for the Last 12 Months

Index/Time	09-01	09-02	09-03	09-04	09-05	09-06	09-07	09-08	09-09	09-10	09-11	09-12
Industrial production index												
Fixed asset investment												
Total retail sales												
Total imports & exports												
Fiscal revenue												
Industrial business profit												
Residents' disposable income												
Loans from financial institutions												
Money supply M2												
Consumer price index												
Early warning index												
	75	73	79	78	84	87	94	97	103	103	114	121

Notes: Red light (hot) Yellow light (hotter) Green light (stable) Light blue light (colder) Blue light (cold)

Figure 9. China's total import and export volumes January 2008 - December 2009[49]

49 Source: Department of Comprehensive Statistics under the General Administration of Customs of the People's Republic of China http://www.customs.gov.cn/publish/portal0/tab4370/module3760/info209220.htm

In addition, China's foreign trade import and export volume fell to the lowest point in February 2009 (see Figure 10) but began to recover in March with eight consecutive months of growth. The total value of imports and exports grew by 7.9 per cent from September-October 2009 (7 per cent in exports and a 9.1 per cent in imports). Compared with September 2009, these values grew by 0.7, 0.7, and 0.8 per cent respectively. These figures dipped slightly in November but were followed by a surge in foreign trade volume in December, which increased by 17.7 per cent over the same period of 2008.

4.2. Future Impacts of the Stimulus Package on China's Economy

In 2009, total fixed-asset investment reached RMB 22.48 trillion (US$3.29 trillion), an increase of 30.1 per cent (3.1 percent higher than the growth rate over the same period in 2008). This includes investments in urban fixed assets totaling RMB 19.41 trillion (US$2.8 trillion), an increase of 30.5 per cent (2.9 per cent higher than 2008). The investment in rural fixed assets was RMB 3.07 trillion, up 27.3 per cent (4.3 per cent higher than 2008). Investment in infrastructure (excluding power facilities) increased 52.6 per cent, including a 67.5 per cent increase in railways, 40.1 per cent increase in roads, and a 58.5 per cent increase in such sectors as sanitation, social security, and social welfare. Investments in real estate development reached RMB 4.31 trillion (US$630.3 billion), a 19.9 per cent increase over the same period in the previous year (and 10 percent higher than the growth rate in the first half of 2009).

The direct stimulus effects of investment on each industry can be measured with an input-output model. The results show that increased investment exerts the largest initial boost to the construction industry, which will generate an additional added value of RMB 569.92 billion (US$83.44 billion), equivalent to 14.22 per cent of the total initial stimulus effect. The second largest beneficiary is the equipment manufacturing industry, which will create an additional added value of RMB 292.8 billion (US$42.87 billion), accounting for 7.2 per cent of the total stimulus effect.

China's consumption function was estimated through a regression analysis of statistics for the period of 1978 to 2007. The results show that China's marginal consumption propensity is 0.49 (i.e. if income increases by 1 RMB, 0.49 RMB will be consumed). According to the income multiplier model and China's

national income multipliers, it is estimated that the stimulus funds will indirectly generate an additional 3.79 trillion RMB (US$554.30 billion) in consumption demand.

The impact of the stimulus package on each industry was measured using an input-output model. The analysis concluded that agriculture and the public sector received the greatest portion of stimulus-generated growth, accounting for 15.13 and 14.36 per cent of the total indirect stimulus effects respectively. Analysis of the total investment and impact of the stimulus (both direct and indirect) on each industry found that the stimulus package also provides the largest total added value for agriculture, where an estimated 725 billion RMB will be generated (11.6 per cent of the total package). The construction industry came next with an added value of 495 billion RMB (7.91 per cent of the total package). Overall the stimulus package is estimated to generate at least 6.25 trillion RMB in total GDP growth. [50]

The total impacts of the stimulus are not all felt overnight. Previous experience in China demonstrates that the impact of large-scale investments generally take effect over a 6 year period. This is due to the time required to complete the cycle from policy to investment, to project construction and implementation as well as other factors. The coefficients for the transformation of investment into productive capital for each year of the 6 year cycle are 24 per cent in year one, 30 per cent in year two, and followed by 19, 13, 8, and 6 per cent in years 3-6. When calculating the lag coefficients of the stimulus funds over the next few years, it is important to account for the stimulus effect on GDP over time. Assuming that the stimulus funds will be invested evenly over a two-year period in 2009-2010, the stimulus will peak in 2010, but will continue to positively impact the economy through 2014. Assuming this stimulus package follows this pattern, the stimulus effects will amount to an estimated 750 billion RMB (US$109.8 billion) in 2009 and 1.69 trillion RMB (US$247.05 billion) in 2010. Thus the peak stimulus effects will occur in 2010 and then these effects will decline on a yearly basis thereafter. This entire six-year cycle of transforming stimulus funds into productive capital should be considered when investigating their impact on the macro economy.

50 The total of direct and indirect stimulus effects of the investment on production and export of sectors and resident income has been taken into account in this calculation.

4.3. Estimation of China's Future Energy Consumption Using a STIRPAT Model

Ehrlich and Holdren first proposed the IPAT accounting equation in the form I=PAT to calculate the impact of human populations on the environment. It concerns the relationship between environment (E), population size (P), its level of affluence (A), and the environmental damage inflicted by technology (T). Since its formulation, the model has been widely adopted to analyze the impact of population growth on the environment. Nevertheless, the model also has its limitations. For instance, the IPAT equation assumes the effects of each factor are proportional and the analysis is carried out on the assumption that only one factor changes while the others remain static. To overcome that limitation, some scholars proposed a stochastic model to measure the disproportional impact of population upon environment. York, together with others, reformulated the IPAT accounting equation and introduced the STIRPAT (stochastic impacts by regression on population, affluence, and technology) model which is:

$$I_i = a p_i^b A_i^c T_i^d e_i$$

STIRPAT retains the multiplicative logic of IPAT, and regards population size (P), its affluence (A), and the environmental damage inflicted by the prevailing technologies (T) as three determining factors for the impact upon the environment in terms of emissions (I). The logarithmic model is as follows:

$$\ln I_{it} = a + b(\ln p_{it}) + c(\ln A_i) + d(\ln T_{it}) + e_{it}$$

Wherein i = country, t = year, P = population, A = affluence, T = technology or energy efficiency of economic activities, and I = CO_2 emissions.

Currently, the equation has been widely employed by many countries to estimate their carbon emissions. China's carbon emissions from 1969 to 2003 match well with the figures calculated based on the STIRPAT model[51]. Based on the STIRPAT model, figures for population, GDP per capita, and energy intensity (energy

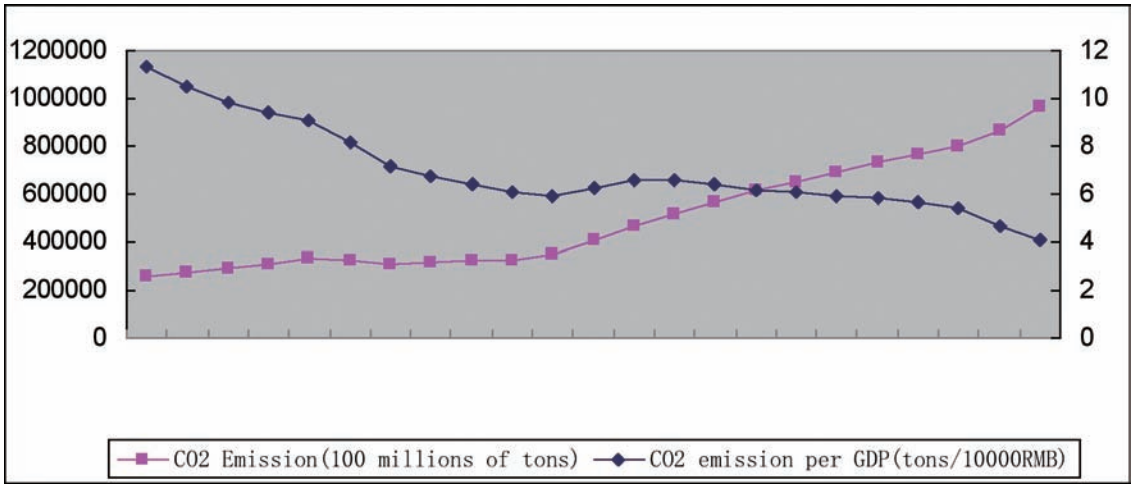
51 Source: Wei Yiming, et al. "China Energy Report (2008)—CO2 Emission Research", Science Press

consumption per unit GDP) are taken from the period 2000-2008 to calculate their relative importance on CO_2 emissions. The model used to assess China's overall energy consumption for the next couple of years is also developed from STIRPAT. Affluence (A) is derived from per capita GDP and technology (T) is represented by energy intensity. The lower the amount of energy consumption per unit of GDP, the higher the energy efficiency of economic activities, and the lower carbon emissions will be.

Table 6. Variables in the STIRPAT model[52]

Variable	Definition	Measurement Unit
CO_2 emissions	The release of CO_2 into the atmosphere during the burning of fossil fuels and industrial processes	Ton carbon equivalent
GDP per capita	Current GDP per capita	RMB
Population	Population	Person
Energy intensity	Energy use per unit of GDP	Thousands of tons standard coal used /10,000 RMB

The STIRPAT assessment of CO_2 emissions in China reveals several key insights. The steep rise in demand for housing and transportation since 2002 has led to the rapid development of heavy industries, which in turn has brought about increases in CO_2 emissions, both on an absolute basis and per unit of GDP. Starting in 2007, the advancement of technology, development of energy-saving industries, and adjustments



52 Source: Y.Liu, et al. C02 Emission from Cement Manufacturing and its Driving Forces in China. International Journal of Environment and Pollution, 2009. Vol.37 (no.4)

to the energy structure have slowed the rate of growth in CO_2 emissions and reduced the emissions per unit of GDP. This trend will continue. Using this model, it was previously estimated that CO_2 emissions in China would reach 6.54 billion tons in 2008, 6.91 billion tons in 2009, 7.22 billion tons in 2010, and 9.63 billion tons in 2020. As a result of the stimulus package, however, CO_2 emissions in 2010 are expected slightly higher than the above assessment, jumping in the short term, but soon falling below previous levels.

Using a regression model, we analyzed the contribution of each additional unit of RMB investment in fixed assets to total GDP from 1978-2003 for each province in China. If calculated according to the previous fixed assets investment structure, each 1 RMB invested will lead to a 0.5 RMB return on investment within the country as a whole. The stimulus funds focus on infrastructure, such as railroad, highway, and particularly airports and subways, will likely bring about slower return rates on investment. As such the return on 2010-2011 GDP will be likely be less than that which could be generated by common fixed asset investments. The average return rate on investment based on the input-output model of 2007 is 0.375.

Based on this calculation, we estimate that the 2 trillion RMB (US$292.7 billion) investment of stimulus funds in 2009 will bring about a 750 billion RMB (US$109.76 billion) increase in return on GDP, a 2.3% per cent increase in GDP for 2009.

4.4. Analysis and Forecast of the Stimulus Package's Impact on China's Demand for Major Energy-Intensive Products

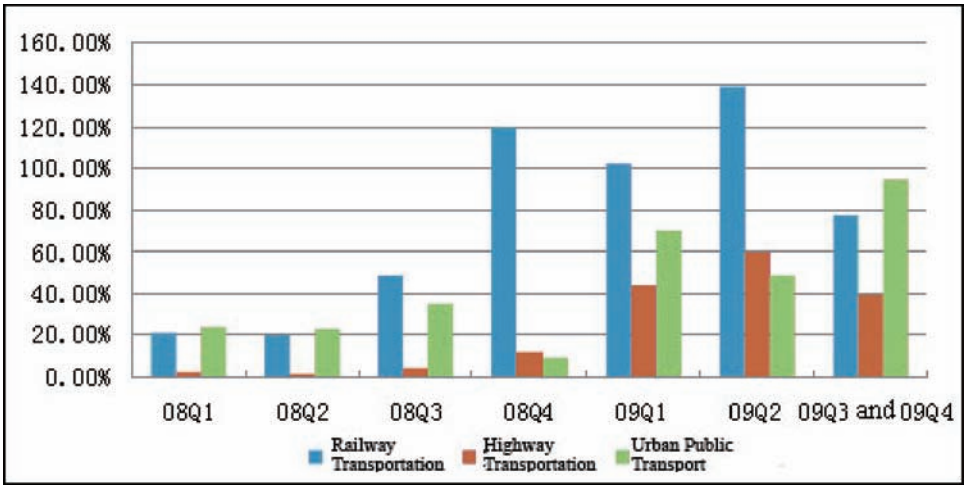


Figure 10. Annual Growth Rate of China's Investment in Railway, Highway and Urban Public Transport over the Past Eight Quarters

The stimulus package has not been directly used to construct new large-scale plants, refineries or other energy intensive facilities. Its impact on energy consumption, though indirect, is considerable. In 2009 the investment in railway, highway and urban public transport in China totaled RMB 1.92 trillion, the highest annual investment of its kind in China's history, which in turn heightened demand for production from energy intensive industries. China's energy-intensive industries suffered a brief collapse for several months when the financial crisis hit hardest, but they have since rebounded and are showing a V-shaped recovery (see figure 13). The impact of the investments in construction (including railways, highways, infrastructure, government-subsidized housing and post-disaster rebuilding) on several energy intensive industries and energy consumption are discussed in further detail below.

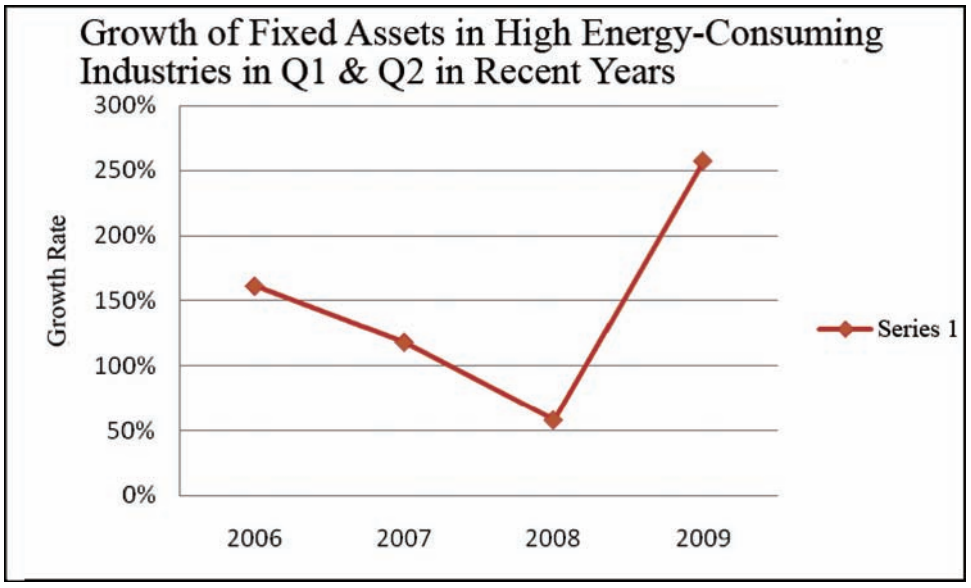


Figure 11. Growth of Q1 and Q2 Investments in China's Energy Intensive Industries over the Past Few Years

Figure 14 clearly shows the link between the stimulus investments in infrastructure, the corresponding demand for iron, steel, cement and concrete and the resulting consumption of energy to produce them.

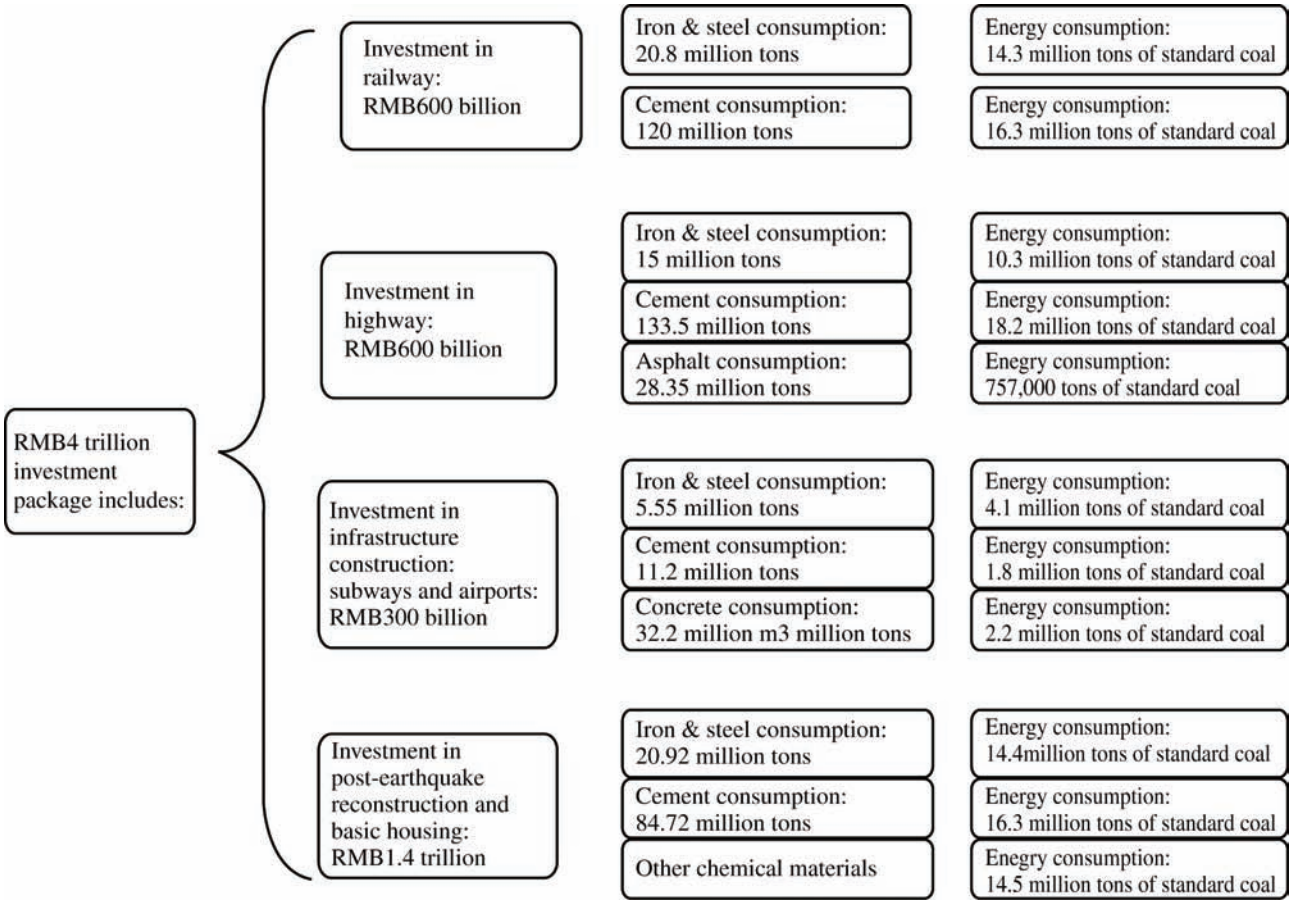


Figure 12 Preliminary Workflow for Calculation of Energy Consumption by Energy Intensive Products Resulting from the Economic Stimulus Package

The stimulus funds will invest 600 billion RMB in railway projects, which includes building railway bridges, tunnels, roadbeds, tracks and locomotives. Based on the average demand set out in China's 11th Five-Year Plan (2006-2010), the construction of new railway infrastructure will require over 17.5 million tons of general steel, 3.3 million tons of steel tracks and 20,000 tons of railway switches. Such huge demand means that China's steel market will continue to maintain steady growth in the coming years. For the energy-intensive iron and steel industries, the stimulus funds will spur the consumption of 14.3 million tons of standard coal[53]. Furthermore, the construction of railway infrastructure also generates a huge demand for cement. Estimates by China International Capital Corporation predict that 120 million tons of cement will be required to build bridges, tunnels, roadbeds etc. As each ton of cement requires as much as 135 kg of coal to produce, increased demand for cement could result in the consumption of 16.3 million tons of coal. While railway construction will increase energy consumption and CO_2 emissions over the short term, its impact on transport efficiency over the long term will result in lower emissions from the land transportation sector.

Another 600 billion RMB will be allocated for highway construction, of which expressways will account for over 75 percent of the overall investment. On average, producing one kilometer of highway in China requires 30-50 million RMB, 1,000 tons of steel, 8,900 tons of cement and 1,890 tons of asphalt. The massive investment in highways will generate demand for 15 million tons of iron and steel, 134 million tons of cement, 28.4 million tons of asphalt and require 29.3 million tons of coal to produce.

China's 300 billion RMB investment in new infrastructure will also lead to the construction of a large number of airports and underground railways. It is estimated that this will result in the use of over 5 million tons of iron and steel, 11 million tons of cement, huge quantities of concrete) and over eight million tons of coal.

53 This calculation is based on the standard estimate of an energy consumption of 686 Kg of coal per ton of steel produced

Another 400 billion RMB will be used to build 220 million square meters of government-subsidized housing and for post-disaster reconstruction. Based on an average usage of 55 kg of steel and 221.5 kg of cement in the construction of every square meter of housing (commensurate with current design practices in China), this new construction will generate demand for 10.5 million tons of steel and 42.3 million tons of cement. While the immediate increase in energy consumption and CO_2 emission from housing construction is unavoidable, long-term gains can be made through widespread investments in energy efficient buildings. Post-disaster reconstruction will bring about an equal or even higher demand for steel and cement, requiring at least an additional 10.4 million tons of steel, 42.4 million tons of cement and a huge quantity of chemical products. This demand for raw materials will directly result in the consumption of 45.2 million tons of coal.

4.5. Preliminary Estimation of the Stimulus Package's Effects on Energy Consumption in China

So far this chapter has detailed how the stimulus funds have catalyzed the rapid increase in short-term demand for energy-intensive industries through major investments in resource intensive infrastructure projects. Consequently, China's energy consumption has grown rapidly in recent months in line with the increased construction. Beginning in June 2009, China's output of raw coal and electric power have both exceeded their highest level in 2008.

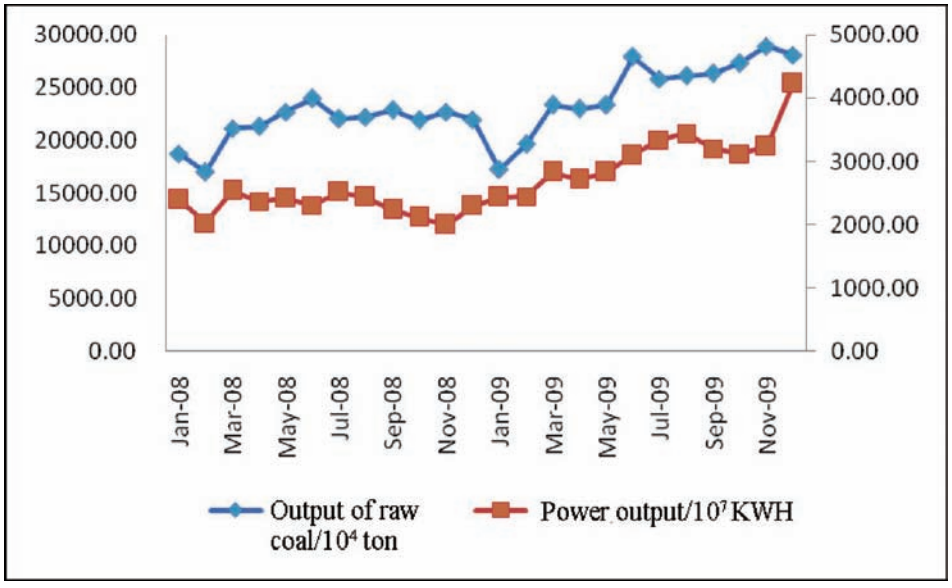


Figure 13. China's Output of Raw Coal and Electric Power 2008-2009

China's GDP grew by 7.9 per cent and 8.9, 10.7 per cent in the second, third, and fourth quarters of 2009 respectively. During the same period, China's output of raw coal rose by 8.8 per cent. If one includes China's net import of almost 130 million tons of coal that occurred in 2009 the growth rate of raw coal output reaches approximately 13 per cent. A quick look at the annual power output from 2009 only shows a relatively slight increase in overall consumption. A closer examination, however, shows that China experienced record high levels of monthly growth during the second quarter of 2009, which overlaps with the onset of the stimulus funds.

Figure 16 presents a comparison between the energy consumption per unit of added value in China's energy intensive industries and the average level of energy consumption in all industries in 2006[54]. Energy consumption in the energy intensive industries was on average approximately 2.5 times higher than other industries. As shown below, the four major industries of oil, chemicals, construction materials and iron and steel are much larger energy consumers. If the overall industrial output value remains unchanged, each percentage point increase in the energy intensive industries proportion of total industrial output will increase China's overall industrial energy consumption by 1.49 per cent.

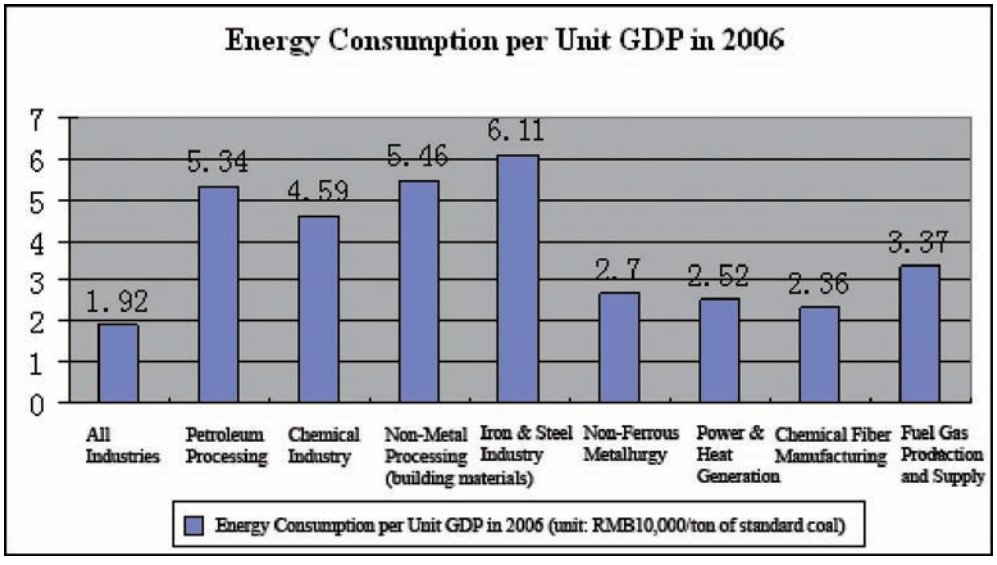


Figure 14. Energy Consumption per Unit of Added Value in China's Energy Intensive Industries

54 Source: China Statistics Yearbook 2007

Figure 17 shows the trend of investment in six of China's energy-intensive industries over the past seven quarters. In the first to third quarters of 2009, investment in the six most energy-intensive industries of mining, chemicals, materials (mainly cement), iron, steel, non-ferrous metals and metal products reached RMB 2.24 trillion. This accounted for 19.8 per cent of China's total investment in urban fixed assets - far higher than the 15.7 per cent level for the same period of 2008.

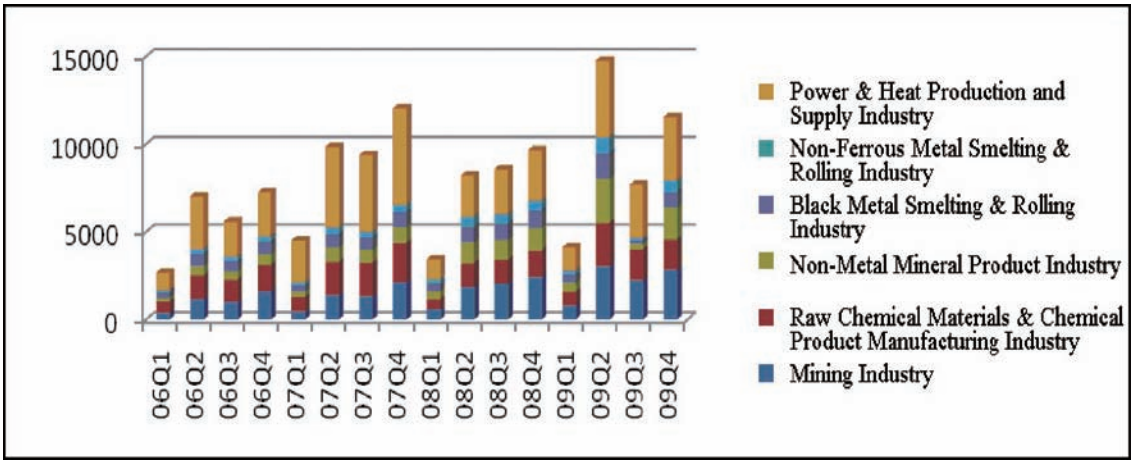


Figure 15. Investment in China's Energy Intensive Industries 2006-2009

The effects of the seasons on energy intensive industries were researched in order to reduce the errors in our findings caused by seasonal factors. Investment between the first and second quarters of 2008 was near 100 per cent. Following the economic stimulus package in 2009, investment in fixed assets in China's energy-intensive industries increased 257 per cent from the first to second quarter. This provides a clear correlation between the onset of stimulus funds and a spike in investment in energy intensive industries.

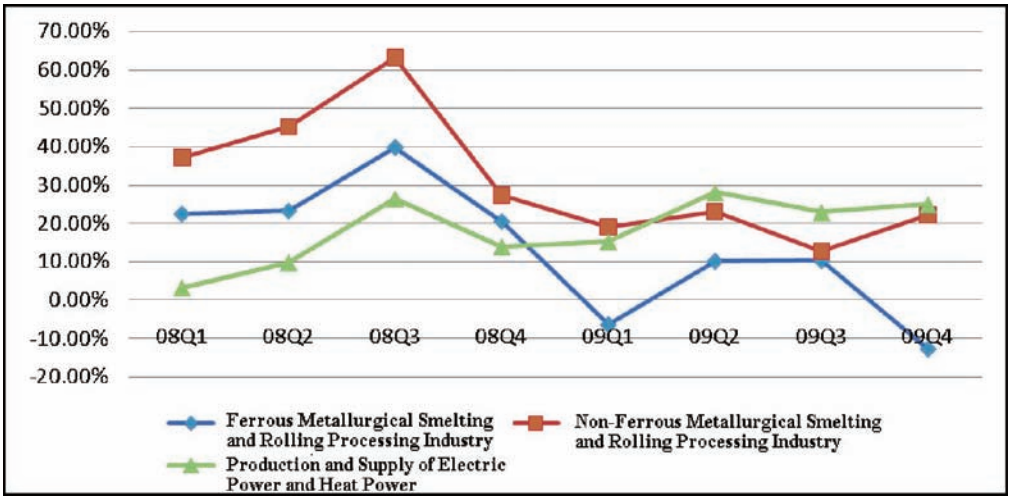


Figure 16. Quarterly Growth of Investments in China's High Energy-Consuming Industries 2008-2009

The onset of the financial crisis in 2008 caused a sharp decline of investment in energy intensive industries in the fourth quarter of that year. The economic stimulus package however, has indirectly helped restore and accelerate growth in the major energy intensive industries from 2009 onwards (see Figure 18). This will undoubtedly put pressure on the realization of China's energy conservation and emission reduction goals.

At the same time however, it is clear that since the second half of 2009 the Chinese government has made carbon emissions reduction a priority. For instance, in August 2009, at a press conference held by the State Council Information Office, China's Minister of Industry and Information Technology Li Yizhong announced that in the next three years the government would not allow new iron, or steel projects, will promote the merging of the iron and steel industries and will inhibit excessive production capacities in these industries[55]. The accrediting criteria for non-ferrous metals, building materials and other energy intensive industries will also become increasingly strict. It is predicted that the current investment spike in energy intensive industries is only a short-term phenomenon. In the long term, after going through mergers and restructuring, eliminating outdated production capacity and maintaining it at a sustainable level, promoting technology upgrades, China will be able to control it's energy consumption levels.

55 China chemical industry information web site, http://www.cheminfo.gov.cn/zxzx/page_info.aspx?id=27152&Tname=zcfg&c=0

Increases in energy consumption and emissions will follow the large-scale construction projects, which means that energy consumption and emissions levels will be at their highest levels during the periods with the heaviest construction. It is likely that construction levels will not reach their highest levels immediately following the allocation of stimulus funds in 2009-2010. During the first four years of the 11th Five Year Plan (2006-2010), the cumulative energy consumption per unit of GDP dropped by 14.38 per cent, while COD and sulfur dioxide emissions dropped by 9.66 per cent and 13.14 per cent respectively[56].

56 Premier Wen Jiabao's 2010 Government Work Report

V. Summary of the Impacts of the Stimulus Package on Energy Conservation and Emissions Reduction in China and Policy Recommendations

5.1 Summary of the Impacts of the Stimulus Package on Energy Conservation and Emissions Reduction in China

From the above analysis it is evident that in the short term, the stimulus package will increase China's annual energy consumption and will cause a jump in carbon emissions. In the long run however, the stimulus package is still expected to make positive contributions to China's energy conservation and emissions reduction. First, energy savings of around 20% are expected in the transportation sector by 2020 after the completion of rail transit networks like railways and subway systems. This is equivalent to 220 million tons of carbon dioxide emissions. Second, energy conservation projects and nuclear power plants will begin to come on line starting from 2010. Because a high level of investment in energy intensive industries cannot be sustained, the impact of the stimulus package on energy consumption in China is expected to turn from negative to positive by 2014. Furthermore, it is anticipated that by 2020, this investment will bring about an annual emissions reduction of at least 270 million tons. This will bring China's carbon dioxide emissions

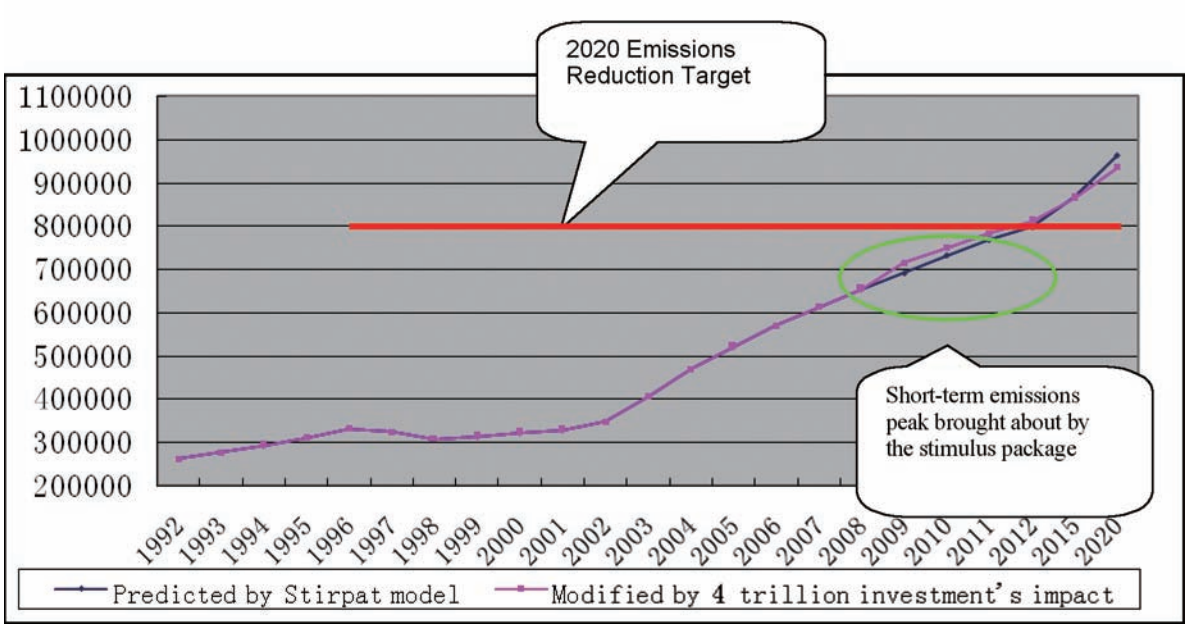


Figure 17. Projection of China's past and future CO_2 emissions (Unit: million tons, without reference to the impact of policies after 2009)

down to 9.36 billion tons from the 9.63 billion tons predicted by the model used in this report. This figure still represents a big gap from the goal which China pledged at the Copenhagen Climate Conference: to reduce its emissions per unit of GDP 45% by 2020.

If China relies only on the emissions reductions resulting from the stimulus package to achieve the goal of reducing emissions per GDP unit 45% by 2020, then a large gap will still exist. The stimulus package only accounts for a small part of the Chinese economy. To realize the commitments made at the Copenhagen Conference, China must learn from the lessons of the stimulus package and give full consideration to the 2020 emission reduction goal when developing future macroeconomic policies.

In the long run, however, the impacts of the stimulus package on energy conservation and emissions reduction are still expected to be positive. The transport sector is one example. Energy consumption in the domestic transport sector (as a percentage of total national consumption) is likely to increase from 7.7 per cent in 2006 to around 12 per cent by 2020. As a result of the stimulus package and other investments, new railways and urban rail transit systems are expected to play a greater role, thereby saving almost 20 per cent of energy consumed in the transport sector (about 220 million tons of CO_2 emissions annually). In addition, 210 billion (US$30.73 billion) RMB out of the 4 trillion RMB stimulus funds will be spent on energy conservation and environmental protection. Approximately 100 billion RMB (US$14.635 billion) will be invested in nuclear power plant construction. Investments in energy conservation and nuclear power are expected to bring about 51 million tons of CO_2 emissions reductions annually. Thus, in the long run, the stimulus package is expected to save about 270 million tons of emissions per year. With the rail transport and nuclear power facilities in operation, as well as a leveling off of infrastructure construction, the impact of the stimulus package on carbon emissions should shift from negative to positive by 2014 and the originally forecast 9.63 billion tons of CO_2 emissions per year will decline to 9.36 billion tons by 2020.

However there is still a large gap between this figure and the 2020 target China pledged at the Copenhagen Climate Conference (about 8.5 billion tons of total CO_2 emissions by 2020 calculated on the basis of a relatively high target of 45%, as the red lines in Figure 19 show). Therefore China must step up its energy conservation and emissions reduction efforts.

Out of the 4 trillion RMB in stimulus funds, 58 billion RMB (US$8.488 billion) has been put into energy conservation. However, compared to the level of investment devoted to infrastructure, this amount is relatively small. Moreover, the impacts of eco-engineering projects on emissions reduction will take a long time to manifest. Another problem is that China's domestic energy intensive sectors, such as the building industry, have not been given a sufficient share of the stimulus funds. It is estimated that only about 11 billion RMB (US$1.609 billion) will be invested in the building industry, which obviously does not match its 30 per cent contribution to total domestic energy consumption. Meanwhile, none of the stimulus funds were directly invested in renewable energy resources, which will have an adverse impact on China's energy conservation and emissions reduction efforts in the future as well as its efforts to position itself as a global leader in the clean energy industry.

Unlike the experience of developed countries, China is developing a low-carbon economy as it industrializes, which poses a major challenge to China's economic development even as it provides a good opportunity to leapfrog directly to cleaner production techniques. Therefore, it is inevitable that China has to increase investment in energy conservation and emissions reduction, as well as in clean energy. At the same time, China will also have to speed up industrial restructuring in order to replace traditional energy intensive industries with low-carbon industries.

In the 12th Five Year Plan currently being prepared, there are plans for revitalizing ten major industries and for developing thirteen regions. The experience and lessons from this stimulus package can provide guidance in making prudent investment decisions in the future.

5.2 Policy Recommendations for Energy Conservation and Alternative Energy in the Future

(1) Addressing Energy Intensive Industries, Conducting Demonstration Projects and Improving Energy Conservation Standards for New Projects

There is enormous potential for energy efficiency gains in Chinese industries. For instance, energy efficiency in buildings, cogeneration plants, blast furnaces, electrical machinery and air conditioning are still

very low. According to Morgan Stanley, the potential market for energy-saving industries in China is estimated at 800 billion RMB (US$117.08 billion)[57].

At present, China stands at the peak of marginal utility in terms of potential energy savings through technology. Every 10,000 RMB invested in energy efficiency can save 4-5 tons of coal per year, far more than investments in solar energy, wind energy, and nuclear power plants[58]. Therefore, the promotion of industrial energy efficiency is crucial for China. The analysis in Chapter III shows that 90 per cent of domestic energy consumption can be accounted for by seven sectors, including buildings, iron and steel, nonferrous metals, building materials, electricity generation, the petrochemical and chemical industries, and transportation, indicating that priority should be placed on energy efficiency gains in these sectors. Figure 20 presents the potential energy savings per unit of investment for different industries in China.

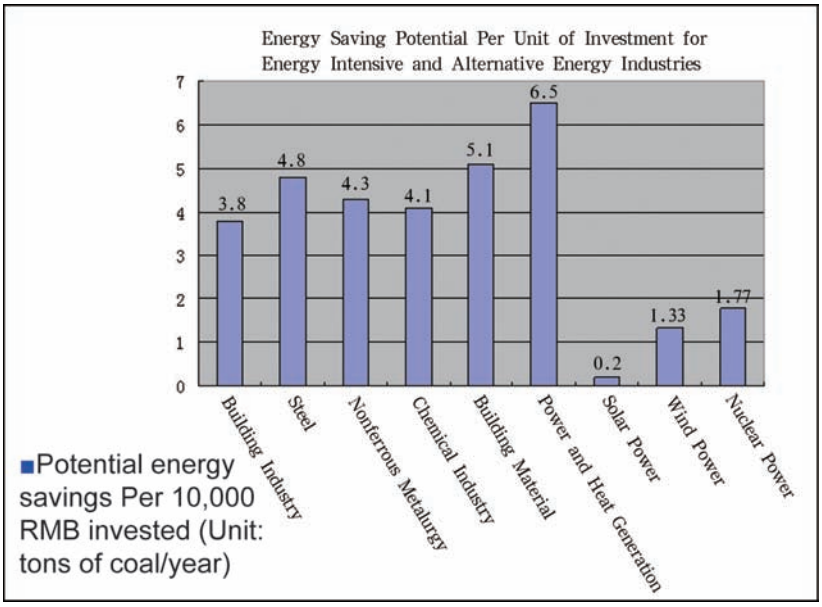


Figure 18. Potential energy savings per 10,000 RMB investment in different sectors

57 JP Morgan web site, http://www.jpmorgan.com/cm/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1158570320229&ssbinary=true&blobheadername1=Content-disposition&blobheadervalue1=attachment;filename=China_s_Clean_Revolution.pdf

58 The energy saved per unit investment in solar energy, wind energy, and nuclear energy increases as technology advances. The data in Figure 18 are averages based on several recent domestic construction projects.

At present, energy conservation efforts in China have proceeded relatively slowly due to lack of awareness as well as the absence of a standard accounting system. In order to boost the development of energy efficient industries, the government should set up large-scale demonstration projects. This would give all parties a better understanding of the economic and environmental benefits of energy conservation and encourage enterprises to place greater emphasis on this area. Demonstration projects would encourage private investors to invest in energy conservation, especially in the building industry. As a result, low-emissions and even zero-emissions office buildings and residential complexes could be developed. In addition, strengthening of the energy efficiency standards for approval of new energy intensive projects such as steel mills and power plants could spur planners to consider energy conservation from the very beginning of their projects.

In addition, alternative energy should be vigorously promoted, particularly in the automobile industry. The widespread use of electric automobiles can reduce energy consumption due to their superior efficiency compared to internal combustion engines, while reducing greenhouse gas emissions and at the same time can change area pollution to point pollution, making it easier to control.

(3) Increasing Wind Power Investment; Supporting Technological Innovation

China has abundant wind energy resources. Potential installed capacity exceeds one billion-kW capacity, which is equivalent to 500 Three Gorges dams and exceeds the country’s current installed capacity. Hence China’s wind energy resources are sufficient to meet the country’s energy needs for a long time into the future. By the end of 2008, China’s installed wind power capacity was only 13 GW, which means there is great potential for future development. According to the 11th Five Year Plan, China's wind power capacity is expected to reach 30 GW by 2020, equivalent to an average annual growth rate of 20 per cent over the next decade[59].

59 Windpower equipment is characterized by a high-energy reproduction ratio. Taking 50 kW medium-sized power units as an example, the 7-ton tower is mainly composed of steel (as well as some concrete), with other components such as the motor and blades being less than half of its weight. 10-tons of steel consumption (or the equivalent composite material), is equivalent to 7.38 tons of coal consumption. The construction of a 200 MW power station will use 40,000 tons of steel and therefore about 30,000 tons of coal. A 200 MW power station can generate about 400 million kW of electricity a year, saving 160,000 tons of coal as compared to thermal power. Even by a conservative estimate, wind power stations can break even in terms of energy consumption within a quarter and the rate of energy regeneration exceeds 80 within a 20-year life cycle.

China’s wind power industry currently faces three major weaknesses. These include the relatively small scale of the industry at present, the low level of research and development in wind power equipment, and an inadequate electrical grid that prevents more electricity generated from wind from being utilized. These factors severely impinge upon wind power’s utility value, as well as its economic value. Meanwhile, many localities have indiscriminately introduced poor quality wind power technologies. The benefits of these efforts are scant and serve only short-term interests, while wasting a great deal of money and leading to the formation of poor quality production capacity.

As a result, increasing investment, supporting independent innovation, and eliminating backward production capacity have become urgent needs for the development of wind power in China. In order to improve this situation, measures such as favorable loan policies and tax incentives can be used to encourage central power enterprises, local power companies and local governments to build wind power plants that utilize the best available technology. Furthermore, focusing on technological R&D and innovation will expand research in this sector, and will encourage power companies to adopt advanced wind power equipment while phasing out outmoded technologies. Finally, the construction of wind power facilities and smart electrical grids need to be synchronized so as to upgrade obsolete grid networks that cannot handle heavy load requirements.

(4) Increasing the Domestic Use of Solar Photovoltaic Products while Promoting the Development of Advanced Photovoltaic Technology

According to the analysis in Chapter III, the solar photovoltaic industry currently makes very little contribution to energy conservation and emissions reduction in China. This is mainly due to the fact that the domestic solar photovoltaic industry primarily uses poly-silicon technology, and the majority of the photovoltaic (PV) products (about 90 per cent) produced in China are exported. China’s output of PV products in 2009 reached 2.800 MW, accounting for 33.7 per cent of the world’s output. If domestic installed capacity for PV equipment increases from 10 per cent to 20 per cent, i.e., an additional 280 MW, the annual power generation will be about 420 million kWh. Shi Dinghuan, chairman of the Chinese Renewable Energy Association, notes that China’s PV installed capacity will likely reach 20,000 MW in 2020. For this to happen,

the domestic sales ratio would need to increase to 40 per cent.[60] If this goal is achieved, China's PV industry will have an annual generation capacity of about 30 billion kWh, equivalent to saving about 2.8 million tons of coal annually (assuming an 80 per cent proportion of poly-silicon and a rate of energy regeneration of 8).

Compared with polycrystalline silicon cells, amorphous silicon solar cells have the advantages of low cost, low energy consumption, are pollution-free, and have a better dim light response with only 1/200 the thickness of the former. They are more suitable to being placed on a building's exterior walls, and can also be used in portable electronic devices. Presently, amorphous-microcrystalline multilayer technology, which evolved from amorphous silicon (a-si) technology, can address the short lifespan of a-si solar cells while increasing the energy conversion efficiency to about 10 per cent. This technology and its variants are relatively mature and have been successfully utilized in industrial applications in Europe. The expectation is that it will be a mainstream PV technology in the future.

We recommend increasing domestic sales of PV products so as to meet the installed PV capacity target for 2020. First of all, incentives for the export of poly-silicon PV products should be gradually reduced or even eliminated. Second, large state-owned power enterprises should be given preferential loans and other financial incentives to encourage them to invest in the construction of large-scale PV power plants. Third, residents should be given subsidies to install rooftop solar panels. Fourth, more resources should be invested in solar photovoltaic research and the establishment of high-level research institutions, especially in support of amorphous/microcrystalline thin-film PV technology and nano-crystalline coextruded film technology. Finally, advanced foreign amorphous/microcrystalline thin-film solar cell production technologies should be introduced with the goal of eventually developing independent R&D capabilities in the solar photovoltaic area.

(5) Developing Other Alternative Energy Sources

Alternative energy sources such as geothermal for both power and direct use, tidal and biomass has large potential for application in China, and can serve as supplemental energy sources in some regions.

60 Source: Study Report on Competition of China Solar Battery Market 2009, published by China Business Data Center in 2009.

However, inadequate financial support together with unsound investment and financing mechanisms has resulted in a low level of commercialization. Therefore, we recommend that local governments, businesses, and even individuals develop alternative energy projects where appropriate (e.g., geothermal energy in the Bohai Sea region, tidal energy along Fujian and Zhejiang, etc.). At the same time, the central government should formulate a set of preferential tax and loan programs targeting these small- and medium-sized projects. In addition, we also recommend stronger support for research, in particular for the development of shallow geothermal energy, cellulosic ethanol systems (non-food and agricultural product based ethanol), low head large discharge generator units, etc., so as to encourage the maturation of these alternative energy technologies.

5.3 Optimizing Investment and Building a Low-carbon Economy

(1) Restrict Iron and Steel, Nonferrous Metallurgy, Chemicals, Cement and Other Energy-Intensive Industrial Projects

In the past year, the stimulus funds were mainly focused on infrastructure projects, encouraging local governments, enterprises, and private capital to invest in the metallurgical industry, building materials, chemicals, coal, electric power generation, and other energy intensive industries. These investments increased energy consumption in spite of higher investment in energy conservation, alternative energy and improved labor productivity. Now that the low carbon economy has become a goal which all nations aspire to, its achievement is clearly incompatible with the continued development of polluting, energy intensive systems of industrial production.

China exports a large amount of heavy industrial products, such as iron and steel, nonferrous metals, chemical fibers and other low value-added goods. These products earn low profits and consume large amounts of energy. Furthermore, their benefits mostly accrue abroad while generating pollution at home. At the same time, there is a serious problem of production over-capacity which results in severe price competition among export enterprises. Massive exports of energy intensive products have also caused intense trade frictions, which provide a pretext for foreign governments to implement protectionist policies.

The influx of funds to energy intensive sectors will occupy a great deal of private capital and result in excess production capacity. This in turn will cause a lot of duplicate construction and a serious waste of resources. Hence we recommend strict approval procedures for new projects in energy intensive sectors, especially the four major industries of ferrous metals, nonferrous metals, chemicals, and cement. Projects funded with stimulus money should make full use of existing industrial capacity, and purchase from manufacturers that have completed energy efficiency retrofits.

(2) Appropriate Planning of Infrastructure Projects, with Focus on Energy Efficient Modes of Transportation

In the 4 trillion RMB stimulus package, about 1.5 trillion RMB (US$219.52 billion) flowed into infrastructure projects, which will greatly improve traffic conditions and provide a solid foundation for the next round of economic growth. However, in the past decade, China's infrastructure development has been clearly lopsided, with a focus on highway construction to the exclusion of rail transport. Preference has been given to highways instead of railways for long distance travel, while in urban areas, the development of the private car industry has been encouraged even as subway construction lags behind. China's highway network has reached more than 60,000 km, whereas the railway system only increased from 68,700 km in 2000 to 80,000 km in 2009, showing the distinct imbalance of China's transport infrastructure development. Meanwhile, recent years have witnessed an explosion in private car use in China, which will lead to much higher energy consumption.

The project portfolio of the stimulus package is more balanced in this regard, but it still could not fundamentally change China's present situation of inadequate railway networks (including rail, subway, and light rail).

The advanced development of highways and slow expansion of urban public transport systems will encourage the development of private cars and limit available rail space. This is unfortunate given the relative energy efficiency of rail transport as compared to road transport and civil aviation. A comparison of the energy consumption and cost of these three modes of transport is given in Table 8.

Table 8. Energy consumption and cost of various traffic modes

		Energy consumption	Cost	Others
Long-distance transport	**Rail**	**about 30l oil / 10,000 tons * km**	**30-100 million RMB/km**	**small area occupied**
	highways	**about 200l oil /10,000 tons * km**	**about 100 million RMB/km**	**large area occupied**
	civil aviation	**about 3000 kg oil/ 10,000 tons * km**[61]		**high operation cost**
Urban transport	**private cars**	**about 10l oil / person *100 km**	**three times that of subways**[62]	**high degree of individual freedom**
	Subway	**about 0.54l oil / person *100 km**	**400-700 million RMB/km**	**small area occupied**

Energy efficient modes of transportation should be the clear choice for China due to its large population and scarce resources. Therefore, we recommend adjusting infrastructure development to support rail, subways, and other energy efficient modes of transportation. At the same time, we propose stricter approval procedures for highway projects, as these consume large amounts of energy. Second, we recommend eliminating unnecessary infrastructure projects. If infrastructure development is carried out extensively in underdeveloped areas with low population densities and limited development potential, it will be under-utilized and bring new burdens to the country.

(3) Promoting a Low-Carbon Economy through Smart Grids and the Information Super Highway

As a national strategy, the stimulus package should be devoted to creating a favorable environment for the development of low-carbon industries rather than focusing on any specific industry. With the development of alternative energy technologies, the range of use of fossil fuel energy sources like coal, oil and natural gas will gradually narrow while the secondary energy represented by electricity will play a more important role in production and daily use. Non-fossil fuel energy sources (e.g., solar power, nuclear energy, hydropower, wind energy, etc.) will therefore become more common. Additionally, centralized electricity production is more

61 According to data released by the Civil Aviation Department, with the unit of jet fuel * kilogram [eh?]
62 Get by comparing with the average capacity of China's metro system as well as the average price and carrying capacity of mid and low-end private cars.

environmentally friendly than the distributed production of primary energy. Therefore, a smart and integrated electricity grid is of vital importance. Only on this basis can electric vehicles and various alternative energy industries flourish and become the dominant modalities.

Meanwhile, with the rapid development of information technology, network bandwidth is becoming bottlenecked. China is now in the process of shifting from a manufacturing economy to a service economy, so industries like IT, software, services outsourcing, film and television, entertainment, media, finance, and logistics will play a more significant role and will generate higher demand for data transmission. Compared with energy intensive manufacturing sectors, the service industry is characterized by low energy consumption and high added value. A highly developed service industry is an indicator of a mature economy. Compared with developed countries however, China lags behind in its communications network and can hardly meet the requirements of the service industry.

In the United States' stimulus plan, US$11 billion and US$7.2 billion have been allocated to smart grid and high-speed internet access, respectively, while China has not taken any steps in these areas. Therefore, we strongly suggest that China's stimulus funds should be allocated to the construction of electrical grid and communications infrastructure. The grid should account for a higher percentage of overall infrastructure development, while funds for structural adjustment should prioritize upgrading the quality of the Internet in China. These two areas should be given priority in follow-up investments, so as to create a favorable environment for China's low-carbon industries.

(4) Supporting the Development of Emerging Low-carbon Industry Represented by Electric Vehicles

In addition to energy conservation, low-carbon industries also feature new technologies and approaches that contribute to increased efficiency and lower energy consumption, such as electric vehicles, fiber-optic communications, OLED displays, etc. They are able to achieve the same effect as conventional technologies with greater energy efficiency by using different energy sources, different or less raw materials, or increased work efficiency.

Electric vehicles are a good example. Their energy consumption is about 10 kW/person 100 km, only 1/9 (direct energy consumption) that of ordinary passenger vehicles. If calculated on the basis of emissions per unit of mileage, the energy consumption of electric vehicles' is about 40-45 per cent that of ordinary cars (estimated based on a charging efficiency at (of) 80 per cent) while that of electric bicycles is less than 5 per cent that of gasoline powered vehicles. Currently, electric vehicle technology is far from mature and its supply chain is incomplete. This will require a large amount of investment in R&D and the rapid adoption of new scientific and technological achievements in the production process. Meanwhile, the development of the entire supply chain for electric vehicles can be accelerated by providing subsidies for production and consumption, and by promoting the construction of charging outlets. Electric bicycles are ideally suited to conditions in China given their flexibility, energy efficiency, and low emissions, so the appropriate policy is to encourage their widespread use.

Table 9.Energy consumption levels of different modes of private transport

	Energy Consumption	Cost	Features
Gasoline powered vehicles	About 10l/Person*100km	Comparatively low	Mature technology, large-scale industrial production
Electric vehicles	About 10kW/person*100km, 1/9 that of ordinary private vehicles'	About 1.5 times that of g asoline vehicles'	Less mature technology, only at the pilot production phase
Electric bicycles	About 1kW/person*100km, 1/90 that of ordinary private vehicles'	1/50-1/100 that of gasoline vehicles'	Comparatively mature technology, large-scale industrial production

Fiber-optic cables are another example. Their transmission bandwidth is 1000 times that of copper cables, while requiring less energy in the production process. According to some experts, copper consumption in communications could reach about 300,000 tons (equal to 5-7 per cent of total copper consumption) per year by the end of the 11th Five-Year Plan. Assuming that one ton of refined copper (whose raw material is copper ore rather than secondary copper) requires 5 tons of coal to produce; this industry alone can save more than one million tons of coal per year simply by replacing copper with optical fibers.

Due to the constraints of immature technology, the small scale of production, and inadequate facilities, a new industry needs to be supported by the government in its early stages rather than immediately having to

face the fierce competition of the marketplace. Only after reaching a certain stage can the new industry begin to produce some economic benefits. For this reason, measures such as subsidies, tax incentives, lower barriers to entry, concessionary loans and support for scientific research in related fields are essential for the development of new technologies.

5.4. Creating a Green Financial Platform

Energy management companies (EMCOs) are the core of the energy management industry. However, EMCOs are currently unable to obtain financing due to the fact that the majority of Chinese enterprises are unwilling to enter into energy management contracting types of service, and related investment and financing mechanisms are inadequate. These reasons explain why the Chinese energy services industry remains small and scattered.

The World Bank/Global Environment Facility has implemented EMCA Phase II from 2004 to 2009. In this program, the World Bank provided US$22 million to establish a credit system for energy management loans. China National Investment & Guarantee Corporation provides a guarantee for EMCOs, allowing EMCOs to invest in their projects by securing loans from the banks. After five years of implementation, this program has proved to be very effective: a US$22 million guarantee fund and US$1.6 million incremental cost input have provided the impetus for about 800 million RMB (US$117 million) in private investment, with a leverage ratio of 1:6. This program has made great achievements in terms of energy conservation, emissions reduction, and economic returns. By May 2009, contractual income from the program reached 1.61 billion RMB (US$235.83 million); energy savings amounted to 310,000 tons of coal per year and CO_2 emissions reductions were 710,000 tons per year. The US$22 million guarantee fund has experienced nearly no losses and can be in circulation in the future. The leading EMCOs like Beijing Shenwu, Hubei Tri-ring, and Ld-harvest have all benefited from this program. In order to highlight the achievements of this program, Figure 21 shows a comparison between EMCA Phase I (a grants program, similar to direct appropriation) and Phase II in terms of attracting commercial finance. [63]

63 Source: Study Report on Competition of China Solar Battery Market 2009, published by China Business Data Center in 2009.

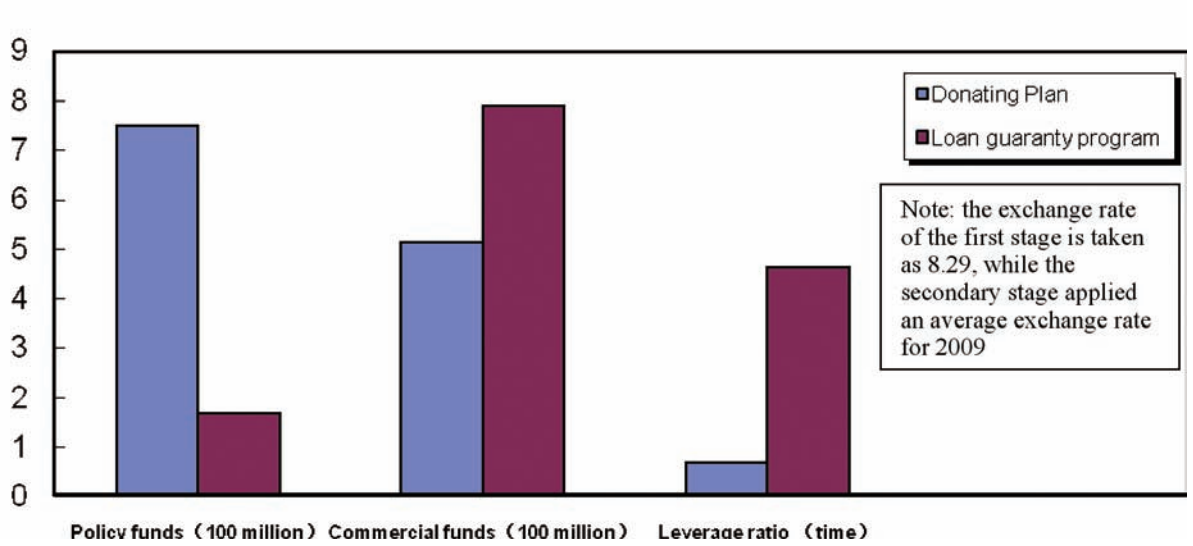


Figure 19.Comparison of the grant program (EMCA Phase I) and the loan guarantee program (Phase II) in terms of commercial finance leverage

However, EMCA Phase II as initiated by the World Bank/Global Environment Facility was actually a pilot program, and therefore it could not significantly increase the scale of the Chinese energy services industry. In order for this industry to grow in China, it has to rely on favorable government policies rather than depending upon investment from a certain foreign institution or the enterprises themselves.

Alternative energy technologies tend to be characterized by immature business models in some cases, with perceived high technical risks – though they do tend to have stable expected cash flows. The loan guarantee program can also be applied to them. In the United States' economic stimulus plan, US$8 billion out of US$787 billion have been used as a loan guarantee fund for low-carbon industries. This innovative financial platform, which is also an important part of President Obama's energy plan, allows the energy services industry as well as alternative energy enterprises to face the rigors of the marketplace as quickly as possible.

Therefore we suggest that the Chinese government should establish a national energy efficiency loan guarantee fund that would replace part of the state investment in and allocations for energy conservation and alternative energy. By doing so, an innovative green financial platform can be created, which will not only direct business investment towards low-carbon industries, but will also contribute to the reform and

maturation of China's financial services system. Due to the fact that China has a huge market for the energy services and alternative energy industries, a significant share of the loan guarantee fund should be dedicated to providing support for a large number of enterprises. If calculated on the basis of a market with projected needs of 100 billion RMB (US$14.63 billion) in energy conservation and 300 billion RMB (US$43.89 billion) in alternative energy over the next 10 years, the 80 billion RMB (US$ 11.7 billion) loan guarantee fund has to be prepared by the government at a leverage ratio of 1:5. Through successive inputs and pilot programs, this model can reduce business risks and contribute to future implementation in China.

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