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China and Global Warming¹

Andrew Hassing²

Abstract. China has recently become the world's greatest greenhouse gas emitter, surpassing the United States. The unprecedented growth of the economy and population surpassed all expectations. Coal is the cheapest and most abundant source of energy for this expansion. Also, worries of energy dependence complicate the matters. The effects of global warming can be seen throughout the countryside. Although it does not currently have any mandatory emission regulations, China has put forth many initiatives to reverse this trend. More efficient technology is in development, such as advanced coal uses. Other sources of energy like hydroelectric, solar, wind, bio, and nuclear are starting to become more dominant in the energy markets. However, all are still relatively more expensive to coal. Without incentives to switch, industries will continue to use the cheaper source of energy. With regards to international policy, China is a participating member of the Kyoto Protocol, although due to its developing nation status, the only requirement is to report emissions. Without China's cooperation, it could potentially nullify the benefits of the industrialized countries reducing their emissions. China thinks Kyoto will hurt their economy, and that the majority of global warming is due to Western developed countries. The debate now is how to include China and other developing countries without hurting their growth when Kyoto expires in 2012.

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For years, the United States was the world's greatest greenhouse gas emitter. The globe watched and waited to see how America would come to address the problem. However, a new nation has taken the title of top emitter. According to the Netherlands Environmental Assessment Agency, the People's Republic of China contributed 8% more carbon dioxide emissions in 2006 than the United States. Due to its vast growth in both the economy and population in the recent past, it is abundantly clear that they will have to play a major role in the fight against global warming. Thus, China must develop a national policy of energy efficiency, to focus on the use of renewable energy, and to cooperate with international strategies to help stop the impending disaster of climate change.

In 2004 China's greenhouse gas emissions totaled 6,100 million tons of greenhouse gasses, made up of 5,050 million tons of carbon dioxide, 720 million tons of methane, and 330 million tons of nitrous oxide (NDRC 6). Per capita carbon dioxide emissions were 3.65 tons in 2004. This is only 87% of the world average and only 33% of the level in Organization for Economic Co-Operation and Development (OECD). For comparison, the United States' per capita emissions were 20.4 tons in the same year. Some say that per capita emissions are the only reasonable way to assess a country's carbon footprint.

The cause of these gigantic emission rates is China's economic growth. Over the last 27 years, China's gross domestic product has increased 9.5% a year while emissions have risen 5.4% a year (Ding et al.). Coal is the major source of energy for the Chinese economy, leading to these astronomical emission rates. In 2006, coal was the source of 69% of total energy consumption (State Council of China). China contributed around 9%

to a global emissions from coal increase of 4.5% the same year (NEAA). Known coal reserves reached 1,034.5 billion tons. There are currently 21,000 coal mines in operation with around 2,000 coal firing stations. It is reported that two new coal plants open on a weekly basis. “People say you shouldn’t call it a power plant; it’s a money-making machine,” says Li Wenhua, director of gasification research in China for General Electric (Fairley). The relatively cleaner fossil fuels oil and natural gas have to be imported and require special investments in technology, meaning they are more expensive. Also, just like in the United States, energy independence is highly valued for the Chinese. The idea of being dependent on other countries for energy scares the Chinese government. Thus, China will continue to rely on coal for years to come.

The nature of China’s electricity market is highly fragmented, leading to difficulty in regulation. Although Beijing does set a national policy, local interests drive the actions of regional municipalities. Beijing admits their regulations are ignored and that some plants are built without environmental assessments or pollution control (Fairley). The lack of a national power grid means that local plants must provide for the region. Coal is the cheapest, most abundant, and most easily transportable energy source for these plants. These plants run on traditional pulverized coal burning, which is notoriously inefficient. The International Energy Agency estimated that they run at 28% efficiency, while OECD countries average at 38% (in Cooper).

Along with coal, China’s other industries are big contributors to emissions. From 2000 to 2006, steel production rose from 140 to 419 million tons. Car buying went from 1.2 to 7.2 million sales from 1999 to 2006. China produces 45% of the world’s cement, which in turn emitted 540 million tons (Ding et al.). The \$208 billion U.S.D.

construction industry is the largest in the world, seeing an increase of 2 billion square meters in construction area each year, which is almost half the world's total. Exports accounted for 23% of the emissions (Want and Watson).

Other areas of consumption stem from the population growth rate. China's population has reached record highs at around 1.3 billion people in 2007. To feed this growing population, more and more land is being converted to farming areas, releasing sequestered carbon in the soil. China is also a nation of many diverse and extreme climates. Summers are blistering hot for the south while the north has dreadfully cold winters. Thus, energy is used for temperature control of homes.

China is already starting to feel the impacts of global warming. Desertification is forcing farmers off their lands in masses and thus decreasing food supply. Grain production fell from 432 million tons in 1998 to 422 million tons in 2006 (Carlson). Since 2001, the government has spent \$9 billion U.S.D. fighting the encroaching sands, which now cover a third of the countryside. The sea level has had an annual increase of .1 inches over the last several years resulting in coastal erosion, seawater intrusion, and coral reef degradation (NDRC 18). The frozen earth of the Qinghai-Tibet Plateau reduced to a maximum of 4-5 meters, which threatens a recently built railway through the area. Glaciers in northwestern China have shrunk by 21% in the past fifty years (NDRC 17). Due to the glacial recession, runoff in six major rivers has decreased over the last forty years. For example, the Yellow River, also known as the Mother River, once flowed from its 14,000-foot Tibetan source through China's northern provinces towards the ocean. Now, the river is barely a trickle when it reaches the sea because of drought mismanaged dams, and overuse from industry and agriculture sectors. Some years, it

doesn't even accomplish the simple task of reaching the mouth. Of the 4,077 lakes in the Qinghai Province's Madoi County, more than 3,000 have dried up, forcing rural farmers and their herds on long expeditions to find new sources of fresh water (Larmer). Water scarcity has created millions of environmental refugees, with thousands more joining their ranks every year. Because of the massive pollution caused by industries, China is experiencing a spike in birth defects, cancers, and other serious health issues. Yu Baofa, an oncologist from Shandong, refers to the villages of Donping County as "the cancer capital of the world" (Larmer).

In the future, the problems will only get worse. Heat and drought will only further the desertification of the land. The yields from the agriculture sector will become more variable. Farmers will either have to change their schedules to better fit the new seasons or abandon their homes and traditional way of life. It is estimated that agricultural output could be reduced by 5 to 10% by 2030 if nothing is done (Ding et al.). As droughts worsen, forest fires will become more likely. In the north, more lakes and rivers depending on glacial flow will dry up. As fresh water becomes scarcer, disease will spread. On the other hand, the south will experience destructive floods. Severe weather, from typhoons to heat waves, will become more likely. The heat waves will not only kill life, but will exacerbate the consumption of energy for air conditioning. Strains on biodiversity will also be felt. The beloved giant panda, Yunnan snub-nosed monkey, Tibet antelope, and *Taiwania fousiana* Gaussen are all in great danger from a changed environment.

The government has taken notice of these problems and is finally starting to address them. Investments in the development of more efficient technology and

renewable energy have reached global highs. The one child per family law hopes to control population growth. The government has also set forth a goal of 20% reduction of energy intensity, energy consumption per unit gross domestic product (Ding et al). However, there are presently no limits to emissions, no carbon taxes, and no cap and trade systems. Thus, without these mandatory regulations, some industries still lack the incentives to switch to a cleaner technology.

Within recent years, advanced coal technology has made significant strides. The process of coal liquefaction involves taking coal's long hydrocarbon chains and breaking them down into shorter liquid hydrocarbons used in motor fuels. The Shenhua Group, China's largest coal firm, hopes to have eight of these coal-to-fuel plants in operation by 2020 which have the capability of producing 30 million tons of synthetic oil (Fairley). The first plant, located in the city Edros of the Shaanxi Province, is a \$1.5 billion U.S.D. state of the art investment and is set to open this year. By the end of the first year, the plant hopes to produce 20,000 barrels of synthetic oil per day. To produce one ton of synthetic oil, however, ten tons of water must be used. Water is already a scarce commodity in Northern China, and this will only put more strain on resources. "Even though we have so much coal, if we have no water, we will just have to use the traditional way—to dig it out and transport it. Water is a key factor for us to develop this new industry," says Zhou Ji Sheng, vice manager of Inner Mongolia ZMMF Co., Ltd., one of Shenhua's competitors. Also, power producers lack incentives to upgrade from the traditional pulverized-coal plants to the more expensive new technology, which is still seen as a risky investment.

Similarly, coal gasification could prove useful. In the 1990's, the State Power Corporation planned to build a plant using integrated gasification combined cycle (IGCC) technology in Yantai. Similar to natural-gas-fired plants, this plant used syngas from treated coal. Emissions from this new fuel are more heavily concentrated than traditional coal, making it easier to capture greenhouse gasses. The gasses would then be sequestered underground. Guodong Sun, a technology expert at Stony Brook University of New York, said "China has to rely on coal for future electricity and fuel needs, and it will eventually have to cap its carbon dioxide emissions. Gasification is one a very few technologies that can those conflict scenarios at reasonable cost" (Fairley). The day when gasification is affordable is still far off, however. IGCC plants cost 10 to 20% more than traditional coal plants. The Yantai has had a bumpy history of losing funding and interest a couple times in the past.

Individual industries are starting to cut back on emissions as well as efficiency technology is being developed. For example, the construction industry is starting to go greener. In 2007 the government appropriated \$125 million U.S.D to update household heating meters. Use of renewable energy is widely being encouraged as well. Around 700 million square meters of construction were being powered by solar energy, while 80 million square meters were powered by geothermal heat (China Climate Change Info-Net). Qui Baoxing, deputy head of the Ministry of Construction, said of the new construction designs, 97% met energy-efficiency standards and 71% of on-going projects did as well. It is estimated that these energy-efficient buildings will save the equivalent of burning 5 million tons of coal. The cement industry, one of China's biggest emitters, has introduced new rotary kilns that are more efficient than the vertical kilns currently

being used. In January 2008, representatives from cement companies around China met at a workshop to discuss the industry's emissions. The China Building Materials Academy launched a CO2 Centre of Excellence which will provide assistance to China's cement companies to measure and manage emissions.

Renewable energy will become more significant in China's future. The industry is already growing as fast as, if not faster, the coal-fired power plants, and it is currently used in most regions of the country. China had the world's largest total investment of about \$6 billion U.S.D. in renewable energy sources in 2005, and 2006 saw renewable energy produce 8% of non-renewable energy generation output. This is the equivalent of 200 million metric tons of coal (China Strategies). China hopes to have renewable energy produce 10% of consumption in 2010, 15% of consumption in 2020, and 30% by 2050. The plan for 2020 includes 300,000 megawatts of hydropower, 30,000 megawatts of wind power, 30,000 megawatts of bio-mass, 1800 megawatts of solar power, and 50 million tons per year of bio-fuels. This plan for renewable energy will require an investment of about 800 billion Yuan (\$100 billion U.S.D.).

Hydroelectricity is one source of renewable energy receiving considerable interest from the government. Mao Zedong, the father of China's Communist Party, was determined to harness the powers of the rivers when he was in office in the 1950's, although at the time the focus was on preventing flooding rather than producing energy. Since then, dams have sprung up along many of China's major rivers. The Yellow River is dotted with 20 dams, with 18 more scheduled for construction by 2030. China has the potential for 378 gigawatts of power from hydroelectric sources, the equivalent of burning 50.7 billion tons of coal (Our Energy).

China has a couple large scale hydroelectric projects. The most famous is the Three Gorges Dam project is currently under construction along the Yangtze River in the central province of Hubei with scheduled completion in 2009. Started in 1993, the dam is the largest on earth at a cost of \$24 billion U.S.D. The wall is about 7,575 feet long and 607 feet tall. The 26 generators will yield a total power capacity of 22,500 megawatts (Our Energy). This is the equivalent of burning 40-50 million tons of coal a year, saving 100 million tons of carbon dioxide from being emitted into the air. The dam also boasts the benefit of ending disastrous floods further downstream.

However, this colossal project also has major problems associated with it. The reservoir created is about 410 miles in length and averages a width of about .7 miles. This will displace 1.4 million people. To the people who will not have to relocate, the dam is causing landslides and other destruction of property. Foundations of homes are being ruined. History is being lost as well. Along the river, there are over a thousand archaeological sites being consumed by water. Humans will not be the only life affected. The Baiji, a species of river dolphin, has gone to near extinction. The wetlands destroyed by the dam are home to the endangered Siberian Crane. Lastly, the dam will block sediments from traveling downstream. The building up of these sediments could eventually block access to turbines, making the dam almost useless.

The bio-fuels industry is thriving as well. China is currently producing a million tons (Bezlova). By 2020 government officials hope 15% of all transportation fuels will come from these green sources (Green Car Congress). Hainan Province has seen a number of different investments from Chinese companies. China's State Forestry Administration has promised 13 million hectares for biofuel expansion (China

Strategies). One such project focuses on the *Jathropa Curcas* tree, a poisonous shrub that is a good feed stock for biofuels. Two-thirds of a hectare of the tree can produce about 3 metric tons of seeds. These seeds can then be processed into 1 metric ton of bio-diesel. The China Hainan New Fuels Industry Development Co. Ltd has planted 240,000 *Jathropa Curcas* trees and plans on adding 5 million more seedlings. The China National Offshore Oil Corporation is building a 60,000 tons per year refinery in Hainan and will own more than 600 hectares of trees. *Jathropa* trees alone will produce 6 million tons of bio-diesel, 30% of China's renewable energy. The Yunnan Provincial Forestry Department promises 1.27 million hectares by 2015, which will have an output for 600,000 tons of biodiesel and 4 million tons of ethanol (China Strategies). For ethanol, the government offers a subsidy of 1,300 Yuan a ton. Traditionally, sugar, corn, and rapeseed have been the primary ethanol ingredients, but there has been recent talk of switching crops. Beijing is now promoting the cassava as the main source for ethanol. However, China's last remaining natural forests are being cleared for the projects. Local governments have been selling off portions to logging companies for years, and the biofuels craze will only make these deals more profitable. Also, using land to grow plants for fuel instead of food could become a major problem for China's poor. Raising food prices will put basic nourishment outside the reach of the poor. To reverse this, Beijing halted corn exportation in March 2006 (Planet Ark). Adding in the desertification of the north areas, the problems are compounded.

About two-thirds of China's regions are exposed to 2200 hours/year of sun. It is estimated that if only 1% of the exposure was converted into power, China's energy requirements for the year would be fulfilled. Thus, the solar power industry is working to

harness some of this massive energy potential. Shandong Province started a 2.1 billion Yuan fund to support conservation of energy and reduction of emissions in 2007 (China Strategies). This fund provides subsidies to hotels, schools, and other establishments to build solar hot water supply systems. About 15 million square meters of buildings use this technology. In the Jiangxi Province, a 12 billion Yuan, 15,000 megaton solar energy grade silicon project was started in August of 2007. It is expected to be at full capacity by 2009. Shi Dinghuan, the Chairman of the China Renewable Energy institute and member of the Counselor's Office of the State council, estimates that solar hot water appliances already cover 90 million square meters of buildings in China and serve 40 million households and 200 million people (China Strategies). This makes China the world's largest producer and user of solar hot water appliances.

Like the solar power industry, wind generation is starting to become more important. The central government estimates that there is the potential of a million megawatts of wind power (BizChina). Projections show there will be 5000 megawatts of wind power by 2010, 10,000 megawatts by 2015, and 30,000 megawatts by 2020. To reach these goals, 45 billion Yuan will have to be invested by 2010 and 13 billion Yuan/year thereafter (China Strategies). Estimates also show that China will be the world's largest market and the center for manufacture of wind power equipment. The cost of producing wind power is decreasing rapidly. On average, the cost of a wind farm is 8000-9000 Yuan/kilowatt. About 60-70% of the cost is equipment. The price of power has been reduced .45-.5 Yuan/kilowatt (China Strategies). Usually, the equipment is imported, but if it is produced in China, costs could be reduced 10-15% more. The city of Chongqing of the Yuan province is building 8 wind farms with total capacity of 450 megawatts that

are set to be operational within 5 years (China Strategies). Inner Mongolia, which is estimated to have 40% of China's potential 230 million kilowatt-hours, has 200 companies fighting for a stake in the region. By 2010 output will reach more than 5000 megawatts. Hainan Province plans to have 4 to 6 wind with total capacity between 250 to 300 megawatt operating by 2010. By 2015, these farms will have increased to 400 megawatts capacity and 2020 will see them at 600 megawatts (China Strategies). Shanxi Province's first wind farm, opened in September 2007, will entail a total of 117 windmills to produce 330 million kilowatt-hours per year at a cost of 2 billion Yuan (China Strategies). Gansu Province is planning to an additional 10 wind farms to their existing 6 under construction. The total planned capacity will be 1000 megawatts (China Strategies).

China's nuclear power capabilities are expanding as well. According to the World Nuclear Association, the first nuclear power plant first began producing power in 1991 and quickly expanded into what is currently an industry with 8.6 gigawatt capacity. There are eleven reactors, six under construction, and several more in the planning stages. The government estimates that there will be at least 50 gigawatt capacity in 2020 and 160 gigawatt capacity in 2050. Much international support is required for the program. Technological help from France, Canada, Russia, and the United States has allowed for the growth. Although China's uranium resources of 70,000 tons are enough to complete short-term goals, the China National Nuclear Corporation (CNNC) is in talks with many governments, such as Kazakhstan, Nigeria, and South Africa, about the importation of the remaining uranium needed. One main concern, as with every other nuclear country, is waste disposal. At the expected capacity level of 2020, there will be 1,000 tons of

waste with cumulative waste 12,300 tons (WNA). Construction of waste storage facilities and reprocessing plants are promising.

Recently, there have been a series of initiatives and programs to help land use. To stop the rapid desertification, silver iodide crystals are shot into the air. This process, called cloud-seeding, helps keep moisture in the sky. Water attaches to the crystals, and when it becomes heavy enough, fall back to earth in the form of rain. A reforestation program has been initiated to fend off desertification. Started in 2002, the program aims to plant 170,000 square miles of trees at a cost of \$2.4 billion U.S.D. (Xinhua). Also, the government is deliberately moving farmers off the land (Carlson). Overgrazing and deforestation can be just as destructive for the environment as using energy. But again, this policy brings up the question of how to feed China's growing population? If less and less farmers are doing their jobs, supply will go down. Demand will also increase with bigger populations. Thus, a high price for food is inevitable.

In 2002 China approved the Kyoto Protocol. "The Chinese government believes that the United Nations Framework Convention on Climate Change and its Kyoto Protocol set forth the fundamental principles and provide an effective framework and a series of rules for international cooperation in combating climate change, and as such they deserve worldwide compliance," said Chinese Premier Zhu Rongji (China-UN.com). Having actively participated on the United Nations Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPPC), China recognizes the importance of having an international policy to help bring together different governments in a united battle on climate change.

Because of its developing country status, China's only obligation is to monitor and report their emissions. Countries with the developing nation status have no caps. One of the main reasons the United States does not join the Kyoto Protocol is because of this exception. President George W. Bush has criticized the treaty, saying it is pointless without the inclusion of China and India. Recent studies give weight to this argument. *The Christian Science Monitor* estimates that the combined increased emissions of China, India, and the United States in 2012, the year Kyoto expires, will amount to 2.7 billion tons of carbon dioxide, while the Kyoto countries will only have reduced their emissions by 483 million tons.

China has resisted these efforts, saying that today's world powers are responsible for the majority of climate change. When these countries went through their own industrialization periods, they were not forced to comply with emission laws because at the time, there were none. Most of the carbon already in the air is mostly from the Western developed nations, so they should bare the responsibility. Also, one important factor of China's economy is processing trade. This is the act of developed countries sending raw materials to China for processing or assembly, then re-exportation back to the home countries. Exports contributed to 34% of China's 2004 GDP. For example, total cement production increased 10% from 2004 to 2005 while cement exports went from 7 to 21 million tons. Rolled steel exports increased 44% in the same period (Wang, Watson). China's exports account for 1,109 million tons of carbon dioxide, 23% of emissions. This point begs the question whether a country should be responsible for the emissions released during the production of goods and services they consume? Thus, these cases lead to the argument that OECD countries should set the example in

emissions reduction and help developing countries through technical assistance and finance. Industrialized nations have more technology available and can make a better, quicker transition to reduced emissions. Europe has been able to change, so the United States should be obligated to as well. They should take the lead, so when the developing countries become stable, they can start to make their own changes to leaving a smaller carbon footprint.

The People's Republic of China recognizes the problems faced with climate change and greenhouse gas emissions. Global warming has already started to cause environmental problems. Programs put forth by the government offer opportunities to grow in efficiency and renewable energy industries. However, the growth of the economy is still favored over the perils of global warming, as evidenced by a lack of any sort of pledged reductions on emissions. Thus, China has resisted the ideas of mandatory reductions put forth by international agreements such as the Kyoto Protocol. But as Kyoto is set to expire soon, it is important to include the developing world as much as possible. Unregulated emissions from these countries could prove to undo the progress made by Kyoto and any following treaty. China will play a key role in this problem of global proportions.

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