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The Power of China: An Analysis of China's Energy Sources and the Case for Clean Energy

Lauren Vunderink
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The Power of China:
An Analysis of China's Energy Sources and the Case for Clean Energy

Vunderink, Lauren
Academic Director: Lu Yuan
Project Advisor: Professor XieJian(谢建)
Connecticut College
Anthropology
China, Yunnan

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and Ethnic Minorities, SIT Study Abroad, Spring 2014

II. Abstract

China's energy demands have been growing exponentially since the early 1980s, impacting the global environment and economy. China is already the world's largest producer and consumer of energy, and as it continues to urbanize and develop its electricity demand is projected to more than double by 2040. China's energy consumption will not continue its rapid growth forever; its population growth and energy demand are expected to level off by 2040. While mostly relying on the increasing amounts of coal, oil, and natural gas, the Chinese government aims for renewable resources to satisfy 15% of total energy consumption by 2020. That goal is admirable, but will not offset China's reliance on fossil fuels; the quantity of coal used for energy production is set to double by 2040, accompanied by greater environmental and public health issues. China's push for clean energy is motivated more by environmental concern than energy independence, but one of the major advantages of developing renewable energy is the potential for decreasing international conflicts over energy resources. Wind and solar energy production has increased significantly in recent years, but China has chosen to shift its focus away from these clean sources of energy, and instead vigorously develop hydroelectric and nuclear power. These sources have the potential to decrease China's hazardous reliance on coal and oil, but introduce many new environmental problems. Although China is still a developing nation, it is a global leader that should be prioritizing wind and solar energy as the best ways to produce electricity domestically, combat climate change, improve public health, and work towards a future with less environmental damage and international conflict.

ISP Key Words: Environmental Education, Environmental Studies, International Relations

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Introduction

Since 1979 China has developed with dizzying speed from a nation based on subsistence farming into one of the world's largest economies, second only to the United States.¹ Deng Xiaoping took power after Mao Zedong's death in 1976 and quickly began to reshape the Chinese society and economy. The One Child Policy was passed in 1979 in response to the 71% population increase during Mao's 27-year reign,² which considerably decreased the birth rate. The Chinese population has continued to grow, however, and China is now the most populous country in the world, with 1.347 billion people at the end of 2011, making up 20 percent of the world's population.³ With its fast-growing economy, China is the world's largest energy consumer, producer, and importer, greatly impacting the global economy and environment.⁴ The energy demands of an economy that grew from under \$1 trillion in 1997 to more than \$8 trillion in 2012 are enormous.⁵ Still a developing nation, with an estimated 128 million people under the poverty line,⁶ China's economy is expected to continue its growth at around 9% per year until 2025, according to the director of the China Center for Economic Research at Peking University, Justin Yifu Lin.⁷ This growth is accompanied by a voracious demand for electricity, consistently rising by 15% per year.⁸ China's population is projected to peak around 2030, at which point the surging energy demand will gradually flatten.⁹ The enormous heavy industry that has turned China into the "workshop of the world" is the largest consumer of energy,

¹(Borenstein 2013)

² (Sanders 1999: 1203)

³(Wang 2012b: 4)

⁴(EIA 2014: 1)

⁵(Ma 2013)

⁶(Wang 2012a: 104)

⁷(Zweig 2005)

⁸(Bradsher 2010)

⁹(ExxonMobile 2012: 1-6)

responsible for 3/4th of China's total electricity consumption.¹⁰ In comparison, the United States' industry is responsible for about 1/3rd of its total electricity consumption.¹¹

The current President Xi Jinping and Premier Li Keqiang began leading the government in March 2013. The new administration has spoken enthusiastically about interest in "sustainable growth" and the reforms and developments that are necessary to lead China into a sustainable future. China passed the United States to become the world's largest power generator in 2011,¹² nearly tripling the amount of power generated in 2010.¹³ With the growth of industry and increasing urbanization, energy consumption has been skyrocketing.¹⁴ The amount of electricity produced in China is expected to double by 2040, powered mostly by coal, natural gas, and renewable resources.¹⁵ The model that powered China's early development boom was based on the ideas that "1) energy was inexhaustible, inexpensive and benign, and 2) China could count on raising its living standards by forever being the world's low-cost manufacturing workshop, based on cheap energy."¹⁶ As China's growth has outstripped its resources, the government has realized that its pursuit of energy sources must change.

In 2011, China's energy was produced by 69% coal, 18% oil, 6% hydroelectric, 4% natural gas, nearly 1% nuclear power, and 1% other renewables (see Figure 1).¹⁷ China's goal is to produce at least 15% of its energy from renewable resources, including nuclear, by 2020. The Chinese government and companies are

¹⁰(EIA 2014: 31)

¹¹(Ma 2013)

¹²(EIA 2014: 1-2)

¹³(EIA 2014: 31)

¹⁴(Ni 2005: 10)

¹⁵(EIA 2014: 31)

¹⁶(Friedman 2008)

¹⁷(EIA 2014: 2)

investing hundreds of billions of dollars in renewable energy projects, as stipulated in the current Five-Year Plan.¹⁸ Despite China's recent push to increase its clean energy resources, its dependence on coal and fossil fuels is much more prevalent and expanding more rapidly. China is the world's largest producer and consumer of coal, accounting for nearly half the world's coal consumption.¹⁹ China's vast coal resources have been the driving fuel behind the country's development, and will remain so for the foreseeable future. China is the world's second largest oil consumer, behind the United States, but is expected to pass the U.S. to become the largest net oil importer by the end of 2014.²⁰ The per capita amount of energy resources is very low: China only has about 1/15th of the average per capita amount of oil and natural gas, only about half of the average per capita amount of coal, China's most abundant resource, and about half of the average per capita amount of hydropower.²¹ With only 30% of the average per capita amount of arable land, biomass energy development has been "hindered".²² China's energy consumption per capita is only half of the world's average,²³ a striking statistic since China is already the world's leading producer and consumer of energy.

The energy challenges that face China are severe: growing electricity demand, domestic resource shortages, terrible environmental pollution, the struggle to decrease greenhouse gas emissions, and supplying rural areas with energy as they develop.²⁴ China's resource scarcity, combined with its growing demand for energy, is one of its most pressing issues.²⁵ Every year tens of millions of rural laborers are

¹⁸(EIA 2014: 34)

¹⁹(EIA 2014: 28-29)

²⁰(EIA 2014: 1)

²¹(Wang 2012b: 8)

²²(NDRC 2007b: 4-5)

²³(Ni 2005: 5)

²⁴(Ni 2005: 6)

²⁵(Ma 2013)

moving to urban areas, requiring more energy and putting more pressure on the electricity grids.²⁶Energy security is a growing issue, as China becomes increasingly dependent on imported energy; in 2013 nearly 60% of oil and 30% of natural gas was imported.²⁷In 2007 China became the largest emitter of greenhouse gasses,²⁸leading to health concerns and increased environmental damages. The government recognizes that clean energy offers a solution to these problems, and is striving to expand its renewable resource programs like hydro,wind, biomass, and solar, as well as improve energy efficiency.²⁹China needs to move away from coal and oil and instead rely on its vast potential for renewable resources.

Environmental Considerations

China's commitment to clean energy is not only motivated by energy independence and addressing the growing demand for energy, but also by the staggering effects of climate change and pollution on public health and the economy. Developing nations are especially vulnerable to the negative effects of climate change, so as China's already formidable demand for coal and oil continues to grow, the situation grows more dire.³⁰Coal and oil are not sustainable substances on which to build China's future and the cost of their use is too high. The Chinese government has repeatedly committed to environmental protection, demonstrated by signing international agreements like the United Nations Framework Convention on Climate Change and setting up internal agencies like the National Coordination Committee for

²⁶(Wang 2012b: 4)

²⁷(Ma 2013)

²⁸(Borenstein 2013)

²⁹(Ni 2005: 51)

³⁰(Wang 2012b: iii)

Climate Change.³¹ From 2006-2010, 1.68 million environmental protection projects were approved across China,³² nationwide emissions standards were put in place,³³ and the destructive ozone depleting chemicals carbon tetrachloride, methyl chloroform, and chlorofluorocarbons (CFCs) were eliminated from industrial processes.³⁴

In 2013, Premier Li declared a “war on smog”, after Beijing’s abysmal 2012 air quality ratings, which failed to meet government standards 52% of the time, according to the Ministry of Environmental Protection.³⁵ As a direct result of its high coal consumption, China is the world’s leading carbon dioxide emitter, producing more than the United States and India (the next biggest emitters) combined (Borenstein 1) and accounting for one quarter of global CO₂ emissions.

The United States does have the highest carbon dioxide emissions per capita, however, three times higher than China’s and more than 10 times higher than India’s. The US is addressing this issue by focusing on improving energy efficiency and clean energy production.³⁶ China has pledged to reduce its overall carbon dioxide emissions by 40-45% between 2005 and 2020, motivated by the effects of pollution and man-made climate change.³⁷ However, since 2005 China’s emissions have kept increasing by about 10% per year.³⁸ Emissions are not expected to stop rising until around 2025, mostly due to improved energy efficiency and safer methods of energy production.³⁹ In a study released in March 2013 in *Geophysical Research Letters*, Chinese and Canadian researchers concluded that “about 90 percent of the

³¹(NDRC 2007b: 30)

³²(Wang 2012a: 53)

³³(Wang 2012a: 63)

³⁴(Wang 2012a: 100)

³⁵(Shen 2013: 1)

³⁶(ExxonMobile2012: 35)

³⁷(EIA 2014: 2)

³⁸(Borenstein 2013)

³⁹(ExxonMobile2012: 34-35)

temperature rise [in China can] be traced directly to man-made greenhouse gases.”⁴⁰From 1908 to 2007 the average temperature of the earth’s surface in China has risen by 1.1 degree, which is more than the world average. The adverse effects of this climate change can already be seen on agriculture and public health, and with the increase in natural disasters like severe droughts, floods, and heat waves.⁴¹ A document published by the Chinese government warned that if changes are not made “the productivity of China’s agricultural crop production will decrease by between 5 percent and 10 percent by 2030 due to climate change, leading to large yield reductions in wheat, rice, and maize... The impact will be even greater after 2050, as climate change will greatly affect the existing crop system.”⁴²The conversation about China’s food resources already includes the strong potential for future shortages, so this decrease in agriculture productivity due to climate change is a huge concern. That same document states that global warming “will possibly reinforce the frequency of drought in northern China, and intensify water scarcity... and overall will have a severely negative impact on agriculture in China.”⁴³The Chinese government acknowledges the devastating effects of man-made climate change and invests heavily in clean energy, yet simultaneously continues the rapid growth of its coal and oil production. Former President Hu Jintao stated that addressing climate change and creating a sustainable development strategy go hand in hand, helping to conserve resources, innovate, and be environmentally friendly,⁴⁴ but increasing coal and oil consumption does nothing to achieve these goals.

⁴⁰(Borenstein 2013)

⁴¹(Wang 2012b: 12)

⁴²(Wang 2012b: 13)

⁴³(Wang 2012b: 13-14)

⁴⁴(Wang 2012b: 24)

One of the driving factors pushing the Chinese government to develop alternative energy is the impact coal has on public health. Photochemical smog events began appearing around China in the 1980s and continuously worsened, leading to today's record breaking high pollution concentrations.⁴⁵ Published in 2013 in the Proceedings of the National Academy of Science, a study conducted by an American, an Israeli, and two Chinese scholars analyzed data collected by the Chinese government from 1981 to 2001 and concluded that "southern Chinese on average have lived at least five years longer than their northern counterparts in recent decades because of the destructive health effects of pollution from the widespread use of coal in the north."⁴⁶ Five years longer! The study highlighted the increase in cardiorespiratory diseases and other health problems related directly to coal use as the cause for the drop in life expectancy. Environmental protection is intrinsically linked with public health, sustainable economic development, and social welfare. The public health cost of China's coal dependence is too high.

Coal

Coal will soon pass oil to become the largest source of the world's energy, mostly due to China's coal development efforts. Burning coal is still much cheaper than using renewable resources, which is why the Chinese government continues to focus on the development of the coal industry. The chief executive of the World Coal Association, Milton Catelin, said that global coal use "is expected to increase 50 percent by 2035" from the 2012 levels. In 2011 coal supplied 30% of the world's energy, its highest percentage since 1969."⁴⁷ China's investments in clean energy are dwarfed by its love affair with coal. As the world's top producer, importer, and

⁴⁵(Wang 2012b: 19)

⁴⁶(Wong 2013)

⁴⁷(Galuszka 2012)

consumer of coal, China accounts for about half of global coal consumption, consuming an estimated 4 billion tons of coal in 2012.⁴⁸ Coal has driven the rapid expansion of the Chinese economy and made it possible for China to become the world's largest energy producer in 2007.⁴⁹ Until 2009 China exported its coal surplus, but has since imported coal to satisfy increasing demand – the 2012 coal consumption levels were more than double the 2000 levels (see Figure 2). The majority of coal from China's approximately 12,000 coalmines is processed for the generation of electricity and 45% is used by the industrial sector.⁵⁰ There were 1,384 accidental coal miner deaths in 2012, in line with a steady decrease from the peak of 7,000 deaths in 2002.⁵¹

The U.S. Energy Information Agency projects coal to account for 63% of China's energy mix in 2020 and 55% in 2040, down from 69% in 2011. The percentage decrease will be due to increased energy efficiency and more energy source diversification, but because of the dramatic increase in energy consumption, the total coal consumption is actually projected to increase 50% by 2040.⁵² In 2012 Chinese planners proposed 363 new coal-fired power plants, with the capacity to generate “more than half again as much” the current capacity of all the United States' coal plants,⁵³ and amounting to an almost 75% increase in China's coal-fired generating capacity.⁵⁴ Coal production is expected to grow 2-3% per year for the next five years, as 13 new large-scale coalmines were approved for excavation in 2013.⁵⁵ Exacerbating water scarcity through the production process, increasing

⁴⁸(EIA 2014: 28)

⁴⁹(EIA 2014: 1)

⁵⁰(EIA 2014: 29)

⁵¹(Lelyveld 2013)

⁵²(EIA 2014: 2)

⁵³(Forsythe 2014)

⁵⁴(Luo 2013)

⁵⁵(Stanway 2014)

environmental damages, worsening public health, and thousands more accidental coalmine deaths are all continued threats of expanding of the coal industry. These problems pose a real threat to China's economic development; a sustainable approach is far better for long-term, healthy growth.

Professor Ni Weidou, the Chairman of Steering Committee of Tsinghua-BP Clean Energy Research and Education Centre at Tsinghua University, believes that the most important aspect of both energy supply and environmental issues is developing clean coal technology. He particularly calls for large-scale coal gasification polygeneration as the most economically and environmentally beneficial way to make competitive “coal derived liquid fuel and clean power.”⁵⁶

The Chinese government is focusing on making coal plants more efficient and lowering their carbon dioxide emission levels. The National Development and Reform Committee (NDRC), has called for “developing the coal industry in an orderly way” by renovating or closing down small, inefficient coal power plants, promoting the use of clean coal technology, and building “large, highly efficient, environment-friendly coal power plants.”⁵⁷ Between 2005 and 2010, the government shut down 80 GW of small and inefficient coal power plants, but plans to add an additional 450 GW of new coal-fired power by 2040,⁵⁸ offsetting any environmental benefits of closing those small coal power plants. Due to the absurd levels of air pollution, the building of new coalmines has been banned near Beijing, Shanghai, and Guangzhou. Many of China's current 12,000 coalmines are being shut down, consolidated or merged as well, with the goal of eventually replacing small,

⁵⁶(Ni 2005: 24-25)

⁵⁷(NDRC 2007b: 5)

⁵⁸(EIA 2014: 33)

inefficient, hazardous coalmines with only 4,000 large, efficient ones.⁵⁹ Since 2004 China has shut down mines worth 300 million tons of coal, but the building of large new mines is outpacing the closure of small ones.⁶⁰ China's coal industry is still rapidly expanding.

Oil

China began importing oil in the early 1990s, and in 2009 became the world's second-largest importer of crude oil and petroleum products. By the end of 2014 China will pass the United States to become the largest oil importer, as China's energy demand continues to grow dramatically.⁶¹ China's domestic oil production is currently the fourth largest in the world, but is expected to reach peak production in 2020, then begin to decrease.⁶² In 2014 China is projected to produce 4.5 million bbl/d of oil liquids and import 6.6 million bbl/d, while the United States, for comparison, will import 5.5 million bbl/d. The small amount of growth in domestically produced oil liquids, only an estimated 1.1 million more barrels per day by 2040 (for a total of 5.6 million), will be from more technologically involved operations like coal-to-liquids and gas-to-liquids.⁶³ Some of China's largest oil fields are located in Xinjiang Uyghur Autonomous Region (see Figure 4), and in the South and East China seas, all of which are conflict zones. Use in homes and vehicles is driving up the demand for oil, so the Chinese government is striving for hydrogen power to be the main energy source for transportation by 2050, easing the dependence on oil.⁶⁴ The Energy Information Agency expects China to import over 66% of its total oil by 2020 and

⁵⁹(EIA 2014: 30-33)

⁶⁰(Stanway 2014)

⁶¹(EIA 2014: 4)

⁶²(Ni 2005: 13)

⁶³(EIA 2014: 4)

⁶⁴(Ni 2005: 15-22)

72% by 2040.⁶⁵This dependence on oil imports has many geopolitical implications; the Chinese government's policies are increasingly motivated by this skyrocketing demand for oil.⁶⁶

Energy security is a growing issue for China as reliance on oil imports increases. The Middle East is the largest source of China's oil imports, an unstable region that is projected to encounter more turmoil as the United States military pulls out (see Figure 5).⁶⁷China is seeking to diversify its supply sources through various political and economic means, and to achieve a 6-10% growth rate in oil and gas production by 2015.⁶⁸Recent social unrest and political uprisings in Sudan and Libya, among other places, temporarily disrupted China's oil imports. By 2020 the Chinese government aims to have an oil storage supply that will be able to satisfy oil demand for 90 days in case there is a temporary problem with oil imports. China's oil imports are supplied in large part by Saudi Arabia, Angola, Kazakhstan, and Sudan, but China has assets in nearly 30 countries. After the 2008 financial downturn, China rapidly increased its global overseas acquisitions of oil resources through various methods, including oil-for-loan agreements, which supply loans for countries like Russia, Kazakhstan, Venezuela, Brazil, Ecuador, Bolivia, Angola, and Ghana to develop new infrastructure in exchange for long-term oil and gas trade with China at established prices.⁶⁹The Chinese government seeks to build goodwill with the countries whose energy resources it desires by giving aid, forgiving national debt, and strengthening trade of non-energy goods. China says that these programs help to raise the standard

⁶⁵(EIA 2014: 11)

⁶⁶ (Forsythe 2014)

⁶⁷(EIA 2014: 11)

⁶⁸(EIA 2014: 10)

⁶⁹(EIA 2014: 10-17)

of living in the developing world, but critics warn against the blatant exploitation of developing country's resources.⁷⁰

China continues to pursue global oil assets, investing an estimated 34 billion USD in overseas acquisitions in 2012 alone, according to the CNPC Economic Technology Research Institute, mostly off the coast of West Africa and Brazil and oil sands and shale gas projects in North America. China's largest overseas acquisition was its deal with the Canadian oil company Nexen in 2013.⁷¹ As China's thirst for oil expands its global presence, the foreign policy implications and international cooperation efforts are important to consider. The benefits of clean energy are numerous, and include the possibility of less international conflict over energy resources.

International Relations

Since oil and coal are going to remain China's main source of energy for the foreseeable future, it is important to note how their use is impacting the world. The Chinese government's international relations and foreign policies have been reshaped by the growing demand for energy resources.⁷² Between 2010 and 2020, China will need to add almost nine times more electricity generation capacity than the United States.⁷³ The United States has reshaped the political atmosphere of parts of the world in its search for oil and gas, so the current and future global repercussions, both positive and negative, of a resource hungry China should be considered. Some of the international energy organizations that China is a part of or has close relations with include:

⁷⁰(Zweig 2005)

⁷¹(EIA 2014: 9-10)

⁷²(Zweig 2005)

⁷³(Bradsher 2010)

China-EU Energy Cooperation Conference, Sino-US IPCC (which led to the signing of the U.S.-China Ten-Year Framework for Cooperation on Energy and Environment), Sino-Japanese Comprehensive Forum in Energy Conservation and Environmental Protection, the Asia-Pacific Economic Cooperation (APEC), Association of Southeast Asian Nations (ASEAN) plus China, Japan, and ROK (10+3), Energy Cooperation, International Energy Forum, World Energy Conference, and Asia-Pacific Partnership for Clean Development and Climate, the World Energy Agency, and the Organization of Petroleum Exporting Countries (OPEC)⁷⁴

China also participates in many joint projects with countries willing to offer technological guidance, such as working on electric vehicles with Germany, clean energy with Italy, green building with Britain, sustainable architecture with Canada, renewable development with Sweden, and energy efficiency with the EU as a whole.⁷⁵ China looks to Africa, the Arab world, and Latin America for energy resources. The China-Africa Cooperation Forum (CACF) was established in 2000 with 44 African countries, and has since worked closely with the governments of Algeria, Egypt, Gabon, Angola, Nigeria, the Central African Republic, Chad, Congo, Libya, Niger, and Sudan, among others, to promote trade and development, often revolving around energy resources. In 2004 China's President Hu Jintao met with the Arab League to increase oil shipments and bilateral trade and China boosted trade enormously with Iran. According to the Financial Times, the amount of trade between China and Latin America in 2004 was five times as high as the 1999 levels, making China's economy the driving force for export growth in many Latin American countries.⁷⁶

The search for oil and gas does not have to breed conflict; countries sometimes work together to secure resources, such as the 26 members of the International Energy Agency, including the United States, who have created a joint oil reserve. China could be a part of cooperative efforts like this one. However, the

⁷⁴(NDRC 2007b: 38)

⁷⁵(Wang 2012b: 111)

⁷⁶(Zweig 2005)

pursuit of resources on the global level often breeds more conflict than cooperation. The United States and Japan are particularly concerned about China's expansion efforts in pursuit of resources, and the accompanying sphere of influence that could threaten their interests. China has placed its search for oil above its diplomatic relationship with the United States. China and Iran continue to engage in billions of dollars worth of trade every year, while the United States enforces sanctions against Iran.⁷⁷ When China established oil trade with Venezuela, Venezuela's late President Hugo Chávez said, "We have been producing and exporting oil for more than 100 years, but these have been 100 years of domination by the United States. Now we are free, and place this oil at the disposal of the great Chinese fatherland."⁷⁸ The United States supports Japan in the territorial disputes between China and Japan over the East and South China Seas, which promises to be a continued, and possibly escalating, conflict over the oil and gas reserves, as both countries want to develop offshore platforms and decrease their imports. China has engaged in similar, but less publicized conflicts with Vietnam and the Philippines, as it has developed offshore oil fields and increased its naval presence in contentious areas, like Vietnam's 200-nautical mile exclusive economic zone.⁷⁹ China's increasing appetite for oil and gas cannot bring the kind of peace and stability that clean renewable resources have to offer.

The international community has been very active in forming groups to discuss environmental issues and environmental protection. China has had meetings and drawn up agreements regarding environmental issues with:

The China-Japan-South Korea Environmental Ministers, the Sino-US Joint Commission on Environmental Cooperation (beginning in the 1980s), Sino-Japanese Environmental Cooperation, China-EU Environmental Policy, China-ASEAN

⁷⁷(ibid)

⁷⁸(Zweig 2005)

⁷⁹(EIA 2014: 8)

Environmental Cooperation Forum, the United Nations Environmental Program (UNEP) including signing the United Nations Framework Convention on Climate Change and the 2002 Kyoto Protocol, the China-Australian Climate Change Partnership Project, and the China-Africa Environment Center of UNEP, among others⁸⁰⁸¹

China has also signed bilateral environmental protection agreements with several African countries, including South Africa, Morocco, Egypt, and Angola. The relationship between China and Africa is especially interesting, since China, a developing nation that receives international aid and is often criticized for its environmentally damaging policies, is giving aid to developing African countries and educating them about how to protect the environment. Between 2005 and 2012, the Chinese government held 12 environmental management seminars, where 300 representatives from African countries received fully funded trips to Beijing to receive training in how to approach environmental issues.⁸² Training seminars for environmental management have also been held for representatives from Southeast Asia, Arabia, and Latin America.⁸³ Energy and environmental issues have resulted in increased international discussion, cooperation, and conflict. The Chinese government has devoted its attention to acquiring fossil fuels from countries around the world, and the affects of these changing relationships and trade interests will impact global politics and the environment.

Natural Gas

The development of natural gas in China has a lot of potential. In 2007 China became a natural gas importer, and every year imports greater amounts.⁸⁴ In 2011 natural gas supplied 4% of the country's total energy consumption, which was nearly

⁸⁰(Wang 2012a: 95-100)

⁸¹(Wang 2012b 98: 109-110)

⁸²(Wang 2012a: 98-99)

⁸³(Wang 2012b: 113)

⁸⁴(EIA 2014: 18)

triple the 2002 levels, and the government is rapidly increasing its development, including coal-bed methane, shale gas, and other unconventional oil and gas resources. By 2020 the government aims for 10% of total energy consumption to be provided by natural gas, mostly as an alternative to coal big cities, to decrease heavy pollution.⁸⁵ Beijing, for example, plans to replace all of its coal plants with gas plants by the end of 2014.⁸⁶ The demand for liquefied natural gas (LNG) has expanded greatly in recent years, and accounts for half of China's natural gas imports. In 2012 China passed Spain to become the third largest LNG importer in the world.⁸⁷ The government plans to create more gas-fired power plants, investing in domestic production, as China's natural gas reserves are potentially immense.⁸⁸ China's natural-gas industry is in its early stages and relies on foreign investors with gas experience to help it develop, including the development of coal-bed methane (CBM), coal-to-gas (CTG), synthetic natural gas (SNG), and shale gas technologies. Xinjiang Uyghur Autonomous Region has been one of China's top gas-producing regions, as well as oil producing; in 2012 the Tarim Basin in Xinjiang was the second largest gas-producing area in China, contributing 18% of China's total gas.⁸⁹ This is a huge part of why the social unrest in Xinjiang will only lead to increased military presence; the Chinese government will not grant such a resource-rich area independence. Natural gas is, of course, a nonrenewable fossil fuel whose burning contributes to pollution and climate change, and it is crucial that it be recognized as such. Moving away from a reliance on oil and towards a reliance on natural gas is not a sustainable solution. Hydraulic fracturing, commonly called "fracking", is a method of recovering shale gas reserves

⁸⁵(Wang 2012b: 46-47)

⁸⁶(EIA 2014: 33)

⁸⁷(EIA 2014: 26)

⁸⁸(Ma 2013)

⁸⁹(EIA 2014: 20-21)

that has received a lot of criticism for its destructive methods and ensuing environmental damages, including threatening water resources. Natural gas may give China some energy independence as it shift away from oil, and may help decrease heavy smog in cities, but these short-term benefits should not detract China's focus from expanding its clean energy base.

Strategy for Advancing Clean Energy

The 12th Five-Year Plan for National Economic and Social Development (2011-2015) is committed to making the country more energy efficient and increasing non-fossil energy to 11.4% of total energy.⁹⁰ Energy conservation, increasing clean energy, and reducing emissions were also focuses during the 11th Five-Year Plan (2006-2010).⁹¹ Despite the political and long-term cost benefits of clean energy, the major push for growing China's use of renewable resources has come from the environmental perspective, as the government acknowledges the affects of man-made climate change and intense pollution. The Ministry of Environmental Protection contributed to the 12th Five-Year Plan's environmental economic policy.⁹² China has an enormous bureaucracy, and many groups' duties overlap with environmental protection. For example, the China Association of Resource Comprehensive Utilization and the Chinese Renewable Energy Industry Association together created a "China Climate Solution Exchange", joining the ranks of many other groups that hold discussions regarding energy and the environment.⁹³ China's National Climate Change Program (CNCCP), which seeks to "achieve...green and low carbon

⁹⁰(Wang 2012b: 118)

⁹¹(Wang 2012a: 18)

⁹²(Wang 2012a: 40)

⁹³(Wang 2012b: 87)

development in terms of resources and environment,”⁹⁴ also offers policies and suggestions for clean energy. The central government ultimately relies on the President and Premier to lead the country into a more sustainable future.

The environment is a growing priority for the Chinese government, as demonstrated by the 156.4 billion RMB spent on environmental protection during the 11th Five-Year Plan period, three times the amount spent during the 10th Five-Year Plan period.⁹⁵ The government has invested huge amounts in pollution reduction projects, 861 billion RMB by 2012,⁹⁶ and the 500,000 USD contributed to the Environmental Agency in 2010 was double the amount donated in 2006.⁹⁷ China has invested more in hi-tech Research and Development (R&D) to focus on innovating the clean and efficient use of energy.⁹⁸

China has many projects that focus on low-carbon or clean energy implementation. The China Urban Transportation Development Strategy Partnership Demonstration Project (CUTPP), funded in part by grants from the United States and World Bank, seeks to implement and improve the low-carbon public transportation systems in 19 cities across China⁹⁹. In 2010, the National Development and Reform Commission (NDRC), launched a “low carbon province and low carbon city” project, where five provinces (Guangdong, Hubei, Liaoning, Shaanxi, and Yunnan) and eight cities (Tianjin, Chongqing, Hangzhou, Xiamen, Shenzhen, Guiyang, Nanchang, and Baoding) were chosen to focus on green and low-carbon projects and lifestyles, while reaching their respective high goals for carbon emissions reductions by 2020.¹⁰⁰ In 2008, after a disastrous earthquake, the Chinese Red Cross and Global Village Beijing

⁹⁴(Wang 2012b: 24)

⁹⁵(Wang 2012a: 6)

⁹⁶(Wang 2012a: 21)

⁹⁷(Wang 2012a: 40)

⁹⁸(Wang 2012b: 78)

⁹⁹(Wang 2012b: 104)

¹⁰⁰(Wang 2012b: 53)

sponsored a low-carbon reconstruction project in Daping Village, Sichuan, that sought to reestablish a “harmonious village” balanced with nature by turning the village into an eco-friendly, clean energy leader. The All-China Environment Federation teamed up with the China Tourism Association to create “low-carbon tourism experiments” at 48 tourist resorts,¹⁰¹ so the growing tourism industry can embrace renewable resources and showcase China’s clean energy technology. A green building project in Shaxi Valley, Yunnan, funded by the Swiss embassy, is in the process of converting an old temple into a low-carbon community center, which uses renewable resources to unite the community.¹⁰² These few projects exemplify the many similar undertakings happening around China, initiated and funded by various organizations determined to grow China’s use of clean and low-carbon energy sources.

As a developing country, China is primarily focused on economic growth, but the government is aware of the economically detrimental impacts of environmental damages and has numerous laws and policies in place that address pollution, most notably efforts to reduce carbon dioxide emissions from power plants and factories. The Chinese government recognizes that it is necessary to change the economic patterns in order to address environmental issues, but the reality of desired rapid economic growth often overshadows the ideal of “environmental harmony”.¹⁰³ Luckily the two are not mutually exclusive, but can actually go hand in hand; clean energy can bring many, safer, jobs to China, if the desire to invest and develop is big enough. Resource scarcity and energy independence seem like more avoidable, long-

¹⁰¹(Wang 2012b: 87)

¹⁰²(Huang 2014)

¹⁰³ (Wang 2012a: 105)

term problems that do not rival the immediacy and ease of coal-fired energy, but this mindset needs to change – clean energy should be a bigger priority for China.

Education

Public awareness of environmental and energy issues is important, even in countries like China where laws and policies do not necessarily reflect the will of the people. The Chinese government and NGOs have been working to promote awareness of environmental issues and influence people towards “conscientious action”.¹⁰⁴The government established the National Environmental Education Guidelines in 2003, which stipulate that environmental education is a required part of the national curriculum. The World Wildlife Fund recognized this action as a significant contribution to conservation efforts, but there has been criticism of its implementation, or rather the lack thereof, in some places.¹⁰⁵One of China’s environmental initiatives is the creation of Green Schools; there are more than 40,000 Green Schools in China. The purpose of these schools is to offer environmentally oriented education to elementary and middle school students, instilling them with environmental awareness. There are also some environmental protection vocational colleges that prepare students to enter the environmental industry.¹⁰⁶The efforts to educate the public do not stop at schools, however; the Chinese government organizes many programs to spread public awareness of environmental issues. Since 2005, the Ministry of Environmental Protection has hosted an annual World Environment Day, involving celebrities and officials in the celebrations to encourage public participation in responding to environmental issues. Some of the themes of World Environment Day include: “Everyone participates in Building a Green Planet”, “An Ecology-Safe

¹⁰⁴(Wang 2012a: 78)

¹⁰⁵(WWF 2003)

¹⁰⁶(Wang 2012a: 85-88)

and Environment-Friendly Society”, “A Pollution-Reduced and Environment-friendly Society”, “Reduce Pollution-Take Action”, “Low Emission – Green Life”, “Ecological Civilization Construction, Sharing a Green Future”, “Green Economy: Does it include you?”¹⁰⁷ China also has an annual ‘Energy-Saving Publicity Week’ that focuses on encouraging energy conservation.¹⁰⁸ National Tree Planting Day on March 12th draws a lot of media attention as millions of trees are planted across China. In 2006, the China Meteorological Administration began a ‘Public Education on Climate Change Using TV’ project, producing more than 100 episodes to educate the public about the science of climate change. They also produced programs for elementary and middle school students. The Chinese government, including the China Energy Network, has been vocal about the effects of climate change, and uses film and media to educate the public about climate change and advocate for low-carbon lifestyles.¹⁰⁹ There are many education efforts in China, but due to the large number of people and the lack of reliable education in rural areas, the public at large is still not very aware of environmental and energy issues.

Energy Conservation

Prices are probably the most important aspect affecting the use of particular energy resources. China has cheap and highly regulated energy prices that the government has subsidized, keeping them artificially low, in order to encourage economic growth. This policy has not encouraged energy efficiency, but rather energy-intensive projects that boost development.¹¹⁰ The National Energy Administration (NEA) works with the National Development and Reform

¹⁰⁷(Wang 2012a: 79)

¹⁰⁸(Wang 2012b: 82)

¹⁰⁹(Wang 2012b: 89)

¹¹⁰(Ma 2013)

Commission (NDRC) to set energy prices, and they formed the National Energy Commission in 2010 to wade through and consolidate the many energy policies passed by various agencies under the State Council,¹¹¹ which helped to more easily establish pricing regulations. The Chinese government has prioritized energy conservation, since eliminating waste enhances existing energy resources and only requires adjusting infrastructure or building infrastructure with new efficiency standards. According to the NDRC, “to attain sustainable economic and social development, [China] must take the path of conserving resources.”¹¹² Energy efficiency improvements have been significant since efficiency requirements were given new significance and governmental pressure. Due to increased efficiency, per capita energy consumption dropped by 20.27% from 2005 to 2010. The growth rate of energy consumption is higher than that of energy efficiency, however, so while China can measure the amount of coal energy “saved” by increased efficiency, total energy consumption has dramatically increased, including the amount of coal and oil used.¹¹³

In 2007 the NDRC stated that China would promote energy conservation by targeting resource consumption and pollution in industry, developing new technologies to reduce energy consumption, replacing old, inefficient machinery and appliances with new ones, implementing special projects for energy-saving, reaching out to both urban and rural energy users, passing more laws and tax policies regarding resource use and prices to encourage conservation, and expanding public education efforts through schools and the media.¹¹⁴ The China Energy Conservation Association contributed to creating the 2004 Medium and Long-term Energy Conservation Plan,

¹¹¹(EIA 2014: 5)

¹¹²(NDRC 2007b: 14)

¹¹³(Wang 2012b: 35-42)

¹¹⁴(NDRC 2007b: 15-19)

which outlines the goals that shape specific laws and programs. By 2010 there were more than 2,300 service companies receiving government funding that work with businesses and industries to help them conserve energy.¹¹⁵ According to government reports, mandatory energy efficiency standards are almost always observed in new building projects, and projects to encourage higher energy efficiency have been put in place nationwide.¹¹⁶ In 2007 the ‘Civil Action for Energy Saving by 20 Percent’ program began, involving fifty environmental organizations, including the All-China Environment Federation, Global Village Beijing, and China International Non-Governmental Organizations, which ran programs encouraging people to live low-energy consumption lifestyles.¹¹⁷ From 2006 to 2010, the Chinese government focused on ten broad conservation projects that involved thousands of specific projects, including upgrading industrial coal-fired kilns, petroleum conservation and substitution, energy conservation in buildings and government agencies, green lighting, and energy conservation monitoring.¹¹⁸

The government has passed many mandatory national standards for efficiency, and labels appliances such as refrigerators, washing machines, air conditioners, computers, electric fans, printers, and copiers with their energy efficiency information to promoting more efficient products. The government has also subsidized the production of “some 360 million high-efficiency illumination products, 30 million high-efficiency air conditioners, and one million energy-efficient motor vehicles.”¹¹⁹ In 2010, these policies led to high-efficiency illumination products accounting for 67% of illumination products sold, and high-efficiency air-

¹¹⁵(Wang 2012b: 45)

¹¹⁶(Wang 2012b: 36)

¹¹⁷(Wang 2012b: 86)

¹¹⁸(Wang 2012b, 32)

¹¹⁹(Wang 2012b: 43)

conditioners accounting for 70% of air conditioners sold. On October 1st 2012 the government began the ban on the import and sale of incandescent bulbs, instead promoting high-efficiency lighting technology.¹²⁰ These conservations and efficiency efforts have had positive impacts on China's development, and efficiency is set to continue improving as China strives to make its energy resources go further.

Clean Energy Introduction

China has made significant strides in its clean energy production, an industry that has developed with China's characteristic speed. Although China's ravenous consumption of fossil fuels far out shadows its investments in clean energy, it has made some notable advances and is already one of the world's top producers of and the world's biggest investor in renewable energy.¹²¹ The Renewable Energy Law (2005) and the Medium- and Long-term Program for the Development of Renewable Energy (2007) are the most significant pieces of legislation relating to clean energy and the promotion of a sustainable economy. The latter describes the purpose of advancing renewable energy as: "establishing a resource-saving, environmentally-friendly society, and realizing sustainable development."¹²²

Clean energy provided almost 12% of China's total energy in 2011, and the government aims for it to produce 15% by 2020.¹²³ Wind, solar, and biomass energy combined currently make up less than 4% of total energy, with government plans to

¹²⁰(ibid)

¹²¹(Shen 2014)

¹²²(NDRC 2007a: 4)

¹²³(EIA 2014: 34)

increase their percentage to 8% by 2020, when coal will still dominate the energy market.¹²⁴The potential of clean energy is only limited by the infrastructure; Greenpeace's Liu Shuang believes that 50% of China's energy needs could be met by renewable sources, with 37% of that provided by wind and solar power.¹²⁵The 2012 investments of 65 billion USD in renewable energy projects were 20% higher than the 2011 investments. The current Five-Year Plan stipulates that 473 billion USD will be spent on investments in clean energy between 2011 and 2015, and that the development of clean energy infrastructure will be encouraged through additional economic incentives.¹²⁶One of China's goals is to improve the quality of life in rural areas by increasing access to clean energy resources, especially household biomass and solar technologies, but also small wind-power and hydropower stations.¹²⁷The main barrier, by far, to advancing clean energy is the cost: wind energy is still 20-40% more expensive than coal energy, and solar power is at least twice the cost of coal power. The government subsidizes clean energy by reimbursing grid operators for the losses sustained when they buy renewable energy instead of coal energy, and makes bank loans with very low interest rates available for the development of clean energy. However, the government does not help with building power lines to renewable energy producers like wind turbines. A 2009 law, passed to address this barrier, states that "a grid operator that does not connect a renewable energy operation to the grid must pay that operation twice the value of the electricity that cannot be distributed."¹²⁸Clean energy has increased rapidly because the

¹²⁴(Bradsher 2010)

¹²⁵(Biello 2008)

¹²⁶(EIA 2014: 34)

¹²⁷(NDRC 2007b: 20-25)

¹²⁸(Bradsher 2010)

government is spending huge amount on incentives, motivating power companies to buy the competitively priced alternative energy and production equipment.

The renewable energy industry is a huge job creator, with more than one million jobs and adding 100,000 a year. China is becoming the leading energy-equipment exporter, with large-scale production similar to its other industries. In 2010 China's high-tech manufacturing industry moved up to second in the world, with an output double that of its 2005 level.¹²⁹ In 2009 China's wind turbine market became the largest in the world.¹³⁰ China is also the world's biggest producer of solar panels, hosting about 80% of the world's solar panel manufacturing, most of which, nearly 99%, are exported to Europe and the United States.¹³¹ Producing the technology is advantageous for domestic use, even though the industry primarily focuses on exports. The Chinese government is expanding clean energy to address environmental issues and energy availability and security, but it needs to push its use of renewable resources much further and decrease the amount of coal and oil used, not just the percentage, if it hopes to see real change.

Wind and Solar

China's commitment to increasing its energy production while decreasing environmental and health damages has led it to develop more wind and solar energy. China is currently the world leader in wind energy production and aims to increase wind capacity to at least 100 GW by 2015 and 200 GW by 2020.¹³² In 2013, China harnessed 92 GW from wind resources, according to the China Wind Energy Association. Wind power is a new industry in China that has developed very rapidly,

¹²⁹(Wang 2012b: 32)

¹³⁰(Bradsher 2010)

¹³¹(Woody 2013)

¹³²(EIA 2014: 35)

from 546,900 KW in 2003 to 47.84 million KW in 2011.¹³³ Since 2005, when 1.26 GW were produced, the wind power capacity has almost doubled every year.¹³⁴ When the 2010 goals were reached 3 years early, the government doubled the previous goal, demonstrating its commitment to growing the wind power.¹³⁵ The 2011 levels were 64% higher than the 2010 levels, making China the world's largest wind energy provider.¹³⁶ The NDRC projects China's total potential for exploitable wind resources, the largest in the world, is about 1,000 GW, which could be reached by 2050 if the pace of development keeps up.¹³⁷ Despite these rapid developments, the 2020 estimates have wind power providing less than 3% of total electricity. The United States currently gets 3.46% of its electricity from wind power, and Denmark, with the highest worldwide percentage, has more than 30% of its electricity supplied by the wind.¹³⁸ The provinces with the most abundant wind resources are along the east coast, such as Hebei, Fujian, Jiangsu, Liaoning, Shandong, Jilin, Guangdong, and Shandong, as well as Inner Mongolia and Xinjiang.¹³⁹ Three-fourths of China's wind resources are offshore. Typhoons pose a threat to the offshore wind farms in the south, especially when they are not well built.¹⁴⁰ Developing energy grids quickly enough to connect all the energy generated has also been a problem, resulting in losing as much as a fourth of the energy generated. Wind energy is very clean, renewable, and sustainable, the Chinese government should continue its development with increased focus.

¹³³(Wang 2012b, 48-49)

¹³⁴(NDRC 2007a: 3)

¹³⁵(Biello 2008)

¹³⁶(EIA 2014: 35)

¹³⁷(NDRC 2007a: 1)

¹³⁸(Biello 2008)

¹³⁹(NDRC 2007a: 8)

¹⁴⁰(Biello 2008)

China's investments in solar energy have resulted in 3GW produced in 2012, with hopes to increase production to 35GW by the end of 2015.¹⁴¹ China has only recently begun to develop large solar panel fields; the main source of solar energy comes from solar-powered heaters in mostly rural, but also urban, areas.¹⁴² In 2011, China had 217 million square meters of solar-power heaters,¹⁴³ and that number has continued to increase as they become a staple of a family home or apartment, since it is as or more cheap than the alternatives. According to the Medium- and Long-term Program for Renewable Energy Development "two-thirds of China's territory enjoys over 2,200 hours of sunshine annually...these regions have favorable conditions for solar energy development, with extremely favorable conditions found in West China."¹⁴⁴ In September 2009, plans were announced to build the world's largest photovoltaic power plant on 16,000 acres in Inner Mongolia that would produce enough electricity to power 3 million homes. This would be a great achievement, but the government has still not given the go ahead.¹⁴⁵ In 2012, Premier Wen Jiabao stated that China will focus on expanding nuclear and hydroelectric power, while ending the "blind expansion" into solar and wind energy. Wen also reiterated the government's commitment to developing shale gas.¹⁴⁶ This was not a good development in China's pursuit of renewable resources; while hydroelectric and nuclear power are worth developing, they are subject to a lot of criticism and numerous environmental drawbacks that wind and solar power have to a much lesser degree or not at all. China does still plan to expand its wind and solar production capacities, but the focus has,

¹⁴¹(EIA 2014: 35)

¹⁴²(NDRC 2007a: 3)

¹⁴³(Wang 2012b: 50)

¹⁴⁴(NDRC 2007a: 2)

¹⁴⁵(Woody 2013)

¹⁴⁶(Green 2012)

sadly, shifted away from these truly renewable resources that are viewed as more expensive and unstable than hydro or nuclear.

Hydroelectric

China is the world's largest hydroelectric power producer, with more than half of the world's large dams within its borders.¹⁴⁷ Hydroelectricity is often hailed as the most cost-effective, cleanest option for generating electricity in China, and is one of China's fastest growing energy industries. China has abundant water resources, and has focused extensively on developing dams, despite the resulting environmental concerns and human displacement.¹⁴⁸ From the 1950s to the 1970s, about 87,000 reservoirs were built across China, often poorly, as part of the "Harnessing Water" campaign,¹⁴⁹ and the push for hydropower did not stop there. All of China's major rivers are dammed, and the world's largest hydropower project, the Three Gorges Dam, was completed in 2012. The government is currently focusing on developing the Lancang, Dadu, and Minjiang Rivers, and officially states its commitment to ecological awareness.¹⁵⁰

After the 2009 Copenhagen Climate conference, China pledged to boost its hydropower by 90% by 2020, investing 147 billion USD between 2010 and 2015.¹⁵¹ China's approximately 85,000 dams accounted for 15% of total electricity generation in 2011,¹⁵² which supplied 6.3% of total energy consumption.¹⁵³ According to the 2003 Nationwide Hydropower Resource Assessment, China's "total potential

¹⁴⁷(Bosshard 2009)

¹⁴⁸(EIA 2014: 34)

¹⁴⁹(Fish 2013)

¹⁵⁰(Wang 2012a: 54)

¹⁵¹(Qi 2010)

¹⁵²(EIA 2014: 34)

¹⁵³(Wang 2012b: 47)

capacity of economically feasible hydropower is 400 GW”¹⁵⁴; in 2011, 230 gigawatts of hydropower had been developed.¹⁵⁵ By 2020, the Chinese government plans on hydropower producing at least 300GW of energy.¹⁵⁶ Yan Zhiyong, director of the Planning and Design Institute of the Ministry of Water Resources said that hydropower “will have to account for 60 percent of China's non-fossil energy by 2020 if the country is to meet its target”¹⁵⁷ of 15% of total energy consumption provided by clean energy. Professor Lai Hun Suen, a Chongqing University professor of sustainable development and a municipal government official, thinks that within 30 to 50 years hydropower will replace coal to become the main source of energy.¹⁵⁸ In 2013 the central government and local governments announced plans to build 40,900 new small-sized dams before the end of 2015.¹⁵⁹

China’s investments in hydropower are impressive, but the environmental community is not celebrating – in fact there has been an outpouring of criticism against the ecological harm and cost, both immediate and long-term, of dams, including the increased risk of earthquakes, landslide, and dam collapse. According to International Rivers, between 40 and 80 million people have been displaced by dam construction worldwide, with majority of them in China and India. This displacement, often forced, introduces a whole host of social and economic issues. The world’s deadliest energy accident and deadliest structural failure was the August 1975 collapse of a cascade of 64 dams in Henan province, including the Banqiao and Shimantan Dams, that killed 171,000 people and displaced 11 million. Caused by a typhoon and poor engineering, this disaster should not be forgotten. The serious

¹⁵⁴(NDRC 2007a: 1)

¹⁵⁵(Wang 2012b: 47)

¹⁵⁶(NDRC 2007a: 6)

¹⁵⁷ (Qi 2010)

¹⁵⁸(Biello 2008)

¹⁵⁹(Fish 2013)

safety concerns that dams present are a real consideration. However, modern dam technology, engineering, and materials have improved considerably since the 1950s, when most of the dams in question were built, and, even though the central government has identified more than 40,000 dams that need repairs, few experts are worried about a disaster as serious as the Banqiao Dam collapse happening again.¹⁶⁰ The sheer quantity of dams demanding constant repairs and investments, combined with the pressures to build more dams to meet the 2015 and 2020 deadlines, leaves some worried about the quality of the projects. The director of the National Energy Administration, Zhang Guobao, said that new dam projects are developed under more strict approval procedures, pay more attention to environmental protection, and are more concerned about the rights of relocated communities and land resources.¹⁶¹ It is difficult to condemn China's eager pursuit of hydropower, since it is an alternative to the possibly more detrimental use of coal, but it is worth noting both its positive and negative aspects.

Nuclear

Nuclear energy is possibly the most controversial form of new energy. Its inclusion in the "renewable resources" classification is debated; the International Energy Administration does not define nuclear power as renewable, since it is based on using nonrenewable uranium resources that are mined from the earth, but nuclear power certainly has a lot of potential for supplying low-carbon energy. As the technology for nuclear energy becomes safer, lowering the risk of meltdown and proliferation, China is embracing it as a leading source of alternative energy, guided

¹⁶⁰(Fish 2013)

¹⁶¹ (Qi 2010)

by the Mid- and Long-term Plan for the Development of Nuclear Energy.¹⁶² China currently has 20 nuclear reactors in operation, 28 reactors under construction, and more in the planning stages. The United States, for comparison, has more than 100 nuclear power plants. In 2013 China's nuclear capacity was 14.7 GW, and the nuclear plants under construction were projected to supply 35 GW, almost half of the global nuclear capacity.¹⁶³ By 2020, China intends to triple its nuclear energy production capacity to 58 GW.¹⁶⁴

The safety concerns that nuclear power plants present are the reason they are not fully embraced as a great source of energy. After the 2011 Fukushima disaster in Japan, China temporarily halted approving new nuclear plants in order to check the safety of the plans.¹⁶⁵ No major nuclear accidents or failures in nuclear security have ever happened in China, so there have not yet been any negative public health or environmental impacts.¹⁶⁶ Since 2003, China has focused on the safety of nuclear power plants, adhering to the international safety standards and passing laws such as the Law of the People's Republic of China on Prevention and Control of Radioactive Pollution, Regulation on the Safety and Protection of Radioisotopes and Radiation Devices, Regulation on the Supervision and Management of Civil Nuclear Safety Equipment, Regulation on the Administration of Transport Safety of Radioactive Articles, and Regulation on the Safety Management of Radioactive Waste. There is a national repository for radioactive waste that keeps the waste contained, and the average irradiation dosage of workers in the industry is lower than the international average.¹⁶⁷ Besides the risk of meltdown, the other major problems with nuclear

¹⁶²(Wang 2012b: 47)

¹⁶³(EIA 2014: 34)

¹⁶⁴(Shen 2014)

¹⁶⁵ (ibid)

¹⁶⁶(Wang 2012a: 14)

¹⁶⁷(Wang 2012a: 11-15)

energy are disposing of the radioactive waste (which poses huge potential threats to the environment), the large amount of water used by nuclear power plants, and the risk of radioactive or chemical pollutants in water runoff. If these problems are addressed, nuclear energy will be great source of power while uranium supplies are abundant.

Biogas

China has been a proponent of biogas since its first anaerobic digester was built in 1921. The government promoted biogas in earnest in the 1950s, as it provides rural people with a good source of energy, safe organic fertilizer, and cleaner communities. In addition to residential use, biogas can also be used to create electricity and bio-natural gas (BNG) that can be used as fuel for vehicles. China is a world leader in individual household digesters,¹⁶⁸ but the use of biogas is still relatively small.¹⁶⁹ There are more than 40.68 million household digesters in rural China,¹⁷⁰ up from 18 million in 2005,¹⁷¹ which provide biogas mainly used for cooking to more than 160 million people.¹⁷² China currently has 86,370 small and medium-scale biogas plants and 5,600 large-scale biogas projects, which all together supply 1.54 million additional households with gas and generate 1.2% of China's total energy use.¹⁷³ In 2011 the total biomass capacity in China was 8 GW¹⁷⁴; by the end of 2015, China aims to produce 13 GW, have 50 million household biogas digesters, and 7,000

¹⁶⁸(Li Xiujin 2013: 4-39)

¹⁶⁹(EIA 2014: 35)

¹⁷⁰(Li Jingming 2014: 6)

¹⁷¹(NDRC 2007a: 3)

¹⁷²(Li Xiujin 2013: 8)

¹⁷³(Li Jingming 2014: 7)

¹⁷⁴(EIA 2014: 35)

large-scale digesters. By 2020, China's target is to reach 30 GW, have 80 million household biogas digesters, and 8,000 large-scale biogas projects.¹⁷⁵¹⁷⁶

In 2013 Dr. Li Xiujin, a professor of environmental engineering at Beijing University of Chemical Technology, estimated that China's total biogas potential is more than double its current natural gas demand.¹⁷⁷ Biomass resources include agricultural waste, organic waste, animal manure, municipal wastewater, and municipal solid waste, all of which are abundant in China's large rural, agricultural areas, but less so in urban areas.¹⁷⁸ From 2003-2012, China invested around 13 billion USD to expand biogas development, with the central government providing around 4.5 billion USD and the rest provided by local governments and farmers themselves.¹⁷⁹ More financial support is provided for the agricultural projects than for urban ones, since biogas is usually viewed as a method of providing gas to individual rural households, but if the government hopes to expand biogas' electricity generation it should focus on developing more large projects with urban bases whose electricity production is subsidized.¹⁸⁰ The Sino-German Biogas Research and Development Center has played a helpful role in the development of China's biogas, and China has extended the invitation for more international involvement in its biogas industry.¹⁸¹ Biogas technology is wonderful infrastructure for rural areas, because it simultaneously makes liquid fuel from waste, removing that waste from the environment, limits deforestation by replacing wood with gas, and creates excellent

¹⁷⁵(NDRC 2007a: 6)

¹⁷⁶(Li Jingming 2014: 11-12)

¹⁷⁷(Li Xiujin 2013: 30)

¹⁷⁸(NDRC 2007a: 1)

¹⁷⁹(Li Jingming 2014: 5)

¹⁸⁰(Li Xiujin 2013: 38)

¹⁸¹(Li Jingming 2014: 17)

fertilizer. It has become a staple of environmental development in rural communities, representing the ideal of using existing resources to create energy.¹⁸²

Conclusion

China's energy demands are shaking the world. The government's goal to produce at least 15% of its energy from renewable energy sources by 2020 is admirable, but, as Thomas Friedman, Pulitzer price winning journalist and author, said of southern China, "the renewable energy here literally a drop in the bucket."¹⁸³ China is already the world's largest energy producer and consumer in the world, and the electricity demand will more than double by 2040, with total coal consumption doubling as well (see Figure 3). China's energy demand will not keep rising forever; its population growth and energy demand are expected to level-off by 2040, allowing for less frenzied development of energy production.¹⁸⁴ By the time China's energy demand levels-off it will be enormous – China will continue to shape global politics and impact the environment through its pursuit of resources. The wind and solar energy production has increased significantly in recent years, but China has shifted its focus away from these renewable resources, and instead chosen to develop hydroelectric and nuclear power with renewed vigor. These sources have a lot of potential to decrease China's hazardous reliance on coal and oil, but introduce many new environmental problems. Clean energy is the only sustainable way to power our countries, so although China is still a developing nation it should be prioritizing wind and solar energy as the best ways to produce energy domestically, combat climate change, improve public health, and work towards a future with less environmental damage and less international conflict.

¹⁸²(NDRC 2007a: 3)

¹⁸³(Friedman 2008)

¹⁸⁴(ExxonMobile 2012: 23-30)

Case Study: Lijiang, Yunnan

Lijiang is a prefecture-level city in northwest Yunnan province, southern China. With a population of 1.26 million people, it is considered a small city by Chinese standards. The population is diverse, made up of twelve ethnic groups and two autonomous counties. Lijiang was named a UNESCO World Heritage site in 1997, refocusing the city's economy to encourage the tourist industry. In 2013 nearly 20 million tourists came to Lijiang, about 95% of which were domestic, bringing in nearly 30 billion RMB. In the last ten years, the government has increasingly focused on environmental issues, in addition to economic growth, which has led to more cooperation with NGOs working on environmental and energy issues.¹⁸⁵ When planning out its energy use, the city combines tourism, economic growth, and environmental concerns, which has led to a focus on expanding the clean energy base.¹⁸⁶ Lijiang's coal industry is declining: government officials say that coal mined in Lijiang is shipped to other areas in Yunnan, not burned in Lijiang, so that the booming tourist industry is not affected by smog or pollution. For the same reason, Lijiang does not have any big factories, instead focusing on developing tourism, the service industry, and agriculture. Lijiang is still dependent on coal energy, which providing 62.96% of total energy in 2010. While the goal to decrease the percentage to 40% by 2015 is admirable, the quantity of coal used for energy will almost double, representative of the trend in China as a whole. Lijiang plans to eventually eliminate its use of coal energy, but that goal will not be attained in the near future. Oil supplied 12.1% of Lijiang's energy in 2010, and the city government intends to increase that percentage to 14.1% in 2015, all of which will be imported from other parts of China

¹⁸⁵ (He 2014)

¹⁸⁶ (Li Guowu 2014)

or internationally. Natural gas made up 0.22% of total energy use in 2010, and Lijiang plans for it to supply 0.9% in 2015. Lijiang currently has one wind power station and no solar fields, but the use of personal solar water heaters is very high, at more than 95% in urban areas and 70% in rural areas. 30-40% of public streetlights are powered by solar panels, sometimes accompanied by small wind turbines. Wind and solar power supplied 0.47% of total energy in 2010, and Lijiang plans on it supplying only 2% in 2015. Solar water heaters enjoy government subsidies in rural areas, but most urban dwellers purchase them individually, as the cost is so low.¹⁸⁷ Lijiang receives 2,530 hours of sunshine annually; its high-altitude and low-latitude location make it well suited for solar power. The main barrier for developing solar energy is the cost; Lijiang plans installing more solar panels as the technology becomes more accessible. In April 2013, city officials announced plans to develop a 300MW solar park starting in 2015 by partnering with Clenergy and CGN Solar, two of the biggest solar providers in China.¹⁸⁸ Hopefully Lijiang will pursue the development of solar energy fields to generate electricity, as its location is ideal for solar power production. Since Lijiang is on an earthquake fault zone the risk of building a nuclear power station is too high to entertain, so while government officials think it is a good source of energy, Lijiang will not host a nuclear power plant.

In 2010 Lijiang got 19.97% of its total energy from hydropower, and by 2015 plans to have almost quadrupled the amount of energy produced, increasing hydropower's contribution to 40% of the total, equal to Lijiang's 2015 percentage of energy from coal. Lijiang's six dams and 100 small hydropower stations are all on the Jinsha River, a main tributary to the Yangtze. The six dams are the Jinanqiao, Liyuan, Ahai, Longkaikou, Ludila and Guanyinyan dams. Two dams

¹⁸⁷(Li Jianchang 2014)

¹⁸⁸(Clenergy 2013)

are currently in planning are the Longpan and Liangjiaren dams. Lijiang used to have frequent power outages, but hydropower has stabilized and localized the power sources, decreasing power outages. Dam construction usually requires the displacement of rural people, and Lijiang is no exception. Including the two new dams in planning, about 100,000 people have had to relocate.¹⁸⁹Lijiang has abundant water resources, which has allowed it to develop hydroelectricity more rapidly than other cities. The National Development and Reform Committee (NDRC), says that 70% of total hydropower resources are located in southwest China.¹⁹⁰ Accordingly, southwest China has witnessed massive dam construction, and hundreds of dams are currently being planned.¹⁹¹

About 60% of households in rural Lijiang use biogas digesters to generate gas for cooking and lighting.¹⁹²The government usually supplies sufficient funding and subsidies for biogas development in rural Yunnan, since they believe that it helps rural communities by providing gas, removing animal dung from the environment, protecting forests, supplying great fertilizer, and reducing carbon emissions.¹⁹³After heavy flooding in 1998, the government issued a logging ban, which led to a big conflict as most of rural Yunnan relied on firewood as their main source of energy. The Ministry of Agriculture and the Ministry of Forestry began to provide subsidies for biogas technology, working with farmers to install digesters, resulting in their widespread use today. Interestingly, as the tourist industry has developed in Lijiang rural people have become less interested in using the gas from their biogas digesters, since electricity is more convenient and does not require shoveling animal

¹⁸⁹(Li Jianchang 2014)

¹⁹⁰(NDRC 2007a: 1)

¹⁹¹(Fish 2013)

¹⁹²(Li Jianchang 2014)

¹⁹³(Chen 2014)

dung.¹⁹⁴This situation exemplifies why household biogas digesters are great for rural areas but become obsolete as areas modernize. The government should pursue large biogas projects, utilizing the abundant biogas resources to satisfy the rising demand for electricity in modernizing areas. Mr. Chen Yongsong founded and runs the Green Education Center (GEC) and Yunnan EcoNetwork (YEN) in LaShiHai Village, Lijiang. Chen says that the government, while providing the biogas digesters, does not do enough to educate the people about how to use the digester or the importance and benefits of using it. He and his volunteers have run programs all across Yunnan, educating rural people about how and why to use biogas.

The U.S. Nature Conservancy has a strong presence all across China, including a branch in Lijiang. The Nature Conservancy Lijiang is fully the responsibility of Chinese citizens, and mostly focuses on preserving forests and endangered animals in Yunnan.¹⁹⁵ Like the Ministry of Forestry, the Nature Conservancy focused on spreading biogas technology in an effort to stop over-logging. The Nature Conservancy has recently shifted its focus away from biogas, but its alternative energy projects in the past were responsible for installing more than 14,000 biogas digesters, solar water heaters, and energy efficient stoves in 420 villages in rural Yunnan.¹⁹⁶ The Nature Conservancy cooperates with the government, following regular NGO protocol, and received one third of the funding for clean energy technology from local governments.¹⁹⁷ The Nature Conservancy provided another third, and the individual family put up the last third themselves. The Nature Conservancy believes that the family should participate, either financially or through labor, with the installation of their biogas digester or solar water heater, since it gives

¹⁹⁴(Chen 2014)

¹⁹⁵(Liu 2014)

¹⁹⁶(Yuan 2009)

¹⁹⁷(Liu 2014)

them a sense of ownership of the technology rather than viewing it as something given to them by others. The Nature Conservancy also runs education programs about environmental issues and clean energy resources, working with the government's environmental education programs.¹⁹⁸

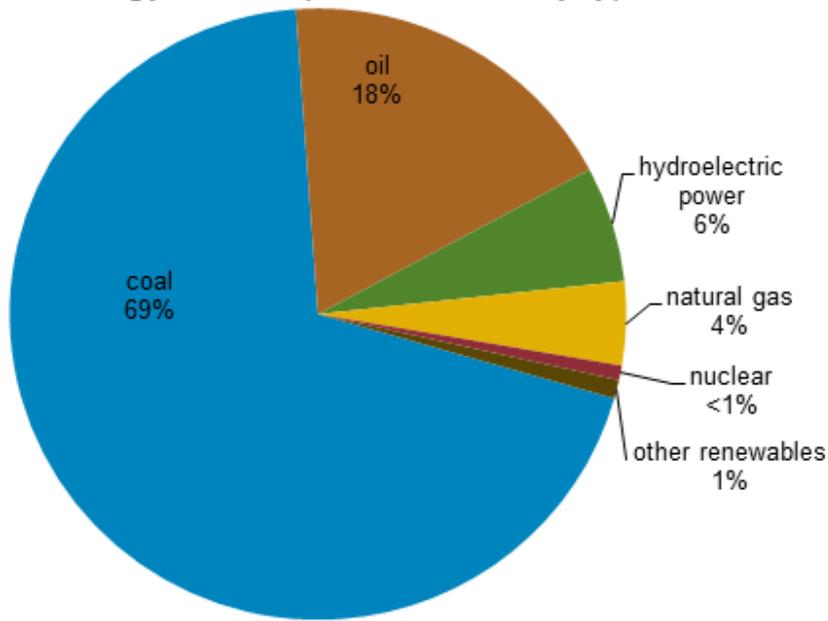
Lijiang's use of clean energy is more developed than many cities in China, due to its abundant hydropower resources. If the city focuses on developing its wind and solar energy, it could dramatically reduce its coal and oil use to become a leader of clean energy in both China and the world.

Figures

Figure 1

¹⁹⁸(He 2014)

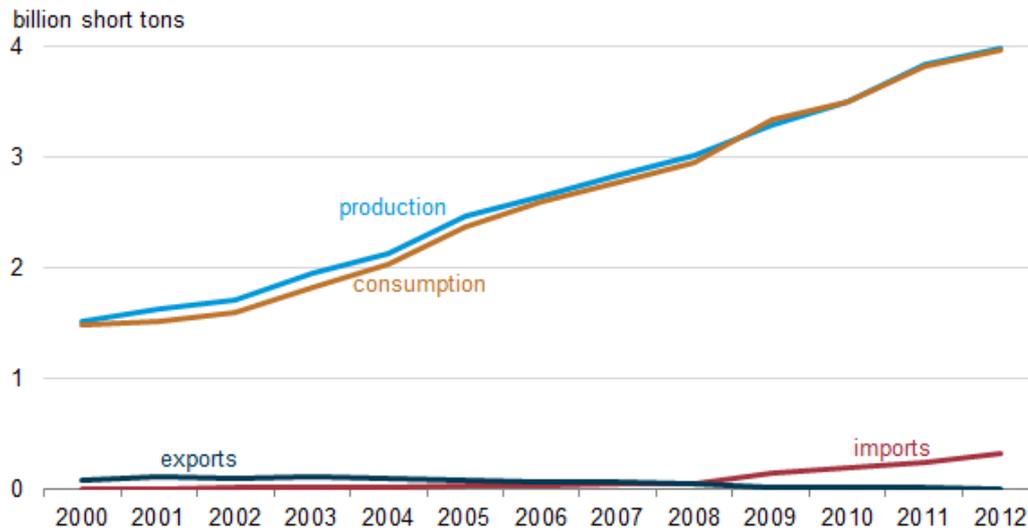
Total energy consumption in China by type, 2011



 Note: Numbers may not add due to rounding.
Source: U.S. Energy Information Administration *International Energy Statistics*.

Figure 2

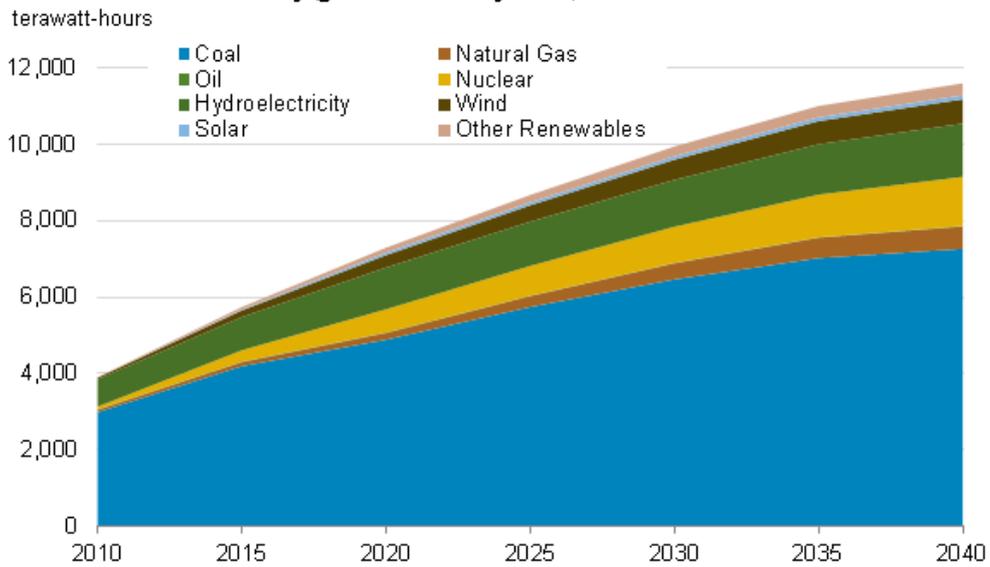
China's coal production and consumption, 2000-2012



 Note: Production and imports exceed consumption and exports as a result of coal inventory build.
Sources: U.S. Energy Information Administration, *International Energy Statistics*, FACTS Global Energy.

Figure 3

China's net electricity generation by fuel, 2010-2040



eia Source: U.S. Energy Information Administration, *International Energy Outlook*, 2013.

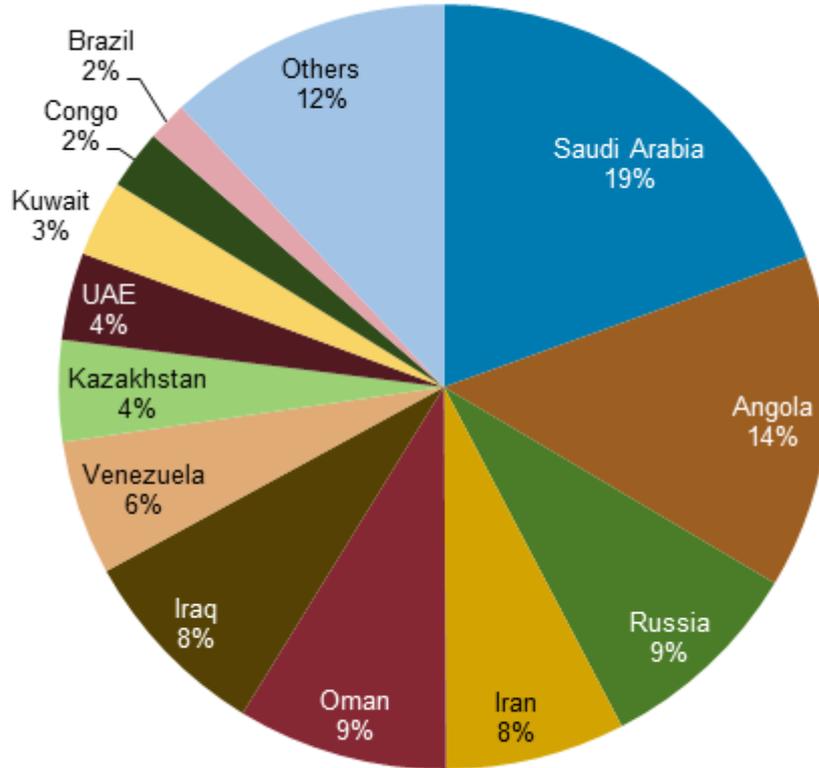
Figure 4
Map of China's Largest Oil Fields



Source: U.S. Energy Information Agency, *International Energy Outlook*, 2013

Figure 5

China's crude oil imports by source, 2013



 Source: FACTS Global Energy, Global Trade Information Services.

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- ISP: Spring 2008 “Renewable Energy and Agriculture: Promoting Biogas in the Rural Communities of the Lashihai Wetland Nature Reserve” by Amanda Lee
- ISP: Fall 2007 Environmental Education in Kunming by Ian Jensen
- ISP: Spring 2007 Environmental Concerns with Hydroelectricity in China by Monty McGee

Appendix A: Methods

When I chose to study clean energy in China for my Independent Study Project, I anticipated relying heavily on books and articles, which was indeed the case. I did spend a very productive week and a half in Lijiang, interviewing informants about energy issues in order to develop a strong case study to supplement my paper. I met with Mr. Chen Yongsong (陈永松) at his Lijiang Green Education Center (GEC) in LaShiHai Village, Lijiang, where we discussed the development of bioenergy, modernization, and Lijiang's clean energy. That afternoon I met with a very helpful employee at the Lijiang Energy Bureau, Li Jianchang (李建昌), accompanied by Zhou Lan(周岚), an employee from the Lijiang Foreign Relations Bureau. That meeting formed the bulk of my case study, as it provided a great understanding of Lijiang's energy situation. I also met with He LushanJizhen (和继珍), an employee at the Lijiang branch of the U.S. Nature Conservancy from 2002 to 2013, at her family's restaurant in Yuhu, a village at the base of Jade Dragon Snow Mountain. Her perspective on working with an NGO in Lijiang was very interesting. I also had an email correspondence with the current project manager at the Lijiang branch of the U.S. Nature Conservancy, Liu Hui(刘辉). Living in Lijiang and researching for the case study was a great experience, but the bulk of my paper, analyzing China's energy demands and their implications, required extensive research. I am very grateful to have had the opportunity to devote myself to this topic for a full month, as I believe China's energy demands will have a huge impact on the world.

Appendix B: Recommendations for Future Study

The topic of clean energy is both very broad and very important, so I highly recommend future SIT students continue this study. It is crucial that the ISP is of interest to the student, so if one aspect of China's uses of renewable resources stands out to you, pursue it! I wanted to get a broad overview of China's energy situation, so almost all of the topics covered in my paper could use a more in-depth analysis. Studying just Yunnan's solar and wind energy usage would be a great paper, or just the hydro energy, since there are tons of dams here. It would be fascinating to see how people use coal in their daily lives, and compare that data with the official laws and numbers. Although Yunnan does not have any nuclear power plants, studying nuclear power in China would be a great paper, since it is such a focus right now. One could study the impact of pollution in Yunnan, or the effects of biogas digesters on forests. A student could do a more in-depth case study of a city's energy use, and poll the citizens to gauge their feelings about energy sources. The possibilities are limitless!

Appendix C: Laws

There are hundreds of relevant Chinese laws regarding energy and environmental protection that add to or reflect the goals laid out in the Five-Year Plans. The following is a list of laws and administrative degrees that have been recently passed, amended, or issued regarding environmental protection, in addition to the Environmental Protection Law of the People's Republic of China:

the Prevention of Radioactive Pollution Law, the Environmental Impact Assessment Law, the Circular Economy Promotion Law, the Prevention and Control of Environmental Pollution by Solid Wastes Law, the Water Pollution Prevention and Control Law (Wang 2012a, 3-4), The Vehicle and Vessel Tax Law (rewards saving energy and reducing emission) (Wang 2012a, 42), a Ministry of Environmental Protection Law that banned 300 kinds of “double high” (high pollution and high environmental risk) products from being produced (Wang 2012a, 42), Major Project of Water Pollution Control and Management, Major Project of Development of New GM Crops (Wang 2012a, 60), the Best Feasible Technical Guide for Pollution Prevention, Administrative Measures for National Environmental Protection Technology Assessment and Demonstration, National Category of Advanced Pollution Prevention Technology (Wang 2012a, 63), the Regulations on the Administration of Ozone Depleting Substances (Wang 2012a 100)

The following is a list of laws and administrative decrees regarding clean energy or energy efficiency that have been recently passed or issued:

Green Credit Guidelines issued by the Ministry of Environmental Protection and the China Banking Regulatory Commission (Wang 2012a, 41), the Measures for the Administration of Desulphurization Pricing of Electricity and Operation of Desulphurization Facilities of Coal-Fired Generating Units issued by the Ministry of Environmental Protection and the National Development and Reform Commission (NDRC), Measures for Energy Saving and Environmental Protection Generation Dispatching (Wang 2012a, 43), the National Middle & Long-term Science and Technology Development Plan (2006-2020) has projects like the Major Project of Large Advanced Pressurized Water Reactors and High Temperature Gas-coolant Reactor Nuclear Power Stations (Wang 2012a, 60), the Plan on Establishing National Management System on Environmental Technology, issued Report on Environmental Protection Technology Development and Category of State Encouraging Development on Environmental Protection Technology (Wang 2012a, 63), the Decision of Accelerating the Fostering and Development of Strategic and Newly Emerging Industries released by the State Council (Wang 2012b, 31), the Medium and Long-term Energy Saving Plan, the Mid- and Long-term Plan for the Development of Renewable Energy, the Mid- and Long-term Plan for the Development of Nuclear Energy, the 11th Five-Year Plan for Renewable Energy Development, Decision on Strengthening Energy Conservation Work, Opinions on Accelerating the Development of the Circular Economy, The Comprehensive Working Plan for Energy Conservation and Emission Reduction

Appendix D: Interview transcripts

Li Jianchuang 李建昌, Lijiang city government employee, April 29, 2014

Li: Lijiang only has hydropower stations and one wind power station, and has a solar energy field in the plan for next year or the year after next. The coal industry in Lijiang only exports or transmits Lijiang’s power to other province and local Lijiang people sell the coal, they do not consume it. Plan to kick out the coal energy in the

future because now Lijiang's coal resources are dwindling, do not have enough coal. The Swiss embassy is discussing doing a recycling and natural gas program in Lijiang. Nuclear energy is very efficient and a clean source of energy, we think nuclear energy is very good, however Lijiang is on an earthquake fault zone. The nuclear power plant station site's geological structure requirements are very high, so it would be very difficult to build a nuclear power plant in Lijiang.

Lauren: Why is there not more solar energy?

Li: It's expensive. The policy of solar power has just been launched by our government last year. This energy is very expensive and needs high technology. Now we don't have that technology, but the technology is getting better and better, and we plan to use more solar power from now on. More money is coming from the government to get big companies here to grow the solar energy. Solar Water heaters are very popular in Lijiang, in the city widely used by more than 95% of households, use in the countryside has reached 70%.

Lauren: Do you know how much biogas is used?

Li: Maybe 60% of families in Lijiang use biogas, use it for cooking and light in the countryside. The government helps them to build it. Urban households do not use biogas, they use electricity.

Lauren: Do you know what amount of money the Lijiang government is investing in clean energy?

Li: Depending on the electricity, the government will fund a certain amount of money to the enterprises.

Lauren: What is the role of NGOs?

Li: Yes, we have some NGOs, in the past a German NGO helped the rural people build their own very small solar power station, a one or two family used station in very high mountains. Some foreign NGOs come here and help fund hydropower stations. The solar powered street lamps are a government project, about 30% or 40% of all the street lights are solar powered.

Lauren: Do you know about Lijiang's relationship with Cleanergy or CGN Solar Energy Development?

Li: No

Lauren: How has mayor He Lianghui approached clean energy?

Li: The future target strategy for Lijiang has three targets. One is for Lijiang to be an international tourism destination, the second is to build a clean energy base. The mayor attaches great importance to this.

Lauren: Has Lijiang being named a World heritage site affected the city's clean energy policy?

Li: Of course. First we can't build new coal power stations because of increased tourism, which is part of why the goals for decreasing coal energy are so high. We produce the coal but we don't use it, we sell it to other provinces, the industry of coal production is declining. Lijiang has no industry, only tourism, agriculture, and service industry. We can't build factories that cause a lot of pollution. We mainly use hydropower. We have an abundance of natural resources, so we prefer to use this kind of clean energy.

Lauren: How many dams are in Lijiang?

Li: There are six dams in Lijiang in the Yangzeriver, and about 100 small hydropower stations without a dam. Yunnan province has a lot of dams. All the hydropower stations in Yunnan produce 70 million kw. Lijiang's hydropower stations produce about 600-700kw. The six dams in Lijiang are: Jinanqiao 金安桥, Liyuan 梨园, Ahai 阿海, Longkaikou 龙口, Ludila 鲁地拉, Guanyinyan 观音岩.

Lauren: Are new dams being built?

Li: More dams are being built on the Yangtze. Two new dams are in planning. The two dams that are currently being planned are : 龙盘 (longpan) 、两家人 (liangjiaren) 。

Lauren: How do those dams affect the rural communities they are built in?

Li: Some people need to move away, the government gives them enough money to move. Maybe around 30,000 people total in Lijiang have had to move for dams. With the two new dams, 70,000 people will have to move, for a total of around 100,000 people.

Lauren: How does Lijiang's use of clean energy compare to the rest of China's?

Li: It is better than average.

Lauren: Why is that?

Li: Because Lijiang's natural resources are better than most parts of China, especially hydropower. It will be a good place for solar energy because of the high elevation.

Lauren: How have renewable resource affected rural people's lives?

Li: Solar power water heaters, hydropower stations, and biogas, these three are the things that affect rural people's lives the most. For biogas, in the past people used wood, so they needed to cut down the forest, it is very slow, inconvenient, and causes a lot of pollution. Now we use biogas, it's very convenient, they don't need to cut the forest down, so it protects the forest. So has hydroheat.

Lauren: How has clean energy affected urban people's lives?

Li: In the past we often ran out of electricity, but now with so many hydropower stations, we seldom run out of electricity. There are some pilot programs in Lijiang, on one or two buildings their windows do the same as solar panels.

Lauren: Do you think people in Lijiang think clean energy is an important issue?

Li: Yes, they think It's very important. Normal people in the Lijiang community attach great importance to environmental protection, I think they think it's very important.

Lauren: Even people in the countryside?

Li: For people in rural areas, they only care about the energy being convenient and cheap, and clean energy is actually cheap and clean, so they like and prefer to use it. It is better for public health.

He LushanJizhen 和继珍, former Nature Conservancy Lijiang employee, May 1, 2014

Lauren: What kind of work did you do at the Nature Conservancy (大自然保护协会)?

He: My work was not directly doing biogas or solar heater clean energies, but it evolved. Actually I worked for the Nature Conservancy at the beginning for the ecotourism program, then for environmental education, and then I worked for the visitor center, so actually a lot of communication and education work. But we have our specific team working on the clean energy at the Nature Conservancy and they provide biogas and solar heaters to the local families in northwest Yunnan. For more than 10,000 family households already installed biogas and solar heater and efficient stove, some of that. I worked for the Nature Conservancy from 2002 to October 2013, 11 years. I have just accepted a job in another company.

Lauren: And is that working with the government?

He: Yeah, we always cooperate with the government. They local government puts in one third of the funding, the Nature Conservancy puts in one third, and the local

families also put in one third. So three parts, we all work together. We don't want to totally just give to the villagers because let them feel something got from others, they not evolve, not feel their ownership. So we want the local villagers to also feel ownership, they also put some money, put some work, so this is some project they want, not that somebody is just giving to you. Most of our projects are working three parts, one third, one third, one third. Some villagers don't put the money, they put the work, which we count as the money, because if we ask some laborers come to help, we need money as well, so local villagers provide their labor and their time and some of the basic things that they already have in their home, so we count this as their funding.

Lauren: So, the team that works on clean energy, do they mostly focus on the small projects like solar water heaters for individual families?

He: Yes, we found that a big threat to the forest in Northwest Yunnan is field wood collection, and they used a lot of material that were not really organized, so we try to work with individuals. Of course, at the beginning we work with local government, township government, we have a lot of meetings, workshops, making sure they really understand what kind of threat they are facing, and what the solutions we have to support them to make some changes. Some part in Lijiang and some part in other places. I suggest you go into visit the Nature Conservancy office in the Bailong culture square in the middle courtyard.

Lauren: When you were doing the education programs, who were you working with?

He: We most focused on local villagers and local kids and adults. We focus on adults. Children are effective for the future, future decision makers, but we think now the urgent thing is that adults need to understand so we also hold a lot of workshops for adult villagers. At the same time we focus on adults, on local schools for the future decision makers so they understand the value of their hometown, what kind of future they want, you know it's depending, so we're really working on the two different parts, adults and children. And always cooperating with the local education departments and the village school, those sort of things.

Lauren: Does the Chinese government also have some education programs for them?

He: Yes, yes, actually they have quite fair for environmental education because they have their school book called Science, so they have food chain, food web, talking about the ecosystem, they're teaching about all those kinds of things. However, sometimes we find that because schools are under pressure, lots of competition, and then a lot of schools do not really pay a lot of attention to teaching science, they're more focused on mathematics or art, other subjects.

Lauren: What changes have you seen in the Lijiang area since you started working at the Nature Conservancy in 2002?

He: Actually quite a big change, because at that time the big environment, the government, the people's awareness, everything is not that focus on environment, not so much stance on environment, even the government. It's not just because of the Nature Conservancy's efforts, but it's a big environmental effort. And after 10 years now, we find all the different levels of government, they have really a big focus on save the energy, environment friendly, environmental friendly construction, everything. They're thinking about the environment, so it's much easier now to cooperate with the government. Talking about environmental friendly or conservation, because they are also working on it, we can work together on the same objective, same goal. But 10 years ago it was not like that, we have a lot of GDP, a lot of pressure on other work and they were not focused on environment.

Lauren: How does the Nature Conservancy feel about all the dams in the Lijiang area?

He: You better ask someone who still works there, I'm not in a position to talk about that. But personally, from my personal point of view, the Nature Conservancy is worried about a lot of dams in China and in the world. The US has learned a lot of lessons, building the dam, destroying the dam, redoing the dam, restoring the ecosystem. So the Nature Conservancy is of course worried about dam, but the Nature Conservancy's working methodology is not for conflict with the government, so we try to cooperate, negotiation, communication, so we are quite positive to talk with the local government. What the Nature Conservancy's effort, in my experience, is we invite a lot of expert from Canada, from the US, very top dam experts come here to visit dam project and sit down with the provincial government, city level government, talking about US experience. And let them know what happens to dams in the US, what kind of lessons the United States has experienced, so we just share our experience, let them to feel what kind of benefits they want, long-term benefits or short-term benefits. So we do something, but not directly to stop them, we never say "oh stop that, that is not good", never work in that way, always work in a different way, to share our experience, let them think and make their own decision. An that effects it. We invited 4 or 5 experts to take with the provincial government and city government, did several workshops, in Yunnan it reduced a lot of dam projects, reduced about 10 different dam plans. They already had plans then they stopped because they learned something. Also we work with fresh water projects they bring

back a lot of video documentary, how to remove the dam, how much money to remove the dam, and share with the local government, the water department or something. So we always do this kind of thing, we never really say “don’t do that, that’s not good”, not exactly education, but sharing experience. I think the Chinese government has a lot of wisdom, they know how to do that, of course, there is a lot of conflict, they need the power, the electricity, they have a lot of rivers and this is something difficult to balance. It is good to use less coal, balancing is difficult.
Lauren: Do you know how many locations the Nature Conservancy has around Yunnan?

He: In Yunnan Lijian, Dali, Puer, but we used to have in Meilishnow mountain, Shangri-La, Lujiang, used to, but not anymore. Wetlands, forests, depends on the ecosystem. Puer monkey habitat. But actually we cover quite a lot of areas. We work in all of China actually, 52 different...

Lauren: What was your experience as an educator in rural china?

He: I enjoyed it very much. Every where I go to the local village, most beautiful places, the local people are so lovely, hospitality, nice, honest, beautiful smile, they are poor but very happy, so actually sometimes it is not us educating them, it is them educating us. And sometimes later we were asked to think about that. We call this program environmental education, but I don’t like using the word “education” sometimes, because it is not really us educating them, we share experience, and more like learn from each other. We always discuss with them what kind of future we want, depending on how we act now, what kind of things we want to leave for the next generation, that depends on how we act now, how we take action. So we always talk and discuss, and always come out on the same page with a very good conclusion. Just needs a lot of patience and communication. Sometimes people know this, but they’re so busy with their life that they forgot, need somebody to remind them. So I very much enjoyed that project.

Lauren: Why do people in rural areas want clean energy?

He: They appreciate it, but sometimes it conflicts with their tradition. Clean energy is some new technology. The solar water heater is very good because they can take shower and after a hard working day they have hot water in the home, that’s really fantastic, they love it. But biogas also, they use all the waste, use for cooking, that’s also really good. However, when they’re cooking with biogas sometimes, because of their local tradition of having a fire with stove, local people like to surround the fire and feel warm, but without fire stove and just using biogas, very convenient cooking but they don’t see the fire, they don’t feel warm. So a lot of local people still feel something is missing in their home without the fire. So with this kind of experience we are always learning how to balance, sometimes we use clean energy, but sometimes we help them to preserve their tradition, so we also help them to improve their stove as an efficient stove, use less firewood, always learning. For me, I look like an educator but actually I am also learning as well from the local villagers.

Liu Hui 刘辉 email correspondence on May 5, 2014

Lauren: What is your job at the Nature Conservancy? How long have you been working in Lijiang?

Liu: Project manager at the Nature Conservancy of Lijiang. I am living and working in Lijiang for one year.

Lauren: Please give an overview of what The Nature Conservancy does in the Lijiang area. How many people work for the Lijiang office?

Liu: Responsible for financing ten million, to complete the environmental protection work of the divisions.

Lauren: Where does the funding for the Nature Conservancy come from?

Liu: Funded by local entrepreneurs.

Lauren: How is the Nature Conservancy's relationship with the Chinese government?

Liu: Normal NGO and government relations.

Lauren: Is the Nature Conservancy in China run by Chinese people even though it is based in the United States?

Liu: Yes, TNC China is the responsibility of the Chinese people.

Lauren: What does the Nature Conservancy do to promote clean energy like biogas and solar water heaters? Why does Nature Conservancy think clean energy is important?

Liu: There are currently no clean energy projects, after the early projects we thought clean energy projects did not have such a big effect on the destruction of the forests. For this reason, it is unlikely that this kind of project will happen in the near future.

Lauren: How has clean energy in Lijiang changed in the time you've been working here?

Liu: For the time being we are not pushing this kind of project.

Lauren: How many locations does the Nature Conservancy have in Yunnan? Why those locations? How many in China?

Liu: In Yunnan province there is currently the Lijiang project, ready to add a new Heqing project. Lijiang and Heqing want to push new protection methods, so build this project site. China also has the inner Mongolia, Sichuan, and Shanghai projects, etc, and within 10 years China will add 10 new project sites.

Lauren: In your opinion, how has Lijiang's use of clean energy changed because of the increased tourism?

Liu: The effects of the tourist industry on Lijiang's environmental impact are many, the negative impacts are giving priority.

Lauren: What is the Nature Conservancy's stance on the dams in the Lijiang area?

Liu: The Nature Conservancy is not currently doing any work on the dams, so is not evaluating them.

ChenYongsong 陈永松, founder of Lijiang Green Education Center and Yunnan EcoNetwork, April 29 2014

Lauren: Where does the funding come from for the school and the biogas projects?

Chen: Self-raised funds, and some funds we purchase from the government, we also apply for funds from some international donors. Also, we provide education service, training service, sometimes we collect some fees. These sorts of things.

Lauren: Okay great, so if a family wants a biogas generator do they pay for that in part or does your organization cover it?

Chen: The facilities are donated by businesses that produce those kinds of products, so they give them to us for free. When we began to raise pigs we have to pay by ourselves, some students when they come here and see the pig, they love the pig and really feel happy and of course they will donate a little bit. For example, I want to donate a little money so we can buy some food for our pigs. We raised pigs for almost three years, each year we raised two or three pigs, but we stopped this year.

We haven't raised pigs this year because we already found we can also get the resources from the horse riding pit, they have a lot of horses around La Shi Hai lake, so we can get the horse dung from the pit. That is one part of our education.

Lauren: How many projects has the GEC done?

Chen: Well, because we are an education, this is called Green Education Center here, you see, so, we normally accept students or visitors from around the world, so we give them education, give them training, or get them for some community service, or they are here to intern with us. We normally do not apply for project, we can do something like education in the rural or urban schools, that means we not only sit here waiting for somebody to come, we also go out, go around, go to the mountain areas, bring our education stuff and give them training.

Lauren: Okay, so you teach people how to use biogas, but you don't build any yourselves.

Chen: We teach them how to use and maintain biogas, we don't build anymore. In 2006 we did build biogas in one of the counties around Kunming city, we got the funds from Tokyo power, but we stopped this because we know that the government already covers these projects. They provide subsidies to the farmers and, yes, biogas technology, or biogas funds is very sufficient from the government side. The other side is very weak, that means the knowledge. Once you get the biogas you have to teach them how to use it, how to maintain it, the skills. For us, we really want them to know that biogas can reduce carbon. It can really mitigate, it is a kind of mitigation. It can also help clean the environment.

Lauren: Right, because it helps limit the runoff of animal dung.

Chen: Exactly.

Lauren: So, out of all the renewable resources, why is biogas the one that you are most interested in educating people about?

Chen: This is because, first, in 2002, when I first came across the biogas issues, I know the Chinese government really wants to help farmers to replace the old stuff, they used fire wood as energy, which puts a lot of pressures on the forest. So in 1998 when the heavy flood happened in the Yangtze river, the government really felt that they probably had to do something, so they issued the logging ban. This really caused a great impact to the people living in the southwestern part of China, the rural area people, because the really depended on logging for their firewood, for their energy. In this case, the Forest Department, the Ministry of Forest, began to provide the technology, the subsidy to farmers, to help them to build biogas. The Ministry of Agriculture also raised money and helped the farmers to build biogas. Since these two government departments were focusing on the biogas, I knew it was very important. But their vision is different. The first department, their vision is they want to protect the forest. The Ministry of Agriculture, their vision is they really want to help people to raise the livelihood, to get fertilizer to help agriculture. So the two different visions somehow puzzled the farmers a little bit. The farmer think if they can use biogas, that's fine because they can get energy, but at the same time they have to raise pigs or any kind of animals so they can get efficient resources to produce biogas. So they may not really link the forest. Once when they use biogas, of course, we see they may not directly depend on the forest. So the agriculture department, I think their impact is very visible. So the forest protection is the second, more indirectly visible. So you may not directly see, when you use biogas you protect the forest, you cannot see that! I think this is some 4 or 5 years ago, farmers, because their livelihood became better and better so they can afford to have electronic appliances. So some biogas users began to replace, stop using biogas. For example, in La Shi Hai, we have some 16,000

population, some 60% of farmers households had biogas installed by the government, but now, well I don't have a survey for that, but in our village we have 35 households, some 80% of them used to use biogas, but now maybe only 1 household uses biogas. The others, they only use biogas to store the manure, they don't use the gas. So they use electronic appliances or LPG. It has changed because people mainly focused on agriculture before, but now they can also operate the tourism. They still have livestock, horses and pigs, but it seems that the members of the families have changed. Normally there are 3 generations, the parents the children and the grandparents living together, but now the children go to a far away school because they have money, and the parents want to join in the tourism, the other still live on the land. The grandparents don't have enough energy to maintain the biogas, the others don't have enough time to stay there to maintain the biogas. So it could be more efficient to use electronic appliances, switch on switch off is easier than shoveling the dung and checking the biogas everyday.

Lauren: Okay, so in rural communities the small scale biogas of individual families, but in urban communities it doesn't work as well. So do you think there is an opportunity for large scale biogas projects serving urban communities? How do you see urban communities using biogas?

Chen: In 2005 when I was in Japan, Nagauya, I found that Japan can collect the kitchen waste to produce biogas. Also in New York I find the big dairy farm also uses a big biogas tank, and use it to produce electricity. In China the large scale is very popular now, but in this special wetland it is really hard because if you raise a large amount of animals here it would produce a lot of waste, runoff, and of course I think even the large scale biogas plant you need a government subsidy to compete with hydropower electricity, because that electricity is very cheap. When you use biogas electricity it is very expensive.

Lauren: Yeah, the government is really pushing biogas, I know by 2020 they want to have 15% of primary clean energy produced from biogas, do you think that China is on track to reach that 15%?

Chen: Yeah, it's diverged a little bit, they may not really keep that goal. This is my consideration, because I know here, I know the people have begun to stop using the biogas, okay, but some people's families are still using the biogas, so it depends! Some farmers believe their life is very normal, they don't want to change their lives, for example to go to the city to find jobs, or they want to be more relaxed, they don't want to do any rural work, so some farmers keep their tradition, keep their own normal lives, so for those people they believe biogas is really, really smart. But for others, their minds are changed quickly, they want to by house in a city if they have money, they want to become urban people, not stay here as a farmer. The competition has become more and more intense. Before when the farmer grew fruits and vegetables they could consume by themselves and sell the surplus, but now it's hard because some company will come up here, which causes a lot of competition. The farmers will sometimes feel upset if they stay here, since they can probably do nothing. So that will force some of them to go look for another opportunity or even stay in the city for employment.

Lauren: Okay. How does Yunnan's use of biogas compare to China's use as a whole?

Chen: I have the PPT and I can show you after this, because they have the development plan for the whole province, so I can show you how the number and the development rate each year.

Lauren: Oh, great! It seems like Yunnan is really pushing clean energy.

Chen: Yeah, that is from the government's perspective. But from the farmers' maybe they might not really catch up with what the government wants from them.

Lauren: Do people still think of coal as a good source of energy?

Chen: Yeah, in Yunnan coal is largely used in the north, around Kunming, but in the northwestern part, here, or in south Yunnan, people normally don't use coal, they use electricity or LPG (liquefied petroleum gas).

Lauren: Lijiang has a lot of solar and wind energy, do you ever work with that aspect of renewable energy?

Chen: A company donated a solar energy water heater to us, but we don't have any direct connection with that, no, because our focus is not only on renewable energy, but also on environmental protection here, especially the education related to the environmental issues. We're really focusing on wetland protection. Some businesses are already intruding on the center of the wetland, so that really causes danger for the animals, especially since the habitat will be changed. Our approach is education. We believe that more and more people should understand where they live and what the uses of their natural resource are. Yulong county is one of the poorest counties in China, so they county government applies every year for funds from the government to help the poor. La Shi Hai is in Yulong county. Five years ago their prospects began to change because they believed this beautiful area could attract tourists. So their approach changed, now they really focus on helping tourists get here to bring in money. This change happened very naturally, I have seen the change of the people and of this place. Now the expressway cuts right through the wetland. This is a big concern, the pressure that tourists bring to the wetland. The quick development of the economy brings more pressures. More tourists, more pollution. People begin to build hotels and restaurants to meet the new demands. In one part they destroy, occupy the wetland that used to be the habitat for the birds, and in other ways they begin to produce runoff, pollution.

Lauren: Do you think that the increased tourism has had an effect on the government's use of clean energy?

Chen: Uh, not really directly. But I see that the tourists come here and stay a very short time, maybe one or two hours, so if you use unstable energy, it is not really useful for that business. So electricity or LPG is very sufficient, but at the same time the farmers also use their firewood. They can collect firewood around, the apple tree's branches or whatever they can collect, they also use that. So I find that the farmers use the bioenergy to power their rice cooker, but cook the vegetables or pork in a big pot, so electricity is not really enough, they use the fire wood.

Lauren: Do you know where is the electricity that the farmers use is produced?

Chen: We are very close to hydropower around here, because we are close to the Jinshajiang, Chuangjiang. Because the Yangtze river is here. Some 50 km away you can see the first hydropower station, and then another, and then another one, up and up you can see. The South National Grid company provides electricity here.

Lauren: How much of your time and funds goes to biogas as opposed to the other conservation projects?

Chen: When I came here in 2007 we had some 15 biogas facilities checked, maintained, and replaced. We provided funds for those farmers. After that we only give education to kids and their parents on how to use biogas, what is the use of biogas. We spend most of the time on education. From the beginning of 2012, three years ago, we concentrate on education of trash issues. For example, if you use the animal waste for biogas it can be a clean fertilizer, but if you don't use it, it remains

garbage. We focus on schools, colleges, universities, because it is easier to teach students than adults. We went to some 27 schools to teach, sometimes the parents also come to listen and learn too. Teaching them what can be recycled. They begin to promise that they will leave not trash on the ground, almost 1,000 people have signed a pledge to not leave trash on the ground. These garbage issues are easier for us to do, just don't throw trash on the ground, put it in the trashcan. We want to spread this culture.

Lauren: Where are your offices?

Chen: We also have an office in Kunming, but most of the time we are here, because this is next to the wetland, so the background is more easily recognized. The office in Kunming is just a room in a building, you can see nothing, only can talk. Two locations, one office in Kunming, located in a residential area, and this school.

Tour around the school:

Chen: The farmer may have depended on the forest for energy for generations, we have to respect them using the forest carefully in a wise way, but globalization is inevitable, and the more people that come, the consumption of the woods increases, so we give them energy efficient products, so you can use less firewood. You can also use solar energy, wind power, very popular in Lijiang. More and more public places use solar energy. We want children to prepare by using biogas. When you have the knowledge of how it works, you know how to make it function. You know what is a resource, like kitchen waste and corn stock, and know what can be recycled. People need the knowledge! A social professor from Seattle University said that almost all of the bacteria are killed in the biogas tank. A sophomore from Yale university who's major is public health, said that the schistosomiasis from the animal waste in the water, which spreads by the egg. Her study showed that the pressure from the biogas tank destroys the egg, stopping that disease from spreading. Biogas is very useful. The biogas residue is a really clean fertilizer. The government can take care of the instillation, but they never pay attention to the education, the training! The children often use the biogas to cook dinner, since their parents stay in the field so late. One girl student, some 12 years old, said she hates the biogas. Her story is very simple, when she used the biogas, the flame burned her hair! So that's why we give education, not only for knowledge, but also for safety safe. I don't know how many other biogas education NGO's there are in Yunnan or China, I could only guess. Mine is the only one I know, the only one in this area! We get horse dung from a nearby horse farm, good experience for the kids. Student's summer camp collect horse dung. Two students argued, they came from Beijing, I think grade four. The girl student really enjoyed it because we were collecting material for biogas, but the boy student rejected it. He said, "no, my parents never tell me, in Beijing I never see this kind of bullshit!" He said he would never do it, if he did, it what would his parents say, it was too rural. So the girl student said "no, you're wrong, you already learned what biogas is, if you want the biogas to function you must use the materials. And this is the material resource, not waste". The answer from the boy, he said "if it is the resources I will collect it, but if it is horse dung, I will never do it!" In reality he began to collect it. Waste can be turned into useful things, if you have the knowledge. I want to teach the children how to recognize what is garbage. If it comes from nature, is should go back to nature. Biogas is the best way to turn animal waste into fertilizer.

China's move towards nuclear energy is due to international pressure, the belief that it is a sustainable way of development, some companies get subsidies,

otherwise it couldn't compete with hydropower or petroleum. Probably a little bit complicated for the government, they only want to keep some balance, pressure to not use coal.

Slide from Chen's Yunnan EcoNetwork PowerPoint

Household Biogas Dominates Rural Market in China

Year Planned	No. of Households	increase No.	Popularization percentage
2005	18million		15%
2010	39million	21million	32.5%
2015	61million	22million	50.8%
2020	84million	23million	70%