CHAPTER II

CHINA'S SEARCH FOR ENERGY SECURITY

2.1 Oil as the Main Cause of Conflict

Realist international relations theory asserts that states will act in their own interest. This explains the chaos in the international system as each state attempts to make gains over others. According to US Energy Information Administration (EIA), oil made up 40% of total world energy consumption in 2005. Considering that oil is a finite resource and that many nations are dependant on it, would nations not go to war over the remaining supply if scarcity became an issue to ensure their share?

That oil is a non-renewable resource and will one day be depleted is an uncontested fact. M. King Hubbert, a Shell Oil Company geophysicist, was a great contributor to the exhaustion of oil school of thought. He coined the term *peak oil* with his model of oil production and depletion, which consisted of plotting oil production against time. He predicted, in the 1950s, that oil production rates from wells in the United States would peak around 1970, which it did, at nine million barrels per day in 1970, and has declined to around six million and under in the 2000s (Goldstein, 2006: 36) Hubbert's followers all agree that oil production is fast approaching its peak with the only dissent being on when.

Other experts contest the depletion of oil, pointing to the increase, rather than decrease, in oil reserves. Daniel Yergin, chairman of Cambridge Energy Research Associates, and his colleagues Peter Jackson and Robert Esser, all disagree over the imminent exhaustion of oil (Yergin, 1991). Better technology has improved oil excavation, making it possible to drill deeper, more precisely and recover more oil cheaply. 3D and 4D seismic analyses have improved the chances of locating oil fields. World oil reserves have increased, not decreased, since Hubbert's prediction. Michael C. Lynch and M. A. Adelman, prominent oil economists of the

Massachusetts Institute of Technology, go so far as to say that earlier predictions about oil, such as Hubbert's, did not take technological innovation into account (Manning, 2000: 24-32). Past oil crises were not due to shortage in oil but rather to policies designed to alleviate the crisis passed out by governments. According to them, market mechanisms are enough to stabilize oil supplies; demand for oil will drop as the price increases. They are also against government intervention in the search for alternative energy as the market will seek alternatives without government prompting when oil prices have risen past a certain point. However, that point does not lie in the near future.

Others find that complete exhaustion of oil is remote but oil scarcity is imminent. According to them, discovery and production rates will not increase fast enough to keep pace with rising demands. Though there may be plenty of oil left, not all is available for use as much are in forms that are economically not worth extracting. Discovery of major fields have declined and most of the ones in production today are old. An increase in production that would be able to keep up with future demand requires enormous amounts of investment, which even the oil rich countries of the Gulf, let alone the other third world oil producers, will not be able to raise on their own. Foreign investment in the usually state-run oil companies is difficult, if not downright illegal, as many of these countries have laws that forbid foreign ownership. Without investment in newer technology, the production rates will not increase enough to supply the growing demand. According to the EIA, $16 trillion is needed in global investment, with 75% going to production and exploration, to support long-term growth and offset the decline in production, in the next three decades (Cornelius and Story, 2007: 13).

Scarcity is enough to provoke conflict, or at least, heighten tension to a point where conflict seems unavoidable. Michael T. Klare, in his 2001 book *Resource Wars: The New Landscape of Global Conflict*, hypothesized that resources were the main contributors of conflict, not differences in culture and civilization as expounded by Samuel Huntington in "A Clash of Civilizations?" In this book, Klare regarded all scarce and valuable resources, gold, diamonds, copper, timber, water, oil, land,

fisheries, etc, as equal triggers for conflict. In his 2004 book *Blood and Oil*, Klare had reevaluated his ideas due to 9/11 in 2001 and the events that followed subsequently. He concludes, in this book, that oil has more potential than any other resource to provoke conflict. If resources that are not essentially necessary to the operation of modern society, such as gold and diamonds, were enough to provoke conflict in the past, securing oil must then become a priority for nations as continued growth and stability is dependant on a stable and constant access to energy.

The finite amount of oil and the propensity of nations to fight over scarce resource to ensure their own survival lead to the distressing conclusion that war and conflict is inevitable. This scenario is, however, dependant on continued world dependence on oil. Renewable energy has been offered as a solution through the idea that reliance on oil would be reduced through fuel diversification. Fuel diversification would reduce risks of involvement in foreign conflicts as China is following the United States in its methods of securing energy through energy deals in volatile regions such as the Gulf, Central Asia, Africa and Latin America. Some of these deals, such as the ones in Central Asia with Kazakhstan and Kyrgyzstan, involved arms trade and military training (Downs, 2006: 50). These foreign conflicts could escalate in scale were China and the United States to back different factions as in the Cold War era when the United States and the Soviet Union supported different groups and barely avoided outright war. Renewable energy offers an alternative to dependence on oil and the potential conflicts that follow. Renewable energy could also mean less dependence on energy imports, reducing trade deficit and increasing funds available for domestic investments. As an additional benefit, renewable energy sources, are perceived as more environmentally friendly than oil.

Current research either appears to be too optimistic or too pessimistic. Daniel Yergin, his colleagues, Michael C. Lynch and M. A. Adelman, all believe that scarcity is not an issue and that even if it were an issue, the market would solve the problem in its own time. This view ignores the fact that states are pursuing energy security measures in the belief that oil will become scarce, and the resulting antagonism will remain the same whether oil actually becomes scarce or not. Michael

T. Klare seems overly pessimistic with his doom forecast. His writing gives the impression that conflict over the energy issue is inevitable as long as China continues to grow and increase stress on the existing supplies of oil. Very little is said about cooperative ventures whose numbers have increased in frequency as countries become more interdependent. This research will look into these cooperative instances to see whether they can provide a more sustainable path to energy consumption pattern and prevent future conflicts over energy.

2.2 China's Energy Security

China's lack of self-reliance in energy and increase in energy imports has caused it to take a proactive approach in rectifying the situation. This sense of insecurity is enhanced by contrast with the previous self-reliance during the Mao period. That China used to be an exporter of oil merely emphasizes its current dependence on imports. China only began importing oil in 1993; by 2006, China was importing 162.87 million tons (Zhong, 2007). Almost half of China's oil demands are met by imports and that number is predicted to increase as consumption increases faster than China's oil production. However, oil remains a small share of China's energy composition. According to the EIA, in 1996, oil made up 20% of the total energy used by China, that figure rose to 24.5% by 2002, and is expected to rise to 25.9% in 2020. Coal is and will remain the main source of energy for China, as China is the biggest global producer of coal, producing an estimated 2 billion tons of coal in 2005; however, inefficient mining, irrational distribution and transportation delays have caused power shortages to occur throughout the country (Ebel, 2005: 61-66). By the third quarter of 2005, China had imported 18.76 million tons of coal (People's Daily, 2005, *China's Coal Imports*). The increased dependence on energy imports has raised China's vulnerability to energy shortages and fluctuating global oil and coal prices. Energy security is therefore high on the Chinese agenda.

One obvious solution to energy security is to use less energy. Lower demand means there is less need to acquire additional energy. Energy efficiency is therefore

very important for energy security. Though the Chinese government has long recognized the importance of energy efficiency, energy efficiency activities are underfunded as, in 2003, only RMB 23 billion was spent on energy conservation while RMB 424 billion was spent on increasing supply (Sinton et al., 2005: 10). Though there have been many measures put into place to increase energy efficiency, such as 22 administrative measures, seven standards and 14 policies including an Energy Conservation Law, energy efficiency has not received the boost it needs to make a significant change (Sinton et al., 2005: 10). Low investment in energy efficiency combined with the little incentives for change due lax enforcement of energy efficiency measures and low government subsidized energy prices have stunted the growth of energy efficiency. Sinton et al. (2005) recommends that China should invest 10 % of its energy investment budget in energy efficiency, enforce created measures rigorously, and target the industries as they consume 70 % of the energy consumption.

2.2.1 Source Diversification

On the supply side, there are basically two main strategies in China's search for energy security: source diversification and fuel diversification. Source diversification is the more visible and contentious of the two. This is essentially China's "going out" strategy. Literally, in 2002, China began the official "Go Out!" campaign which encouraged Chinese firms to "go out" and buy foreign assets, specifically in the field of natural resources (Friedberg, 2006: 22). However, China had long since encouraged its state oil companies China National Petroleum Corporation (CNPC), China Petroleum & Chemical Corporation (Sinopec), and China National Offshore Oil Corporation (CNOOC) to engage in acquiring overseas assets. China now has oil deals that range across the globe, thus diversifying its sources of oil. The idea behind this rests on the assumption that were there to be difficulties in a region, China will still be able to get oil from its other partners. However, though sound in theory, the reality is that the far flung deals that China has made have not made China more energy secure. First, the deals that China has made have been in volatile areas. Deals with Ethiopia, Sudan, Somalia, Angola, Iran, Iraq, and Burma

are among the most controversial. As stated in Chapter One, China's dealings with governments embroiled in inner conflicts have increased the military budget and power of these governments, making Chinese assets in those countries, people and property, targets for the "rebels," and increasing the chance of escalating the existing conflicts. As elaborated in Chapter One, these investments could destabilize global security. Hence, these oil deals will not provide China with a secure energy source but be a liability in cases where the conflicts do escalate.

Other oil deals, such as in Venezuela, Saudi Arabia and Russia, China competes directly with US interests. For instance, in the case of Venezuela, China's increasing influence in Latin America is making the US very nervous as this is a sphere in which the US has become unused to competition. According to the EIA, Venezuela supplies the US with 20 % of its oil imports and is considered as a component of US's energy security measure under source diversification. Hugo Chavez, Venezuela's left-wing President, has been attempting to create an anti-US bloc in Latin America through the support of other radicals in neighboring countries. With an oil deal with power hungry China, Chavez can ensure that Venezuelan oil will have a market, even without the US, and gain more freedom from US involvement through its association with the emerging superpower. China is receiving a warm welcome as it cultivates relationships with countries in the US's backyard. Collins and Ramos-Mrosovsky (2006) speculate that China is seeking a different route of oil, which can be shipped through the Panama Canal, now operated by a Chinese company, Hutchinson Whampoa. This will provide China with an alternative in transportation route as the route from the Middle East is mainly controlled by the US fleet. The oil deal with China has made it possible for Chavez to follow through on his threat to cut off oil exports to the US and make China its main export destination if relations between the US and Venezuela worsen.

Though the relationship between the US and other countries might not be as antagonistic as the one with Venezuela, China's acquisition of foreign oil assets is competing with the US. In 2004, Saudi Arabia, traditionally a staunch US ally, cut oil sales to the US, from its 2002 peak of 1.7 million barrels a day to 1.1 million, and

made China its new largest customer (Rose, 2004). The US is facing a geopolitical shift away from itself and its traditional spheres of influence. Although the situation has not deteriorated to the point where the competition becomes physical, the increase in energy demand, fueled partly by China's own dramatic increase, has increased the price of oil. No matter how many deals China makes, oil price fluctuations are a global occurrence and will affect all those deals equally, making any oil deal an unstable energy source.

Transportation of the oil also poses a major security problem. The oil from China's oil deals in Africa and the Middle East must all be transported through waters where the US fleet is the dominant force. China would be vulnerable to embargoes were China and the US to engage in conflict. The route through the Panama Canal and through the Pacific, though an alternative, suffers from the same vulnerability as the US is also the dominant marine force in that area. China consequently sought and is still seeking to make oil deals with its neighbors. The Shanghai Cooperation Organization (SCO), created by Russia, China, Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan in 2001, and according to its charter, cooperates on various issues, including developing effective cooperation in energy and working together to maintain regional peace, security and stability. A closer relationship with its oil-rich neighbors has permitted China to gain various oil deals and allowed China to entertain the idea of overland transport through pipelines and completely bypassing oceanic routes.

The pipelines, though free from US naval interference, have their own weaknesses. In the first case, China's major cities are located in the east, while any pipeline from Central Asia would come from the west. The construction of any pipeline would have to add the cost of the two-fold transport. The 3000 km Kazakhstan-China pipeline, in which China conducted a feasibility test in 1997, was shelved in 1999 due to economic reasons; the $3.5 billion in construction of the pipeline alone could not be justified by the combined reserves of the Aktyubinsk and Uzen, the originating fields (Downs, 2006: 24-29). However, two other shorter pipelines, 962.2 km from Atasu in Kazakhstan to the Alataw Pass of Xinjiang and a

252-km oil pipeline between Alataw Pass to Dushanzi, have been completed. The first pipeline is now operational and is estimated to transmit 10 million tons of oil a year. Plans are already in motion to expand the pipeline to 3,000 km by 2011 and transmit 20 million tons (Xinhua, 2006, *Kazakhstan-China oil*). The pipeline from Russia's Siberian region also looks promising. To date, one third of the 2,700 km pipeline, which will transmit up to 30 million tons a year when completed, has been built after only a year of construction (Reuters, 2007, *Russia: 1/3*). Nevertheless, any pipelines constructed would be vulnerable to terrorist attacks and the border regions are rife with terrorist activities prompting the SCO to conduct numerous counter-terrorist exercises (McDermott, 2007).

China's attempt at achieving energy security through acquiring foreign assets is not helping it acquire energy security but is, instead, creating more political tension as its interests collides with the US and embroils itself in volatile areas.

2.2.2 Fuel Diversification

A fuel diversification strategy is also currently being pursued with aims of increasing the share of other fuels in the energy composition, in this case, nuclear, natural gas, and renewable energy. The idea is to diversify primary energy sources to an extent in which disruption in one would not damage the economy.

Nuclear energy, in 2004, consisted of 2.3% of the total energy consumption that year (Xinhua, 2004, *China accelerates*). According to the same article, from 2003, nuclear energy began featuring in national energy development plans, making a comeback after sluggish development in the last two decades. Not only is China turning to nuclear energy to diversify its fuel, environmental problems from coal-fueled power plants have reached a critical point. Pan Yue, the head of the Chinese government's state environmental protection bureau, points to the fact that "acid rain falls on one third of China's land, most of our biggest seven rivers are poisoned, a quarter of our people have no clean drinking water and a third of them breathe polluted air" (Sheridan, 2006). Sheridan (2006), in addition, states that an estimated

400,000 premature deaths are caused by pollution each year and the effects of pollution are also felt halfway across the world as the monstrous toxic clouds drift across the Pacific to California. Nuclear energy will help to lessen the air pollutants from coal power plants as it gains in total energy share.

The Chinese nuclear plan is very ambitious, aiming to increase the current output of 8,700 megawatts (MW) to 36,000 by 2020, that is, from 2.3% of total primary energy consumption to 4% (Xinhua, 2004, *China accelerates*). This translates into approximately 28 new reactors if the goal is to be achieved. Bidding for the construction of the first four reactors is particularly fierce because of the limited opportunities for reactor construction worldwide though no matter who wins, China is likely learn from the construction process and proceed to constructing the rest of the reactors themselves (Ebel, 2006: 66-68). However, though nuclear energy might not emit air pollutants like coal power plants, toxic waste is still an issue and the disposal of the quantity likely to be produced by 2020 could become a major problem. Furthermore, safety of the plants is a key concern, considering the deadliness of the Chernobyl incident.

Natural gas, according to a projection in 2002 from the Energy Research Institute of China, will grow at 12% per year and increase from 2.5% of the total energy consumption to 12.5% in 2020 (Yamaguchi and Cho, 2003: 2). China is developing its domestic natural gas reserves in anticipation of the demand. However, the biggest reserves are in the west and transportation is costly. Consequently, pipelines have now been built to transport the gas from the west to the east where consumption is concentrated. The 4,000 km long West-East pipeline, from the Xinjiang Uygur Autonomous Region to Shanghai, completed in 2004, has a capacity of 12 billion cubic meters a year(China Daily, 2005, *Rosy future).* With the rise in prices of coal and oil, natural gas has become a competitive alternative. The demand for natural gas has been so strong that a second pipeline. PetroChina is considering the feasibility of a pipeline that will connect the Xinjiang Uygur Autonomous Region to Guangzhou with double the capacity of the Shanghai line (China Daily, 2005, *China plans*). If the assessments are favorable, the construction of the pipeline will

begin in 2020 and be capable of carrying gas from Russia and Kazakhstan to help meet surging demands.

Natural gas has the advantage of burning cleaner so it pollutes less than coal and oil, but will suffer from the same vulnerabilities as oil as consumption outstrips production. Natural gas reserves are found in most of the same regions as oil, will entail the same dangers of conflict, depletion and transportation. Though China has domestic natural gas reserves, it is also making deals to import natural gas with Kazakhstan, Russia, Iran, Indonesia, Malaysia, and Australia, to name a few. Ebel (2006: 68-72) predicts that most of China's natural gas consumption will come from imports. By 2010, China will need to import 20 billion cubic meters of gas as consumption is projected to reach 110 billion while domestic production will only reach 90 billion (Forbes, 2006, *China natural gas*). Natural gas can contribute to fuel diversification but does not provide a secure energy source.

In addition, China aims to boost the renewable energy sector to 15% by 2020 (Biopact, *China unveils*). According to the EIA, in 2002, renewables consisted of 7.2 % of total consumption. A renewable energy law, passed in 2006, encourages the renewable sector through financial incentives, subsidies, price fixing, and even requiring power grid operators to purchase power from renewable sources. Though 15% is a small share of the total energy consumption, energy from renewable sources does not suffer the vulnerabilities that fossil fuel sources suffer. However, renewable energy is not the magical solution that some seem to consider they are. There are, as always, advantages and disadvantages. Though there are no price fluctuations on wind, water or solar sources, ethanol and biodiesel components[2] could suffer from price increases as demand for the product increases and farmland decreases. Nonetheless, they have the ability to make China less dependant on energy imports and feel more secure about being able to control a portion of its energy supply.

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[2] Sugarcane, corn, barley, wheat, sugar beets, sorghum; basically high starch crops.

On the issue of energy security, China's interest is best served by keeping itself free from being embroiled in conflict. Its dependence on energy imports through sea routes make it vulnerable to embargoes and any conflict will certainly result in one. What are the options for China in its quest for energy security? How can energy be secured? The most obvious approach to ensuring security energy, self sufficiency, is out of line with reality. There are very few countries that have enough natural resources to sustain their energy consumption. The second approach: diversification of supply and an establishment of a "security margin" to buffer against oil stock and price fluctuations have worked so far but as oil reserves begin to deplete, it would not matter where the oil comes from as the market price will rise globally. Diversification of fuel would aid in energy security as the combined targets of nuclear, natural gas and renewable would bring the total alternative to 31.5 % of total energy consumption, if all of them reach their targets. However, nuclear energy is risky and natural gas suffers from similar vulnerabilities as oil, and though renewable energy is not the panacea to all the problems, it offers the most sustainable secure path towards maintaining energy security. Development and research by individual countries would utilize too many resources and be time-consuming. As demonstrated above, conflict cannot lead to energy security. Cooperation, in this case, could prove much more beneficial and lead to greater energy security for all those involved.

2.3 Renewable Energy

As previously argued, energy security lies in cooperation over renewable energy as it ensures a more sustainable path than other energy sources. As such, this paper is not trying to determine whether international cooperation over renewable energy in China will make China into a mainly renewable energy consumer country but will assess the potential ability of the current international cooperation to assuage China's energy security worries. Therefore, this will be viewed as part of China's overall energy policy that encourages diversification of fuel and source.

Renewable energy technology has made leaps and bounds in the past twenty years. REN21, a policy network which will be covered in more detail later, stated in its 2005 annual global status report that the renewable energy sector had strong growth and was gaining significance. This, nonetheless, is by no means a claim that conventional energy is soon to be eclipsed by renewable energy. Renewable energy accounts for only a small fraction of world energy consumption.

Nevertheless, renewable energy sources could reduce energy imports because they can generally be made available domestically. There are many different types of renewable sources available such as solar, wind, geothermal, hydro, and bioenergy, and each has their own advantages and disadvantages (EIA, 2005, *Renewable energy*). Their viability of each technology depends on whether the projects initiated have managed to compensate for the disadvantages.

Solar power is energy, in this case sunlight, gathered mostly through photovoltaic (PV) cells which convert the sunlight into energy. It currently provides a more economical solution than extending electricity grids to remote villages. Solar power is a cheap and clean energy source in the sense that sunlight is abundant and the conversion process produces no toxic byproducts. However, the cells themselves are expensive and batteries are needed to store energy for use in the nighttime when there is no sunlight. Fortunately, the costs of the cells are likely to decrease as solar energy becomes more popular and production volume of the cells get higher.

Wind power operates through harnessing the wind movement into turbines which turn the movement into electricity. Wind power, though considerably less popular than solar power, has enjoyed extensive growth in the US and Europe but is not yet prevalent in China. According to the China Academy of Meteorological Sciences, the country possesses tremendous onshore wind power potential, a total 235 gigawatts (GW) (Feller, 2006). To put this into perspective, 200 GW was China's electric power generating capacity in 1995 (Ebel, 2006: 26). Wind power does not produce any toxic byproducts but has drawbacks in the fact that it needs more space than solar panels and conventional power plants. Wind power is therefore only useful

in places with lots of space with steady wind flow. Some people oppose the installation of windmills as they consider them aesthetically unpleasant. It is a special concern since wind power plants need large tracts of land and the spaces available are in areas far from cities and close to or in naturally beautiful scenic areas. Placing them in remote areas or on off shore sites could be an answer but would require greater investment in set-up costs and efficient energy transportation methods. Another complaint over the increased usage of windmills is their effect on the ecosystem as some turbines have been placed in flight paths and even in migratory paths, resulting in the death of many birds.

Geothermal energy is heat energy from the hot rocks deep in the Earths crust, heat continually conducts out from the molten larva that forms the Earths core. Geothermal energy can be converted to electricity by using a geothermal power plant. In such a plant, the heat of the rocks is used to boil water, the steam so rendered drives a turbine. Geothermal power plants give off no emissions, produce no hazardous waste, can produce a large amount of energy with a relatively small plant, run constantly regardless of weather conditions, and do not carry the risk of disastrous malfunction such as pollution spillages and meltdowns that has been associated with other types of plant. Current geothermal plants must be situated on geothermal wells, pockets of underground hot water. There are many practical geothermal sites in China, especially in the fault area known as the Himalayan Geothermal Belt. Estimates made in 1994 indicated a total potential of 1,740 MW from the 181 known geothermal systems (Taylor and Li, 1996: 3). This estimate is likely to grow as new exploration methods aid in the discovery of new geothermal systems. Disadvantages of geothermal energy lie in the high cost of exploration and operation, the location of geothermal spots which are often situated in volcanic area and the associated dangers, and finally, the unpredictability of the site itself as some spots unexplainably stop producing steam, only to start again years later.

Hydropower is probably the most controversial energy source amongst all the renewable energy sources but contributes the biggest share in renewable energy in China. Governments adore the construction of dams while environmentalists, human

rights organizations and villagers adversely affected by dam constructions abhor them. Development projects in the past have emphasized the use of big dams to generate electricity, displacing villagers around the area and flooding large areas of land, resulting in the destruction of the local ecosystem. The damage is not limited to the immediate area of the dam but affects those downstream also. Fish are unable to move freely up and downstream to spawn which could affect the fish population of that river. The increase in water flow speed due to the narrower outlet of water causes more erosion along the shore and augments the amount of silt in the river and harms fish. Consider then the potential damage to the fish population from a decrease in spawning rates due to obstructed waterways, an increase in mortality rate due to lack of oxygen because of the elevated levels of dirt in the river and add erratic water flow patterns determined by the dam releases. The dam will significantly affect people who rely on those fish for food or for their livelihood. Not only that, farmers along the river will be affected by not being able to supplement their nourishment and income with fresh catches, the erosion of their riverbank land, and also by the change in water flow as the water released by the dam might not be enough for crop use during dry seasons and may be too much during planting seasons; either of which will drastically lower crop yield.

Hydropower is also controversial in the sense that it also has transboundary elements to its negative effects. Damage caused by dams do not stop at the borders, but can be felt all the way downstream. The lower Mekong basin countries are beginning to feel the effects of dams constructed upstream in China. The Tonlé Sap Lake in Cambodia is suffering from a decrease in water levels and the delta in which the Mekong empties out into the sea in Vietnam is suffering from an increase in saltwater as the flow of fresh water is reduced (The Telegraph, 2004). Crops are being ruined, water quality is degraded, and fish are dying. China is not the only culprit in the matter, there are many other dams that dot the Mekong within the lower Mekong basin and each contribute to the problem.

China itself is home to the controversial Three Gorges Dam, the world's largest hydro-electric dam that displaced over a million people. A year after

completion, it is host to a myriad of environmental problems. Already there is a problem with runoff sewage and industrial waste collecting in the reservoir, brewing a toxic mix that threatens agriculture and water supplies (Oster, 2007). Oster (2007) cites problems with ground stability upriver as the weight of the water in the reservoir and fluctuating water levels erode the steep shores and cause landslides, weakening the ground under places like Miaohe, a village about 10 miles up the reservoir from the dam. Flooding downriver is also becoming a problem as silt is collected by the dam, making water released from the dam faster and eroding shores and dikes. Small hydro projects are becoming increasingly popular because of their lower impact on the environment.

Water covers over 70% of our planet surface and it is no surprise that damming rivers is not the only method of harnessing energy from water though it might be the most popular. For coastal countries, there is an option to take advantage of energy from the sea. For China, this could prove doubly advantageous as most of its big cities lie along its coastal areas. Tidal power can be harnessed through two methods, ebb generation and wave farming. In ebb generation, power is generated during low tide as water trapped into a basin during high tide flows out, turning a turbine which produces electricity. Wave farming operates similarly to harnessing wind power as the tidal turbine is anchored to the seabed and relies on the currents to turn its turbine, much the same as a wind turbine relies on wind flow to spin its turbine. However, tidal turbines have an advantage over wind power generation as water is heavier than wind due to its density and is able to generate more power. Tidal power, nevertheless, suffers from the same drawbacks as wind power in the sense that those who oppose it deem tidal turbines and basins would damage the aquatic ecosystem and the placements of these contraptions along the shore would be as aesthetically unpleasant as windmills on land. In China, and in many other countries, collecting energy from the sea has not been yet received the same kind of attention as other renewable energy sources yet it remains one with great potential for countries with large coastal areas as ocean water levels and currents are much more reliable than rivers since only very major events, such as the melting of the Greenland ice

shelf or the poles could significantly affect sea levels and currents while river flow can be influenced through man-made and/or natural upstream changes.

Bioenergy encompasses biofuels, biogas and biomass, all of which can be used in power generation. As is evident from the use of bio as a prefix, bioenergy is energy from living organisms, from animals, their byproducts and plants. The traditional use of bioenergy, from the burning of wood, dung and so on, makes up a sizable proportion of the energy consumption in poor rural areas in developing countries. Biomass is extremely popular as agricultural waste is abundant and burning garbage from urban areas could reduce landfill problems while providing energy. Modern innovations in the field have made bioenergy a darling of the media and, consequently, the most hyped up renewable energy source. Current innovations have made it possible to trap gas escaping from livestock and their byproducts and convert them into energy. However, the most often referred to and most commonly used is liquid biofuels.

Liquid biofuels such as ethanol and biodiesel have been special recipients of attention from the media and governments due to their potential in phasing out oil without having to compromise current lifestyle choices and habits. Liquid biofuels can also, in one blow, deal with energy security concerns of fuel dependency and loss of currency as it eliminates the need to import fuel due to the possibility of domestic production. Ethanol can be made from a variety of plant matter such as corn, sugarcane, rice, anything that can be fermented and distilled. The ethanol, however, is rarely used on its own but is mixed with gasoline since modification of engines would be necessary to burn pure ethanol or high compositions of ethanol. The most commonly used ethanol blend is E10 which is composed of 10% ethanol and 90% gasoline. The addition of ethanol into gasoline allows the fuel to burn cleaner and reduce carbon emissions. It is therefore lauded as the fuel of the future, plentiful, cheap and clean. Biofuels will have a significant impact on the world as their usage increases. Alexander M. Iler, Assistant Director-General for the Sustainable Development Department of the Food and Agriculture Organization (FAO) predicts in

a UN-Energy paper on Sustainable Bioenergy the rise of biofuels to 25% of the world's energy consumption in the next 15-20 years.

Opponents of biofuels see the rush to reap the perceived benefits of biofuels as deeply worrying. Biofuels is a relatively new technology and its environmental and social impacts are not yet known. Proponents of biofuels point out that ethanol blends are better for the environment but skeptics argue that E10 blends do not make a significant improvement. Also, the addition of ethanol into the fuel mix lowers fuel price, possibly leading to an increase in usage and negating any positive gains. Furthermore, the energy needed to manufacture ethanol (distillation) comes from the burning of traditional fuels and further offsets environmental benefits and reduces energy independence. Biofuel supporters defend ethanol by pointing out positive social impacts such as an increase in income as more jobs and opportunities are created as the industry grows. Developing countries, which are mostly situated in the tropics, are likely to benefit from this expansion as the conditions for growing oil plants are favorable due to long and steady periods of sunshine and cheap labor. However, the rise in demand for these crops to make ethanol could make the prices of those crops rise and affect food security of the poorest people (UN-Energy, 2007: 6-36). Though deeply interested in biofuels as an alternative energy source, China is highly concerned about food security as self-sufficiency in food is of paramount importance in a country that suffered one of the greatest famines in human history in the 1950s and 1960s. The idea of using food has fuel has not found resonance in a country where 70% of the population are farmers and many of them are poor (Lee, 2007). However, these concerns will not result in China rejecting biofuels but will make China proceed at a cautious pace. Another concern is as to whether the expansion of the ethanol industry would increase deforestation as the forest is cut down to make way for agriculture.

There are those who question whether a switch to renewable energy really has any beneficial environmental gains as the production process of each type of energy is damaging in its own way. However, most of these concerns are on whether renewable energy makes a difference environmentally. This paper does not

encompass that argument as it only looks at whether renewable energy projects can help China feel more energy secure, not environmentally sound. Though China has encountered problems in its search for renewable energy, such as in the case of dams, if the problems can be overcome, renewable energy is essential for future energy development as renewable energy technology has advanced to a point where it can play a significant role in alleviating China's energy concerns.