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China Going Nuclear

by Eva Sternfeld[1]

The international nuclear industry is receiving encouraging signals from China. While other countries in the world are slowing down their nuclear programmes, China is committed to substantial development of the industry. In 2009, the Chinese government adjusted its energy development plans and now aims for a tenfold increase of nuclear capacity by 2020. Going nuclear is expected to solve the severe power supply shortages in China's eastern provinces, and at the same time help improve environmental quality and mitigate greenhouse gas emissions. Therefore, in recent years, the Chinese government has been promoting nuclear energy alongside with renewable energies as a "clean" CO_2 emission free energy source.

Despite the mentioned environmental advantages, critics are wondering if China is sufficiently prepared for managing this rapid expansion of nuclear facilities, and whether or not it will be able to handle the potential risks of nuclear accidents as well as nuclear waste disposal. Despite the ambitious plans, to present China is lacking trained researchers, engineers and technicians to adequately staff research institutes and power plants under construction. The Chinese public has so far been kept pretty much in the dark about the potential risks of this massive nuclear development. As a result, only a few environmental activists have been addressing nuclear safety issues in power plants as well uranium mines, enrichment facilities and disposal sites.

China is the only remaining country in the world committed to substantial development to substantial development of nuclear industry. By end of 2010, twelve nuclear power reactors were in operation, another 24 under construction. And the plans for the future are even more ambitious. They aim for a tenfold increase of nuclear capacity from a present 10 GW (Giga Watt) up to 80 GW by 2020, up to 200 GW by 2030 and up to 400 GW by 2050.[2] Going nuclear is not only expected to ease severe power supply shortages in China's energy hungry Eastern provinces. Nuclear energy is also promoted as a "clean" CO_2 emission free energy source and thus was incorporated into China's environmental and climate protection strategy. To mitigate greenhouse gas emissions China has committed herself to increase the share of non-fossil energy sources (renewable and nuclear) to 15 percent of the energy mix (from a present 9 percent).

Whereas in many Western countries environmental movements have their roots in the anti-nuclear movements, the recent nuclear boom has not been a priority issue being addressed by Chinese environmental NGOs. Very few activists dared to raise underlying questions whether or not the country is sufficiently prepared for managing this rapid expansion of nuclear facilities, and whether or not it will be able to handle nuclear waste disposal and the potential risk of nuclear accidents. However, the more plants are being built, the more critical voices of the concerned public are heard.

The Energy and Environmental Challenge: Dependency on Fossil Fuels

China's recent rapid economic development has been accompanied by a huge increase in energy demand. Between 2000 and 2008, total energy consumption increased more than 100 percent.[3] In

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[2] www.world-nuclear.org/info/inf63.html accessed 12 November 2010

[3] Total energy consumption increased from 1,38 billion tons SCE (standard coal equivalent) in 2000 to 2,85 billon tons SCE in 2008, National Bureau of Statistics of China: China Statistical Yearbook, 2009, p. 243

2009, 19.5 percent of the world energy production was consumed in China. The country is the world's second largest energy consumer (after the United States) and the third largest energy producer (after the United States and Russia).[4] Unlike any other country in the world China's economic miracle is built on coal: almost 70 percent of primary energy consumption and 80 percent of electricity is produced from coal. China will not have to worry about receiving sufficient supplies for several decades to come. In 2009, proved recoverable reserves were estimated to amount to 114 GT (Giga Tons) (representing 13.9 percent of the world's total), which is sufficient for supplying the country for another 41 years at present consumption levels.[5] At present China consumes 46.9 percent of the world's coal production.

The reliance on coal as the major energy resource comes at a high price, though. Many of the country's severe transport and environmental problems are directly related to the coal dominated structure of the energy sector. Energy resources are not very well distributed with regard to economic development and demand. While coal reserves are mainly located in the northern and northwestern parts of the country, energy demand is especially high in the eastern coastal provinces of Guangdong, Zhejiang and Jiangsu and in the mega-cities Shanghai, Beijing and Tianjin. In recent years, frequent power cuts during peak season have reportedly created severe problems for local economies in those places. Distances between the locations of energy reserves and Chinas industrial centres have caused a gigantic logistic bottleneck, with half of the country's railway capacity being used for the transportation of coal. When unexpected events cause disruption of major transport lines, such as unusual snow falls and freezing temperatures in Southern China in early 2008, power cuts and collapsing economic systems can hardly be avoided. On top of that, Chinas coal mines have the reputation of being the most dangerous in the world. Every year, several thousand miners die in mining accidents. An estimated one million people suffer from silicosis. Heavy reliance on coal is the major cause for the severe air pollution problems in China's cities which rank among the most polluted cities in the world. According to the World Bank, economic losses caused by air pollution are estimated to amount to at least 3.8 percent of the GDP.[6]

Rising consumption of fossil fuels has caused a sharp increase in the emission of greenhouse gases. By 2007, China had overtaken the United States as the world largest emitter of CO_2 emissions and is now contributing 20 percent to annual global carbon dioxide emissions. Not only is the country the world leader in emissions of greenhouse gases, China is also one of the countries that are severely affected by global warming. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) the speed of the temperature increase in China is observed to be significantly higher than the global trend. Global warming has already caused the shrinking of glaciers on the Tibetan Plateau by one fifth within the last 50 years. The IPCC report further predicts an increase of extended droughts and higher frequency of sandstorms in Northern China, as well as an increasing intensity of typhoons in Southern China and rising ocean levels affecting the Yellow River , Yangtze and Pearl River deltas. As a consequence of global warming, China will have to be prepared for considerable decreases in agricultural productivity and hundreds of millions of environmental refugees.[7]

In view of the energy crisis and environmental problems related to fossil fuels, in recent years the Chinese government has shown serious commitment to improve energy efficiency and develop renewable and so called "clean energies", including nuclear energy. For the first time in the history of the PRC, the 11th Five-Year Plan (2006 – 2010) sets a goal on reducing energy consumption: 20 percent per unit GDP by 2010. In addition, in November 2009, China's chief climate negotiator and deputy director of the National Development and Reform Commission (NDRC) Xie Zhenhua unveiled the target to reduce CO_2 emission intensity per unit GDP by 40-45 percent from 2005 levels by 2020.[8] China aims to increase the share of non fossil energies in the energy portfolio up to 15 percent, which translates into an increase of the share of nuclear energy to five percent from a present 2.5 percent. Though compared to some Western nations (for example France) China's share of nuclear power remains relatively modest, the aimed increase will equal at least the construction of 30 additional nuclear power plants by 2020. This will make China the last nation with considerable de-

4 BP Statistical Review of World Energy, June 2010, www.Bp.com, accessed 10 July, 2010

5 BP Statistical Review of World Energy, June 2010, p.32

6 World Bank, State Environmental Protection Administration (2007): Cost of pollution in China. Economic Estimates of Physical Damage. P. xiii

7 IPCC Fourth Assessment Report, Chapter 10 Asia, 2006, p .472-487

8 South China Morning Post 27.11.09 „Mainland unveils carbon target"

velopment of the nuclear power sector at present and in the near future.

Organisation

Just like the energy sector as a whole, the nuclear energy sector is controlled by the state. The China Atomic Energy Authority (CAEA) is the chief agency in charge of civil nuclear programs and international cooperation. CAEA is also the responsible institution for conducting feasibility studies for planned nuclear power plants. It is also in charge of radioactive waste disposal.The National Development and Reform Commission (NDRC) sets the targets for energy development (including the share of nuclear power). All planned projects need be approved by NDRC. The Science, Technology and Industry for National Defence Commission (STC) oversees the facilities for nuclear fuel production, recycling and radioactive waste management.

The National Nuclear Safety Administration supervises safety regulations and the compatibility with international agreements, whereas the Department for Nuclear Safety of the Ministry for Environment (MEP) oversees health and environmental impacts and is charge of regulations for nuclear waste disposal. The implementation of waste management lies in the responsibility of the nuclear companies with the Beijing Research Institute of Uranium Geology (BRIUG) as the lead institute for exploration of repository sites for deep geological disposal of high-level radioactive waste.

The nuclear power industry sector is dominated by two state-owned corporations, namely the China National Nuclear Corporation (CNNC) and the China Guangdong Nuclear Power Corporation (CGNPC), the latter being a joint venture with the Hong Kong energy company China Light and Power. Beside nuclear power plant construction and operations, CNNC is also involved in research and development, uranium exploration and mining, enrichment, fuel fabrication, reprocessing and waste disposal. CNNC's subsidiary China Nuclear Energy Industry Corporation (CNEIC) is in charge of uranium fuel trading. Only recently, two other corporations, the China Power Investment Corporation and China Huaneng, one of the leading power companies in China, have been approved to built and operate nuclear power plants. So far there has been only one joint venture with a Western energy company. The Guangdong Taishan Nuclear Power Joint Venture Company belongs to CGNPC with a share of 30 percent held by Electricité de France (EdF). The joint venture builds, owns and will operate the Taishan nuclear plant which is currently under construction in Guangdong Province.

Development and Present Status of China's Civilian Nuclear Programme

When starting its civilian nuclear program in the early 1980s, China could rely on military research and facilities of its nuclear weapons program, in which the country had been involved since the 1950s. In 1958, the first research and development facility nuclear weapons was built in Haiyan County near Qinghai Lake, Qinghai Province, today also known as Atomic city (*Yuanzicheng*). Chinas's first atomic bomb was developed here and successfully detonated on October 16, 1964, making China the 5th nuclear power in the world.

China's civilian program for nuclear power generation began in the early 1980s with the homegrown design and construction of a 300 MW pressurized water reactor (PWR). Since 1985, the Qinshan Unit 1 plant was constructed about 100 km southwest of Shanghai in Zhejiang Province. Commercial operation of China's first nuclear power plant started in 1991. Also during the mid 1980s, the larger Daya Bay Nuclear Power Plant in Guangdong Province was projected. During the planning phase, environmental activists in Hong Kong collected about one million signatures protesting against construction of a nuclear power station only 50 km from their border, but their protests were ignored by authorities in Beijing. Unlike Qinshan Unit 1 the project was realized with foreign technology. Daya Bay Units 1 and 2 are equipped with PWR units of 984 MW supplied by the French company Framatome (today Areva). Daya Bay was mainly designed for supplying Hong Kong. When the two reactors began their commercial operation in 1994, they transmitted 70 percent of the power generated to Hong Kong, 30 percent were designated for the supply of Guangdong Province.

During the 1980s nuclear energy development had influential supporters within the government. Premier Li Peng, an engineer and energy expert, was one of the strong promoters of early nuclear power projects. He also managed to find key positions in the nuclear power business for some of his family members. For many years, Li's wife Zhu Lin held the position of general manager of the China Guangdong Nuclear Power Corporation, the company running Daya Bay and other nuclear projects in Southern China.[9]

Nevertheless, up to the late 1990s, China's nuclear industry saw only modest development. Starting in 1997 as a result of the Asian crisis and the decline in energy demand, many planned projects were put on hold because of concerns of excess capacity, safety and the high costs of nuclear power. Plans to develop nuclear power industry were only were resumed with the 10th Five-Year-Plan (2001-2005), which explicitly incorporated the development of nuclear energy as one major goal within China's energy strategy. The 10th Five-Year-Plan included the construction of eight nuclear reactors (Lingao Phase II, Qinshan Units 3 and 4, Sanmen and Yangjiang). Development speeded up, when from 2003 onwards severe power shortages affected China's main industrial centers in the eastern coastal regions. The 11th Five Year Plan (2006-2010) included even more ambitious plans (14 units in total).

Since the beginning of this millennium, another ten reactors have been connected to the grid: Qinshan Units 2 A and B with Chinese designed reactors started operation in 2002 and 2004, respectively. Qinshan 3 A and B began operation in 2003 using Canadian CANDU units, and in 2002, Lingao Units 1 and 2, also located in Guangdong Province and equipped with 990 MW Framatome units similar to those in Daya Bay went into operation. In 2007, both units of the Tianwan power plant (equipped with Russian 1060 MW VVER light water pressurized reactors) were connected to the grid near Lianyungang, Jiangsu province. In September 2010 Lingao Phase 11 (Guangdong) started operation. By autumn 2010, 12 nuclear power reactors with a total installed capacity of 10.2 GW were in commercial operation, and 24 were under construction.[10]

(see Annex 1 and 2 at page 9 and 10)

All nuclear construction sites are located in the densely populated eastern coastal areas, but inland regions are eager to join. For the coming 12th Five Year Economic Program (2011- 2015) it is expected that the nuclear power projects for inland regions will be included. Development plans have been adjusted repeatedly. In July 2009, the State Council was quoted as considering reaching a target of 80 GW installed capacity (an eightfold increase compared to 2010) and 18 GW under construction by 2020. According to NDRC targets, nuclear generating capacity could already reach as much as 160 GW by 2030.

Technology and Policies for Developing the Nuclear Energy Sector

From its beginning, China's nuclear power sector has been relying both on home grown as well as international technologies from Canada, France, Russia and recently the USA. So far, PWR technology mainly has been used, with three reactors designed in China (Qinshan 1, 2 and 3); four reactors purchased from France (Daya Bay and Lingao), two reactors of Canadian design (Qinshan 4 and 5) and two Russian designed pressurized water reactors (VVER 1060). Qinshan 4 and 5 are Canadian CANDU-6 pressurized heavy water reactors. The two plants in Sanmen and Haiyang presently under construction will be equipped with four "third generation design" AP 1000 reactors (Westinghouse Electric, now owned by Toshiba).[11] China will be the testing ground where "third generation" reactors go into commercial operation for the first time. In exchange, Westinghouse agreed to transfer the AP 1000 technology to China. This deal will allow China to build its own third generation PWR reactors derived from the AP 1000 design. In October 2008, a similar agreement between the French Areva and CGNPC about the technology transfer of the EPR (European Pressurized Reactor) and PWR plants were signed.[12] Though CNNC's indigenous development of a second generation CNP 1000 technology (based on the technology used in Qinshan) is reportedly put on hold, most nuclear plants under construction will be equipped with CGNPC's CPR 1000 type, derived from Areva design and for which Areva maintains the intellectual property rights.

Qinghua University's Institute of Nuclear Energy has developed a test 10 MW high-temperature gas-cooled reactor (HTR-10), also called pebble bed modular reactor (PBMR), which started operation in 2000 and remains the only operational PBMR in the world.[13] The technology is based on an earlier German development and was introduced by Chinese engineers trained at

[9] Nowadays Li Xiaopeng, Li Peng's son, is the director general of the China Huaneng Group, a company that recently set up several nuclear power projects.

[10] *China Daily, 2July 2009,* www.chinadaily.com.cn/2009-07/02 accessed 11 August 2009 and http://www.world-nuclear.org/info/inf63.html accessed 4 September 2010

[11] "Third generation"reactors are expected to have a longer operational life (60 years compared to 40 of "second generation" types) and improved safety provisions.

[12] http://www.world-nuclear.org/info/inf63.html accessed 2 December 2009

[13] Durnim 2007

the Juelich Research Institute in Germany.[14] In 2006, the State Council announced that the small reactor is a high priority project for the coming 15 years. By October 2010, the China Huaneng Group scheduled to start construction of the first two reactor modules (210 MW) of a demonstration HTGR plant in Shidaowan, Shandong Province. Long term plans include construction of another 18 modules (total 3800 MW. Analysts are predicting the PBMR technology to be widely introduced in the future as it is less costly than traditional nuclear power technology and can be factory built. They are regarded as useful support modules especially for the energy intensive process of seawater desalinsation. And the gas cooled reactors could also operate in water scarce regions where sufficient access to cooling water has so far limited nuclear development plans.[15]

While countries such as Germany closed down their fast breeder programs because of the potential environmental risks related to Plutonium extraction, China - with Russian assistance - is pursuing the development of "fourth generation" fast neutron reactors (FNR). A 65 MW test reactor is already under construction near Beijing. In October 2009, Chinese and Russian governments officially agreed on further cooperation in developing the Russian BN-800 technology.[16] By 2012, CNNC plans to start construction of a 800 MW reactor near Sanming City, Fujian Province.[17]

Uranium Resources, Mining, Enrichment and Fuel Fabrication

China has reserves of an estimated 100,000 t(U) uranium, which on the long run will not be sufficient for the ambitious development plans of the nuclear industry. China's first eight uranium mines were established in the first phase of military nuclear development during the years from 1962-65. Over the years a total of 26 mines have been established. In the course of an extensive reorganization some of the inefficient mines were closed down between 1984 and 1999. The current production for civilian use of 840 tons uranium from five local mines in Western China (Xinjiang Autonomous Region, Shaanxi, Guangxi, Liaoning) meets about half the actual demand, the remaining half has to be imported from Kazakhstan, Russia and Namibia, and starting in 2010 also from Jordan.[18] China plans to increase domestic uranium production to 2,000 tons a year until 2020.[19] However, Zhou Zenxing, head of the uranium development unit of CGNPC, estimates that his company alone will need more than 10,000 tons by 2020.[20] An agreement on Nuclear Transfer and Nuclear Cooperation signed in 2006 between China and Australia, which holds 40 percent of the world's uranium reserves, helped solve China's worries about sufficient uranium supplies. The agreement allows Australia to supply the lacking uranium to China.[21] The China Nuclear International Uranium Corp. (SinoU) is also active in uranium exploration in Niger, Kazakhstan, Mongolia and Algeria. In addition, Canada and South Africa are potential suppliers. Increasing dependence on imported uranium will expose China's nuclear energy sector to the price dynamics of international markets, which already react to China's nuclear development plans by recommending to heavily invest into uranium mines.

Uranium enrichment is undertaken either within China or by the European URENCO. Within China, facilities in Chengdu (Sichuan Province), Lanzhou (Gansu Province) and Hanzhong (Shanxi) provide uranium enrichment for civilian purposes. Fabrication of PWR fuel is done at a plant in Sichuan Province, another plant in Inner Mongolia is designated to provide PHWR fuel for the CANDU type plants.

Used fuel Storage, Reprocessing and Disposal of Nuclear Waste

With the growing number of nuclear plants in China, the question of nuclear waste storage has become an increasingly important issue. At present, low-level waste is stored in stainless steel casks and disposed of at regional facilities near the nuclear plants. High level-nuclear waste is stored directly at the reactor sites. A centralized storage facility with an initial capacity of 550 tons of fuel has been in operation since 2000 near Lanzhou (Gansu Province). As older plants such as Daya Bay have already used up their onsite storage facilities, spent fuel assemblies are transported overland by special trucks over a distance of 4000 km from Guangdong to

[14] Kadak 2006, p.5

[15] Durnim 2007

[16] http://www.world-nuclear.org/info/inf63.html accessed 2 December 2009

[17] Wall Street Journal 30.10.09

[18] http://www.world-nuclear.org/info/inf63.html accessed 2 December 2009. For 2010 it was expected that 700 tons of uranium will be shipped the mine in Jordan. Wall Street Journal 30.10.09

[19] Wall Street Journal 30.10.09

[20] Reuters 10.12.09

[21] South China Morning Post, 4.4.2006

Lanzhou.[22] Recycling and reprocessing is mainly done in France, but in 2006, a pilot reprocessing plant with a capacity of 50 t per year started operation in China. A larger reprocessing plant is projected for 2020. In 2007, French Areva and CNNC signed an agreement on setting up a reprocessing plant for used fuel and mixed-oxide.

Like most other nuclear power nations, China has to date not set up a site for permanent nuclear waste disposal. Since 1985 a nationwide screening was conducted to find potential repository sites, since 1990 at the most promising sites an area screening is underway. The three proposed granite sections (Jiujing, Xianyangshan Xinchang and Yemaquan) are located in an uninhabited desert area in the Beishan region in western Gansu province, North-Western China.[23] The terrain is rocky and the location in an elevation between 1,400 and 1,600 m above sea level with an average precipitation of 70 mm and 3000 mm/a evaporation. Year long surface water does not exist in the area. Since 1999 surface geological, tectonic evolution hydrological and geophysical surveys and borehole drilling has been conducted in the three sites. At a second step an underground laboratory will be built at the selected site by 2020 and the construction of the final repository is expected to start by 2040. Disposal is expected to start by 2050.[24]

Nuclear Safety

In June 2010 a report by the Hong Kong based Radio Free Asia quoting an unidentified expert about a radioactive leakage incident at the Day Bay nuclear power plant caused some disconcertment and irritation in Hong Kong and mainland China.[25] The Hong Kong operating company CLP immediately assured that this had been a minor incident with a "very small leakage" from a fuel rod with no radiation escaping the building. Hong Kong authorities confirmed that 10 radiation sensors in Hong Kong had not detected any increases since the leakage occurred reportedly on May 23.[26] However, the report launched a debate about nuclear safety and the transparency of the Chinese nuclear industry and its authorities. Although according to the China Atomic Energy Authority "China established a safety and supervision management system and nuclear safety standards in line with international standards. A three-level nuclear accident emergency management system is in place…"[27] The details about this system have not been made public.

As China joined the civilian nuclear power community relatively late, all Chinese nuclear power plants have been equipped with post-Chernobyl technology and just like other countries worldwide, Chinese civilian nuclear power plants are regularly inspected by the World Association of Nuclear Operators (WANO) and the International Atomic Energy Agency (IAEA). So far, no accidents of abnormal releases of radioactivity and only few other technical and operational problems of Chinese reactors have been reported. However, according to Zhou Shirong, deputy director for nuclear safety at the Ministry for Environmental Protection, his department is concerned about safety standards in older facilities, a shortage of sufficiently trained staff to operate and maintain the rapidly increasing number of nuclear plants, unclear policies for nuclear waste management, numerous and dispersed potential radiation sources and a weak infrastructure to respond to nuclear incidents.[28] Despite impressive results in nuclear research, the country is still lacking well-trained engineers and researchers to adequately staff power plants and monitoring stations. According to the Science and Technology Commission the country needs to train at least 13,000 specialists to adequately staff the nuclear sector in the near future.[29]

More severe are safety concerns about the nuclear facilities in the inland provinces. Uranium mines, most of them located in the less developed regions of the country, are reported to be causing environmental pollution and health risks. Cases of radiation poisoning affecting local residents have, for example, been reported from uranium Mine No. 792 in Diebu County, Gannan Tibetan Autonomous Prefecture, Gansu Province.[30] In the

[22] Kadak 2006, p.14

[23] The Beishan granite site is located north of the Lanzhou-Urumqi railway line, about 150 km north of Jiayuguan and 50 km north-east of Yumen City

[24] Wang et. al 2006

[25] Radio Free Asia: „Plant Accused of Stalling“

[26] Bradsher (2010)

[27] China Atomic Energy Authority 2004:3

[28] Meng Dengke, Cao Haidong 2010

[29] Kadak 2006, p. 5

[30] The mine opened in 1967, was run by the military, and milled between 140 and 180 tons of uranium bearing rocks annually. Although in 2002, the mine was officially closed down, according to locals it managed to continue operation as a privately owned mine. Sun Xiaodi, a former employee repeatedly travelled to Beijing and met with foreign journalists to make the case public. In 2006, for his courage he was awarded with the Nuclear-Free-Future Award. In China this international publicity did not help his case. Under accusation of revealing state secrets he has been repeatedly detained and in 2009 was sentenced for two years to a

event of natural disasters, civilian and military nuclear facilities in the inland provinces are a potential high risk. In 2008, official reports were quick to assure that the nuclear facilities in Sichuan survived the devastating earthquake without major releases of radioactivity, although at least one research reactor is located in Mianyang near the epicentre of the 2008 Wenchuan earthquake .

Nuclear Industry, Government and Civil Society

In the past, the Chinese media have reported about anti-nuclear protests and accidents in nuclear power plants in foreign countries. The Chinese public is therefore relatively well informed about Chernobyl, accidents in Japanese nuclear power plants, anti-nuclear rallies in Taiwan, international protests against Taiwan's nuclear waste shipments to North Korea and the Stop-Castor campaign in Germany. However, when it comes to the planned massive development of nuclear industries within China, local media are quick to assure that nuclear power is a clean and safe energy source. Although China has seen a promising development of environmental NGOs in recent years with countless groups mushrooming all over the country, none of them have so far openly addressed concerns related to nuclear safety. Only recently, a few citizens have raised their voices against nuclear power projects. However, criticism against these projects is related to general environmental impacts but so far has not openly addressed specific issues such as nuclear safety and nuclear waste disposal.

For example Wen Bo, an environmental activist himself, reports about protests against the Hongheyan Nuclear Power Plant in Changxing Island, Liaoning Province. The plant is built on an island that has always been the breeding ground of the endangered spotted seal as well as an important resting place for migratory birds. Before construction of the nuclear power plant started the local environmental bureau was not consulted. Local officials later leaked information to environmentalists that no adequate environmental impact assessment (EIA) report had been submitted. Despite protests local authorities lacked the power to put the project on hold.[31]

In another case, concerned citizens initiated a petition campaign against three proposed nuclear plants in the vicinity of the popular seaside resort Silver Beach in Shandong Province. The campaign managed to collect several hundred signatures, which were sent to Prime Minister Wen Jiabao and the State Environmental Protection Administration (SEPA). [32] In December 2007, SEPA reported on their website that the planned Hongshiding nuclear power plant had not yet submitted the EIA application, Therefore the developers were requested organize a public hearing. [33] Obviously the project has been deferred and by November, 2010 construction has not started at all.[34]

Environmental activists as well as environmental authorities are especially worried about observed changes of the maritime environments in the vicinity of nuclear plants. Long-term monitoring in Daya Bay revealed that warm wastewater discharge from the nuclear plants Daya Bay and Lingao caused a substantial increase in surface water temperature: about 1.1 C° in the Bay and as much as 8-9 C° in the vicinity of the plants. Along with increases in water temperatures and pollution, a decrease in species, coral bleaching and an increase of harmful algal blooms have been observed.[35]

Similar concerns were raised by citizens in the vicinity of a projected inland nuclear power plant at the upstream of Han River in Guangdong Province who were interviewed by the researcher Xiang Fang 2008. The majority of interviewees opposed the project because of possible negative environmental side effects such as an increase of surface water temperature. The citizens approached their local delegates of the provincial people's congress to protest against the project. In early 2007, the Guangdong People's Congress responded to the delegates questions simply by assuring that the planned nuclear power plants would be safe and indicating that preparations for the project will continue. Four months later, though, the Guangdong Development and Reform Commission decided to postpone the project until 2015, a decision that might have been

"Reeducation through labor camp "
www.nuclear-free.com/english/frames7.htm,
http://www2.ohchr.org/english/bodies/hrcouncil/docs/7session/A-HRC-7-21-Add1.pdf

31 Wen Bo 2007, p. 106

32 Wen Bo describes this a typical NIMB (not in my backyard) protest. Wen Bo 2007, p. 2007

33 South China Morning Post 2.12.07

34 http://www.world-nuclear.org/info/inf63.html accessed 6 Sept. 2010

35 Wang Youshao et.al 2008 and Yu Jing et.al 2007

influenced by the intervention of local politicians.[36]

Though official Chinese media at first did not report about the recent Daya Bay leakage in May 2010, the incident obviously caused public attention in China, not only near Daya Bay but also in other regions where nuclear power plants are planned or under construction. On July 1, 2010 the Guangzhou based newspaper *Southern Weekend (Nanfang Zhoumo)* reported that the leakage has caused heated internet debates of a group of citizens opposing a planned nuclear plant in Xinyang (Henan province). The paper also quoted experts stating that people are afraid of nuclear power plants because they associate it with the atomic bomb and do not know enough about civilian use of nuclear power. The article also suspects that a lack of information and transparency leads to public mistrust and opposition to nuclear power. However the same article also quotes Li Ganjie, director of the National Nuclear Safety Administration under the Ministry of Environmental Protection: "If expansion is too rapid, problems will arise, thus threatening the quality and safety of nuclear construction."[37]

Outlook

During the past five years, unlike any other country in the world, China pursued a massive expansion of its nuclear power sector. The main motivation for nuclear energy development comes from the need for a fast increase in energy supply, especially in the booming eastern coastal areas. In some regions such as the provinces Guangdong and Zhejiang, nuclear power plants are presently already producing more than ten percent of the consumed electricity and this share is expected to rise. In addition, environmental and climate protection have become powerful arguments for promoting nuclear power development. Chinese authorities keep praising nuclear power as a "clean energy" that helps to reduce the country's dependency on coal as primary energy source. Development of nuclear power is thus seen as a promising strategy to realize the country's aim to reduce CO_2 intensity per unit GDP.

Although for the coming 12th Five_Year-Plan (2011-2015) as many as 16 provinces have announced their intention to build nuclear power plants, the chances for nationwide expansion of nuclear power generation are limited. Apart from financial constraints at the present state of technological development, nuclear power is no real option for water scarce regions in Central and North-Western China, where access to cooling water remains a problem.

Access to uranium resources is another limiting factor to nuclear development beyond the already projected plans. Chinas domestic uranium mines are only sufficient to supply half of the required uranium. Thus growth of the nuclear sector will go hand in hand with an increasing dependency on international uranium markets.

The major challenge for the nuclear sector though is to find a solution for the permanent disposal of nuclear waste. Just like other nuclear economies, China has not been able to solve the question of how to guarantee the long term (100,000 year) safety of repository and has to prevent disposed radioactive waste from affecting the natural environment and human beings. The exploration of possible underground disposal sites has only just begun.

In addition, development of nuclear power does not come without environmental costs, safety risks and related social costs. For the time being, safety issues and questions about nuclear waste management are not openly discussed and nuclear managers are quick to assure that state-of-the-art technology is in place and international safety regulations are observed. As long as transparency and access to information is not given, safety concerns remain. This encompasses all kinds of nuclear facilities such as uranium mines, enrichment, fuel fabrication, temporary storage and recycling facilities, and especially those facilities that are located in the less developed western parts of the country. The transportation of used fuels overland by special trucks from the nuclear plants at the east coast to the temporary storage site in Lanzhou is another source of safety risks. In the coming years, China will need to train tens of thousands of technicians and inspectors required to operate and monitor the increasing number of nuclear facilities. There is not only a need for technical training, but also for the creation of a safety culture which includes awareness for safety issues and the willingness to report irregularities to superiors.

So far, the Chinese environmental activists just started to raise questions related to the nuclear safety issue. With the expansion of the nuclear program authorities will have to face increasing protests by locals living in the neighbourhood of planned nuclear projects.

[36] Xiang Fang 2008, p. 151-156

[37] Meng Dengke (2010)

Annex 1: Nuclear power reactors in operation

Units	**Province**	**Net Capacity**	**Type**	**Operator**	**Commercial Operation**
Daya Bay 1&2	Guangdong	944 MW	PWR, France	CGNPC	1994
Qinshan Phase 1	Zhejiang	279 MW	PWR, China	CNNC	1994
Qinshan Phase II, 1 & 2	Zhejiang	610 MW	PWR, China	CNNC	2002.2004
Qinshan Phase III. 1 &2	Zhejiang	665 MW	PHWR, Canada	CNNC	2002, 2003
Lingao 1 & 2	Guangdong	935 MW	PWR, France	CGNPC	2002, 2003
Tianwan 1 & 2	Jiangsu	1000 MW	PWR (VVER), Russia	CNNC	2007
Lingao Phase II, 1	Guangdong	1037 MW	PWR, France	CGNPC	Oct. 2010
Total		**10234 MW**			

CGNPC = China Guangdong Nuclear Power, CNNC= China National Nuclear Corporation
PWR= Pressurized Water Reactor
PHWR = Pressurized Heavy Water Reactors
Source: World Nuclear Association (2010), www.world-nuclear.org/info/inf63.html

Annex 2: Nuclear power plants under construction (as the end of 2010)

Facility / Unit	**Province**	**Capacity**	**Reactor Model**	**Operator**	**Begin of Construction**	**Targeted Date of Commer-cialOpera-tion**
Lingao Phase II, Units 1&2	Guangdong	2x 1080	CPR-1000	CGNPC	12/05, 5/06	12/10, 8/11
inshan Phase II, Units 3&4	Zhejiang	2x650	CNP-600	CNNC	4/06, 1/07	2011,2012
Hongyanhe Units 1-4	Liaoning	4x1080	CPR-1000	CGNPC	8/07, 4/08, 3/09, 7/10	10/12, 2014
Ningde Units 1-4	Fujian	4x1080	CPR-1000	CGNPC	2/08, 11/08, 11/09, 7/10	12/12-2015
Fuqing Units 1&2	Fujian	2 x 1080	CPR-1000	CNNC	11/08, 6/09	10/13, 8/14
Yangjiang	Guangdong	4 x 1080	CPR-1000	CGNPC	12/08, 8/09, 7/10, 3/11	8/13- 2016
Fangjiashan Units 1&2	Zhejiang	2 x 1080	CPR-1000	CNNC	12/08, 7/09	12/13, 10/14
Sanmen Units 1&2	Zhejiang	2 x 1100	AP 1000	CNNC	3/09, 1/10	10/13, 10/14
Haiyang Units 1&2	Guangdong	2 x 1100	AP 1000	CPI	9/09, 6/10	5/14, 3/15
Taishan Units 1 &2	Guangdong	2 x 1700	EPR	CGNPC	10/09, 4/10	12/13, 11/14
Fangchenggang Units 1 & 2	Guangxi	2x 1080	CPR-1000	CGNPC	7/10	2015
Changjiang units 1 & 2	Hainan	2 x 650	CNP-600	CNNC & Huaneng	4/10	2014,2015
Shidaowan	Shandong	210	HTR-PM	China Huaneng	9/09 or 1/10	2013 or 2014

Abbreviations:
CGNPC = China Guangdong Nuclear Power,
CNNC= China National Nuclear Corporation
CPI= China Power Investment Corporation
Source: World Nuclear Association (2010), www.world-nuclear.org/info/inf63.html

References:

"2006 Nuclear-Free Future Resistance Award – Sun Xiaodi, China" www.nuclear-free/english/frames7.htm accessed 6 December 2009

BP: BP Statistical Review of World Energy June 2010. www. Bp.com/statistical review

Bradsher, Keith: „Chinese Nuclear Plant Experienced a Small Leak Last Month, a Stakeholder says" www.nytimes.com, accessed 6.9.10

Bundesanstalt für Geowissenschaften und Rohstoffe (BGR), Rohwirtschaftliche Länderstudien Heft XXVI: China. Kohle, 2003

China Atomic Energy Authority: "Present Situation and Development Prospect of Peaceful Uses of Nuclear Energy in China", Beijing Review, Oct. 14, 2004

China Daily, 2July 2009: "Nuclear Power to rise 10-fold by 2020 www.chinadaily.com.cn/2009-07/02 accessed 11 August 2009

Durnim, Matthew: „China's Nuclear Future", China Security Vol. 3, No.4 Autumn 2007, p. 129 -132

IPCC Fourth Assessment Report (2006), Chapter 10, Asia, p. 471- 497

Joerss, Martin and Jonathan R. Woetzel, Zhang Haimeng: „China's green opportunity", May 2009, Mc Kinsey Quarterly, http://www.mckinseyquarterly.com accessed 29 May 2009

Kadak, Andrew: "Nuclear Power: Made in China", 2006, http://web.mit.edu/pebble-bed/papers1_files/Made%20in%20China.pdf accessed 13 August 2009

Liu Yunyun: „Clean Power on Tap. China adapts the most advanced nuclear power technologies to meet long-term energy needs" , Beijing Review, Vol. 52, No.29, July 23, 2009, p. 28 -29

Liu Yunyun: "Clean Energy – The Ultimate Solution" (Interview with Zhou Dadi, Director general Emeritus of the Energy Research Institute of the National Development an Reform Commission) in Beijing Review, Vol. 52, No.29, July 23, 2009, p.30-31

Meng Dengke: "Panic stations", August 23, 2010 www.chinadialogue.net/article/show/single/en/3785-Panic-stations.html accessed 6.9.10

Meng Dengke, Cao Haidong: Demystifying nuclear power, August 24, 2010 www.chinadialogue.net/article/show/single/en/3785-Demystifying-nuclear-power.html accessed 6.9.10

National Bureau of Statistics of China: China Statistical Yearbook 2009. Beijing 2009

Radio Free Asia 15.6.2010: "Plant accused of Stalling" www.rfa.org/english/news/china/leak-06152010171943.html accessed 6.9.2010

Reuters 10.12.2009: "China struggles to fuel its nuclear energy boom" http://www.reuters.com/article/idUSPEK20761020091210?type=marketsNews accessed 13.12.09

South China Morning Post 12.12.07 "Nuclear Power Plant on drawing board still not approved"

South China Morning Post 4.4.09 "Focus on free trade after uranium deal"

South China Morning Post 27.11.09 „Mainland unveils carbon target"

Wall Street Journal 30.10.09 "China Plans to Build Advanced Nuclear Power Plant" http://online.wsj.com/article/SB125683823531916471.html accessed December 10, 2009

Wang Ju, Lin Sen, Li Cheng : "Deep Geological Disposal of High-Level Radioactive Waste in China: A Three Step Strategy and Latest Progress" in Witherspoon, P.A, Bodvarsson, G.S.: Geological Challenges in Radioactive Waste Isolation, 4th World Wide Review, Earth Science Division, Berkeley National Laboratory 2006

Wang Youshao, Lou Zhiping, Sun Cuici, Song Sun: "Ecological Environment Changes in Daya Bay, China from 1982 to 2004, in Marine Pollution Bulletin 56 (2008), p. 1871-1879

Wen Bo: "A call for transparency: China's emerging anti-nuclear movement", in China Environment Series, Issue 9, 2007, p. 106-109

World Bank, State Environmental Protection Administration (2007): Cost of pollution in China. Economic Estimates of Physical Damage. Online available at www.worldbank.org/eapenvironment

World Nuclear Association: Nuclear Power in China. http://www.world-nuclear.org/info/inf63.html accessed September 6, 2010

Xiang Fang: "Citizens Finding a Voice: Bottom-up Politics in China's Nuclear Power Debate", in China Environment Series Issue 10, 2008, p. 151-156

Xu Guoqing, Wang Ju, Zheng Hualing, Sun Donghui: "Deep Geological Disposal of high Level Radioactive Waste in China" in in Witherspoon, P.A, Bodvarsson, G.S.: Geological Challenges in Radioactive Waste Isolation, 2nd World Wide Review, Earth Science Division, Berkeley National Laboratory 1996 Yu Jing, Tang Danling, Wan Sufen, Lian Jianshen, Wang Youshuo: "Changes of Water Temperature and Harmful Algal Bloom in Daya Bay in the Northern South China Sea", Marine Science Bulletin, 2007, Vol.9, No. 2, p. 25-32

Yu Jing, Tang Danling, Oh Im-Sang, Yao Lijun: "Response of Harmful Algal Blooms to Environmental Changes in Daya Bay, China" in Terr.Atmos.Ocean.Sci 2007, Vol. 18, No.5, p. 1011-1027

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