Washington International Law Journal

Volume 21
Number 3 *The Future of Nuclear Power in East Asia*

6-1-2012

Will China's 12th Five Year Plan Allow for Sufficient Nuclear Power to Support Its Booming Economy in the Next Twenty Years?

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WILL CHINA'S 12TH FIVE YEAR PLAN ALLOW FOR SUFFICIENT NUCLEAR POWER TO SUPPORT ITS BOOMING ECONOMY IN THE NEXT TWENTY YEARS?

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Abstract: A major part of China's 12th Five Year Plan focuses on energy conservation and environmental protection. Its 12th Year Environmental Plan provides that China will increase its nuclear capacity by 30% from 2010 levels of 10.8 gigawatts to 43 gigawatts in 2014. Two questions arise from this plan. First, will enough energy be produced from other sources to supply the country's energy needs or will there be the need for an expansion to its nuclear program? Second, are the locations of its nuclear power plants safe in light of the disaster at the Fukushima nuclear power plant in Japan following the tsunami in early 2011?

I. INTRODUCTION

The People's Republic of China, with its dependence on fossil fuels for its increasing energy needs, is on the cusp of an energy crisis due to the finite life of this form of energy. Coal, on which China relies for 80% of its energy, is predicted at current usage levels[1] to last 118 years.[2] The Chinese government is well aware of the need to focus on other sources of energy apart from coal. At the People's Congress on March 5, 2011, Premier Wen Jiabao reported on the work of the government when the 12th Five Year Plan ("Plan") was announced, and stated that the Chinese government has to improve energy efficiency and move to cleaner energy production.[3] A number of related issues were also addressed in Wen's report, such as the need to invest in improving energy conservation in buildings and build low carbon cities in the future. Wen also stated that China will adapt to climate change and respond to extreme climate events by establishing monitoring systems for greenhouse gas emissions.[4] Renminbi ("RMB") 51.8 billion is

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[1] Donald Mann, *How Long Will Coal Last*, NEGATIVE POPULATION GROWTH www.npg.org/commentsmay2007COAL.html (last visited Mar. 30, 2012).

[2] *Coal*, WORLD COAL ASSOCIATION, http://www.worldcoal.org/coal (last visited Mar. 30, 2012).

[3] PREMIER WEN JIABAO, REPORT ON THE WORK OF THE GOVERNMENT 23 (2011), *available at* http://online.wsj.com/public/resources/documents/2011NPCWorkReportEng.pdf.

[4] *Id.* at 25.

to be put aside to invest in strategies to conserve energy and reduce greenhouse gas emissions.[5]

Part of the Plan requires increased investment in nuclear energy capacity, growing from 1.4% to 4% by 2020.[6] This initiative was a cause for concern following the Fukushima Daiichi disaster in Japan in March 2011, when a 9.0 magnitude earthquake and fourteen-meter tsunami caused the emission of dangerous levels of radioactivity from the nuclear reactor that is owned and operated by the Tokyo Electric Power Company ("TEPCO").[7] The reactors are General Electric Boiling Water Reactors, which came into operation between 1971 and 1979, so they are of a fairly old design.[8]

Though the world reacted to the Fukushima disaster by questioning the safety and ongoing use of nuclear energy, the effect on China's nuclear energy program was negligible.[9] The day after the disaster, the Vice Minister of Environmental Protection, Zhang Lijun, stated that China would continue with its nuclear program.[10] Even though Premier Wen Jiabao had organized an ad hoc committee to review China's nuclear program and announced the suspension of nuclear projects pending a review of safety issues,[11] on March 26, 2011 the government confirmed its commitment to its nuclear program.[12] Tian Shujia, the Director of Nuclear Safety under the Ministry of Environmental Protection, stated that China would not abandon its plants over fear of slight risks.[13] However, China will have reduced its program by ten gigawatts ("GW") by 2020, not for safety reasons, but because the original one-hundred GW plan was considered unrealistic.[14] The Chinese government has stated that all reactors in operation in China are

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[5] BRUNSWICK GROUP CHINA, ANALYSIS OF THE FOURTH PLENARY SESSION 11TH NATIONAL PEOPLE'S CONGRESS: A REVIEW OF KEY ISSUES FOR THE 2011 LIANGHUI 13 (2011).

[6] ANDREW KADAK, NUCLEAR POWER: "MADE IN CHINA" 2 (2010).

[7] *See* JAPAN NUCLEAR INSTITUTE OF TECHNOLOGY, REVIEW OF ACCIDENT AT TOKYO ELECTRIC POWER COMPANY INCORPORATED'S FUKUSHIMA DAIICHI NUCLEAR POWER STATION AND PROPOSED MEASURES (2011), *available at* http://www.gengikyo.jp/english/shokai/Tohoku_Jishin/summary.pdf.

[8] Josie Garthwaite, *Would a New Nuclear Power Plant Fare Better than Fukushima?*, NATIONAL GEOGRAPHIC DAILY NEWS (Mar. 23, 2011), http://news.nationalgeographic.com/news/energy/2011/03/110323-fukushima-japan-new-nuclear-plant-design.

[9] Paul Joskow, *The Effects of Fukushima on the Construction of New Nuclear Power Plants*, EU ENERGY POLICY BLOG (Jan. 6, 2012), http://www.energypolicyblog.com/2012/01/06/the-effects-of-fukushima-on-the-construction-of-new-nuclear-power-plants/.

[10] Justin Bergman, *After Japan, Will China Scale Back its Nuclear Ambitions?*, TIME WORLD (Mar. 28, 2011), http://www.time.com/time/world/article/0,8599,2061368,00.html.

[11] Gregory Kulacki, *China Reacts to Fukushima*, MRZINE (Apr. 1, 2011), http://mrzine.monthlyreview.org/2011/kulacki010411.html.

[12] Bergman, *supra* note 10.

[13] Hooman Peimani, *Nuclear Energy in Asia: A Post Fukushima Perspective*, JOURNAL OF ENERGY SECURITY (May 31, 2011), http://www.ensec.org/index.php?option=com_content&view=article&id=309:nuclear-energy-in-asia-a-post-fukushima-perspective&catid=116:content0411&Itemid=375.

[14] Joskow, *supra* note 9.

safe, as they are diluted by the air and sea.[15] Though the head of China's National Energy Administration, Liu Tienan, commented that modern Generation III reactors are safer than the Generation I and II reactors located at Fukushima,[16] the reason for the disaster was the height of the tsunami.[17] Professor Ragheb has stated that the protective wall surrounding the plant was 6 meters in height, but the tsunami was 14 meters in height; the breakwater was breached and the plant drowned.[18] The damage resulted in the exposure of fuel rods for several hours before fire trucks could pump in emergency seawater in to cool the fuel rods.[19] The Chinese government has thus made it clear that it remains focused on increasing the number of nuclear power plants, though it made the concession to revise nuclear accident safety standards at existing plants.[20]

II. CHINA'S CURRENT AND FUTURE ENERGY STATUS

A. Assessment of China's Increasing Energy Needs

China's current primary energy sources are coal (80%), oil (2%), gas (1%), and hydropower (15%).[21] In 2010, China's energy use was 397,500 GW hours, up 14.69% from the previous year.[22] The breakdown of energy production at the end of 2010 shows that 707 GW of energy production came from coal, hydropower produced 213 GW, nuclear capacity produced 10.8 GW, and wind turbines produced 31 GW.[23] Though hydropower as a source of energy has increased significantly with the building of the Three Gorges Dam, which produces around 18,300 MW annually and which will increase when another six installed generators become operational in the near future.[24] The 2011 drought in Southern China reduced water levels; this

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[15] *See China Suspends Approvals For New Nuclear Plants*, CHINA DAILY (Mar. 16, 2011), http://www.chinadaily.com.cn/world/japanearthquake/2011-03/16/content_12182932.htm.

[16] *Id.*

[17] M. RAGHEB, FUKUSHIMA EARTHQUAKE AND TSUNAMI STATION BLACKOUT ACCIDENT 1 (2009).

[18] *Id.*

[19] *Id.* at 2.

[20] *Id.*

[21] *Nuclear Power in China*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/inf63.html (last updated Apr. 2012).

[22] *China's Power Generating Capacity Leaps Above 900 Mln Kilowatts*, ENGLISH.NEWS.CN (Sept. 20, 2010), http://news.xinhuanet.com/english2010/china/2010-09/20/c_13521557.htm [hereinafter *Capacity*].

[23] *Nuclear Power in China*, *supra* note 21.

[24] *The Three Gorges Dam China*, POWER-TECHNOLOGY.COM, http://www.power-technology.com/projects/gorges (last visited May 2, 2012).

in turn reduced hydroelectric capacity, a factor that is always present when electricity is produced through this medium.[25]

China's demand for energy is increasing rapidly, due to the needs of its massive population of over 1.3 billion and the increasing affluent middle class that seeks the Western lifestyle embracing gadgets and goods that rely on electricity.[26] In 2001, China accounted for 10% of global energy demand and was able to meet 96% of that figure with local energy supplies.[27] However, its demand for energy rose at a more rapid rate than economic output, so that by 2005 it became a net importer of energy for the first time.[28] Between 2002 and 2005, there was a 3.8% increase of energy use per unit of Gross Domestic Product ("GDP").[29] This was in spite of the 10th Five Year Plan having set a goal of a 15% to 17% reduction in energy use per unit of GDP between 2000 and 2005. By 2006, almost 50% of global energy demand growth was a direct result of China's growth.[30] By 2007, China's global energy use reached 16%, a startling figure that few had anticipated in the years preceding this dramatic increase.[31] In 2007, the United States International Energy Agency ("IEA"), in its 2007 World Energy Outlook, increased its estimate for China's projected 2030 energy demand to 3.8 billion tons of oil equivalent, an increase of 2.1 billion tons.[32]

B. Electricity Demand in China Compared to the United States

In 2009, the United States consumed 3,723,803 GW hours of electricity; by comparison China, consumed 3,253,185 GW hours in the same year.[33] However, China's population of 1.3 billion is four times that of the United States, which currently has a population of approximately 313 million.[34] Per capita figures produced by the EIA show that in 2006, per

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[25] Frank Holmes, *Coal Use in China Shines Light on Growth*, WALL STREET PIT (Apr. 29, 2011), http://wallstreetpit.com/72668-coal-use-in-china.

[26] Patricia Blazey & Peter Gillies, *China: Growth and its Challenges*, 6 MACQUARIE U. BUS. L. J. 253, 255 (2009).

[27] *Capacity*, *supra* note 22.

[28] Ross Garnaut & Ligang Song, *China's Resources Demand at the Turning Point*, *in* THE TURNING POINT IN CHINA'S ECONOMIC DEVELOPMENT 285 (Ross Garnaut & Ligang Song eds., 2006).

[29] Nan Zhou, Mark D. Levine, & Lynn Price, *Overview of Current Energy Efficiency Policies*, *in China*, 38 ENERGY POL'Y 6439 (2010).

[30] *Id.* at 6440.

[31] C. FRED BERGSTEN, CHARLES FREEMAN, NICHOLAS R. LARDY, & DEREK J. MITCHELL, CHINA'S RISE: CHALLENGES AND OPPORTUNITIES 137 (2008).

[32] *Id.* at 141.

[33] Figures taken from *International Energy Statistics*, U.S. ENERGY INFORMATION ADMINISTRATION, http://205.254.135.7/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=2 (last visited Apr. 11, 2012).

[34] *See China's Energy Demand*, ECOWORLD (May 19, 2007), http://www.ecoworld.com/energy-fuels/chinas-energy-demand.html; *U.S. & World Population Clocks*, UNITED STATES CENSUS BUREAU, http://www.census.gov/main/www/popclock.html (last visited Mar. 30, 2012).

capita consumption in millions of British thermal units per person was 276.2 in the United States, compared to 56.2 in China.[35] These figures reveal that the average American consumes twelve times more energy than the average Chinese person at this point in time. This will change in the future, as China further develops and its per capita GDP increases, allowing the population to purchase the electronic devices that the West takes for granted but which consume vast amounts of energy.

C. Current Fuel Sources for Energy Production in China

China predominately relies on coal power stations for electricity production and is now the largest consumer of coal in the world.[36] The demand will continue to increase with average short-term electricity growth predicted to increase by 15% per year and long-term growth in the region of 4.3% over the next fifteen years.[37] Current figures show that in the first quarter of 2011, electricity use had risen by 13.4% compared to the same period in the previous year.[38] In 2010, China consumed 2,616 metric tons of carbon equivalent ("MTCE") compared to the United States' consumption rate of 733 MTCE.[39] Taking the above figures into account, it is not surprising that concerns are raised about the security of supply, as this rate of coal consumption cannot be sustained indefinitely.[40] Even though China has ample supplies of thermal coal, it does not have ample supplies of metallurgical coal used to make concrete and steel and is reliant on imported coal.[41] The world's main coal deposits are located in five regions: the United States contains 27%; Russia, 18%; China, 13%; Europe and Eurasia, 11%; and Australia and New Zealand, 9%.[42] In 2007, these regions together produced 4.9 billion tons of coal.[43] However, given that world consumption of coal in 2003 was 10,561 million tons, and the annual growth rate is likely

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[35] *U.S. & World Population Clocks*, *supra* note 34.

[36] *Nuclear Power in China*, *supra* note 21.

[37] Holmes, *supra* note 25.

[38] *Id.*

[39] *Coal*, *supra* note 2.

[40] Richard Heinberg, *China's Coal Bubble . . . and How it Will Deflate the U.S. Efforts to Develop Clean Coal*, ENERGY BULLETIN (May 4, 2010), http://www.energybulletin.net/node/52684.

[41] Holmes, *supra* note 25.

[42] U.S. ENERGY INFORMATION ASSOCIATION, INTERNATIONAL ENERGY OUTLOOK 2011 79 (2011) *available at* http://www.eia.gov/oiaf/ieo/coal.html.

[43] NEIL WEMBRIDGE, DAVE BURBIDGE & ROSS WILDES, COAL PRICE AND AVAILABILITY STUDY REPORT FOR THE ELECTRICITY COMMISSION 4 (2009).

to escalate beyond the 2.5% growth rate recorded in 1990,[44] known world coal reserves could feasibly run out in 118 years.[45]

China operates vast numbers of coal-fired power stations. In 2008, the Wall Street Journal reported that a new coal-fired power station was being built every ten days in China.[46] The efficiency of China's power stations is questionable; many are very old and considered to be less than 25% as efficient as those operating in Britain.[47]

Local coal production is concentrated mainly in Northern China because it is not only easily accessible, but also cleaner, whereas in the South the coal tends to be high in sulfur and ash.[48] It is difficult to ascertain just how many coal mines operate in China because many are small and uneconomical, often closing down after short operational periods.[49] In 2006, it was estimated that there were about 17,000 coal mines in existence.[50] The above figure paints a very different picture from the 1980-2001 period when the Chinese government kept energy intensity levels to less than half of its GDP growth as a result of the rigorous monitoring of industrial energy use, the provision of financial of incentives for energy-efficient investment, and the promotion of energy conservation through education, research, and specifically-designed service centers.[51]

To summarize, the year 2011 witnessed China as the world's second largest energy consumer and the greatest emitter of greenhouse gases in the world due to its reliance on coal doubling since 2000.[52] China's share of the world's energy market has increased to 15% of global energy demand with an increasing reliance on overseas supplies of oil, gas, and coal.[53] The Australian Bureau of Agricultural and Resource Economics forecasts that by

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[44] Mann, *supra* note 1 (citing BP, BP STATISTICAL REVIEW OF WORLD ENERGY (2011)).

[45] *Coal*, *supra* note 2.

[46] Rowan Callick, *Coal Fired Power Heats Up China*, THE AUSTRALIAN—BUSINESS WITH THE WALL ST. J. (Mar. 17, 2008), http://www.theaustralian.com.au/business/mining-energy/coal-fired-power-heats-up-in-china/story-e6frg9df-1111115813288.

[47] Ben Webster, *China's Coal-Fired Power Stations 'Among the Least Efficient in the World'*, SUNDAY TIMES, Sept. 23, 2009.

[48] *See* NATHANIEL ADEN, DAVID FRIDLEY, NINA ZHENG, & ERNEST ORLANDO, CHINA'S COAL: DEMAND, CONSTRAINTS AND EXTERNALITIES 8-9 (2009), *available at* http://www.circleofblue.org/waternews/wp-content/uploads/2011/02/coal_bohai_report.pdf.

[49] Esteli Reyes, *Challenges for Effective Policy Implementation Toward a Sustainable Coal Sector in China* (China Environmental Science and Sustainability UBC Research Group, Working Paper No. 1, 2007), *available at* http://www.iar.ubc.ca/LinkClick.aspx?fileticket=F9_B-KMbNcc%3D&tabid=248&mid=640.

[50] *China to Close Another 7,000 Coal Mines Before '08*, CHINA DAILY (June 15, 2006), http://www.chinadaily.com.cn/china/2006-06/15/content_618094.htm.

[51] Zhou et al., *supra* note 29, at 6439.

[52] *See* ERIC MARTINOT & LI JUNFENG, WORLDWATCH INSTITUTES, POWERING CHINA'S DEVELOPMENT: THE ROLE OF RENEWABLE ENERGY 5 (2007).

[53] *Id.* at 4.

2050, China will have quadrupled the amount of power sourced from coal-fired stations, thus surpassing the United States as the world's biggest coal-based energy producer.[54] It is as a result of this scenario that the Chinese government sees the need both to move into renewable energy and to undertake a massive investment in nuclear energy.[55]

III. NUCLEAR ENERGY IN CHINA AND WORLDWIDE

A. Nuclear and Renewable Energy

Nuclear energy is clean, though not renewable; uranium cannot be reused once it is mined.[56] However, a small amount of uranium produces a considerable amount of energy.[57] The benefits are that it is relatively cheap, does not produce greenhouse gases, produces little waste, and above all, it is reliable.[58] The disadvantages are that the residue from its use requires difficult and lengthy periods of disposal in order for the dangerous radioactivity to diminish.[59] When the spent nuclear reactor fuel has been removed from a reactor, it is stored at the reactor site in large pools of water that cool the radioactive isotopes and prevent the environment from being irradiated.[60] Waste of this nature is stored for twenty to forty years and as time passes, the radioactivity decreases and the fuel can eventually be stored in dry storage in a geological repository or reprocessed.[61] Failure to properly store nuclear waste is a constant concern, and supervision of its safe storage must be vigilant.[62]

Along with nuclear energy, the Chinese government mandates an escalation into renewable energy in its 12th Five Year Plan 2011–2015,[63] thus following on from its 11th Five Year Plan, which fostered the rapid

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[54] ASIA PACIFIC ENERGY RESEARCH CENTRE, ENERGY IN CHINA: TRANSPORTATION, ELECTRIC POWER AND FUEL MARKETS (2004), *available at* http://www.ieej.or.jp/aperc/pdf/CHINA_COMBINED_DRAFT.pdf.

[55] APCO WORLDWIDE, CHINA'S 12TH FIVE YEAR PLAN: HOW IT ACTUALLY WORKS AND WHAT'S IN STORE FOR THE NEXT FIVE YEARS 6 (2010), *available at* http://www.apcoworldwide.com/content/pdfs/chinas_12th_five-year_plan.pdf.

[56] Andy Darvill, *Nuclear Power: Energy Through Splitting Uranium Atoms*, ENERGY RESOURCES, http://www.darvill.clara.net/altenerg/nuclear.htm (last visited Mar. 30, 2012).

[57] *Id.*

[58] *Id.*

[59] *Nuclear Energy: Energy From Uranium*, SOLARPOWERNOTES.COM, http://www.solarpowernotes.com/non-renewable-energy/nuclear-energy.html (last visited Mar. 30, 2012).

[60] *Waste From Nuclear Power*, NUCLEARINFO.NET, http://nuclearinfo.net/Nuclearpower/WebHomeWasteFromNuclearPower (last visited Mar. 30, 2011).

[61] *Id.*

[62] *Id.*

[63] APCO WORLDWIDE , *supra* note 55, at 7.

development of wind power, solar power, and bio-energy.[64] In 2010, Chinese photovoltaic manufacturing capacity was over 8 GW, accounting for 53% of total global manufacturing.[65] China is now the largest maker of wind turbines and solar panels in the world.[66] Foreign investment in the renewable energy sector is on the increase, with Vestas of Denmark erecting the largest wind turbine complex in the world in Northeastern China.[67] The New York Times reports that in 2010, China outstripped its competitors in Denmark, Germany, Spain, and United States in the production of solar panels and wind turbines.[68] By 2015, China expects to install solar capacity of 5 GW. However, electricity generated from wind is twice as costly as coal, and solar power is four times as expensive, thwarting the attractiveness of wind and solar power.[69] In its medium- and long-term program for renewable energy development, the Chinese government has a goal of increasing renewable energy consumption to 15% of total energy consumption by 2020.[70] By the end of the 12th Five Year Plan, the installed capacity of renewable energy is expected to reach 130 GW.[71]

China has moved into clean coal technology in the past couple of years along with non-conventional gas resources such as coal bed methane and natural gas hydrocarbons.[72] The 12th Five Year Plan provides for the expansion of solar thermal generation of electricity through the building of thermal solar power stations.[73]

B. The Purpose of China's Renewable Energy Law of 2009

In 2005, China passed the Renewable Energy Law ("REL"), effective in January 2006, and it amended the law in 2009 in order to promote the use

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[64] *See* ELIZABETH R. NESBITT ET AL., U.S. INT'L TRADE COMMISSION, CHINA'S VISION FOR RENEWABLE ENERGY: THE STATUS OF BIOENERGY AND BIOPRODUCT RESEARCH AND COMMERCIALIZATION 2 (2011), *available at* http://www.usitc.gov/journals/Nesbitt_etal_ChinaBioenergy.pdf.

[65] Keith Bradsher, *China Leading Global Race to Make Clean Energy*, NEW YORK TIMES (Jan. 30, 2010), http://www.nytimes.com/2010/01/31/business/energy-environment/31renew.html.

[66] *Id.*

[67] *Id.*

[68] *Id.*

[69] Grant King, The Rise of Unconventional Gas, Speech to the American Chamber of Commerce in Australia (Dec. 1, 2011), *available at* http://www.originenergy.com.au/files/ACCA0122011.pdf.

[70] INFORMATION OFFICE OF THE STATE COUNCIL OF THE PEOPLE'S REPUBLIC OF CHINA, CHINA'S ENERGY CONDITIONS AND POLICIES 23 (2007), *available at* http://en.ndrc.gov.cn/policyrelease/P020071227502260511798.pdf.

[71] *China's Five Year Plan and Renewable Energy: A Detailed Explanation*, DEBLOCK CONSULTING LTD., http://deblockconsulting.com/blog/china-news/chinas-five-year-plan-renewable-energy-a-detailed-explanation (last visited Mar. 30, 2012).

[72] *Id.*

[73] *Id.*

of renewable energy.[74] Four mechanisms are included: 1) a national renewable energy target, 2) a mandatory connection and purchase policy, 3) a feed-in tariff system, and 4) a cost sharing mechanism along with a special fund for renewable energy development.[75] Article 1 of the REL states that the purposes of the law are to enhance the development and utilization of renewable energy; to increase energy supply; to improve energy structure; to guarantee energy safety; to protect environment; and to realize the sustainable development of the economy and society.[76] Article 4 affirms that the State will rank the development and utilization of renewable energy as the priority area of energy development.[77] Article 7 provides that the relevant department of energy under the State Council will enact nationwide medium- and long-term gross targets for the development and utilization of renewable energy.[78] Further amendments passed in December 2009.[79] Five large state-owned power generators (Huaneng, Datang, Huadian, Guodian, and CPI) are responsible for developing renewable energy projects in China, with Guodian's subsidiary, Longyuan, being the largest producer of wind power.[80]

The Mandatory Connection Policy, introduced at the same time as the REL, requires grid companies to purchase renewable energy to be fed into the national grid.[81] China's grid system is run by the State Grid Corporation of China and China Southern Power Grid Company, both of which are state-owned.[82] The original REL introduced a "mandatory connection" policy, whereby grid companies were obligated to connect and buy all renewable energy that the grid was capable of absorbing.[83] However, not all of the

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[74] 中华人民共和国可再生能源法 [Renewable Energy Law of the People's Republic of China 2005, revised by the Standing Comm. of the Nat'l People's Cong.] (promulgated by the Standing Comm. Nat'l People's Cong., Dec. 26, 2009, effective Apr. 1, 2010), 2009 China Law LEXIS 671 [hereinafter Amended REL 2009] of 2009.

[75] SARA SCHUMAN, NATIONAL RESOURCES DEFENSE COUNCIL, IMPROVING CHINA'S EXISTING RENEWABLE ENERGY LEGAL FRAMEWORK: LESSONS FROM THE INTERNATIONAL AND DOMESTIC EXPERIENCE 3 (2010), *available at* http://www.nrdc.cn/phpcms/userfiles/download/201107/06/Improving China's Existing Renewable%20 Energy Legal Framework Lessons from the International and Domestic Experience 2010 Oct.pdf.

[76] Amended REL 2009, *supra* note 74.

[77] *Id.*

[78] *Id.*

[79] *Id.*

[80] SCHUMAN, *supra* note 75, at 2.

[81] Mandatory Connection Policy of the PRC of 2009.

[82] *Power Reform: Power Grid Corporations*, CHINA STATE POWER, http://www.sp-china.com/powerReform/pgc.html (last visited Mar. 30, 2012).

[83] 中华人民共和国可再生能源法 [Renewable Energy Law of the People's Republic of China 2005] (promulgated by the Standing Comm. Nat'l People's Cong., Feb. 28, 2005), art. 14 ("The enterprises of power network . . . shall purchase all of the network quantity of electric charge of the projects of

renewable power mandated was connected to the grid, as evidenced by the fact that though China has doubled its wind capacity each year for the past four years, only 30% of that figure was actually fed into the grid.[84] This was due to companies lacking the infrastructure to connect all renewable power to the grid and the lack of incentives to encourage investment in infrastructure.[85] For this reason, Article 14 of the REL was amended to provide that the State will safeguard the "full purchase of the electricity generated from renewable energy," giving powers to the competent department of energy along with the State Council to "determine the percentage of the electricity generated from renewable energy that shall be attained in the term of the plan in the total amount of electricity generated," and "formulate the detailed measures for priority dispatch and full purchase of the electricity generated from renewable energy by grid enterprises."[86] What this means is that new obligations have been determined for grid companies and will be enforced through Article 29, which provides a penalty in the form of compensation for non-compliance.[87]

The REL also provides for compensation to be paid to grid companies for obtaining renewable energy because it is more expensive to generate than other forms of fuel such as coal.[88] A feed-in tariff has been introduced, funded by a surcharge on consumers of electricity which grid companies are permitted to collect.[89] The end user pays the Renewable Energy Development Fund and the grid company gains compensation from the fund for the additional cost entailed by purchasing renewable energy and integrating it into the grid.[90] Because energy from renewable energy sources is often produced in a different region from where it is consumed, provincial grid companies are required to exchange their shortfall or surplus of surcharge with grid companies in other regions as provided for by the Interim Measures on Revenue Allocation from Renewable Surcharges.[91] The fund is also used to provide finance for other renewable energy projects, particularly in poorer parts of China.[92]

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electricity generation through incorporating renewable energy in [the] power network within the coverage of the power network, and provide network services for the electricity generation with renewable energy.").

[84] Sara Schuman, *China Renews Its Commitment to Renewable Energy*, SWITCHBOARD (Feb. 10, 2010), http://switchboard.nrdc.org/blogs/bfinamore/china_renews_its_commitment_to.html.

[85] *Id.*

[86] Amended REL 2009, *supra* note 74.

[87] *Id.*

[88] *Id.* art. 24.

[89] *Id.*

[90] *Id.*

[91] SCHUMAN, *supra* note 75, at 6.

[92] MINISTRY OF FINANCE, INTERIM MEASURES FOR THE ADMINISTRATION OF RENEWABLE ENERGY DEVELOPMENT SPECIAL FUND OF 2006 (2006).

C. Global Nuclear Energy Capacity

Though nuclear energy is often criticized as being a risky form of energy, in a safe environment it is environmentally friendly and cheap.[93] Other countries have focused on nuclear power production, with 436 nuclear power plants operating in the world at present and many more under construction.[94] For example, the United States has 104; France, 58; Japan, 50; United Kingdom, 17; Russia, 33; and South Korea, 23.[95] India currently sources about 3% of its electricity from nuclear power stations and has thirty-five reactors under construction. France produces 80% of its electricity from nuclear power stations,[96] and though Germany has stated that it is moving away from nuclear energy and closing its reactors by 2022, it intends to purchase nuclear power from France.[97]

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[93] Andy Darvill, *Nuclear Power: Energy Through Splitting Uranium Atoms*, ENERGY RESOURCES, http://www.darvill.clara.net/altenerg/nuclear.htm (last visited Mar. 30, 2012).

[94] Alan McDonald, *Nuclear Power Global Status*, INTERNATIONAL ATOMIC ENERGY AGENCY, http://www.iaea.org/Publications/Magazines/Bulletin/Bull492/49204734548.html (last visited Mar. 30, 2012); *Operational & Long-Term Shutdown Reactors*, IAEA—POWER REACTOR INFORMATION SYSTEM, http://pris.iaea.org/Public/WorldStatistics/OperationalReactorsByCountry.aspx (last updated May 5, 2012).

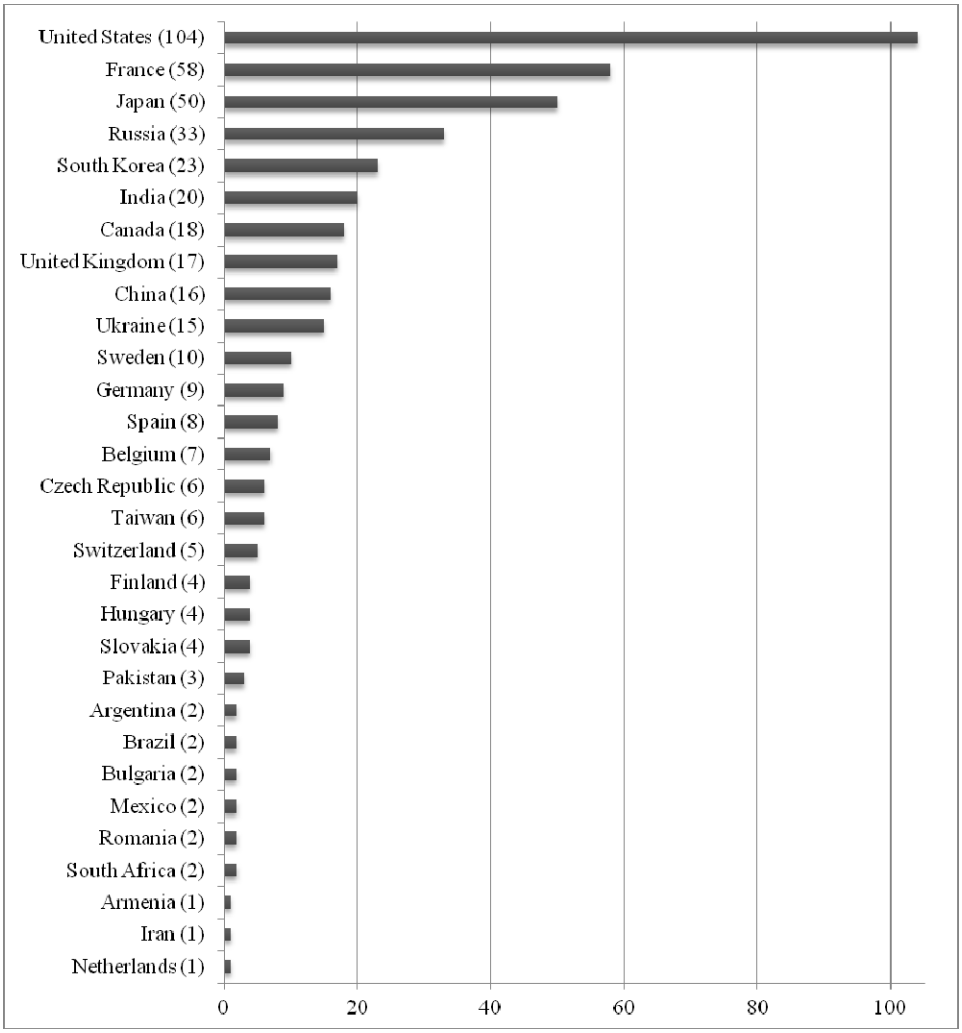
[95] *Operational & Long-Term Shutdown Reactors*, *supra* note 94.

[96] Matthew Saltmarsh, *G8 Energy Ministers Pledge Support for Stricter Nuclear Safety Tests*, NEW YORK TIMES, June 8, 2011, *available at* http://www.nytimes.com/2011/06/08/business/global/08nuke.html.

[97] *German Nuclear Shutdown Sets World Example: Merkel*, NUCLEAR POWER DAILY (May 30, 2011) http://www.nuclearpowerdaily.com/reports/German_nuclear_shutdown_sets_global_example_Merkel_999.html.

The chart reproduced below shows the number of operational nuclear reactors as of May 5, 2012.[98]

NUCLEAR REACTORS IN OPERATION WORLDWIDE

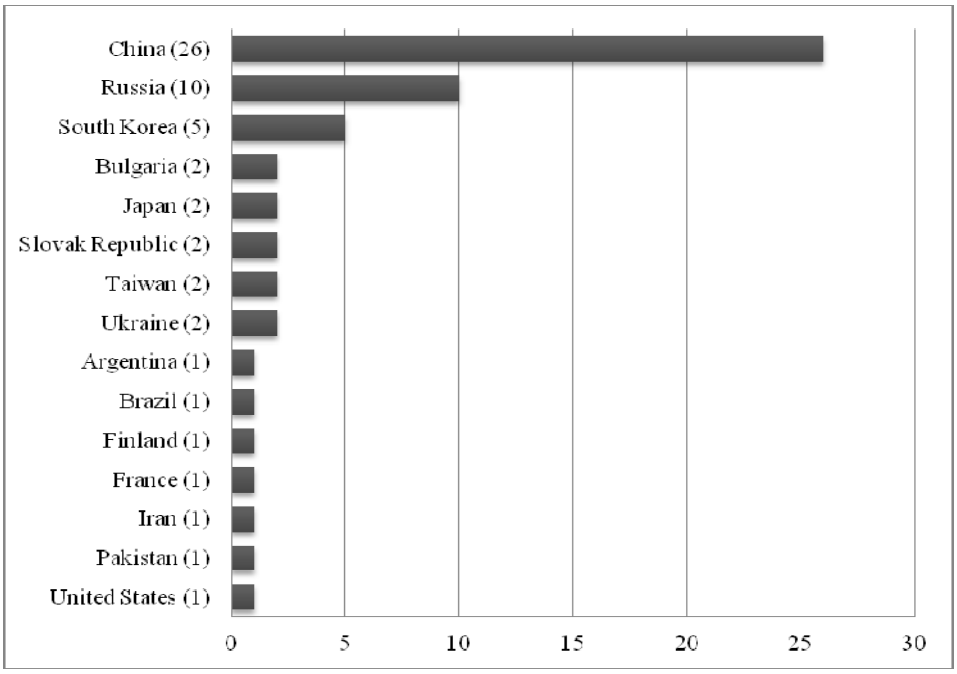


[98] *Operational & Long-Term Shutdown Reactors*, *supra* note 94.

D. Types and Locations of Nuclear Reactors in China

Currently, mainland China has sixteen nuclear reactors in operation,[99] along with ten research reactors, one test reactor, and one prototype reactor.[100] Twenty-six nuclear reactors are currently under construction.[101] The graph reproduced below shows that China is now at the forefront of nuclear reactor construction.[102]

NUMBER OF REACTORS UNDER CONSTRUCTION WORLDWIDE



Four new pressurized water reactors ("PWR") have recently been completed at the Qinshan nuclear power plant south of Shanghai in addition to the five already operating.[103] This is reflective of China's nuclear program, which began in 1970[104] and accelerated in 2005 under the National

[99] *Id.*
[100] *Nuclear Power in China*, *supra* note 21.
[101] *Nuclear Power Plants World-Wide*, EUROPEAN NUCLEAR SOCIETY, http://www.euronuclear.org/1-information/map-worldwide.htm (last updated Mar. 30, 2012).
[102] *Id.*
[103] *Nuclear Power in China*, *supra* note 21.
[104] *Id.*

Development and Reform Commissions' 10th Economic Plan 2001-2005.[105] China uses technology from the United States, France, Canada, and Russia.[106] Some of the most recent technology comes from Westinghouse, which is owned by Japan's Toshiba Company.[107]

In its 12th Five Year Plan, China forecasts a four-fold expansion of the country's nuclear power generation capacity from 10 GW, which is less than 2% of its current electricity generation, to 40 GW.[108] Thirty-four new plants are to add 37 GW capacity, with twenty-six already under construction at a cost of $75 billion.[109] This means that China is building 40% of the sixty-three nuclear reactors currently being constructed around the world. Tianwan 1 is now operational and Tianwan 2, located in Jiangsu, is under construction.[110] Most reactors are built along the east coast of China, which has safety implications due to local seismic activity, discussed below.[111]

China, to date, has primarily built PWRs where light water (ordinary water) is used.[112] The use of light water requires that the uranium fuel be enriched to a higher proportion of fissionable material so that the criticality of the reactor can be maintained.[113] PWRs are considered to be very stable.[114] The water is used as a moderator and primary coolant, and is separate from the water used to generate the steam that drives the turbine.[115] The second most common type of reactor in the world is a boiling water reactor, which is designed for light water to be used both for the moderator and coolant, as there is no separate secondary steam cycle.[116] High temperature gas cooled reactors operate at higher temperatures than PWRs and use gas as the primary coolant with nuclear reaction moderated by

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[105] *Id.*

[106] *The Nuclear Renaissance*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/inf104.html (last visited Apr. 11, 2012).

[107] *See id.*

[108] Krista Mahr, *China's Nuclear Energy Ambitions: Big Bold and Unstoppable*, ECOCENTRIC (Jan. 14, 2011), http://ecocentric.blogs.time.com/2011/01/14/china%E2%80%99s-nuclear-ambitions-b.

[109] *China's Nuclear Energy Program Post-Fukushima*, CHINA BYSTANDER (Mar. 16, 2011, 6:41 PM), http://chinabystander.wordpress.com/2011/03/16/chinas-nuclear-energy-program-post-fukushima [hereinafter *Post-Fukushima*].

[110] Wu Jia, *Experts Call for Enacting Law as China Faces Big Atomic Energy Development* (May 23, 2011), http://english.cri.cn/7146/2011/05/23/2702s638881.htm; *Post-Fukushima*, *supra* note 109.

[111] *Post-Fukushima*, *supra* note 109.

[112] *Everything You Want to Know About Nuclear Power*, NUCLEARINFO.NET, http://nuclearinfo.net/Nuclearpower?WebHomeHowNuclearReactorsWork (last updated Jul. 27, 2010) [hereinafter *Everything*].

[113] *Light Water Reactors*, HYPERPHYSICS—GEORGIA STATE UNIVERSITY, http://hyperphysics.phy-astr.gsu.edu/hbase/hframe.html (last visited May 6, 2012).

[114] *Everything*, *supra* note 112.

[115] *Id.*

[116] *Id.*

carbon dioxide gas.[117] Heavy water reactors are similar to PWRs, but here the water is enriched with deuterium isotope of hydrogen and the moderator and coolant are called heavy water.[118] The advantage of heavy water as the moderator is that natural, un-enriched uranium can drive the nuclear reactor.[119]

These types of nuclear reactors may each be given ratings of I, II, or III.[120] Generation I reactors are those built in the 1950s and 1960s. Generation II reactors are later models and operate in the United States and France today.[121] Generation III (and greater) are advanced reactors. Generation IV reactors will not be operational before 2020.[122] The advantage of the Generation III reactors is that they are of a simple, rugged design and easier to operate.[123] Added to that is their ability to resist serious damage, resulting in a reduced possibility of core melt down accidents.[124]

China has also started to build high-temperature pebble bed reactors, which are the first Generation IV nuclear technologies that have been tested in South Africa.[125] The University of Tsinghua Institute of Nuclear Energy Technology, along with German engineers, has built a 10 megawatt ("MW") thermal high temperature helium cooled pebble bed reactor that can produce 4 MW of electricity using a steam turbine generator.[126] The building of the new Rongcheng pebble bed plant, located at Shidaowan, commenced in April 2011 and is China's first high-temperature gas-cooled pebble bed reactor power plant.[127] The government also uses new technologies to improve the functioning of heavy water reactors and pressurized water reactors.[128] These types of reactors can supplement electric power for both densely and sparsely populated regions.[129]

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[117] *Id.*
[118] *Id.*
[119] *Id.*
[120] *Advanced Nuclear Power Reactors*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/inf08.html (last updated Apr., 2012).
[121] *Id.*
[122] *Id.*
[123] *Id.*
[124] *Id.*
[125] Zuoyi Zhang et al., *Current Status and Technical Description of Chinese 2 x 250 MWth HTR PM Demonstration Plant*, NUCLEAR ENGINEERING AND DESIGN 239, 1212 (2009).
[126] *Id.*
[127] *China's 2110 Pebble Bed Reactor Starts Construction in April 2011*, NEXT BIG FUTURE (Mar. 23, 2011), http://nextbigfuture.com/2011/03/china-210-mwe-pebble-bed-reactor-starts.html.
[128] David Biello, *China Forges Ahead with Nuclear Energy*, NATURE Mar. 28, 2011, *available at* http://www.nature.com/news/2011/110329/full/news.2011.194.html.
[129] *Id.*

E. Government Agencies Responsible for China's Nuclear Energy Program

The central Chinese government is responsible for planning its nuclear energy industry.[130] Its plans are then implemented by other agencies, the chief one of which is the China Atomic Energy Authority.[131] The State Development and Planning Commission approves all nuclear projects and reports to the Committee for Science Technology and Industry for National Defense.[132] Importantly, the Commission formulates guidelines, policies, laws, and regulations that manage nuclear power construction, nuclear fuel, and isotope production.[133] It oversees the National Nuclear Emergency Coordination Commission, which is responsible for dealing with a nuclear accident.[134] This commission is based in Beijing, in the National Nuclear Emergency Centre.[135]

The China National Nuclear Corporation ("CNNC") favors local technology and controls the nuclear industry, research and development, and waste disposal.[136] The major construction company is the China Nuclear Engineering and Construction Company, which is a subsidiary of CNNC.[137] The China Power Investment Company is one of the major state-owned nuclear companies.[138] The other is the State Nuclear Power Technology Corporation, which prefers imported technology.[139] The Guangdong Nuclear Power Joint Venture Company, partly owned by the Guangdong Nuclear Power Company and China Light and Power of Hong Kong, operates the Daya Bay plants near Hong Kong.[140]

Between 1969 and 1992, China awarded contracts to the two French companies Framatome and Électricité de France to build their standard 900 MW nuclear power stations and originally relied on French operators and engineers to assist China in operational activities.[141] This continued until the

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[130] *See Organizations*, CHINA ATOMIC ENERGY AUTHORITY, http://www.caea.gov.cn/n602670/n621894/n621895/32164.html (last visited Mar. 31, 2012).

[131] *Id.*

[132] *Introduction of Mission*, CHINA ATOMIC ENERGY AUTHORITY, http://www.caea.gov.cn/n602670/n621894/n621895/32165.html (last visited Apr. 7, 2012).

[133] *Organizations*, *supra* note 130.

[134] *Nuclear Safety*, CHINA ATOMIC ENERGY AUTHORITY, http://www.caea.gov.cn/n602670/n621902/32236.html (last visited Apr. 7, 2012).

[135] *Organizations*, *supra* note 130.

[136] *See About Us*, CHINA NATIONAL NUCLEAR CORPORATION, http://www.cnnc.com.cn/tabid/643/Default.aspx (last visited Apr. 7, 2012).

[137] *Nuclear Power in China*, *supra* note 21.

[138] CHINA POWER INVESTMENT CORPORATION, http://eng.cpicorp.com.cn (last visited Mar. 31, 2012).

[139] KADAK, *supra* note 6.

[140] *Id.*

[141] *Id.*

Chinese engineers gained sufficient experience. Afterwards, the French engineers were employed to advise the Chinese engineers on specific technical issues.[142]

China's first two nuclear plants were built in the mid-1980s at Dayawan, Daya Bay, Guangdong.[143] Units 1, 2 and 3 operating in that area were designed by Chinese engineers.[144] Four were bought from Framatome, with Électricité de France managing the construction of the first two at Daya Bay and LingAo on the same site.[145] Two purchased from the Atomic Energy of Canada are located at Qinshan in Southern China.[146] These are pressurized heavy water reactors fueled with natural uranium, unlike the low enriched uranium pressurized water reactors.[147] All other reactors for Quinshan 4 and 5 are standard pressurized water reactors.[148] The Daya Bay reactor provides 70% of Hong Kong's power.[149] By 2020, Hong Kong will have shut down its power coal fired plants and will be obtaining 50% of its power from nuclear plants, 40% from local gas supplies, and the rest from renewables.[150]

The Chinese government plans to produce a ten-fold increase in nuclear capacity to at least 80 GW by 2020, 200 GW by 2030, and 400 GW by 2050.[151] This means that the share of nuclear power in the energy market will rise from 2% to 5%.[152] However, taking into account the per capita energy needs addressed above,[153] the current nuclear plans may well need to be increased over the next thirty years.[154]

IV. ANTICIPATING DAMAGE AND MITIGATING RISKS FROM NUCLEAR ACCIDENTS

A. China's Approach to Earthquake Risks

Due to China's susceptibility to frequent and intensive seismic activities, the Chinese government set up the State Seismological Bureau in

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142 *Id.*
143 *Nuclear Power in China*, *supra* note 21.
144 *Id.*
145 *Id.*
146 *Id.*
147 KADAK, *supra* note 6.
148 *Nuclear Power in China*, *supra* note 21, at 13.
149 *Id.*
150 *Id.* at 2.
151 *Id.*
152 Biello, *supra* note 128.
153 *See supra* Part II.B.
154 Zhou, *supra* note 29.

1997, renamed the China Seismological Bureau ("CSB") in 1998.[155] It was implemented through the Law on the People's Republic of China on Protecting Against and Mitigating Earthquake Disasters of 1997. It is controlled by the State Council, and its role is to manage earthquake issues across China.[156] The CSB has thirty one provincial seismological bureaus under its control, although cities prone to earthquakes have set up their own bureaus, which are subordinate to the local governments.[157] The CSB's role is to implement and develop policies, laws, and regulations and provide a national plan for predicting earthquakes and supervising work related to earthquake disaster prevention.[158] It also undertakes the operational function of earthquake emergency response. Over 600 seismic stations have been set up and run by local governments, with about 2,000 observation points.[159]

The dangers posed by earthquakes cannot be ignored. As the map below shows, most activity in East Asia occurs in the region of Japan, China and Taiwan. In 2008, China experienced a devastating earthquake in Sichuan in the vicinity of Chengdu and Wenchuan, resulting in thousands of deaths.[160] Of concern is that the Chinese government is considering building a nuclear reactor at Chongqing, which is less than 500 kilometers from the epicenter of this earthquake and where 31 million people live.[161]

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[155] Guomin Zhang et al., *Predictions of the 1997 Strong Earthquakes in Jiashi Zinjiang*, 89 CHINA BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA, no. 5 (1999).

[156] *China Earthquake Administration*, THE CENTRAL PEOPLE'S GOVERNMENT OF THE PEOPLE'S REPUBLIC OF CHINA, http://english.gov.cn/2005-10/02/content_74193.htm (last visited Apr. 7, 2012).

[157] He Qin, *Protecting Against Mitigating Earthquake Disasters in China*, CHINA SEISMOLOGICAL BUREAU, *available at* http://earthquake.tier.org.tw/document/sedmess/s11.pdf.

[158] *Id.*

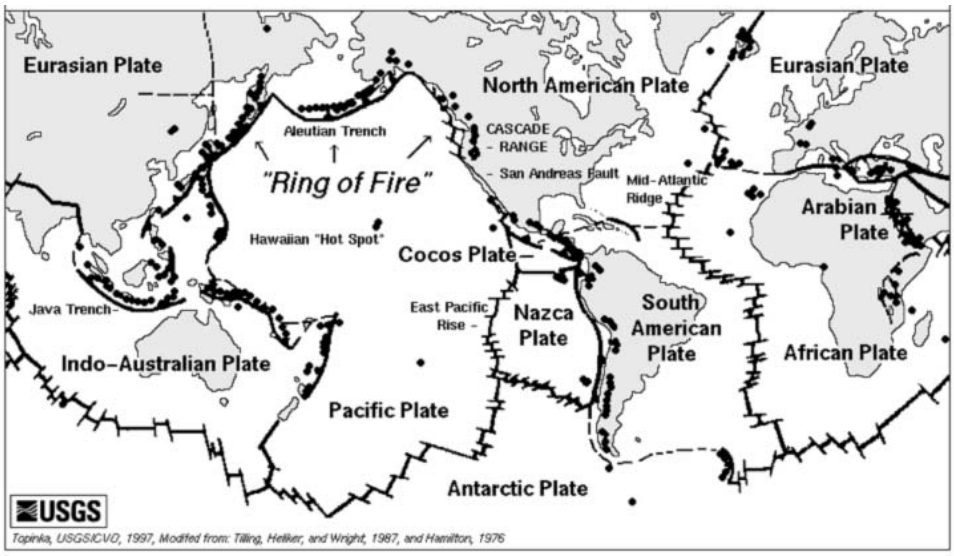
[159] *Id.*

[160] *Earthquake Near Wenchuan, West Sichuan, China*, MASS. INST. OF TECH. DEP'T OF EARTH, ATMOSPHERIC AND PLANETARY SCI., http://quake.mit.edu/~changli/wenchuan.html (last visited Mar. 31, 2012).

[161] *CNNC to Build Nuclear Power Plant in Chongqing by 2012*, CHINAMINING.ORG (Mar. 17, 2011), http://www.chinamining.org/News/2011-03-17/1300326996d43812.html [hereinafter *Chongqing*].

The following map shows the most prevalent earthquake activity, highlighting the Ring of Fire.[162]

ACTIVE VOLCANOES, PLATE TECTONICS, AND THE "RING OF FIRE"



B. China's Nuclear Safety Laws

Even though China is a member of the International Atomic Energy Agency, it has not promulgated an atomic energy act to govern the supervision of nuclear radiation and safety.[163] China has attempted to draft an atomic energy law twice since the 1980s when China's first nuclear energy facility was built, but this has still not materialized.[164] This must necessarily be remedied, considering that of the sixty-four nuclear power reactors under construction worldwide, China is undertaking 40% of that figure.[165] Such a law would state the required supervision of nuclear radiation and safety regulations. The government has, however, passed

[162] *Active Volcanoes and Plate Tectonics, "Hot Spots" and the "Ring of Fire,"* U.S. GEOLOGICAL SURVEY, http://vulcan.wr.usgs.gov/Glossary/PlateTectonics/Maps/map_plate_tectonics_world.html (last visited Apr. 7, 2012).

[163] Wu Jia, *supra* note 110.

[164] *Id.*

[165] *Id.*

numerous laws that deal with earthquake observation and response to earthquake emergencies.[166]

The Law on the People's Republic of China on Protecting Against and Mitigation of Earthquake Disasters of 1998, as well as Stipulations for Issuing Earthquake Predictions of 1998, outline the safety requirements that must be undertaken when construction projects (it does not refer to nuclear power stations) are undertaken in Article 17. Under Article 17, projects must be built, expanded, or rebuilt to meet the requirements for seismic resistance.[167] Yao Weijie points out that these laws focus on a narrow group of problems and that what are needed are basic laws that regulate the nuclear industry itself.[168] Should the Chinese pass an atomic energy law, it will ensure that those operating nuclear power stations will be liable for security and transparency.[169] The question of what happens in the event of a devastating earthquake, such as occurred at Fukushima, is open to conjecture.

Apart from natural disasters, human error can also result in devastating consequences. The most disastrous nuclear explosion occurred

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[166] 地震监测设施和地震观测环境保护条例 [The Protection Act for Facilities of Earthquake Monitoring and Environmental Condition of Earthquake Observations] (promulgated by the Standing Comm. Nat'l People's Cong., Jan. 10, 1994); 地震防灾对策特别措施法 [Emergency Response Act for Destructive Earthquakes] (promulgated by the Standing Comm. Nat'l People's Cong., June 16, 1995); 中华人民共和国防震减灾法 [Law on the People's Republic of China on Protecting Against and Mitigation of Earthquake Disasters] (promulgated by the Standing Comm. Nat'l People's Cong., Dec. 29, 1997) [hereinafter Protecting Against and Mitigation of Earthquake Disasters]; 地震预报管理条例 [Stipulations for Issuing Earthquake Predictions] (promulgated by the Standing Comm. Nat'l People's Cong., Dec. 17, 1998).

[167] Construction projects other than the ones mentioned in paragraph 3 of Article 17 must be fortified against earthquakes in compliance with the seismic-resistance requirements specified in the seismic intensity zoning map or the ground motion parameter zoning map issued by the State. Protecting Against and Mitigation of Earthquake Disasters, *supra* note 165, art. 17.

Seismic safety shall be evaluated for major construction projects and the construction projects which may induce serious secondary disasters. *Id.* The requirements for fortification against earthquakes, which shall be drawn up on the basis of the results of seismic safety evaluation, shall be fulfilled. *Id.*

The major construction projects mentioned in this Law refer to projects which are of great value to or have a vital bearing on the society. The construction projects which may induce serious secondary disasters mentioned in this Law refer to construction projects which may, as a result of earthquake damage, lead to food, fire, explosion, leakage of a large amount of hypertoxic or strong corrosive materials, and other serious secondary disasters. Such projects include large dams, embankments, petroleum and gas tanks and the facilities storing inflammables or explosive substances, hypertoxic or strong corrosive materials and other construction projects which may induce serious secondary disasters. *Id.*

For construction projects such as nuclear power plants and nuclear facilities, which may lead to serious secondary disasters due to radioactive contamination in the wake of earthquake damage, seismic safety shall be evaluated carefully and the projects shall be fortified against earthquakes strictly in accordance with law. *Id.*

[168] Yao Weijie, *Ministry Pushes Ahead on Nuclear Law*, BEIJING TODAY (May 6, 2011), http://www.beijingtoday.com.cn/news/ministry-pushes-ahead-on-nuclear.

[169] *Id.*

in 1986 when the fourth reactor of the nuclear power plant at Chernobyl exploded.[170] This reactor, called a Bolshoy Moshchnosty Kanalny reactor, was a Soviet-designed reactor built in the 1970's.[171] It had many design flaws.[172] It was a pressurized, water-cooled reactor that used graphite as the moderator and had individual fuel channels.[173] The accident occurred during an experiment when all safety systems were shut down.[174] A nuclear meltdown did not occur; rather, radioactive material was released into the atmosphere following two explosions that destroyed the core, and the reactor had not been designed to be contained in a containment structure.[175] The effects on public health were catastrophic. The main effects were different forms of cancer and birth abnormalities.[176] Another major nuclear disaster was the Three Mile Island accident in Harrisburg, Pennsylvania, in the United States in 1979 at a PWR reactor.[177] It occurred as a result of half of the fuel rods melting in one of the two nuclear reactors.[178] Though large quantities of radioactivity leaked from the reactor, most of it was contained and human health was not affected.[179]

What is abundantly clear is that managing nuclear power plants is expensive, requiring well-trained and reliable personnel. In China's case, instigating safety inspections is problematic as China faces a lack of qualified people that can manage nuclear expansion and undertake the inspections.[180] China needs 13,000 new university graduates to enter the industry over the next fifteen years.[181] The shortage is considered so serious that the Guangdong Nuclear Power Company has instigated special programs in universities in order train more staff to enter the nuclear industry.[182]

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[170] *The Chernobyl Accident*, NUCLEARINFO.NET, http://nuclearinfo.net/Nuclearpower/ChernoblAccident (last visited May 6, 2012).

[171] *RMBK Reactors*, WORLD NUCLEAR ASSOCIATION, www.world-nuclear.org/info/inf31.html (last visited May 6, 2012).

[172] *Id.*

[173] *Id.*

[174] *The Chernobyl Accident*, *supra* note 170.

[175] *Id.*

[176] *Id.*

[177] *The Three Mile Island Inside Story*, SMITHSONIAN MUSEUM OF NATURAL HISTORY, http://americanhistory.si.edu/tmi/index.htm (last visited May 6, 2012).

[178] *Id.*

[179] *Id.*

[180] KADAK, *supra* note 6.

[181] *Id.*

[182] *Id.*

C. Who Pays for the Damage After a Nuclear Accident?

1. Japan

A central issue surrounding the Fukushima disaster is the question of who pays for the damage, as this was a *force majeure* situation and not due to human error. It appears that the Japanese government, under the Act on Compensation for Nuclear Damage, would like to make Tokyo Electric Power Company liable for the recent disaster.[183] However, Japan's Atomic Energy Act and associated regulations do not appear to make liable the producers of nuclear energy in such a situation, particularly when Japan has never experienced a tsunami that has caused the death and destruction witnessed in March 2011.[184] The damage claims are estimated to total 90 billion euros, due to compensation claims from victims, plant workers, farmers, fishermen, and other affected industries.[185] If, as is suggested by the Max Planck Institute, the burden, though falling primarily on the government, falls also on other financial institutions, consumers will ultimately be charged higher energy prices.[186] The legal issues are complex, because though the accident was clearly a result of *force majeure*, the fact that the reactor could not be properly shut down begs the question as to whether the operator of the nuclear facility or the Japanese government is liable. If the Japanese State is found liable, Wietzendorfer argues that this would be due to insufficient nuclear energy supervision.[187] However, Japan's new Prime Minister, Yoshihiko Noda, has confirmed that the country will continue to use nuclear power for the next forty years.[188] At present, only seventeen out of Japan's fifty-one reactors are operating, due to scheduled maintenance or safety concerns as a result of the Fukushima disaster.[189] Japan's reactors receive an initial license to operate for thirty years, but can apply for a license to operate for an additional ten years a

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[183] *No Limits for TEPCO's Liability in Fukushima Crisis, Japan Says*, POWER: BUSINESS AND TECHNOLOGY FOR THE GLOBAL GENERATION INDUSTRY (May 4, 2011), http://www.powermag.com/POWERnews/No-Limits-for-TEPCOs-Liability-in-Fukushima-Crisis-Japan-Says_3686.html.

[184] *Id.*

[185] Julius Weitzdörfer, *Legal Study Offers First Comprehensive Overview of Liability Issues in Connection with the Fukushima Nuclear Accident*, MAX-PLANCK-GESELLSCHAFT (Aug. 25, 2011), http://www.mpg.de/4404127/Fukushima_liability_issues.

[186] *Id.*

[187] *Id.*

[188] Charles Digges, *Japan Announces 40-Year Nuclear Phase Out as Germany Grapples With Upcoming Atomic Power Losses*, BELLONA, Aug. 31, 2011, http://www.bellona.org/articles/articles_2011/japan_fourty_year.

[189] *Id.* Three reactors were damaged in the tsunami and are no longer operational. *Id.*

maximum of six times.[190] This would have been the case with the Generation II Fukushima reactors commissioned in 1971.[191] However, following the Fukushima accident, the government has pulled back on its time extensions and it is anticipated that operators will only be permitted to apply for a twenty-year license extension after a forty-year initial operational period.[192] The lesson for China here is that Japan is now being criticized for not having a strong nuclear regulator in place,[193] which is something the Chinese must ensure is addressed.

2. China

China has been concerned over nuclear safety for many years, as evidenced in 1997 when the State Council issued a letter to the Chinese Atomic Energy Authority on the issue of liability for damage from nuclear accidents.[194] The letter stated that the operator of a nuclear power plant or facility is liable for any damage to person or property if there is a nuclear accident.[195] The amount payable in such an event is limited to RMB 300 million, but if the damages payable should exceed this amount, the State will provide financial compensation of up to RMB 800 million.[196] As a result of Fukushima and in light of the fact that China is building more nuclear power plants than any other country in the world, there have been numerous calls for China to pass an atomic energy act, which it has not done to date.[197]

All China has in place are the Regulations on the Safety Regulations for Civilian Nuclear Installation of the People's Republic of China 1986, which require the National Nuclear Safety Administration to undertake the surveillance of all nuclear installations in China. Article 15 of the Safety Surveillance of Nuclear Installation 1995 specifies that nuclear plants can be subject to daily, routine, or non-routine inspection. Non-routine inspections can be announced or not announced. Article 19 specifies that non-routine

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[190] *Id.*

[191] Paul Horak, *China's Energy Future After Fukushima: Challenges and Opportunities*, DUKE EAST ASIA NEXUS, Apr. 17, 2012, http://www.dukenexus.org/867/china's-energy-future-after-fukushima-challenges-and-opportunities.

[192] *Nuclear Power in Japan*, WORLD NUCLEAR ASSOCIATION, http://www.world-nuclear.org/info/inf79. html (last updated May 2012).

[193] Digges, *supra* note 188.

[194] STATE COUNCIL OF THE REPUBLIC OF CHINA, OFFICIAL REPLY OF THE STATE COUNCIL TO QUESTIONS ON LIABILITIES OF COMPENSATION FOR DAMAGES RESULTING FROM NUCLEAR ACCIDENTS (2007), *available at* http://www.oecd-nea.org/law/nlb/nlb-80/documents/103_104_TextChina.pdf.

[195] *Id.*

[196] *Id.*

[197] Wu Gui-feng, *China's Nuclear Safety Laws Progress Slowly*, CHINA TIMES (Mar. 17, 2011, 8:56 AM), http://www.wantchinatimes.com/news-subclass-cnt.aspx?cid=1105&MainCatID=11&id=20110317000012.

nuclear safety is made in response to accidental non-scheduled or abnormal cases or events.[198]

V. CONCLUSION

As could be expected, the Fukushima disaster has raised international concern over nuclear safety. For example, the Group of Eight that met in France in May 2011 prompted calls for international cooperation on standards and nuclear safety.[199] It also recognized that the use of nuclear power is planet friendly and returning to coal-based power stations will result in the continued escalation of greenhouse gas emissions.[200]

In 2010, an increase in nuclear power plants, together with the opening of the second phase of Ling'ao Nuclear Power Plant in Guangdong Province, pushed China's total power generation capacity beyond 900 GW.[201] Nuclear power is continuing to develop quickly and there are plans for nuclear facilities to move inland. Of concern is a plan to build a nuclear plant at Chongqing by 2015 as part of the 12th Five Year Plan. This would be in an area that is less than 500 kilometers from the epicenter of the 2008 Sichuan earthquake where over 31 million people reside.[202]

It is clear that regardless of the dangers that nuclear energy can cause, China will press ahead with nuclear reactor construction. It has engaged in three stages of nuclear development: primary, fast-paced, and mature.[203] The current phase is fast-paced, so that a complete nuclear system will be built between 2011 and 2015 when China's installed nuclear capacity will be 30% above 2010 levels. China has no choice but to move out of coal-produced electricity, as it cannot afford to keep expending huge amounts of money on importing coal, emitting escalating tons of greenhouse gas emissions, and maintaining its current economic progress. As safety issues in the region are of major concern with earthquake activity in the region inevitable, it is hoped that the Chinese government will make the safety of both its population and those of other countries in the region a major priority when planning its nuclear program and engage in transparent planning so that those living in the region are appraised of any likely risks.

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[198] R. Wang, R. Chen Rongda, & H. Mao, *China's Safety Regulation Regulatory Inspection of Operating Nuclear Power Plants*, Conference Report, Tropical Issues in Nuclear Installations Safety Beijing **(**Oct. 18-22, 2004), *available at* http://www-pub.iaea.org/MTCD/publications/PDF/Pub1245_web.pdf (last visited Apr. 7, 2012).

[199] Saltmarsh, *supra* note 96.

[200] *Id.*

[201] *Capacity*, *supra* note 22.

[202] *Chongqing*, *supra* note 161.

[203] *China's Five Year Plan and Renewable Energy: A Detailed Explanation*, *supra* note 71.