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Earthquake Alarm – The Kashiwazaki nuclear incident and the consequences for Japan's nuclear policy

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On July 16th 2007, at 10.13 AM, Japan's largest nuclear power station was hit by a massive earthquake. The tremor resulted in extensive damage to the facility, while radioactive waste material leaked into the ocean and air. Further deterioration of public confidence in the aftermath of the disaster could result in a setback for Japan's nuclear power policy, which is a core element of its national energy strategy.

The earthquake that hit the Kashiwazaki-Kariwa nuclear power plant in Niigata prefecture measured 6.8 on the Richter's scale. The plant's operator, the Tokyo Electric Power Company (TEPCO), admitted afterwards that the facilities were not designed to withstand a tremor of this magnitude. The Kashiwazaki site holds seven nuclear reactors with a combined capacity to produce over 8000 Megawatts of electricity making it the world's largest nuclear power facility. While four reactors were offline for maintenance at the time of the quake the three active reactors were shut down automatically by the emergency system. TEPCO officials quickly claimed that the reactors were not damaged, but this will still have to be confirmed in the damage evaluations which are currently ongoing, including one by the *International Atomic Energy Agency* (IAEA).

Clearly, the damage to the facilities is vast. The quake rocked some used nuclear fuel storage pools back and forth which resulted in flooded floors. Water covered the floor of all seven reactor buildings. A reported twelve hundred litres of contaminated water leaked into the Sea of Japan from Reactor unit 6. Four hundred barrels containing low radioactive waste were knocked over in storage facilities, but TEPCO maintains that there is no danger for public safety. At least fourty barrels lost their lid and spilled their contents. The walls of buildings surrounding the reactors showed cracks and multiple cases of oil and air leaks occurred. Some air leaks were not closed for days and are feared to have leaked radioactivity into the air. On parts of the site, where regulations did not require the ground to be reinforced, the earthquake turned the solid structure of the soil to mud. Japanese television stations showed other areas of

the premises where the earthquake had split the ground and some sections had subsided by several metres. A transformer facility caught fire and could not be extinguished by workers on site, apparently because the earthquake had disrupted both the electricity and water supply.ⁱ

The mayor of Kashiwazaki has ordered all seven reactors closed indefinitely. TEPCO estimates that it will be months before the plant can be restarted. Japanese media are however speculating that the plant will remain closed for at least a year. In the case that investigators find damage to the actual reactors Japan's nuclear industry could face pressure from the public to permanently close down the giant nuclear power plant.ⁱⁱ Now that Kashiwazaki's reactors are shut down 8GW of output capacity has been taken off the grid. This is close to half of TEPCO's nuclear production capacity and some twelve percent of total electricity production. TEPCO has said that it will try to make up for lost production by increasing thermal power output by burning more gas, oil and coal. The high costs of such an operation have already forced TEPCO to announce a 79% drop in expected profits for the year.ⁱⁱⁱ TEPCO has stated it would be interested to procure ten to fifteen extra spot cargoes of Liquefied Natural Gas (LNG) in August alone, but officials admitted to the World Gas Intelligence bulletin that current tight resource markets will make it impossible to secure LNG and oil in sufficient quantities to make up for the cut-back in nuclear output.^{iv} The company said it will purchase more electricity from competitors and will also be forced to ask its main industrial clients to make 'voluntary' consumption cuts. The minister of Economics, Trade and Industry (METI) will also ask industry representatives to reduce power consumption at peak times during the summer. With electricity consumption peaking in Tokyo's hot August and September months – Japan's infamous addiction to air-conditioning – TEPCO faces a tough challenge to meet demand.

Shock

The reaction in Japan was shock and fear over yet another major nuclear incident. Over the past decade the Japanese have come to increasingly distrust the safety of their nuclear facilities. There were lethal accidents at the Tokai-mura uranium processing plant in 1999 and in 2004 at the Mihama No. 3 nuclear reactor. In 2003 TEPCO was required to close down all its reactors for thorough examinations after it was accused of structural falsifications of safety data in an attempt to cover up defects and small incidents. Then, in March 2007, TEPCO and other utilities confessed a secret history of minor and not so minor incidents which they had failed to report to the public. Throughout these scandals the authorities maintained that no serious problems regarding nuclear safety existed, but to the public such statements sounded increasingly like hollow phrases.

And now for the first time a Japanese nuclear facility has suffered a direct hit from a major earthquake, a scenario for which many Japanese had long feared, but had silently hoped Japan's impressive engineering capabilities would be able to harness. However, TEPCO has now admitted that the reactors and other facilities at Kashiwazaki were not designed to withstand a major earthquake and that the company had simply assumed that its plant would not be hit by an earthquake of this size. This, in spite of the fact that in Japan the earth, on average, is shaken once every three minutes, and that three earthquakes of similar magnitude have hit this region of Japan in the past two years alone. Japan's nuclear regulators have knowingly allowed this situation to exist.^v Seismic data from July's earthquake show how a major fault line lies almost straight below the Kashiwazaki-Kariwa facility.^{vi} TEPCO had for years denied evidence that pointed in this direction. Worried local citizens took the company to court and demanded the closure of the plant. But in a bitter irony the Tokyo High Court in 2005 ruled in favour of

TEPCO basing itself on the government's *National Institute of Advanced Industrial Science and Technology's* conclusion that, in fact, "there was no major fault line located under the plant that could cause a major earthquake".

In a different ruling, citizens protesting against the Shika nuclear facility in Ishikawa-prefecture (two reactors, with a combined capacity of 1900 MW), not far from Kashiwazaki, won their case against the government and the nuclear industry on grounds that the plant was not sufficiently earthquake resistant and in an earthquake-prone area. The government immediately appealed which allowed the reactors to continue operations. The earthquake damage at Kashiwazaki will likely weaken the industry's case. If they lose their appeal, which is strongly backed by the government, this could lead to pressure to re-evaluate the construction licenses and resilience to earthquakes of most if not all of Japan's nuclear facilities.^{vii} In a third case, the 5000 MW Hamaoka nuclear plant in Shizuoka prefecture is believed to stand on top of a similarly active fault line as Kashiwazaki. Seismologists have warned before that it should be shut down because of excessive risk. Industry officials privately acknowledge the dangers but rebut that they have no choice for 'where else is Japan going to get its energy from'. To accommodate the criticism, the government regulator ordered in September 2006 that tougher examinations of seismic activity near nuclear plants must be undertaken. At the time of the earthquake these tests were however still underway and no results have been made public. The utilities fear the prospect of mandatory upgrades to the construction of existing plants and reactors, because that would exponentially raise the costs of their nuclear operations.^{viii} After the July earthquake TEPCO announced that it will 'resurvey' the underground structure beneath the ocean floor covering an area running parallel along the Sea of Japan coastline for 140 km and 50 km offshore and check for fault lines. The government regulator has despatched a commission to check the facilities and advice on how to proceed. A citizen's watch group^{ix} questions independence of this commission and says its leader has already stated his belief that the facility will be able to reopen, even before any investigation has taken place.

While the earlier reports and incidents had already seriously eroded the public's confidence in the safety of nuclear power the new earthquake-inflicted disaster offers a new obstacle to plans for a broad expansion of Japan's nuclear programme. Industry officials will now try to limit the public relations damage, hoping that the public will soon forget about this incident. But this time the public relations fallout may be harder for the authorities to control than after previous incidents. Japanese television media have bombarded the Japanese public since the 16 July disaster with disturbing images that are likely to stick in the public consciousness as a permanent, visible reminder of the perils of nuclear power in earthquake-prone Japan. Video pictures that were shot from a helicopter showed heavy black smoke circling from the Kashiwazaki plant. Other pictures showed water in a spent nuclear fuel storage pool making waves and a massive steel crane, used to carry a reactor's outer hull, cleanly broken in two. A frightening, if not morbidly comic image showed TEPCO employees wading through inches of contaminated water, while using paper towels to mop up the flooded halls.^x

Japan's nuclear programme

In a country that lacks natural resources and fears it may be losing the race for energy security, confidence in the safety of nuclear power, which supplies around one-third of Japan's electricity, is crucial. Japan's nuclear programme boasts 55 operating reactors and is the world's third largest, only trailing the United States and France. The 30% of electricity that is produced from nuclear power accounts for 12% of Japan's total primary energy supply.

Japanese policymakers aim to boost these figures further in the next two decades with nuclear power targeted to account for anywhere between 30 and 40% of electricity output. To reduce dependence on imported uranium Japan is getting ready to start reprocessing spent nuclear fuel at a new mega-facility in Rokkashomura in northern Aomori prefecture. Today's rising energy prices, geopolitical shifts confirming Japan's potential weakness in case of supply shocks, the rise of China's demand for energy and the growing visibility of climate change have led to a broad consensus among Japanese politicians, officials, businessmen, journalists and academics on the necessity for Japan to expand its nuclear energy programme. Both the ruling *Liberal Democratic Party* and the main opposition party, the *Democratic Party of Japan*, favour an expanded nuclear power capacity. The government's *New National Energy Strategy* as well as its *Nuclear Power Nation Plan* both provided sweeping measures that must guarantee the expansion and modernisation of nuclear energy production in Japan.^{xi} 'Educating' the public about the safety of Japan's nuclear facilities featured prominently in these plans. The power utilities maintain that they hope to boost the share of nuclear power in their total electricity output from today's 31% to 43% by as early as 2015,^{xii} although many in the industry seem to feel these figures are overly ambitious after public resistance to new plant construction has already slowed down construction over the past decade. Currently only four new reactors are under construction. Several more are planned and ready for the construction phase, but local governments must first be persuaded to accept a new nuclear facility in their jurisdiction. Japanese politicians and officials are trying to push through plans for new nuclear reactors by promising indebted local governments generous subsidies and infrastructural projects in return. But the 'not-in-my-backyard' movement has grown strong in the Japanese countryside and Tokyo's tactics, which were so successful in the 1970s and 1980s, have steadily lost their effect. The governor of Fukushima prefecture for example has told TEPCO to forget about plans for two new reactors as long as he is in office.

Nuclear power in Japan is not just crucial from a security of supply perspective. Nuclear power is also environmental, economic and industrial policy. Japan could never hope to come close to its Kyoto agreement targets without boosting nuclear energy output. Rising oil, gas and coal prices mean that the economic benefits of nuclear power for the Japanese economy and the powerful electricity industry are also growing every day.^{xiii} Furthermore, Japanese power, engineering and construction companies, in tandem with the Ministry of Economy, Trade and Industry (METI) have been planning the export of nuclear facilities to overseas markets such as China and India.^{xiv} These exports could bring prolonged economic benefits for Japan, with the added benefit of moderating CO₂ emissions in these countries, and possibly leading to less intensive competition for limited fossil fuel resources.

What next?

The question now is if the public opinion will move towards a structurally more negative perception of the nuclear industry? It is certain that the not-in-my-back-yard phenomena will grow stronger, but will it be limited to local protests or will this earthquake escalate into a movement that questions the fundamental safety of Japan's nuclear facilities, based on their vulnerability to seismic shocks? Japanese officials will worry that ongoing investigations could show radiation leaks more widespread than have so far been reported. That would give further ammunition to its critics and amplify the call for closure of other large scale nuclear power plants, including those in Shizuoka, Ishikawa and others. Shutting down those plants would knock out a very significant part of Japan's total electricity production and in today's tight fuel markets Japanese utilities would not be able to make up for such a supply gap. In case they

would go on a buying spree to fill emergency reserves of oil and LNG, possibly in anticipation of further plant closings for inspections, the world would immediately feel the effects through upwards pressure on resource prices. This scenario however is something the Japanese economy simply cannot afford and the government will do everything in its power to avoid it.

Earthquakes have throughout history been a fact of life in Japan, but until now the possibility of an earthquake-inflicted nuclear accident had been mere speculation. In spite of the fact that radiation damage in this incident appears to have been limited, the situation for Japan’s nuclear programme has changed. Pictures of the pillar of smoke curling upwards from the Kashiwazaki-Kariwa nuclear power plant have turned earthquakes into a tangible threat in the minds of most Japanese people. Just when Japan’s nuclear power policy has become more indispensable than ever before, energy policymakers must come to grips with this new reality.

Appendix

Nuclear Power Plants

● In Operation

As of October 2006

	Name of Plant	Unit Number	Company	Installed Capacity (MW)	Type of Reactor	Start
1	Tomari	1	Hokkaido	579	PWR	1989.6
		2		579	PWR	1991.4
2	Higashi-Dori	1	Tohoku	1,100	BWR	2005.12
3	Onagawa	1	Tohoku	524	BWR	1984.6
		2		825	BWR	1995.7
		3		825	BWR	2002.1
4	Fukushima Daiichi	1	Tokyo	460	BWR	1971.3
		2		784	BWR	1974.7
		3		784	BWR	1976.3
		4		784	BWR	1978.10
		5		784	BWR	1978.4
		6		1,100	BWR	1979.10
5	Fukushima Daini	1	Tokyo	1,100	BWR	1982.4
		2		1,100	BWR	1984.2
		3		1,100	BWR	1985.6
		4		1,100	BWR	1987.8

6	Kashiwazaki	1	Tokyo	1,100	BWR	1985.9
		Kariwa		2	1,100	BWR
	3	1,100		BWR	1993.8	
	4	1,100		BWR	1994.8	
	5	1,100		BWR	1990.4	
	6	1,356		ABWR	1996.11	
	7	1,356		ABWR	1997.7	
7	Hamaoka	1	Chubu	540	BWR	1976.3
		2		840	BWR	1978.11
		3		1,100	BWR	1987.8
		4		1,137	BWR	1993.9
		5		1,380	ABWR	2005.1
8	Shika	1	Hokuriku	540	BWR	1993.7
		2		1,358	ABWR	2006.3
9	Mihama	1	Kansai	340	PWR	1970.11
		2		500	PWR	1972.7
		3		826	PWR	1976.12
10	Takahama	1	Kansai	826	PWR	1974.11
		2		826	PWR	1975.11
		3		870	PWR	1985.1
		4		870	PWR	1985.6
11	Ohi	1	Kansai	1,175	PWR	1979.3
		2		1,175	PWR	1979.12
		3		1,180	PWR	1991.12
		4		1,180	PWR	1993.2
12	Shimane	1	Chugoku	460	BWR	1974.3
		2		820	BWR	1989.2
13	Ikata	1	Shikoku	566	PWR	1977.9
		2		566	PWR	1982.3
		3		890	PWR	1994.12
14	Genkai	1	Kyushu	559	PWR	1975.10
		2		559	PWR	1981.3
		3		1,180	PWR	1994.3
		4		1,180	PWR	1997.7
15	Sendai	1	Kyushu	890	PWR	1984.7
		2		890	PWR	1985.11
16	Tokai Daini		Japan Atomic Power Co.	1,100	BWR	1978.11
17	Tsuruga	1	Japan Atomic Power Co.	357	BWR	1970.3
		2		1,160	PWR	1987.2
Total		55 Units		49,580MW		

Source: Federation of Electric Power Companies (Japan)

● Under Construction				(Estimated start)	
Tomari	3	Hokkaido	912	PWR	2009.12
Shimane	3	Chugoku	1,373	ABWR	2011.12
Total	2 Units		2,285MW		

● Closed					
Tokai		Japan Atomic Power Co.	166	GCR	1998.3

● Others					
Fugen		Japan Atomic Energy Agency	165	ATR(Prototype)	
Monju		Japan Atomic Energy Agency	280	FBR(Prototype)	

Note: PWR=Pressurized Water Reactor, BWR=Boiling Water Reactor, APWR=Advanced Pressurized Water Reactor, ABWR=Advanced Boiling Water Reactor, GCR=Gas Cooled Reactor, ATR=Advanced Thermal Reactor, FBR=Fast Breeder Reactor

● Preparing for Construction				(Estimated start)	
Namie-Odaka		Tohoku	825	BWR	FY2017
Higashi-Dori	2	Tohoku	1,385	ABWR	FY2017~
Fukushima	7	Tokyo	1,380	ABWR	2012.10
Daiichi	8		1,380	ABWR	2013.10
Higashi-Dori	1	Tokyo	1,385	ABWR	FY2014
	2		1,385	ABWR	FY2016~
Kaminoseki	1	Chugoku	1,373	ABWR	FY2014
	2		1,373	ABWR	FY2017
Ohma		EPDC	1,383	ABWR	2012.3
Tsuruga	3	Japan Atomic Power Co.	1,538	APWR	2014.3
	4		1,538	APWR	2015.3
Total	11 Units		14,945MW		

Source: Federation of Electric Power Companies (Japan)

ⁱ Based on press reports. See also the press statement by TEPCO of July 27th (http://www.tepco.co.jp/en/press/corp-com/release/betu07_e/images/070727e1.pdf)

ⁱⁱ The protective bunker surrounding the reactor is believed to protect against earthquakes up to 8,5 on the Richter's scale which should make reactor-damage in this case unlikely.

ⁱⁱⁱ Reuters, *Tepeco cuts profit forecast by 79%*, July 31, 2007

^{iv} World Gas Intelligence, Vol. XVIII, No. 30, July 25, 2007

^v Japan's official regulator is the *Nuclear Safety Commission* (NSC) which falls under the direct oversight from the Prime Minister's office. It was established only in 2001 after the lethal nuclear accident at the Tokai-mura facility (1999) had revealed inadequate regulatory oversight, lack of an appropriate safety culture, and inadequate worker

training and education (according to a report by United States Nuclear Regulatory Commission, available at: <http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2000/secy2000-0085/attachment1.pdf>)

The NSC usually outsources its regulatory activities to the Nuclear Industrial and Safety Agency (NISA) which is a subdivision of the Ministry of Economics, Trade and Industry. NSC then decides on regulatory issues, based on NISA's findings. The regulatory process has been accused of being structurally flawed, because it is closely affiliated to METI and the Prime Minister's Cabinet, both of which have traditionally made expansion of the nuclear programme a core policy for Japan.

^{vi} The Japan Times, *Quake-hit atomic plant sits atop a fault line: Radiation leak worse than first reported*, July 19, 2007

^{vii} Japan's notoriously slow judicial process will guarantee that the ruling is still some years away.

^{viii} The reactors at Kashiwazaki, Hamaoka and Shika were all built before the new rules were adopted.

^{ix} Citizen's Nuclear Information Center (Genshiryoku shiryō jūhō shitsu), <http://cnic.jp/english/>

^x See for a newspaper report in English: Asahi Shimbun, *Towels used to mop up nuke spill*, July 26, 2007

^{xi} See for a provisional translation in English of the New National Energy Strategy:

<http://www.enecho.meti.go.jp/english/newnationalenergystrategy2006.pdf> and for an outline in English of the Nuclear Energy National plan: <http://www.enecho.meti.go.jp/english/report/rikkokugaiyou.pdf>

^{xii} According to data from the Federation of Electric Power Companies, <http://www.fepc.or.jp/english/library/review/2007/all.pdf>

^{xiii} Although uranium prices have also risen sharply over the past few years the impact on electricity prices has remained limited, because fuel is a relatively small proportion of cost in the production nuclear energy.

^{xiv} See for example: The Japan Times, *Toshiba's Westinghouse to build nuclear power plants in China*, July 26, 2007