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Mismanaging Risk and the Fukushima Nuclear Crisis[1]

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Introduction

"Though global safety standards kept on improving, we wasted our time coming up with excuses for why Japan didn't need to bother meeting them." Madarame Haruki, Chairman, Nuclear Safety Commission, Diet testimony, 2/15/12

The nuclear accident at Fukushima was precipitated by natural disaster, but poor risk management, including a failure to comprehend tectonic risk in the most earthquake prone country in the world, and an institutionalized complacency about risk, were major factors increasing the likelihood of a major accident and fumbling crisis response. Tokyo Electric Power Company (TEPCO), the utility operating the Fukushima Daiichi Plant, and the Nuclear and Industrial Safety Agency (NISA), the government regulatory authority, mismanaged a range of risks – siting, seismic, tsunami, emergency preparedness and radiation – and it is this mismanagement that made Fukushima into Japan's Chernobyl. Investigations into the accident have established that the crisis response was improvised and inadequate because of lack of preparation, institutional flaws in emergency procedures, and poor communication within the government and between officials and TEPCO.

A private panel investigating the nuclear disaster concludes that TEPCO's systematic negligence contributed to the nuclear disaster and criticized its "make-believe" disaster emergency arrangements.[2] The myth that nuclear reactors could be operated with absolute, 100% safety embraced and promoted by what the Japanese call their "nuclear village" of pro-nuclear power advocates made it taboo to question safety standards and militated against sober risk assessment and robust disaster emergency preparedness. Those responsible for operating or regulating nuclear reactors bought into a myth of 100% safety and this collective failure left them unprepared to deal with an accident or worst-case scenario. Paradoxically, this safety myth explains why TEPCO lacked a culture of safety and why it's crisis response was so deficient.

Politicians dealing with the accident lacked knowledge about nuclear issues and crisis management, and did not get sufficient support or information from bureaucrats or TEPCO to cope with the crisis. In addition, the failure to share information bred mistrust between key actors that impaired their ability to coordinate an effective response. One interviewee cited by the private panel compared the premier's crisis management team to children playing soccer, preoccupied by the cascading disaster in front of them (chasing the ball) rather than strategizing accident response.[3]

This paper examines how TEPCO minimized risk assessments and preparations prior to 3/11, how it tried to shirk and shift blame since then, and is trying to mitigate risks to its operations involving nationalization and the sudden onset of nuclear allergy among Japanese.[4] This paper also explores how citizens are responding to the fallout of Fukushima, a bottom-up approach to managing risk. Elsewhere I have examined TEPCO's efforts to blame PM Kan Naoto for its own miscues and failure to prepare adequately for the evident risks.[5] As we explore below, the nuclear village of pro-nuclear advocates had much to gain by shifting blame to Kan and diverting attention from the institutional problems that are at the heart of the crisis.[6]

A record magnitude 9 earthquake and subsequent 15-meter tsunami devastated the Tohoku coastline on March 11, 2011, claiming some 20,000 lives and inundating the Fukushima Daiichi nuclear plant. These extreme seismic events were the proximate causes that led to the loss of electricity and the failure of backup generators. The ensuing cessation of the cooling systems caused three meltdowns within the first 80 hours and the hydrogen explosions that released plumes of radiation, spreading radioactive contamination in surrounding areas but also further afield due to strong spring winds. The long-term health effects are uncertain, but the costs of the nuclear crisis have been enormous and are mounting. The reckoning includes displacement of some 80,000 residents within the 20 km evacuation zone around the crippled reactors, many of whom will probably never return to their homes, loss of livelihoods suffered by local farmers, fishermen, and various businesses in Fukushima, together with anxiety about radiation and even the stigma of radiation that confronts the people of the prefecture. This stigma follows those who leave to restart lives elsewhere and raises concerns among young people concerning marriage prospects and raising families. In addition, there has been a wider economic fallout as bans on Japanese products were imposed overseas and overall in-bound tourism declined by 25% in 2011. Moreover, the nuclear crisis tarnished the Japan-brand, eroding the nation's reputation for technological prowess. Restoring what people and the nation lost will be costly and take considerable time. Compensation for losses are mounting while the costs of decontamination, disposal of tainted debris and decommissioning nuclear reactors will boost the final reckoning immensely. The Japanese will be paying for the folly of Fukushima for generations to come.

It is important to learn lessons from the poor risk management in the nuclear industry because Japan will probably continue to rely on nuclear energy for years to come despite the Fukushima debacle. All but 2 of the nation's 54 reactors are currently idled, and all will be offline by May.

METI Minister Edano Yukio predicts that Japan will not be relying on any nuclear energy this summer and favors minimizing reliance on nuclear energy and replacing it with renewable energy.[7] Perhaps, but there are ongoing efforts to restart some reactors based on stress tests that are based on computer simulations meant to determine whether it is safe to resume operations. Polls show that from two-thirds to three quarters of the public wants to eliminate or reduce nuclear energy, but the utilities have invested vast sums in this option, one made possible only by vast government subsidies, and the powerful nuclear village opposes pulling the plug. Moreover, it will take time to ramp up renewable energy generating capacity. While renewable energy may have a promising future in Japan, in the meantime it is important that regulators and operators minimize the inherent risks of operating nuclear plants in a seismically active nation by learning the lessons of Fukushima and implementing more stringent safety measures and improved crisis response procedures.

Embracing Risk

Fukushima was preceded by a series of mishaps, cover-ups, irresponsible practices, close calls and ignored warnings. In that sense, it was an accident waiting to happen. Charles Perrow has written extensively on the inevitability of accidents in organizations predicated on complex technologies and the problem of unexpected interactions that may cause a cascading disaster such as occurred at Fukushima. He writes,

Status of Nuclear Power Plants, Feb 2012

"…some complex organizations such as chemical plants, nuclear power plants, nuclear weapons systems…have so many nonlinear system properties that eventually the unanticipated interaction of multiple failures may create an accident that no designer could have anticipated and no operator can understand. Everything is subject to failure-designs, procedures, supplies and equipment, operators, and the environment. The government and businesses know this and design safety devices with multiple redundancies and all kinds of bells and whistles. But nonlinear, unexpected interactions of even small failures can defeat these safety systems. If the system is also tightly coupled, no intervention can prevent a cascade of failures that brings it down."[8]

Given this apparent inevitability of accidents, and the fact that Japan suffers 20% of the world's >6 magnitude earthquakes and invented the word tsunami, it may seem surprising that the government decided to place such a big bet on nuclear energy and decided to construct clusters of multiple reactors that amplifies the risks. Certainly the oil embargoes and price hikes of the 1970s reinforced perceptions that Japan had no choice. The nuclear fuel cycle was pursued because it offered the hope of eliminating Japan's dependence on energy imports. And as more money was invested in expanding Japan's network of nuclear power plants it created vested interests in the government and utilities committed to further expansion. This nuclear village is disinclined to reexamine underlying assumptions about whether it is possible to operate nuclear reactors safely in such a seismically active area. And, as time passed and no major mishaps occurred, nuclear advocates became increasingly blasé about the risks and focused narrowly on the benefits of a reliable, relatively inexpensive energy source. Moreover, as concerns about global warming grew towards the end of the 20th century, advocates discovered a new reason to promote expansion of nuclear energy: it contributes to the goal of reducing carbon emissions. Given the clear environmental costs associated with reliance on carbon fuels, ranging from extraction, processing, transporting and emissions, nuclear energy has many advantages. So over the decades, nuclear power developed an accumulating and appealing logic that relied on disregarding the problems related to disposing of radioactive waste and the potential for accidents due to human error, natural disaster or a combination thereof.

As Daniel Aldrich argues in *Site Fights* regarding government and utility efforts to convince communities to host nuclear power plants, there is a keen appreciation among advocates that the public needs convincing precisely because there is trepidation about the risks.[9] Aldrich explains that communities with low levels of social capital are specifically chosen in order to reduce the risk of local opposition and because their marginal socio-economic situation makes them more inclined to accept financial inducements. Hiroshi Onitsuka shows that the deep pockets of the central government and the utilities lavish benefits on hosting communities prior to construction, creating a subsidy addiction.[10] Jobs, tax income, various subsidies and extravagant public facilities are combined with reassuring public information campaigns to assuage concerns and build support for nuclear power projects. In Japan's declining remote coastal towns and villages, it is understandable that the risk of poverty and bleak futures have until now outweighed the potential risk of nuclear energy. Deferential views toward the central government together with a pragmatic assessment that such projects will be built somewhere and someone will benefit, also help explain why hosting *seemed* a reasonable option.

Although the central government and utilities promoted a nuclear consensus—nuclear energy is safe, reliable and cheap—some civil society groups and many individual Japanese contested this effort to little avail.[11] Nevertheless, the nuclear village of pro-nuclear advocates in the utilities, government, the Diet, mass media and academia has dominated the conversation. These advocates are not given to doubts or inclined to reconsider their assumptions and have relied on their power network to prevail. Prior to Fukushima there have been 14 lawsuits challenging nuclear power plants on the grounds that seismic dangers were hidden or downplayed, but the utilities prevailed in each case.[12]

The utilities, government and associated scientists tout the high tech, fail-safe features of nuclear reactors, but as Perrow reminds us, accidents happen. Immediately after the March 11 disaster, TEPCO was quick to claim that the tsunami and chain of multiple failures had been inconceivable, but the record suggests otherwise. In 1975, nuclear chemist Takagi Jinzaburō and others established the Citizens Nuclear Information Center (CNIC) and since then issued regular reports on nuclear power plant safety issues. This activism targeted the regulatory and technical problems with nuclear power and the vulnerabilities specific to seismically active Japan. Fukushima was the nightmare scenario that CNIC had long predicted. In a 1995 interview, Takagi spoke about the risks of a meltdown in the event of multiple failures. He raised the possibility of large radioactive releases from a meltdown resulting from a breakdown in the emergency core cooling system and the failure of back-up diesel generators, exactly what happened at Fukushima sixteen years later.[13]

Warnings by the CNIC and other anti-nuclear activists and experts were not taken seriously by the nuclear village since it would have required abandoning their quest for nuclear power under Japan's seismically fraught conditions. As Perrow argues, "There is the problem that warnings are often seen as mere obstructionism. This was the view of a representative for a Japanese utility who brushed away the possibility that two backup electrical generators would fail simultaneously."[14] This expert witness testified at the Shizuoka District Court in February 2007 on behalf of Chubu Electric Power Co., the utility that owns and operates the Hamaoka nuclear power plant.[15] Exasperated by questioning from the plaintiff's lawyers concerning what would happen in the event of a station blackout and loss of all backup electricity (as happened at Fukushima four years later), this irritated witness blurted out, "If we took all these possibilities into account, we could never build anything." This witness was Madarame Haruki who was subsequently named chairman of the government's five-member Nuclear Safety Commission in April 2010. Repeta writes,

> "I do not know how this performance figured into Madarame's selection to lead the nation's most senior office charged with maintaining nuclear power safety. We do know the result of the suit: As in nearly every other case challenging Japan's nuclear power plants, the court ruled in favor of the power company. In one of many great ironies surrounding the Tohoku disaster, Prime Minister Naoto Kan effectively overruled the court by requesting that Chubu Electric close the Hamaoka facility on May 6 (2011). The company board responded quickly and the shutdown was accomplished eight days later."[16]

As we discuss below, however, Madarame has changed his tune.

In Japan, cozy and collusive ties between regulators and industry embodied in the amakudari system and the nuclear village have

compromised nuclear safety.[17] This situation has led to widespread regulatory capture, explaining the lack of a culture of safety at TEPCO and the averted eyes approach to monitoring the nuclear industry evident at NISA.[18] Workers at Fukushima report being routinely warned in advance of inspections and inspectors did not seem eager to uncover violations.

PM Noda Yoshihiko once stated that he does not support building any new reactors, does not favor extending the operating licenses of aging plants beyond their original design life spans and supports a gradual phasing out of nuclear energy. However, he has backtracked from this position. In particular, he appears much more favorably inclined towards nuclear energy than his predecessor Kan Naoto, calling for reopening of the closed plants. Kan stunned the nation on July 13, 2011 when he called for the gradual phasing out of nuclear energy, stating that he believes it is not possible to operate nuclear reactors safely in Japan. In contrast, Noda stresses the importance of nuclear energy to Japan's economy, favors restarting reactors following stress tests and wants to complete reactors already under construction, while his Cabinet introduced legislation allowing extension of operating licenses for aging reactors (> 40 years).[19]

This new Japanese law requires the decommissioning of aging plants, but features a critical loophole designed to permit their continued operation at the discretion of regulators. Given the track record of regulators in Japan (and the US), what is supposed to happen only in exceptional cases (continued operations of old reactors), may become the norm. Given that so many of Japan's reactors are aging (3 are over 40 years old and another 16 are over 30 years old) with the attendant risk of metal fatigue and dated technology, safety issues are becoming ever more urgent; the three meltdowns at Fukushima occurred in reactors commissioned in 1971, 1974 and 1976. Policymakers, however, under the pretext of mandating decommissioning such aging reactors have actually ensured that the government retains discretionary powers to extend operating licenses and have even lengthened time in between inspections in an effort to improve the lifetime profitability of all reactors.[20] These initiatives are increasing risks.

Whistleblower revelations of systematic falsification of repair and maintenance records in 2002 at all of TEPCO's nuclear plants indicate that more robust inspections, transparency and accountability are crucial to nurture a culture of safety.[21] It is important to remember that in February 2011, shortly before the meltdowns, NISA extended the operating license of Fukushima Daiichi despite expressing reservations about a dubious maintenance record and eerily prescient concerns about stress cracks in the back-up diesel generators that left them vulnerable to inundation.

Shifting Blame

So who is to blame for the three meltdowns at Fukushima? The nuclear village tried to shift blame onto PM Kan, spreading erroneous information about his visit to Fukushima Daiichi to the effect that he forced TEPCO to stop venting and subsequently alleging that he ordered the halt of pumping of seawater to cool the reactors and spent fuel rods stored in adjacent pools.[22] The failure to vent did in fact lead to hydrogen explosions in three secondary containment buildings, but this was TEPCO's responsibility and had nothing to do with Kan's visit on March 12.[23] Similarly, PM Kan never ordered the cessation of seawater pumping and the plant manager actually ignored instructions from the TEPCO president to do so because under international protocols it was his call.[24] TEPCO retracted its allegations against Kan, but not before damaging Kan's reputation and sowing suspicions about his responsibility for the nuclear crisis. Scapegoating Kan served many purposes, especially diverting attention away from TEPCO's, NISA's and METI's responsibility for the accident and woeful crisis response. The LDP also needed political cover since it was the party in power that had promoted nuclear energy and was complicit in the lax oversight that undermined plant safety. Personalizing the problem was an effort to downplay the fundamental institutional flaws that lay at the heart of the crisis. Discrediting Kan also served to discredit his anti-nuclear, pro-renewable energy initiatives.

To his credit, PM Kan in dealing with the disaster did not trust the bureaucrats advising him, knowing from past experience that their ingrained inclination to first establish a consensus and then act was inconsistent with crisis management. Kan also distrusted TEPCO since it was acting to protect its assets and interests and was not providing him with accurate and timely information. But Kan's justified suspicions also left him isolated and unable to call on people and institutions with relevant expertise. According to the *New York Times*, "At the drama's heart was an outsider prime minister who saw the need for quick action but whose well-founded mistrust of a system of alliances between powerful plant operators, compliant bureaucrats and sympathetic politicians deprived Prime Minister Kan of resources he could have used to make better-informed decisions."[25] As a result, those without expertise were making crucial decisions while experts such as NSC Chairman Madarame were giving misleading advice, inevitably leading to mistakes and zigzagging.

Scapegoat: Former Prime Minister Kan Naoto

NISA was responsible for instituting government crisis procedures, and TEPCO was responsible for safe operations of its plants, but both were unprepared when it counted most. On February 17, 2012 former PM Kan asserted that Fukushima was a manmade disaster and that authorities were woefully unprepared to deal with it.[26] There were no systems or procedures in place to respond effectively to Fukushima and officials had to improvise as they went along. "Before 3/11, we were totally unprepared," he said. "Not only in terms of the hardware, but our system and the organization were not prepared. That was the biggest problem." He added,

> "If they had thought about it, they wouldn't have intentionally built it at such a low location. The plant was built on the assumption that there was no need to anticipate a major tsunami, and that was the actual start of the problem. We should have taken more adequate safety steps, and we failed to do so. It was a big mistake and I must admit that (the accident) was due to human error."

He also acknowledged information dissemination was slow and sometimes inaccurate, blaming it on a lack of reliable data. In his view the disaster exposes a wide range of vulnerabilities and risks and the need to overhaul safety guidelines and improve crisis management.

At the end of February 2012 an investigation conducted by the non-governmental Rebuild Japan Initiative Foundation (RJIF) criticized Kan for micromanaging and meddling in the crisis response at the nuclear plant and for closeting himself with a small coterie of trusted advisors, but praised him for refusing TEPCO's requests on March 15th to abandon Fukushima Daiichi and ordering the utility not to withdraw its staff from the stricken plant.[27] The RJIF interviewed all the people in the room with the premier, including those who were critical of his crisis management, when TEPCO made it's request to evacuate personnel from Fukushima Daiichi and they all corroborated Kan's charge that TEPCO had proposed a total evacuation and repudiated TEPCO's subsequent

assertions that it was not proposing to totally abandon the nuclear plant.[28]

TEPCO and its defenders also blamed GE for the accident because it supplied the plant design right down to the placement of the backup generators and refused to modify it despite concerns expressed by local contractors at the time about the need to protect against tsunami. TEPCO also conducted an in-house investigation into the nuclear crisis and issued a report in December 2011 that shirked all corporate responsibility for the accident, instead blaming the massive tsunami, calling it a rare natural event that could not have been anticipated (sotegai), a claim that has been effectively refuted.

Crisis Assessment

The third party panel that investigated the nuclear crisis at the behest of the government issued an interim report at the end of 2011 that was harshly critical of TEPCO and the government, pointing out that the utility was ill-prepared for a crisis and that its' workers made critical errors in shutting off automated emergency cooling systems and wrongly assumed part of the cooling system was working when it was not.[29] The report of the RJIF non-government investigation cited above released at the end of February 2012 reached similar conclusions. These workers and their managers were inadequately trained to cope with an emergency situation and according to the panel lacked basic knowledge concerning the emergency reactor cooling system. Their mishandling of emergency procedures contributed to the crisis. Moreover, TEPCO and its regulators, as we discuss below, failed to act on fresh and compelling evidence about tsunami risk, a blind spot that left the plant needlessly vulnerable. Because the possibility of a tsunami inundating the plant was ignored, TEPCO made no preparations for simultaneous and multiple losses of power. The station blackout halted cooling systems, caused the meltdowns and disrupted communications among emergency workers and between the plant and the government. Workers were largely dependent on mobile phones that could not be recharged while carrying out emergency work by flashlight. Meanwhile the government was kept in the dark about critical developments and officials delayed in giving advice to the prime minister and his advisors on how to respond to the nuclear crisis.[30]

Investigators concluded that TEPCO failed to provide information to the government in a timely manner because it was inadequately prepared for an emergency. The crisis management center for Fukushima Daichi was only 5 km from the plant, and when plant workers arrived they found it wrecked, with no power or functioning communications and unusable because there was no air filtration system to filter out radiation. This poor emergency preparedness delayed the flow of information to the prime minister's office, slowing the government response.

NISA was widely criticized for not having done more over the years to force TEPCO to improve its preventive and emergency measures. It was also revealed that NISA staff abandoned the Fukushima plant after the earthquake on March 11 and thus could not collect and disseminate real-time information as the crisis worsened; after being ordered to return, they did little to help manage the crisis.

The investigations also pilloried TEPCO and the government's mishandling of the evacuation of residents living near the plant, in many instances evacuating people to places where levels of radiation were higher than those where they had left. This reflected the general problem of information bottlenecks; PM Kan and his cabinet were not given data on radiation contamination that could have led to a more sensible evacuation order. The third party panel faulted the government's order for residents within 20 km of the plant to leave the area because state agencies had data showing that radiation contamination did not spread concentrically and that some designated evacuation sites were actually hot zones. The panel confirmed that data generated by the System for Prediction of Environmental Emergency Dose Information (SPEEDI) on radiation dispersal was available and could have been used to evacuate residents at greatest risk to safer areas, but this information was not provided to the Prime Minister's crisis management center until March 23, eleven days after the first hydrogen explosion released plumes of radioactive substances into the air. Finally, one month after the original evacuation, the government used this SPEEDI data to move evacuees out of harms way, meaning that many had been subjected to substantial doses of avoidable radiation exposure. One advisor actually informed PM Kan about the SPEEDI data on March 13, but the chairman of the Nuclear Safety Commission Madarame Haruki misinformed the premier that SPEEDI was not available. When officials responsible for SPEEDI were asked why they did not make this crucial data available to crisis managers sooner, they replied lamely that nobody asked them for it.[31] Kaieda Banri, METI Minister during the crisis, and the top official responsible for the nuclear energy industry, admitted he had never even heard of the SPEEDI system before the accident.

Tsunami Risk

"It's inexcusable that a nuclear accident couldn't be managed because a major event such as the tsunami exceeded expectations." Hatamura Yotaro, Chairman, Third Party Panel Investigation Committee (Dec. 26, 2011)

Hatamura Yotaro chaired an investigation into the Fukushima accident and is a well-known authority on accidents and author of a respected book, *Learning From Failure* (2003). He has analyzed data on over 1,100 industrial accidents focusing on design flaws, system failures and human error. For Hatamura, managing risk at a nuclear power plant is about foreseeing the unforeseen and preparing accordingly. His committee refuted TEPCO's in-house, self-exonerating report released in early December 2011 that blamed the accident entirely on an unanticipated, rare natural disaster. In fact, TEPCO ignored several warnings, including internal research, about the possibility of a monster tsunami. It looked into building a larger tsunami seawall, but decided the cost was prohibitive and took no additional preventive measures. On March 7, 2011, only four days before the tsunami, TEPCO presented the Nuclear and Industrial Safety Agency (NISA), the government's nuclear watchdog authority, with results from simulations conducted in 2008 by its own researchers showing that a tsunami as high as 15.7 meters could hit the area, a finding it ignored.

Telltale warnings began accumulating over the decade prior to 3/11. In 2001, researchers cited geological evidence that the Jogan tsunami of 869 slammed the Fukushima coastline and the wave height was strikingly similar to the 3/11 event. Their research on ancient gigantic tsunami noted that such uncommon disasters occur every 800-1,100 years and specifically warned that the region was overdue for another. In February 2002 the Japan Society of Civil Engineers using new simulation techniques determined that there was a risk of a 5.7 meter tsunami and a month later TEPCO increased its estimates accordingly from the original assumption of a 3.1 meter tsunami when the reactor was being built in the early 1970s. In July 2002 the government's Headquarters for Earthquake Research Promotion warned that an even larger tsunami was possible based on historical evidence. In 2006 the government revised its anti-seismic guidelines, specifically calling on utilities to prepare for rare events. In 2009 NISA and TEPCO discussed the possibility of a 9.2 meter tsunami based on new simulations and archaeological evidence, but NISA did not press TEPCO to take countermeasures.

Clearly, there is no basis to TEPCO's claim that the scale of the 3/11 tsunami was inconceivable; the utility chose to ignore centuries of geological evidence and repeated 21st century warnings from modern scientists, including in-house researchers. In terms of tsunami-related risk management, it turns out that TEPCO and two other utilities actually lobbied the government's Earthquake Research Committee on March 3, 2011 to water down wording in a report warning that a massive tsunami could hit the Tohoku coast. Apparently the committee agreed to modify the report in accord with concerns expressed by the utilities that a stark warning about the possibility of a colossal tsunami might cause "misunderstanding" among the public.[32]

Aside from this dubious intervention, TEPCO ignored ominous developments in the subduction zone off the coast of Honshu island. Subduction zones, where tectonic plates slip under one another, are prone to ruptures that trigger tsunami. The wider the area of tectonic plate overlap, the greater the potential for a mega tsunami. Seismic sensors on the ocean floor indicated growing pressures and risk of rupture along the fault line that runs North-South off the coast of Tohoku. The 2010 subduction zone quake off the coast of Chile and that in 2004 off Sumatra that wreaked havoc in Aceh, Thailand, India and Sri Lanka are recent examples that should have undermined institutionalized complacency about tsunami risk. But TEPCO did not approach risk assessment from the basis of a worst-case scenario, and relied on unduly optimistic assumptions that wished away a cataclysm in a region with a history of killer waves. This unjustified insouciance cost Japan dearly.

Culture of Safety?

Inexcusably, TEPCO did not make safety its ethos while lax oversight by the government allowed this culture of complacency to persist long after it was obvious that TEPCO was cutting corners to cut costs. METI did shutdown all 17 of TEPCO's reactors in 2002, but only because the media reported a whistleblower's revelations about systematic falsification of repair and maintenance records, and exposed the government's initial failure to act on this information. The 2011 third party panel found that safety precautions were based on unrealistic assumptions that left the utility poorly prepared to deal with a crisis, a finding that came too late for the people evacuated from their homes in Fukushima and thousands of farmers and fishermen who lost their livelihoods.

Given the risks associated with operating nuclear power plants in a seismically active, densely populated country it is extraordinary that Japan's utilities did not practice evacuation procedures in reactor- hosting communities. The utilities justify this oversight by arguing that they did not want to alarm local residents by practicing for an unlikely event and thereby undermine repeated assurances that nuclear energy is completely safe. Thus, the utilities and many communities did not prepare to help local residents escape from the radioactive contamination that has blighted Fukushima prefecture. The lack of procedures and guidelines proved a major hole in disaster preparedness. In retrospect, this policy of preserving the myth of 100% safety at the expense of actually safeguarding residents represents an institutionalized inclination to collectively bury heads in the sand, and irresponsibly minimize risk in ways that endangered local residents.

Transparency

In August 2011 a Diet committee investigating the nuclear disaster requested that TEPCO provide it with an operations manual for the Fukushima Daiichi plant. TEPCO initially refused the request, prompting a public uproar. One month later, TEPCO provided a heavily redacted version of the manual and justified blacking out key passages related to emergency procedures, arguing that this information constituted intellectual property it wished to protect and also raised security concerns. These spurious grounds highlighted TEPCO efforts to prevent the Diet from exercising oversight and attempting to cover-up shortcomings in its crisis response. It took six months for TEPCO to release the entire manual. Committee members complained about this stonewalling and stated that, "It was important that we saw the manual to learn why the company had switched part of the emergency core-cooling system off and on again after the earthquake (and before the tsunami) — to find out when the emergency systems were destroyed."[33] Former premier Hatoyama Yukio concluded that it is imperative to nationalize TEPCO in order to promote transparency and learn the lessons of Fukushima precisely because the utility has tried to obfuscate rather than clarify what happened and why. But it is not only TEPCO that is attempting to cover its tracks.

In January 2012 the media reported that various government panels dealing with the Fukushima crisis failed to keep minutes of the proceedings, including the task force set up by the Prime Minister's office. Keeping minutes is standard procedure for government panels, one usually carried out by bureaucratic officials. The failure to keep minutes is a critical oversight because it prevents learning more lessons about the crisis response to avoid repeating the same mistakes in the future. The Asahi termed this absence of minutes a, "monumental level of government ineptitude", fuming that,

> "It would be hard for the officials involved to disprove the charge that they deliberately neglected to keep a record of the meetings so that their blunders and missteps would not come to light later. Now, the oft-repeated pledge by top government officials to share lessons learned by the accident with the international community sounds hollow. Technically, the responsibility for this fiasco lies with the Nuclear and Industrial Safety Agency of the Ministry of Economy, Trade and Industry, which served as the secretariat for the headquarters. But even more to blame are the politicians who failed to ensure that a record of the meetings would be kept."[34]

In February 2012 the RJIF investigation highlighted the lack of transparency, noting that the government withheld information about the full danger of the nuclear disaster from the public and the international community.[35] This conclusion was confirmed on March 9, 2012 when the government released a 76 page summary of the 23 meetings of the Prime Minister's crisis management team that was reconstructed from interviews conducted in early 2012 of officials attending the 2011 meetings and unofficial notes kept by NISA officials. NHK contrasted this post-facto summary, one short on details, with the recent release of the 3,200 page transcript of the U.S. Nuclear Regulatory Commission crisis deliberations about Fukushima. The summary is vague on important issues such as the decision to declare a nuclear emergency, discussions about a meltdown within hours of the earthquake, the decisions to expand the evacuation zone and criticism about the lack of a chain of command in managing the crisis.[36] This belated attempt to quell public concerns about the lack of transparency actually amplified them because it has clarified how much information the government withheld from the public and how little it has divulged about its deliberations during the crisis.

Apparently, managing risk was more a matter of concealing chaotic and inconsistent decision-making by the government and inadequate crisis response procedures by TEPCO than gleaning useful lessons about how to improve crisis response mechanisms. This lack of transparency reflects a "circling of the wagons" mindset that prevents robust risk management, raising serious doubts about operating nuclear reactors in Japan.

Whistleblower

In Diet testimony on Feb. 15, 2012, Madarame Haruki, Chairman of the Nuclear Safety Commission, pulled back the curtain on the nuclear village, drawing attention to cozy and collusive relations between regulators and the utilities, and lax safety standards. He spoke of officials ignoring nuclear risks and admitted, "We ended up wasting our time looking for excuses that these measures are not needed in Japan."[37] He asserted that Japan's safety monitoring technology is three decades out of date, while acknowledging that he and his colleagues had, "…succumbed to a blind belief in the country's technical prowess and failed to thoroughly assess the risks of building nuclear reactors in an earthquake-prone country."[38] He said that regulators and the utilities missed many opportunities to improve operating safety and warned that safety regulations are minimally enforced and fundamentally flawed. Furthermore, he asserted, regulators were toothless and overly solicitous of utility interests. He acknowledged that officials did not prepare for a simultaneous station blackout and failure of backup generators and ignored a series of warnings about the dangers of a large tsunami affecting the Fukushima plant. His testimony confirmed the findings of the two investigations, Third Party Panel

and RJIF, cited above that were released at the end of December 2011 and February 2012 respectively.

In Madarame's view, nuclear reactor safety is compromised because of institutional complacency and perfunctory enforcement of safety regulations and guidelines. He accused utilities of slipshod practices, stating, "Power companies have the fundamental responsibility of securing safety and they need to set their standards much higher than what the government suggests. . . . It is extremely outrageous if power firms are using the NSC's safety standards as an excuse not to raise them."[39]

It is unnerving to have one of the nation's leading nuclear energy experts, the man in charge of the NSC, one who has long been a stalwart advocate of nuclear energy and who defended the nuclear crisis response in the months following 3/11, suddenly voice many of the same objections that anti-nuclear activists have expressed over the years. Madarame as apostate may not be convincing, but his withering indictment of the nuclear power industry and government regulators is an astonishing development in the post-Fukushima discourse. Of course some of it can be attributed to his desire to restore a battered reputation and to shift responsibility.[40] Indeed, in his testimony he explained that he had been trying to reform the NSC and impose stricter monitoring, but having only taken his position in April 2010, he had not had sufficient time prior to 3/11 to overcome an entrenched institutional culture. Now Madarame has exposed the shadowy practices of the nuclear village, including collective heedlessness about safety and poor risk management. In the one sector where a culture of safety should have been foremost, the nuclear safety czar revealed a culture of deceit.

Shortly after his Diet testimony, Madarame dropped another bombshell when he announced that he does not think that the first round of stress tests conducted on Japan's nuclear reactors are sufficient to ensure safe operation.[41] Speaking on behalf of the NSC, Madarame said, "With only the first round (of stress tests), the level of safety confirmation that the commission seeks would not be met. Whether to reactivate (reactors) is the government's decision and we, as the safety commission, won't say anything about it." This high profile indictment of the stress tests comes at an inconvenient time for the government because NISA has already endorsed first stage stress tests conducted for Kansai Electric's Oi power plant. In response to Madarame, the Chief Cabinet Secretary Osamu Fujimura stated that regardless of the NSC, the government will decide on whether or not to resume operations of nuclear reactors based on the initial stress tests and local sentiments in nuclear plant hosting communities.

The Noda cabinet's desire to restore public confidence in nuclear energy through the stress tests, and restart idled reactors, has been undercut by Madarame's statement. Public anxieties about nuclear energy are already widespread and the stress tests have been dismissed all along as empty PR gestures by prominent politicians such as the governors of Niigata, Ishikawa and Fukui, along with experts and citizen's groups. Nothing, however, could be quite as damning as the NSC chairman, one of the nuclear village's headmen, pointedly refusing to endorse the stress tests.

The stress tests were first announced by PM Kan in July 2011, stirring considerable controversy because he did not consult with his cabinet beforehand.[42] Kan's insistence on EU style 2-stage stress tests derailed METI's plans to quickly restart idled reactors last summer and infuriated METI Minister Kaieda. METI had engaged in a PR campaign to reassure hosting communities that reactors were safe, and on June 18 Kaieda announced that METI had confirmed it was safe to resume operation of the nation's reactors. But this haste to resume business as usual in the nuclear industry only three months after the three meltdowns, and not quite one month after TEPCO finally admitted to the meltdowns, backfired. The media exposed how NISA and Kyushu Electric, at the suggestion of the governor of Saga, had orchestrated an Internet "town hall" meeting on June 26, planting questions and opinions among participating "netizens" in favor of nuclear energy and restarting the Genkai reactors in Saga Prefecture. METI's plans suddenly came under fire and Kan seized the opportunity to introduce stress tests and handed responsibility for overseeing the process to NISA and the NSC.

At the time it looked like little more than a delaying measure because the utilities would conduct the computer simulations about the safety of restarting their own idled reactors. Adding to the conflict of interest, key institutions in the nuclear village, NISA and the NSC, would assess the results and presumably endorse them. But the NSC has now upset these plans and in doing so stoked public skepticism about the effectiveness of stress tests based solely on computer simulations. Experts have pointed out numerous flaws in the stress tests and note that they do not measure metal fatigue, an important issue for aging plants, don't examine multiple failures as occurred at Fukushima, and lack hands-on testing of components.[43] Stress tests have not been used anywhere in the world to determine if a plant should be operating. People have good reasons not to trust the utilities to report inconvenient findings from the stress tests since they are known to have falsified repair and maintenance records in the recent past. Moreover, TEPCO conducted computer simulations in 2008 on tsunami risk that it did not share with NISA until four days before 3/11. Critics also point out that much depends on what assumptions are used in the simulations and doubt that utilities, with so much investment in nuclear energy at stake, will uncover the need for expensive retrofitting or decommissioning.

Madarame has undermined the credibility of the stress tests and indicated that more sweeping reforms are needed to upgrade safety and monitoring in the nuclear industry. Will this 'betrayal" of the nuclear village have any impact? Yes, in terms of public sentiments, but his remonstrations notwithstanding, the government appears determined to restart idled reactors. Apart from considering results of the stress tests in deciding whether or not to restart reactors, the government vaguely referred to taking into account the feelings of local residents while rejecting calls for a national referendum. Rather, the government seeks to consult residents of towns that are given lavish subsides to host nuclear power plants that also generate well paid jobs. So by basing the government's restart decisions on the sentiments of those who have the most to gain from resuming operations, and on tests conducted by those with the most to gain from going back online, officials appear to be limiting the risk posed by anti-nuclear public opinion. The media is full of reports about how much hosting communities gain from hosting and how much they stand to lose in terms of subsidies, taxes and jobs if reactors remain idled. So if only these local people's views count, the fix seems to be in. But Fukushima has changed perceptions about nuclear energy safety throughout Japan.

An NHK poll in October 2011 indicated that 80% of the mayors of hosting communities oppose restarting reactors until safety can be verified. The governor of Niigata which hosts the massive Kashiwazaki nuclear plant, closed in 2007 following a magnitude 6.8 earthquake that exceeded reactor design specifications, has repeatedly stated that he would oppose resumption of operations until the Fukushima crisis is resolved and dismisses the value of the stress tests. So it may well be true that local people can be induced or bribed into restarting idled reactors, but they are also keenly aware of how little has been done for the residents of Fukushima and how much they lost.

In Fukushima evacuation centers there is a degree of tension between evacuees from hosting villages and those from neighboring villages that never received any subsidies or benefits, but have experienced the same level of personal loss and dislocation.[44] The politics of cherry picking public opinion are uncertain, but the government does seem to be courting risk by ignoring the voices of many other local residents who have just as much at risk as hosting community residents and nothing to gain.

More worrisome for the nuclear village is the March 8, 2012 NHK poll conducted in 142 communities in the vicinity of Japan's nuclear power plants. NHK found that only 14% of respondents favor restarting idled reactors now or in the near future while 79% opposed or had strong reservations about doing so.[45] Clearly the government faces a steep uphill battle in gaining the understanding of Japanese living near nuclear reactors about plans for restarting reactors.

Nationalization

The government has injected vast sums of money into TEPCO so that it can honor its liabilities and continue operating, but the utility is resisting ceding management control to the government. Decommissioning the four crippled reactors at Fukushima will cost at least US $15.5 bn over the next three to four decades while compensation payments may reach some US$30 bn in the first two years alone. Dealing with the cleanup, from schoolyards and parks to fruit orchards and residential areas, and disposing of radioactive debris will boost the bill significantly. In August 2011 the government adopted legislation that provides guarantees for TEPCO's liabilities and established a 5 trillion yen credit line for a Nuclear Damage Liability Facilitation Fund (NDLFF) funded by special compensation bonds that will be used to lend money to TEPCO.

Compensation will cover about 75% of Fukushima's residents, or 1.5 million people. However, in one of many disastrous PR moves, TEPCO initially required individuals seeking compensation to fill out a complicated 62-page form. The ire over this red tape forced the company to create a simplified form, although the new one still runs to 34 pages and requires applicants, many of whom lost homes and all records, to fill in over 1,000 fields. This onerous compensation hurdle and associated delays have angered victims and left many in difficult financial straits. By early 2012 less than one half of the 70,000 eligible households had filed the necessary paperwork. As of March 2012, only one quarter of the 1.7 trillion yen of financial aid the government provided TEPCO for compensation has been disbursed. TEPCO has postponed settlement of real estate related claims in the no-entry area and designated as hot zones.[46] The government's expected reclassification of such areas in April 2012 will reduce the restricted areas and presumably lower TEPCO's payouts. In addition, since an arbitration board was established in Sept 2011, TEPCO has stonewalled compensation, only settling 18 out of 1,243 cases. Cumbersome procedures and paperwork are part of TEPCO's strategy for managing risk and minimizing payments to those whose lives have been turned upside down by Fukushima.[47]

TEPCO's liabilities exceed its assets, and so technically it is insolvent, but with more than 30 million customers in the Kanto region, including Tokyo, it is too big to fail. This explains the government's decision to rescue the utility despite public misgivings about management miscues. Banks will not lend it any more money or refinance loans in the absence of government guarantees. The government and TEPCO have been sparring over nationalization of the utility with METI Minister Edano arguing that the government should exercise management control because the $12.4 billion injection of public funds is equivalent to a 2/3 stake in the company. While this is what happened to the banks during the Koizumi era (2001-06), TEPCO has powerful backers to help resist a government takeover. PM Noda is much more favorably inclined toward the nuclear industry than his predecessor while the Ministry of Finance along with the business federation Keidanren is also lobbying against full-scale nationalization. In early March it was announced tentatively that the government will obtain 51% of voting rights in TEPCO, but the remaining 15% of its stake will be non-voting shares.[48] According to Japanese law this means that the government can choose board members for TEPCO, but because it doesn't control 2/3 of voting rights it can't force through major management reforms such as mergers and spin-offs. Perhaps this quasi-nationalization will improve corporate governance, but because the utility retains significant management autonomy this agreement marks a major setback for those like Edano who believe that TEPCO requires more fundamental reforms. Edano has lead a chorus of criticism that TEPCO has not gone far enough in streamlining operations, cost-cutting and taking responsibility for its negligence.[49] Since it appears that TEPCO will need further injections to stay afloat, the agreement facilitates access to more public funding. In addition, making TEPCO a ward of the state will help it obtain some 900 billion yen in bank loans from July 2012, but the financial sector is also insisting on assurances of higher electricity rates and restarting some reactors. Yet again, this loan plan reaches deep into taxpayers' pockets as the government's Development Bank of Japan will provide about 500 billion yen of the total while commercial banks, trust banks and insurance companies will provide 400 billion yen and refinance 170 billion in outstanding loans.

The bailout and sham nationalization mean that taxpayers will be paying off the Fukushima tab for decades to come and as ratepayers face higher electricity prices while many of the people who mismanaged risks at TEPCO remain in charge. The estimated 10% rate increase for households that will be introduced from the summer of 2012 has drawn considerable criticism as it follows revelations that TEPCO systematically overcharged customers over the past decade.

Backlash

Over the past five decades the government and utilities have educated Japanese citizens to believe in the safety, reliability and necessity of nuclear energy. Indeed this myth blinded regulators and operators to the risks and rendering adequate crisis management procedures taboo.[50] Thus the Fukushima debacle came as a shock to most Japanese, one that thoroughly undermined the assiduously propagated myths of nuclear energy safety. As the crisis lingered throughout 2011 and it became clear that the nation would be dealing with the consequences for decades rather than months, shock gave way to a backlash, jolting many citizens out of resignation to varying degrees of anti-nuclear activism.[51]

The top-down consensus promoting nuclear energy is now being challenged by a growing bottom-up backlash. Certainly there was anti-nuclear activism prior to Fukushima, but it has become far more widespread since 3/11 due to a lack of trust in official information and reassurances. This activism is evident in social media where websites post radiation readings taken by "citizen scientists" armed with their own Geiger counters that map the spread and extent of contamination, painting a far more grisly situation than official assessments. As it became evident that the government was not ensuring food safety, producers, retailers and consumers have taken matters into their own hands, a do it yourself approach that speaks volumes about public perceptions of official failings. In addition, there is also a citizen's campaign led by Nobel Literature laureate Oe Kenzaburo, among others, to collect ten million signatures for an anti-nuclear energy petition; currently they have 4 million. In the present state of siege, the moat surrounding the nuclear village may have been breached, but the ramparts remain well defended.

Activists have sought a national referendum on nuclear energy and various local referenda are being mooted. The central government, however, will work to prevent public sentiment from dictating national energy policy.[52] The popular mayor of Osaka, Hashimoto Toru, has been very critical of the utilities and when he was governor of Osaka he spoke out against nuclear energy on which the Kansai region previously relied for 50% of its electricity. At present, the three major cities in the Kansai heartland—Osaka, Kyoto and Kobe—are lobbying KEPCO to phase out nuclear energy and disclose information about energy supply and demand, and lower rates. The three cities control nearly 13% of Kansai Electric shares (Osaka 9%, Kobe 3% and Kyoto 0.45%) and plan to table a motion on phasing out nuclear power at the June 2012 shareholders' meeting.

Citizens are also responding to the nuclear crisis through voluntary conservation efforts. In the summer of 2011 there were expectations of rolling blackouts as reactors went offline for regular inspections so the government mandated conservation for large commercial users and urged the public to reduce electricity consumption by 15%. Through lifestyle changes and innovative measures, the public exceeded this target and registered an overall 20% decrease in electricity consumption. Surveys indicate that some 60% of the public practiced conservation since 3/11 and it seems to be a new commonsense norm, one that will be reinforced by higher electricity prices.

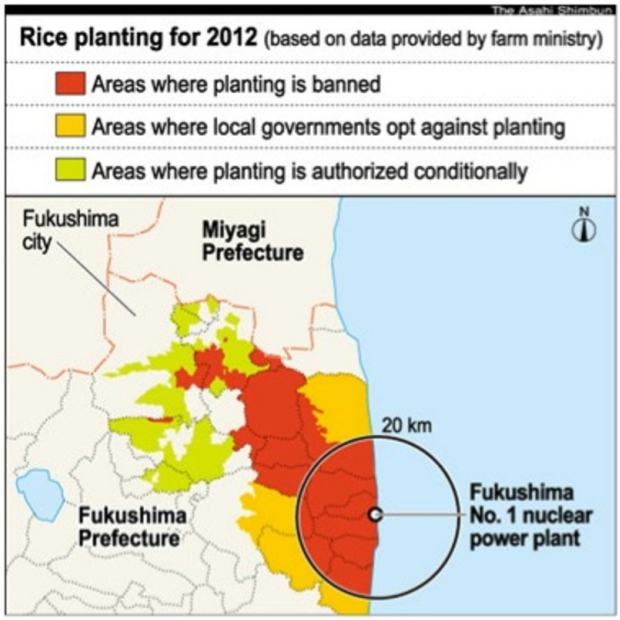
Polls also indicate strong public support for renewable energy and key business leaders such as Son Masayoshi, Japan's Bill Gates, along with others, are tapping into this shift in sentiments and the new Feed-In Tariff legislation to invest in expansion of

renewables.[53] A Yomiuri poll taken in November 2011 asked respondents what source of energy Japan should rely on in the future and 71% chose solar energy while only 6% chose nuclear energy. Smart innovative capital is driving a green revolution, but also encountering resistance from the nuclear village in terms of transmission access and pricing while also facing technological hurdles that raise questions about how quickly such a shift can happen. But because renewable energy now generates only 1% of Japan's electricity supply, there is lots of low hanging fruit that could lead to fairly rapid increases over the next decade if the government gets policy and pricing right.

Checking for Radiation with dosimeter

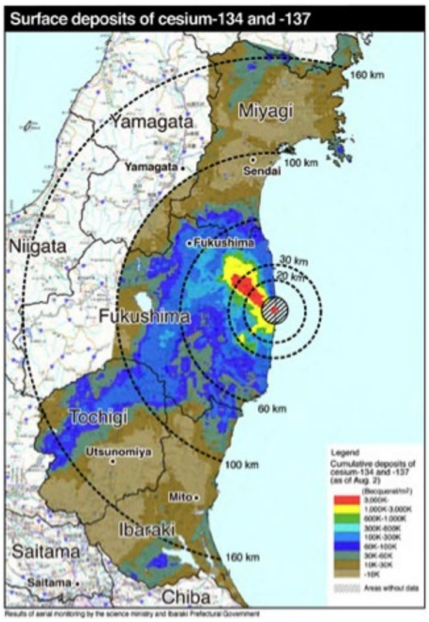
Food and Fuel Risk

In post-Fukushima Japan, risk management includes protecting the public from the radiation that has been spewed from the crippled reactors. In the area of food safety the government continues to underwhelm. The public has grown increasingly skeptical about government pronouncements because one month they are told that Fukushima rice is safe and free from radiation and the next that it is not.



Rice Planting Ban

One of the more puzzling policy decisions involves the government announcing stricter food safety radiation standards soon after it announced a cold shutdown at the stricken nuclear complex in December 2011. The new top limit for cesium is 100 becquerels per kg of rice, meat, vegetables and fish, one-fifth the limit set shortly after the nuclear accident, while the safe level for drinking water was slashed from 200 to 10 becquerels. This drastic reduction in "safe" levels is unnerving for people who have been paying attention to the previous guidelines and believing that they were eating safe food and drinking safe water; now they are not so sure. There is also bafflement as to why the stricter limits only take effect in April 2012 with a further six-nine month "grace period" for beef and rice to meet the new standards.



Cesium Dispersal Map

Grace period? Understandably consumers wonder why stricter standards for what they ingest are delayed. It is also puzzling that at the end of February 2012 the Ministry of Agriculture announced that it would permit rice farming in hot zones where cesium contamination of soil was found to exceed maximum safety levels and tasked local authorities with preventing distribution of any harvested produce exceeding safety guidelines even though there is no system in place to coordinate and conduct such safety checks.[54]

The government has also failed to deal with the immense risk of spent fuel rods that are currently stored in pools located in buildings that house nuclear reactors. After the station blackout on March 11, cooling systems for the spent fuel rod pools ceased functioning meaning the water would evaporate and the fuel rods would overheat, causing a massive release of radioactive substances. This would have rendered Fukushima Daiichi inaccessible, halting nuclear accident crisis operations there. In addition, the scale of the Fukushima accident would have been far worse as the Reactor 4 pool contained recently removed fuel rods that remained "hot" and altogether the pool held the amount of fuel rods typically used to power two reactors. It was "sheer luck" that a catastrophic accident was averted.[55] Reactor 4 was shutdown at the time and was undergoing major upgrading work involving replacement of the core shroud. As part of this work, part of the reactor structure was filled temporarily with a large amount of water. The schedule called for draining the water prior to 3/11, but there were delays due to glitches in the work and by chance, a separator gate was open, so that after the hydrogen explosion, an estimated 1,000 tons of water flowed into the spent fuel storage pool, serendipitously preventing a cataclysm.[56]

These spent fuel rods are supposed to be stored and reprocessed at the Rokkasho facility, but there have been significant delays and problems in completing this project and its capacity is insufficient anyway.[57] The storage pool at Rokkasho is already 95% full

The face of sheer luck: Reactors 3 and 4 at Fukushima Daiichi

while the cooling pools at reactors are nearly full and all remain vulnerable to seismic events. There are no large dry-cask storage facilities in Japan for more secure, interim storage as is the case in Europe and the US. The US faces similar problems in dealing with nuclear waste disposal and has also not moved ahead with a permanent storage solution. At the end of February 2012 the Japan Atomic Energy Agency, now revising Japan's basic nuclear energy policy, suggested the option of direct fuel disposal by burial. This signals a possible move away from the nuclear fuel cycle and reprocessing, but currently there is no disposal site.[58]

Conclusion

"…they allowed their enthusiasm for nuclear power to shelter weak regulation, safety systems that failed to work and a culpable ignorance of the tectonic risks the reactors faced, all the while blithely promulgating a myth of nuclear safety."

The Dream That Failed[59]

It is extraordinary that The Economist , a conservative, pro-business, mainstream weekly, has reversed its longstanding support for nuclear energy, describing it as a failed dream. In Japan, however, the battle lines are drawn between nuclear advocates who cling to this failed dream and opponents who favor a shift towards renewable energy. The nuclear village enjoys many advantages since it is easier to maintain or modestly tweak the national energy status quo than to promote a green revolution. Institutional inertia may constrain reforms, causing changes to be more incremental than dramatic. The trump card of the nuclear village is the need to maintain stable electricity supply and its' advocates maintain that nuclear energy cannot be replaced by renewable energy and note that shifting to carbon fuels is costly in terms of the trade deficit and global warming. The strategy is to transform this politicized debate into a "pragmatic" decision, dictated by a dispassionate assessment of energy, economic and environmental realities.[60]

But the realities that spewed from Fukushima, and revelations about TEPCO's inept safety precautions and crisis response, along with institutional failures in regulatory agencies, lead other actors to draw different conclusions about the safety, reliability and cost of nuclear energy. This pragmatic reassessment by nuclear critics, now including *The Economist*, also draws on the fact that nuclear energy developed because of significant government subsidies and incentives over several decades because it was deemed a pressing national priority. Renewable energy advocates argue that similar government commitment and investments in renewable energy would make it a sustainable alternative, yield less toxic dividends and boost Japan's prospects in global markets for green technologies.

It does seem likely that Japan will continue to rely to some degree on nuclear energy, but there are powerful actors in government and business, supported by public opinion, that favor METI Minister Edano's call for a phased reduction and minimal reliance on nuclear energy based on expansion of renewable energy. PM Noda and other Cabinet ministers, however, side with the nuclear village and one wonders how long Edano will remain in his position and who might replace him. Clearly it has been a bad year for the nuclear village with a surge of anti-nuclear sentiment, but it is too soon to predict the outcome of the ongoing battles over national energy strategy given the nuclear village's networks of power and influence.

The nuclear village has been battered over the past year because there are fundamental questions about safely operating nuclear reactors in such a seismically disadvantaged nation. *The Economist* points out that, "nuclear safety can never be a technological given, only an operational achievement."[61] It also notes that the new generation of supposedly far safer reactors is also vulnerable to unanticipated malfunctions as occurred in Hamaoka.[62]

The nuclear crisis at Fukushima was triggered by natural disaster, but human error played a critical role. A systemic failure in risk management, institutionalized complacency about tsunami risk and incompetence in operating emergency cooling systems were crucial factors in this catastrophe. TEPCO lacked a culture of safety that explains its lapses before, during and after 3/11. Fukushima was an accident waiting to happen and nuclear industry regulatory authorities are complicit because they failed to pressure TEPCO to heed numerous warning signs. Because risks were downplayed, TEPCO and the government were ill-prepared to deal with the meltdowns and respond effectively to the consequences of the accident. Kitazawa Koichi, former chairman of the Japan Science and Technology Agency, stresses that Japan was very lucky that the three-meltdown disaster was not significantly worse.[63] It is equally alarming to know that the scientific community did little to challenge, and in the end perpetuated, the absolute safety myth that enshrouded nuclear energy. Experts occasionally raised red flags but did not follow through when their warnings were ignored and scientists in a position to influence nuclear safety regulations and disaster preparedness averted their eyes from the evident risks and kept silent while nuclear advocates made half-baked claims and cut corners on safety.

The mishandling of the evacuation subjected many Fukushima residents needlessly to radioactive contamination, highlighting how poorly prepared authorities were for a nuclear crisis. Other communities hosting nuclear plants have taken note of lax disaster preparedness and how little has been done for the Fukushima evacuees. As a result, restarting reactors shutdown for inspections and stress tests will prove politically divisive. As of November 2011, an NHK opinion survey showed that 90% of those polled are anxious about nuclear accidents and 70% do not trust the government's safety preparations.[64] In addition, two-thirds of the public expresses misgivings about nuclear energy, with 42% favoring reduction of the number of plants and 24% favoring abolishing them. A March 2012 poll by NHK found that residents of local communities in the vicinity of nuclear power plants have serious reservations about restarting idled plants despite all the subsidies and other financial inducements; only 14% are in favor of restarting or are inclined to agree, while 79% oppose or express strong reservations. Decontamination, decommissioning and disposing of contaminated waste over the coming decades will keep nuclear energy under sustained, critical scrutiny.

TEPCO's risk management prior to and during the crisis may have been woeful, but in the aftermath it has been relatively successful in managing risks to its institutional interests and avoiding accountability. While its reputation may be in tatters, TEPCO has stonewalled ceding management power to the government while obtaining vast sums of public money to cover the utility's enormous costs for clean-up, disposal, decontamination, decommissioning and compensation. It is also lobbying to sideline plans to separate power generation from transmission and distribution, maintaining advantages that may impede the expansion of renewable energy capacity. Bondholders and shareholders stand to gain from averting nationalization, with taxpayers and ratepayers picking up the tab. TEPCO has also resisted government demands for more cost-cutting and it has also muddied the waters of responsibility by maintaining its tsunami defense and diverting attention from the role of the earthquake in damaging cooling system piping.[65] If the quake is implicated in the meltdowns the implications would be enormous, requiring extensive and expensive retrofitting at all of Japan's remaining nuclear reactors because they are all vulnerable to seismic events. This is not the sort of risk management that instills confidence in a company that seeks permission to restart its' idled reactors.

At the end of Feb 2012, the Rebuild Japan Initiative Foundation (RJIF) released a report based on its investigation of the nuclear accident.[66] It is a scathing indictment of Japan's nuclear risk management and crisis response. The report emphasizes the disarray, dysfunction, miscommunication, meddling and vertical sectionalism that prevailed and how these problems exacerbated poor disaster preparedness. The RJIF criticizes leaders who played down the risks of reactor meltdowns in public while privately conducting discussions about a worst-case scenario involving the evacuation of Tokyo. The crisis also exposed the vulnerabilities of the electrical and cooling systems, and lax security rules, raising concerns about a potential terrorist attack. In highlighting these sweeping problems the report underscores the major risks associated with Japan's nuclear industry and raises serious doubts about whether it is possible to manage these risks.

The Fukushima Daiichi reactors remain vulnerable to earthquakes and rely on jury-rigged cooling and electrical systems that are "shockingly feeble-looking"; plastic water hoses critical to the cooling systems have cracked in the cold weather and are mended with tape.[67] In addition, vast amounts of contaminated water used in cooling the stricken reactors is accumulating and, as with accumulating spent fuel rods, there is no waste disposal solution at hand. Utilities are now increasing the safety of back-up energy generating capacity, and in Hamaoka they are finally building a seawall to protect against a predicted tsunami, but these are belated and small steps towards complying with a wide array of previously ignored international guidelines and addressing the nuclear energy risks that Japanese now know all too well.

The great risk in Japan today and well into the future is that the lessons of Fukushima may be skewed, ignored or marginalized in a nation where nuclear energy represents a significant and abiding risk. The coming months will provide a critical barometer as Japan resets its national energy strategy and institutes new nuclear safety and crisis response measures.

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•Miguel Quintana, Ocean Contamination in the Wake of Japan's 3.11 Disaster

•Koide Hiroaki (interview), Japan's Nightmare Fight Against Radiation in the Wake of the 3.11 Meltdown

•Gayle Greene, Science with a Skew: The Nuclear Power Industry After Chernobyl and Fukushima

Notes:

[1] I would like to thank two anonymous reviewers, Mark Selden and Rodney Armstrong for their helpful suggestions.

[2] Asahi 2/28/2012

[3] NHK News 2/28/2012

[4] In assessing TEPCO's approach to safety it is important to bear in mind it's track record of cover-ups and falsification of repair and maintenance records. Jeff Kingston, *Contemporary Japan*. Wiley, 2011. 149-155

[5] Jeff Kingston, 'Ousting Kan Naoto: The Politics of Nuclear Crisis and Renewable Energy in Japan,' *The Asia-Pacific Journal* Vol 9, Issue 39 No 5, September 26, 2011.

[6] The nuclear village includes utilities, vendors, bureaucrats, regulators, politicians, academics and journalists who promote and defend nuclear energy.

[7] NHK News 9 Interview 3/8/2012.

[8] Charles Perrow (2011) " Fukushima and the Inevitability of Accidents", *Bulletin of the Atomic Scientists* 67(6) 44-52.

[9] Daniel Aldrich, *Site Fights: Divisive Facilities and Civil Society in Japan and the West*, Cornell University Press: Ithaca, NY, 2008.

[10] Hiroshi ONITSUKA, 'Hooked on Nuclear Power: Japanese State-Local Relations and the Vicious Cycle of Nuclear Dependence,' *The Asia-Pacific Journal* Vol 10, Issue 3 No 1, January 16, 2012

[11] There was no national anti-nuclear energy movement pre-3/11 and the anti-nuclear bomb activists did not embrace this issue. See Simon Avenell, "From Fearsome Pollution to Fukushima: Environmental Activism and the Nuclear Blind Spot in Contemporary Japan" *Environmental History* (online Feb 22, 2012; print forthcoming) Environmental History 2012; doi: 10.1093/envhis/emr154

[12] Some lower court decisions went against the utilities and/or government, but these were reversed on appeal. Lawrence Repeta, "Could the Meltdown Have Been Avoided?", in Jeff Kingston (ed), *Tsunami: Japan's Post-Fukushima Future*. Foreign Policy: Washington, DC, 2011. Pp. 183-194. This ebook is available on the Foreign Policy website or from Amazon, here. For a broader discussion about how the judicial system has been manipulated to protect conservative interests and stifle civic activism see Lawrence Repeta, "Reserved Seats on Japan's Supreme Court", *Washington University Law Review*, vol. 88 (2011), 1713-1744.

[13] Takagi Jinzaburō, "Kakushisetsu to Hijōjitai: Jishin Taisaku no Kenshō o chūshin ni," *Nihonbutsuri Gakkaishi* 50 (1995): 821.

[14] Perrow, op. cit., 48.

[15] Repeta, op.cit., p. 191

[16] ibid.

[17] NYT, 4/26/2011

[18] Amakudari literally refers to descent from heaven, but in practice means officials securing post-retirement sinecures in the industry they previously supervised in their official capacity. This system, creates a government-wide conflict of interest; officials are loathe to alienate potential future employers by zealous enforcement of regulations and standards.

[19] For a summary of Noda's views on nuclear energy see Watanabe Chisaki, Bloomberg 9/5/2011.

[20] For a discussion of the new law on decommissioning see Sawa Takamitsu, "Tradeoff in Nuclear Power", *Japan Times*, 2/27/2012

[21] On the nuclear reactor whistleblower scandal see Jeff Kingston, *Contemporary Japan: History, Politics and Social Change Since the 1980s*. Wiley 2011, pp. 151-152.

[22] This section draws on Jeff Kingston, *The Politics of Disaster, Nuclear Crisis and Recovery*," in Jeff Kingston (ed.), *Natural Disaster and Nuclear Crisis in Japan: Response and Recovery after Japan's 3/11*. Routledge 2012, pp. 188-206.

[23] Chief Cabinet Secretary Edano Yukio told Kan before he flew to Fukushima that his visit would trigger criticism and Kan responded by asking if it was more important to avoid criticism or try to deal with the crisis. NHK News 2/28/2012

[24] When the TEPCO president called the plant manager and insisted on cessation of saltwater pumping, the manager agreed in a loud voice to do so while quietly telling his staff to ignore the order. Funabashi Yoichi presenting findings of the non-government investigation into the Fukushima accident at the Foreign Correspondent's Club of Japan, 3/1/2012.

[25] NYT, 6/12/2012

[26] Japan Times 2/18/12

[27] AP 2/28/2012. The RIJIF report focuses on the fact that the institutions that should have been prepared to manage the crisis—TEPCO, METI, NISA and the NSC- were totally unprepared and thus did not respond effectively. Kan very quickly sensed this vacuum in the crisis response and was trying to compensate for the shortcomings of the responsible institutions. Thus to blame him for meddling seems to overlook the context of inaction and what was at stake if he shied from intervening.

[28] Funabashi Yoichi responding to question about the RJIF report at the Foreign Correspondents' Club of Japan 3/1/2012

[29] Asahi Shimbun 12/27/2011

[30] NHK News 2/28/2012

[31] Apparently, former Science Minister Takaki Yoshiaki and other top officials in MEXT, the ministry responsible for SPEEDI, decided on March 15, 2011 to withhold data about the dispersal of radiation from the public. Vice Minister Suzuki Kan argues that releasing information about the spread of radioactive substances would have caused public pandemonium. Japan Times 3/4/2012.

[32] Japan Times, 2/27/2012

[33] Taira Tomoyuki and Hatoyama Yukio, "Nuclear Energy: Nationalize the Fukushima Daiichi Atomic Plant", *Nature* (480) Dec. 14, 2011, pp. 313–314, 15 December 2011.

[34] Asahi 1/26/2012

[35] AP 2/28/2012

[36] NHK News 3/9/2012. AP 3/10/2012

[37] AP 2/15/12

[38] NYT 2/15/2012; AP 2/16/2012, Bloomberg 2/16/2012

[39] *Japan Times* 2/16/2012

[40] Indeed, the RJIF report on the Fukushima accident pointed out that as they flew to inspect the Fukushima plant on March 12, 2011, Madarame responded to PM Kan's query by assuring him that hydrogen explosions at the plant would not occur. Later that afternoon the first of three hydrogen explosions happened, destroying trust between Kan and his advisor. Madarame told the committee that later he found himself unable to acknowledge that it was a hydrogen explosion because he had previously told Kan that such a scenario was impossible. *NHK News* 2/28/2012.

[41] *Mainichi* 2/21/2012

[42] Jeff Kingston, "The Politics of Disaster, Nuclear Crisis and Recovery", in Jeff Kingston (ed.), *Natural Disaster and Nuclear Crisis in Japan: Response and Recovery after Japan's 3/11*. Routledge 2012, pp. 194-96.

[43] *Wall Street Journa*l 3/2/2012. Stage two tests are supposed to assess whether utilities are better able to cope with any new accident, but will not be completed before the end of 2012 at earliest. It is not clear what will be tested and how safety will be measured in the second stage of stress tests.

[44] Personal communication, Nils Horner, Swedish Broadcasting Corporation, 2/25/2012

[45] NHK News 3/8/12

[46] AP 3/12/2012

[47] For more on compensation issues see David McNeill, 'Crippled Fukushima Nuclear Power Plant at One Year: Back in the Disaster Zone,' *The Asia Pacific Journal*, Vol 10, Issue 9, No 4, February 27, 2012.

[48] Reuters 3/3/12

[49] Interview NHK News 9, 3/9/2012.

[50] Yoichi Funabashi presenting findings of the RJIF investigation at the Foreign Correspondent's Club Japan, 3/1/2012.

[51] Nicola Liscutin, 'Indignez-Vous! 'Fukushima,' New Media and Anti-Nuclear Activism in Japan,' *The Asia-Pacific Journal* Vol 9, Issue 47 No 1, November 21, 2011; Satoko Oka Norimatsu, 'Fukushima and Okinawa – the "Abandoned People," and Civic Empowerment,' *The Asia-Pacific Journal* Vol 9, Issue 47 No 3, November 21, 2011

[52] The number of referenda has been increasing since the 1970s because citizens believe that it is an important method for expressing their views on important policy issues and it is a way for local governments to challenge national policies imposed by the central government. Numata Chieko, "Checking the Center: Popular Referenda in Japan", *Social Science Japan Journal*, vol 9, (1) April 2006, pp. 19-31.

[53] For an assessment of the prospects of renewable energy see Andrew DeWit, 'Fallout From the Fukushima Shock: Japan's Emerging Energy Policy,' *The Asia-Pacific Journal* Vol 9, Issue 45 No 5, November 7, 2011.

[54] NHK News 2/28/2012. Asahi 3/10/2012. The Farm Ministry and local governments ban farming in 1/8 of Fukushima's paddies, including the no-entry zone in a 20 km radius around Fukushima Daiichi, but guidelines issued on February 28, 2012 allows rice cultivation in other areas where contamination levels exceed official standards. Municipal governments are supposed to monitor rice cultivation from planting to harvesting and inspect all bags of rice to ensure they don't exceed the new maximum 100 becquerel cesium standard before distribution. The Farm Ministry requires that local authorities submit rice inspection plans by June, but this will be after the planting and such capacity does not currently exist.

[55] Interview with Yoichi Funabashi, Chairman of the Rebuild Japan Initiative Foundation, Asahi 2/29/2012. Remarks by Kitazawa Koichi, former chairman of the Japan Science and Technology Agency, at the Foreign Correspondent's Club of Japan, 3/1/2012. Kitazawa explained that it was sheer luck that the hydrogen explosion pushed water into the spent fuel rod storage pool at reactor 4; this was not a fail-safe mechanism.

[56] Asahi 3/8/2012.

[57] Masa Takubo, "Nuclear or Not? The Complex and Uncertain Politics of Japan's Post-Fukushima Energy Policy", *Bulletin of the Atomic Scientists*, 67(5) 2011, 19-26. For recent further details on Rokkasho see Reuters 2/ 24,/2012.

[58] Mainichi 2/29/2012

[59] Special Report on Nuclear Energy, *The Economist* March 10, 2012. Quote from leader on p. 15.

[60] With no sense of irony about the wrecked lives and huge costs piling up in the aftermath of the Fukushima disaster, nuclear advocates slyly remind us that windmills kill birds.

[61] Special Report on Nuclear Energy, *The Economist* March 10, 2012, p. 11.

[62] Ibid., p. 12

[63] Kitazawa remarks drawing on RJIF non-government investigation report on the Fukushima accident at the Foreign Correspondents' Club Japan, 3/1/2012.

[64] Matthew Penney, Nuclear Power and Shifts in Japanese Public Opinion, *The Asia-Pacific Journal*, Feb. 13, 2012.

[65] Earthquake damage is reported by Jake Adelstein and David McNeill, "Meltdown: What Really Happened at Fukushima?" *Atlantic Wire*, July 2, 2011. Accessed Dec. 12, 2011. here

[66] Japan Times, 2/28/2012; Wall Street Journal (Asia) 2/29/2012

[67] AP 2/28/2012