Nuclear post-Fukushima

中外对话 chinadialogue 2013年4月

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foreword

Two years on, the Fukushima nuclear disaster of 2011, has rewritten the course of modern nuclear energy history.

Humanity is grappling with a major energy challenge as it attempts to reduce its reliance on fossil fuels and resolve the technological obstacles to wind and solar deployment at the same time as challenging the wisdom of hydro and nuclear power, so-called clean energy sources.

We face a world of increasingly expensive energy, but also one marred by the environmental consequences of fossil-fuel pollution. Many have put their hopes in nuclear power as a solution, but it is naive to believe it can be harnessed and managed without problems.

As one government official from Fukushima Prefecture once put it to me: "The many nuclear power plants that we've built are like luxurious, spacious, comfortable apartments, except they have no toilets!"

In this context, and after the alarm bells sounded by Fukushima, what are the countries of the world thinking? What are they doing?

With the support of the Heinrich Böll Foundation, chinadialoguehas, over the past two years, published a series of articles examining the principle policy developments of nuclear capable countries and the direction of nuclear research and public opinion. These articles are compiled here.

We hope this publication will help to shed light on Fukushima's legacy, and provide a clearer view of our common future.

Xu Nan

deputy editor, chinadialogue's Beijing office

Geothermal dreams in Fukushima

14 August, 2012

Mure Dickie

With nuclear power out of favour, Japan faces an urgent need for other sources of electricity. In Fukushima, attention is turning to vast reserves of hot water underground.

Image by Si—take

Since a tsunami crippled a nuclear power plant on its Pacific coast, Japan's north-east prefecture of Fukushima has become a byword for nuclear disaster as infamous as Chernobyl or Three Mile Island.

However, if people such as Katsuichi Kato have their way, the name Fukushima could in the future also gain a more positive power-industry association as a leader of renewable energy production in the world's third-largest economy.

The head of an association aiming to revive the quiet hot spring resort of Tsuchiyu, Mr Kato is spearheading efforts to build what would be Japan's first geothermal power plant inside a national park. And while hot spring owners are in Japan usually the fiercest opponents of geothermal energy, here they are its backers. Mr Kato is the managing director of the Tsuchiyu hot spring co-operative.

That makes Tsuchiyu a possible poster child for geothermal, an energy source Japan has largely cold-shouldered in recent years but which experts say has great potential. The same geological inheritance that makes the archipelago vulnerable to earthquakes and volcanoes also grants formidable reserves of hot subterranean water that can be tapped to

drive electricity-generating turbines. A widely cited estimate puts Japan's possible geothermal generating capacity at 23 million kilowatts, trailing only the US and Indonesia. But installed capacity totals less than 550,000 kilowatts and no new geothermal plants have been built in more than a decade.

Tsuchiyu, which hopes to have its first generator up and running by 2014, has good reason to embrace geothermal. The resort, 16 kilometres from the prefectural capital, was suffering falling demand even before 2011's disaster. Now worries about contamination from the Fukushima Daiichi plant are keeping visitors away, even though radiation levels are far below levels considered remotely hazardous for short-term stays.

Boosting hot spring tourism

Mr Kato hopes the planned plant will be a long-term earner for the local hot spring association and other investors. The business case is helped by government subsidies for construction and a mandatory purchase price for electricity from small geothermal plants recently set at a generous 42 yen (US$0.53) per kilowatt hour.

It helps that Tsuchiyu is blessed by a plentiful supply of water from its existing wells. At 140 to 150 degrees Celsius, the water is not hot enough for standard geothermal plants, but it is fine for modern "binary" plants that use a liquid with a lower boiling point than water to drive their turbines.

Playing the role of pioneer should also help fill Tsuchiyu's hotels. "If we can do this, we should be able to attract visitors from all around Japan to come to study and learn how we use geothermal generation," Mr Kato says.

The Tsuchiyu's project will hardly resolve Japan's energy problems. Its initial phase will have capacity of 500 kilowatts – enough to meet most of the resort's own electricity needs but only a little more than one-thousandth of the power generated by the smallest of Fukushima Daiichi's reactors.

Larger plants also remain controversial. Relaxation in 2012 of a ban on vertical geothermal drilling in national parks has sparked excitement among would-be operators, but many in the hot spring sector say new plants threaten water flows.

Kasumi Yasukawa, an expert on geothermal resources at Japan's National Institute of Advanced Industrial Science and Technology, says there is no evidence of such problems and that even if they occur they should be technically resolvable.

Yoshiyasu Sato, chairman of the Fukushima hot spring association, doubts such assurances. The tsunami and nuclear crisis gave Fukushima troubles enough without making geothermal a new

threat to troubled bathing businesses, Mr Sato says. “The most important thing is not to destroy the status quo,” he adds.

Such worries are understandable. The supposedly impossible failure of Fukushima Daiichi was a potent reminder of the need for scepticism toward official promises.

Yet neither Fukushima nor Japan can afford to settle for the status quo. With nuclear power out of favour, there is an urgent need for other sources of electricity - and geothermal is much more stable than weather-dependent solar or wind. Fukushima, too, badly needs to boost business investment and tax receipts.

Officials in the prefecture will have to work hard to overcome opposition – finding ways to ensure hot spring operators stand to benefit from projects and shield them from any losses should their water sources suffer.

However, as the Tsuchiyu project shows, many in the hot spring business realise the troubles caused by the nuclear disaster have also created opportunities. As Mr Kato puts it: “In a pinch, there is a chance.”

Mure Dickie is the Financial Times’ Tokyo bureau chief.

Japan's no-nuclear policy could prove "hollow promise"

19 September , 2012

Andrew DeWit

Will Japan go nuclear-free or won't it? That's been the big question as the country has yo-yoed between positions since the devastating accident at Fukushima in 2011. The uncertainty discussed in this article has continued since publication. The pro-nuclear Liberal Democrat party won a landslide election victory in December 2012, pointing the way for nuclear power to return as a key energy source for the country. But public opinion, business voices and politicians remain locked in debate, while the prime-ministerial post looks like a revolving door. Japan's nuclear future remains unclear.

After months of turmoil, on September 14 the Democratic Party of Japan (DPJ) announced a new energy policy. As Japan's Asahi newspaper correctly argues, the policy is chock full of contradictions and escape clauses. Even so, the policy will almost certainly – perhaps in the course of Sept 2012 – be adopted as is by the cabinet and frame the new "energy basic plan" put out by the Ministry of Economy, Trade and Industry (METI).

The energy policy's main components, so far as much of the domestic and international debate are concerned, are a commitment to withdraw from nuclear energy by the 2030s and emphasise renewable energy. An example of international reaction is the September 14 declaration by the Financial Times that Japan's "decision to phase out nuclear power has sent shockwaves through the energy industry, and could affect everything from global gas prices to the business of making and selling solar panels."

Certainly the policy is different from the June 2010 plan that committed Japan to getting over half its power from nuclear plants by 2030 and included a reluctant nod to renewables (20% of power by 2030). That policy announcement was followed by Fukushima, of course, and Japanese energy politics and policymaking continue to be profoundly shaken by it.

In particular, energy policy is no longer the technocratic exercise it was before Fukushima, when it was dominated by METI and the "nuclear village" of pro-nuclear monopoly utilities, big business, reactor-dependent communities and legions of politicians, bureaucrats and academics. Among the actors actually and effectively at the table now are other bureaucracies, non-nuclear local governments organised into increasingly coherent regional blocs, social-media mobilised civil society, renewable-investing big capital, SMEs, farm coops and households.

Imagine the DPJ's challenge of representing all these interests. The party was never a compact vehicle to begin with, only achieving a certain brief coherence in the 2009 election campaign's imperative of clearly differentiating itself from the long-governing Liberal Democratic Party (LDP). Now it faces an election campaign in the coming months while it attracts an abysmal 10% support in recent polls. Prime minister Noda Yoshihiko knows he needs to appeal to the powerful anti-nuclear, green-growth streams within his own party as well as in the public at large.

Asahi also notes, quite correctly, that other factors may wield significant influence before the election. The September 19 inauguration of the new Nuclear Regulatory Commission (NRC) may lead to further approvals for restarts. Among other problematic outcomes, more restarts could weaken incentives for energy conservation, deployment of renewable energy and progress towards a distributed energy economy.

On the other hand, post-Fukushima Japan is increasingly incentivised to move in the renewable direction by its feed-in tariff(FIT). The FIT was installed in late August 2011 by outgoing prime minister Kan Naoto. In the first month after it came into effect on July 1, the policy attracted 33,695 renewable projects worth about US$2 billion (12.6 billion yuan), well beyond what was anticipated. Led by local banks and credit unions, Japanese finance capital is opening its faucets in this direction.

Electricity is at the core of Japan's "local production, local consumption" boom, and the FIT is the key policy accelerating it. So we need a sense of perspective: the new energy policy is interesting as a snapshot of Japan's fluid energy politics, but the FIT serves as an important institutional conduit channelling that flow.

Flimsy no-nuke promise

The government's pledge to pull the plug on nuclear power by the 2030s could prove to be a hollow promise, with few details yet given on how to achieve it, how quickly to proceed and how to reconcile contradictions along the way.

Observers see the policy as a product of compromise, and something prime minister Noda hopes will both get him re-elected in a party leadership race on Sept 2012 and win support from ordinary voters in the upcoming Lower House election. Noda himself is unwilling to dump nuclear power. It is instead what the public and many in his party have increasingly been demanding.

Noda himself leaned toward shrinking nuclear power by 2030 but not abolishing it. He would have preferred to keep it at 15% of the nation's total energy makeup, according to aides. But Noda could not ignore demands from the public, which overwhelmingly called for a full phase-out by 2030. The government held open forums nationwide and solicited comments on the ideal future contribution of nuclear power. It offered two alternatives to zero-nuclear: 15% and 20-25%, both of which the public rejected.

"Noda needs to win the party's presidential race first," said a lawmaker close to him. "Some DPJ members working on his re-election team back zero nuclear energy. If they turned their backs on him, it would have cast a pall on the management of a new administration even if he was re-elected." But the decision for abolition by 2039, albeit a decade later than 2030, provoked criticism, too.

The United States expressed concern over how Japan would manage plutonium generated in recycling spent fuel. And Yonekura Hiromasa, chairman of Japanese business federation Keidanren, the nation's most powerful lobby, called Noda on September 13 to voice his opposition to zero nuclear power. Under pressure from both an international ally and business leaders, the administration included a clause at the last minute which allows leeway toward scrapping the policy entirely.

"Energy sources available to the nation have been significantly affected by factors such as fuel supply and development of technology in the global market," the clause read. "It is extremely hard to predict how things may develop in the future and we should make sure that we are able to take a flexible approach."

Furukawa Motohisa, national policy minister, insisted on retaining a clause that makes it a legal requirement for central and local governments to achieve the new energy policy. But in a session on the morning of September 14, the clause was taken out. With no legal basis behind the policy, the energy industry and local governments are not bound by it.

METI is expected to flesh out the policy's details as it compiles the Basic Energy Plan this month. But that plan comes up for review every three years. There is no guarantee that an

administration in power in 2015 will stick to it. “If a new administration is formed, the new energy policy could fall through,” said a senior official with the industry ministry, referring to the possible outcome of dissolving the Lower House for a snap election.

What appears in conflict with public sentiment and the overall target for the 2030s is the administration’s pledge to restart reactors as “important sources of electricity” if they are confirmed to be safe.

Since the 2011 nuclear disaster, officials have authorised two of Japan’s 50 reactors to resume activity. The restart came amid widespread public opposition. The Noda administration plans to approve further reactor restarts if the new NRC declares they are safe. The commission is due to be formed on September 19. That, however, could pave the way for Japan to slip back to the situation before the Fukushima disaster, in which it relied on nuclear energy for close to 30% of all electricity output. Once reactors are restarted, plant operators could step up their opposition to abolishing nuclear energy. It could also slow a nationwide drive to reduce energy use and sap momentum towards a nuclear-free future.

Plutonium plans unchanged

Recycling spent fuel is another question entirely. Despite pledging to end nuclear power, the administration offered no change to the problem-laden plan to reprocess spent nuclear fuel to obtain plutonium. Plutonium can be used to generate electricity, but it can also be used to produce nuclear weapons. Critics accuse the Noda administration of planning to stockpile plutonium, even as Japan turns its back on nuclear power. “It makes no sense that rectors will use recycled fuel when they will be decommissioned just a few decades later,” said Katsuta Tadahiro, an associate professor of nuclear power policy at Meiji University.

The government has envisaged bringing a fast breeder reactor on-line around 2050 to get the nuclear-fuel recycling project to take off. Meanwhile, the plutonium stockpile could raise questions about Japan’s motives for the nuclear-fuel recycling programme. “The international community will cast a suspicious eye on Japan if it retains large plutonium reserves that it cannot use at nuclear power plants,” said Yoshioka Hitoshi, a professor of history of science and vice president of Kyushu University.

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This article was first published as Andrew DeWit, "Japan's Energy Policy at a Crossroads: A Renewable Energy Future?" The Asia-Pacific Journal, Vol 10, Issue 38 No. 4, September 17, 2012.

Anti-nuclear sentiment rises in Japan

1 August , 2012

Isabel Hilton

Image by Asahi Shimbun

A rising tide of protest against nuclear power in Japan brought large demonstrations to the capital last week and stimulated the birth of a new, anti-nuclear political party. Anxious Japanese citizens are demanding that their government abandon nuclear power following last year's disaster at Fukushima. Their indignation was further fuelled by a government-appointed inquiry that blasted the country's nuclear regulators and the plant's operators for the failures that led to the accident. It also raised doubts about whether the steps the government and regulators have taken to ensure that other atomic plants are prepared for similar disasters have been effective.

The Japanese government shut down all fifty of Japan's nuclear reactors following the accident and is still working on a new energy policy. But last month the prime minister, Yoshihiko Noda, decided to permit two reactors in western Japan, operated by Kansai Electric

Power Company, to restart. The decision provoked a series of demonstrations, that organisers claim brought 100,000 people onto the streets of Tokyo a week ago and inspired protestors to found the new Green Party. Its organisers hope to register the party in time to fight the next elections, offering voters an anti-nuclear alternative to the two main, nuclear supporting parties.

The effects of last year's disaster at Fukushima are not over yet: the damaged number 4 reactor and the pool of used nuclear fuel have yet to be dealt with and remain dangerous: it is unclear, for instance, what the impact of another earthquake would be.

The report blamed Japan's nuclear regulators for not paying sufficient attention to the recommendations of the International Atomic Energy Agency on improvements in nuclear safety standards. It fails to identify the exact cause of the leaks of radioactive material or the explosions that destroyed three reactor buildings.

Meanwhile, the Tokyo Electric Power Company (Tepco), the operator of the Fukushima Daiichi plant, which was slammed in the report for failing to plan for disaster because the management "believed in the myth" of nuclear safety announced a first quarter loss of $3.69 billion (2.35 billion pounds.) Tepco and other utilities are bearing the extra costs of the fossil fuels they have had to buy to compensate for the absence of nuclear power after all 50 of Japan's nuclear power plants closed following last year's disaster. Although the government has stepped into support the company, its senior management face potential prosecution and the company is still facing a potential $100 billion bill for the costs of clean-up, decommissioning and compensation for the victims of the disaster.

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Germany's risky green wager

27 July , 2012

David Buchan

With China's renewables industry waiting in the wings, able to achieve astonishing economies of scale, a nuclear-free Germany could see its first mover advantage quickly turn sour, writes David Buchan.

China's solar panel makers are well aware of Germany's clean-energy programme. They have been quick to supply technology to it. Some 80% of Chinese solar photo-voltaic exports go to Europe, and much of that to Germany. Indeed, so successful have these exports been that there is talk of the European Union following the United States in taking protectionist anti-dumping measures against Chinese solar panels.

But Germany's extraordinarily ambitious goals to halve its energy consumption, cut greenhouse-gas emissions by 80% and raise the renewable share of its electricity by 80%, all by 2050, deserve a wider audience in China. Not because Germany is a model for China in any literal sense – Beijing has no intention of following the German strategy of abandoning nuclear power while also moving away from fossil fuels. Rather, Germany's attempted energy revolution will show a country like China, which cannot afford to let its energy consumption run away or choke itself with emissions, what can – or cannot – be achieved technically and politically.

Germany's reaction to the Fukushima accident was not a total surprise. The decision never to re-start the eight reactors that were, at the time of the March 2011 accident, shut for repairs or servicing was certainly illogical. These reactors were not in any predictable danger from earthquakes or tsunamis. But the accompanying decision to phase out all of Germany's other nine reactors by 2022 was simply a return to an earlier position: a phase-out by this date was official German policy from 2002 to September 2010, when Chancellor Angela Merkel decided to extend the working life of German reactors by an average of 12 years, to around the mid-2030s.

Indeed, you could argue that it was more surprising for Merkel, in the first place, to extend the life of the nuclear reactors than it was for her later to cut their life short, given German ambivalence towards nuclear power. For many Germans, civil nuclear power was long tainted by the presence of so many foreign nuclear weapons on German soil during the Cold War, in total

contrast to the French whose development of nuclear weaponry was a source of national technical pride. The Germans, too, are probably more worried than most populations about the uncertainty of where and how to store highly radioactive nuclear waste.

But Merkel's second policy u-turn did not totally cancel out the first. For the reactor life extension was decided at the same time as the 2050 energy goals, and was an integral part of this so-called Energy Concept. Nuclear power was given "a bridging role" in this Energy Concept, according to the environment ministry, "until renewable energies can play their part reliably and the necessary energy infrastructure has been established".

It would therefore have been quite understandable for the Merkel government to accompany its 2011 announcement on nuclear with a parallel easing of those Energy Concept targets, whose attainment will be harder without nuclear power. Unless the carbon-free power provided by the nuclear reactors is entirely replaced by renewable energy, Germany will find it more difficult to meet its emission-reduction goal. But the Merkel government decided to stick to its earlier goals. It only added a series of measures to speed up grid expansion, market integration and investment in non-nuclear forms of generation capacity to back up renewables.

A first-mover disadvantage?

Of course, German energy policy may change again. Germany is unlikely to alter its position on nuclear power, but could do so in relation to clean energy and emission-reduction targets, which could be scaled down by a future government. But one has to ask why Germany is being so bold now. The answer is that, while Germans appear more nervous than ever about nuclear power, they also appear more self-confident in their technical ability to do without it. "We can be the first major industrialised nation to accomplish the transition towards a highly efficient, renewable energy system," claims the environment ministry.

In other words, Germany is hoping to reap a "first mover" advantage in renewable energy. It has already gained much in technology and employment. Germany rivals the United States and China in deployment of wind power, and especially in solar PV power, which together employ 370,000 people in Germany. A large part of its big engineering sector, led by Siemens (which has pulled out of nuclear engineering), has a vested interest in Germany's renewable revolution continuing. If the world market for clean energy and environmental goods and services continues, then Germany's gamble will have paid off.

Equally, however, Germany could end up providing a cautionary lesson on the impossibility of rapid transformations in energy systems. In trying to rush change, Germany could incur a "first mover disadvantage". To an extent, it has already done so by paying high subsidies for solar PV generation and now regretting the cost. German households, through the renewable subsidies they pay, have effectively made the world a gift of solar technology, which China has been happy to

exploit. Germany also has many energy-intensive industries, such as chemicals and steel. These companies pay the renewable electricity surcharge at a reduced rate. But anything that raises their energy costs could harm their international competitiveness.

Rushed replacement of nuclear power could produce another "first mover disadvantage". Germany is investing in additional coal-fired plants – as complementary back-up to renewables – before its public is ready to accept the fitting of carbon capture equipment that would reduce carbon pollution from these plants. Germany runs the risk of locking itself prematurely into more dependence on coal, before excess supply in the world gas market can exert downward pressure on the price of gas in the German market.

Like several other European countries, Germany has recently been cutting solar subsidies. These cuts are intended to reflect the sharp reduction in solar PV production costs which, according to the environment ministry, fell by more than 30% between late 2010 and early 2012. However, the sharpest decrease in production costs has come in China, where massive output of PV panels, in large part stimulated by German (and other European) subsidies, has led to economies of scale and a rate of price reduction that German solar manufacturers have been unable to match. As a result, the year 2011 to 2012 saw a number of German solar companies file for bankruptcy – among them Q-Cells, once the world's largest maker of solar cells.

Some observers have expressed surprise that the German government has been prepared to allow this reduction in the country's solar capacity, given its claims about the first mover technology advantages stemming from its renewable revolution. On the other hand, it could hardly bail these solar companies out just as it was acknowledging the wastefulness of past solar subsidies and curtailing future support. This shows how finely balanced technology pioneering can be, and how easily a first mover advantage can turn into disadvantage.

David Buchan is senior research fellow at The Oxford Institute for Energy Studies. He is author of recent paper "The Energiewende: Germany's Gamble", on which this article draws.

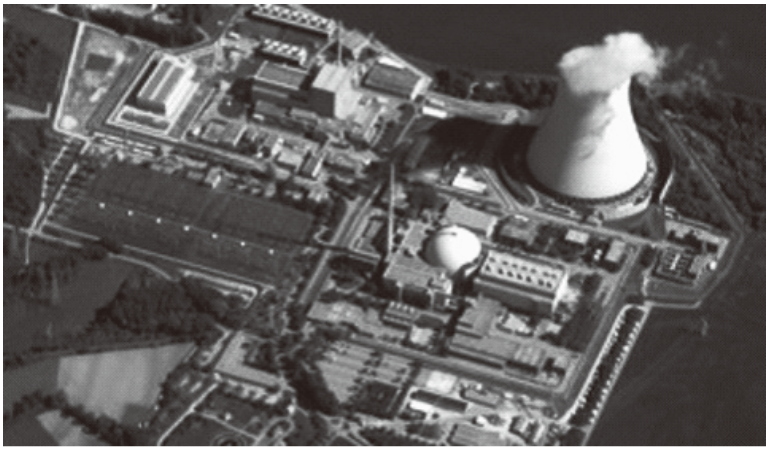

image from brewbooks

How Germany learned to hate nuclear power

23 October , 2012

Paul Hockenos

Germany's move to phase out nuclear power isn't the reaction of a spooked people to Fukushima, but the product of an anti-nuclear consensus rooted in 1970s activism.

The fact that Germany, in the aftermath of the 2011 Fukushima disaster, redoubled its efforts to phase out nuclear energy has nothing to do with hysteria or post-war angst. On the contrary, a majority of Germans, including much of the political class, has been unconvinced of its merits since the early 1980s; the source of this anti-atom consensus lies not in emotional populism but rather in the persuasive, fact-based arguments of a powerful, grassroots social movement that has long included nuclear physicists and other bona fide experts.

Of the many misconceptions that cloud the perception of Germany's energy stand, one is that Germany is somehow on its own in Europe, on the fringe of the continent's mainstream. In fact, Ireland, Austria and Norway dismissed the nuclear option years ago. Greece, Portugal, Italy and Denmark don't and will never have atomic power plants. Like Germany, Sweden, Switzerland, the Netherlands and Belgium are in the process of phasing out nuclear power. Spain has banned the construction of new reactors.

In terms of popular opinion, over 80% of Germans oppose nuclear energy, a figure that climbed higher in the wake of Fukushima and is comparatively high in Europe. But 90% of Austrians object to the nuclear option, and Austria even has no-nukes enshrined in its constitution. In 2011, 94% of Italians voted against nuclear power in a popular referendum. And then, of course, there are the pro-nuclear nations, led by France and the Czech Republic, where 68% and 67% of citizens respectively are in favour. (In the US the figure is 70%.)

Another myth is that post World War II Germany was viscerally anti-nuclear from its earliest days, an allergic reaction to the horrors of the war and Hiroshima. While there was a strong anti-nuclear-weapons peace movement in the 1950s, its proponents and the left-wing Social Democratic party were thoroughly enthusiastic about the non-military potential of nuclear science. The new technology, they thought, could provide the country with a clean, risk-free new energy source that might one day even make energy bills obsolete.

The protesting wine-farmers of Wyhl

In fact, it wasn't until the early 1970s, when protests broke out in Germany's south-westernmost corner, that Germans began looking twice at the nuclear-power facilities and waste repositories in their backyards. The anti-nuclear energy movement was born in the wine-growing region of the Black Forest abutting the borders of Switzerland and France's Alsace-Lorraine. There, in the tiny hamlet of Wyhl, the area's staunchly conservative farmers, joined by left-wing activists from the nearby university city of Freiburg, as well as concerned French and Swiss citizens, organised to stop the construction of a planned reactor.

The Wyhl coalition bore many of the characteristics that would define the movement for years to follow: It was locally led, politically diverse, and committed to non-violent civil disobedience. Initially, the farmers' objection was that the steam clouds from the reactor's cooling towers would block the sunlight in their vineyards, not that radioactivity as such was a hazard. This changed as the community learned more about the health effects of low-level radiation.

Against all odds, the Wyhl coalition forced the utility giant to back down and scrap its plans. The protests, covered by national media, captured the country's imagination. If the wine farmers of the Black Forest could do it, so could others, concluded Germans living near nuclear installations.

Germany's anti-nuclear energy movement would prove one of the most enduring and successful mass movements in contemporary Europe; it would change the way Germans thought about the atom as an energy source, give birth to a political party committed to its goals and, ultimately, lay the groundwork for Germany's decision to embrace a future based on clean, renewable energy. Its emblem was a smiling sun with the simple slogan "Atomkraft, Nein Danke!" (Nuclear Energy? No, thank you!)

In the 1970s and 1980s, the anti-nuke movement swelled and linked up on a national level. Its epicentres were the localities where reactors, planned reactors, breeder reactors, waste-processing plants and waste dumps were located, places with names like Brokdorf, Kalkar, Wackersdorf, Grohnde and Gorleben.

"The movement created a highly networked infrastructure of NGOs, newspapers, training centres and expertise," explains Dieter Rucht, Germany's foremost expert on social movements. "These grassroots structures and in particular the regular protests in Gorleben [against the waste dump] enabled the movement to persevere for so long, until today."

Moreover, unlike the 1960s' student movement, the anti-nuke campaign was broad-based and un-ideological – and has remained so. The Wyhl occupation was one of the first times that Germany's urban leftists were able to find common ground with people beyond their own ranks. "At first, the wine growers looked at me like I was from another planet," explains Eva Quistorp, a

Berlin-based feminist and peace activist who was at Wyhl. "But we learned from one another."

"This diversity was – and still is – so important because it made it impossible for politicians and the energy lobbies to label the protesters as crazy, leftwing agitators," explains Rucht. "They had to be taken seriously because they were the conservatives' own constituency, upstanding folk with jobs and families who voted Christian Democrat."

Defecting nuclear scientists

A decisive facet of the German experience – one that distinguishes it from France – was the presence of experts in its ranks, including former nuclear-industry scientists who had broken with their companies. One key figure was the German nuclear engineer Klaus Traube who had held top managerial positions in both West German and US nuclear installations. After witnessing an accident in a German reactor caused by a minor human error, he became dubious of nuclear power's safety. The Three Mile Island accident in Harrisburg, Pennsylvania, in 1979 transformed him into a full-fledged opponent. Traube provided the movement and his party, the Social Democrats, with invaluable technological and economic explanations of the dangers of nuclear power. When the Chernobyl reactor melted down in 1986, the entire nation looked to Traube to explain what had happened and how it would affect them.

"Experts like Traube made the German movement evidence-based, not simply emotional appeals or moralistic preaching," explains German historian Erhard Stölting from the University of Potsdam. They took on the nuclear lobby at the highest technical level, he says.

Then, of course, came Chernobyl. In April 1986, the reactors in western Ukraine melted down sending a radioactive cloud across Central Europe. The Soviets' failure to announce the accident, the German government's initial soft-peddling of it, and the uncertainties of the health risks set the

An anti-nuclear protest in German city Hanover (Image copyright: ohallmann)

country in panic. West Germans were glued to their television sets, hungry for news, tips to deal with contamination and the weather forecasts. Playgrounds were closed, fresh vegetables destroyed and pregnant women advised to stay indoors. There is not an adult (former West) German who doesn't remember those dark days in spring 1986.

Rise of the Green Party

The Germans also had an anti-nuke party as of 1980, namely the Greens, who carried the concerns of the mass movement into the national parliament, the Bundestag. No other country in the world has had a force so determined and influential in taking on the powerful atomic energy lobby. The Greens emerged out of the New Social Movements of the 1970s, as an alternative to the Social Democrats who were split on the issue of nuclear power. The environmental party entered regional legislatures during the 1980s and 1990s, and then finally shared in national power in the 1998-2005 "red-green" government. Pushed by the Greens, the government negotiated a compromise with the energy companies to phase out nuclear power over 30 years. (The current Merkel government backtracked on this pact, and then reversed in the aftermath of Fukushima.)

Germany's Energiewende, or "energy transition" isn't the reaction of a spooked people to Fukushima. Indeed, it has arguably been part of Berlin's energy agenda since the early 1990s. Now every political party says it's on board. Opinion polls show Germans convinced of a future based on renewables, and even willing to pay slightly higher energy bills for the sake of it.

The accidents in Three Mile Island, Chernobyl and Fukushima galvanised public opinion. But the grassroots campaign begun in Wyhl kept up the pressure. Its ability to shun sectarian politics and constantly reinvent itself kept it vital. Today, anti-nuclear groups like Campact rely heavily on the internet and social media to put together demonstrations at record speed. X-tausendmal quer specialises in blockades of nuclear waste transports, while another Gorleben-based group, Castor Shottern, takes civil disobedience a step further sabotaging the train tracks along which the waste transports run.

And today there's even another new constituency: the green-collar workers of the renewable energy industry. They're conspicuous at demonstrations in their work clothes and badges, yet not out of place. The almost 400,000 clean energy jobs in Germany, many in the down-trodden eastern states, and the promise of more is another sound argument in the quiver of Energiewende proponents.

Paul Hockenos is an American writer living in Berlin and author of the blog Going renewable with the DGAP (German Council on Foreign relations). His most recent book is Joschka Fischer and the Making of the Berlin republic: An Alternative History of Postwar Germany.

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Nuclear waste: the 270-tonne legacy that won't go away

24 October , 2012

Olivia Boyd

Governments want to bury their nuclear waste deep underground, but finding a place to dig the hole is proving tricky.

Rebecca Harms was 18 when she started campaigning for solutions to nuclear waste-storage in Germany. The Green Party MEP is now nearing her 56th birthday, but the country isn't any closer to burying its radioactive waste. Last year – after decades of on-off drilling at the site of an old salt dome in north Germany and more than a billion euros of public money spent – the federal government announced it was starting from scratch with its search for a suitable site for a "deep geological repository" in which to store spent fuel.

Germany is not alone. "None of the countries which started to use nuclear fission for power production 50 years ago have an acceptable solution for nuclear waste and final storage. None," Harms says wearily, speaking on the telephone from Brussels. Though she is firmly against nuclear power, Harms is strongly in favour of building a geological repository in Germany; essentially a giant cavern in the bedrock, in which the country's high-level radioactive waste can be sealed away while its isotopes decay over hundreds of thousands of years (in fact, regulations dictate that the repositories guarantee safety for up to a million years). "I've been working on this for decades and I'm convinced it is the best way," she says.

Many others agree. Several countries are planning to build deep repositories of their own. But their plans keep hitting bumps. In late 2012, confidence in the UK's scheme was undermined when the three councils in the running to host the waste got cold feet and postponed a decision to allow test drilling at the last minute(Since the time of writing, the councils have completely rejected plans to build a repository within their borders, leaving the UK with no proposed site.). And in 2010, the US Energy Department pulled the plug on the Yucca Mountain storage facility in Nevada – after spending more than US$12 billion building it – on grounds opposition to the project had made it unworkable. [*since the time of writing,the councils have completely rejected plans to build a repository within thier borders,leaving the UK with no proposed site.*]

Even in Scandinavia, the region furthest along in the process, there are still uncertainties. Finland is expected to open the world's first repository at Onkalo by 2020, and neighbouring Sweden expects to start building its repository in 2017. But a Swedish scientist has recently raised alarm about the stability of the copper casks that will be used to contain the waste. Waste disposal company SKB is conducting lab tests in response.

Nuclear waste is the problem that won't go away – literally. Even if the world stopped all nuclear projects now, it would still have to deal with the legacy of past operations. Globally, there are around 270,000 tonnes of high-level waste in temporary storage, to which 10,000 tonnes are added each year, according to World Nuclear Association (WNA) figures.

Getting it underground isn't actually urgent. Spent fuel needs decades to cool down before it can be moved to long-term storage, and some of it gets reprocessed anyway. But piles of waste sitting around in interim storage with no ultimate solution in sight is at the very least politically uncomfortable, particularly in the wake of last year's meltdown at Fukushima, where an unstable spent fuel pond significantly complicated recovery efforts. Chairman of the Japan Atomic Energy Association called it the biggest single threat to the plant.

Let's bury the waste – but where?

Governments realise this, which is why many are trying to do something about it – in Europe, there is extra pressure thanks to new rules requiring EU member countries to put a long-term plan for dealing with nuclear waste in place by 2015. Though more off-beat ideas like burying waste in the sea-bed are floating around, the hole in the ground approach is the favoured option. As long as it's located under the right kind of rock, and in a seismically stable area, the consensus says this is a safe way forward: bury all the waste in one very secure location and be done with it.

But where? That's where things get sticky.

In Germany, many of the present problems stem from the opaque manner in which the siting process was conducted, starting in the 1970s, says Harms. Government secrecy and a string of decisions perceived to have put politics over safety have contributed to public mistrust (80% of the population is anti-nuclear) and resulted in a parliamentary probe. In September 2012, Angela Merkel herself was questioned by the inquiry over whether or not she had lied to the public in the 1990s about the suitability of the site selected for the repository by the government, Gorleben.

The German magazine Spiegel details how drilling teams first arrived in Lower Saxony in 1976, claiming to be searching for oil, when in fact they were checking out former salt domes as potential nuclear storage sites. When locals worked it out, protests erupted as dairy farmers feared their milk would be contaminated. Later, the government decided to focus on Gorleben alone – a relatively unpopulated area where protests were deemed less likely, but about which geologists held

Image by Koeberg Alert Alliance

serious concerns. Among other things, the salt dome lay near natural gas deposits, raising fears about potential future explosions, according to Spiegel. "Previously unknown documents and interviews with contemporary witnesses already reveal that instead of geology and nuclear physics, partisan politics and power struggles shaped the search for permanent repositories from the start," the magazine said in 2010.

Crisis at an existing nuclear waste storage site – the Asse II salt mine, which is in danger of collapse – further fomented public concern. And in November 2011, the government said it would restart the search for a permanent waste dump.

Three decades of wrangling has taken its toll: an employee at utility EnBW told me Germany's utilities had spent around 1.5 billion euros on research at Gorleben. The nuclear utilities were so annoyed by apparent back-tracking from the project in the early 2000s that they refused to participate in roundtable talks about the search for a new site; hardly a triumph for open dialogue.

Volunteering for nuclear dumps

While Germany's story has been shrouded in secrecy, Sweden and the UK have taken public participation to an extreme – by inviting communities to volunteer to host repositories.

In Sweden, this approach has been a great success, says Jenny Rees, a spokesperson for SKB, the company tasked with disposing of the country's nuclear waste.

After a very lengthy public consultation process, dating back to the 1970s and involving regular meetings, residents groups, tours of their facilities and more ("people would invite us home

to their kitchen tables"), the country has a municipality signed up to host the repository, in which local people voted for the project in a referendum. An application for a licence has been filed and – provided concerns over copper don't waylay plans – SKB hopes to start building in 2017. The latest opinion poll commissioned by the company put local support for the scheme at 80%.

"Every country of course has to decide for themselves how they would like to do this, but what I can say is this has worked for us. I would say be as open as possible, listen, open up your facilities and make time for questions," says Rees.

Other countries have, of course, taken note, including the UK. But early signs suggest the process may not work so smoothly there, thanks to a worryingly small pool of volunteers. In September, Shepway council in the south of England dropped out as a contender after a survey showed 63% of residents didn't want it. The final three councils, all in the northern county of Cumbria, where there is a nuclear plant already, have put off making a decision. Even if they go ahead, there will be uncertainties – the local geology could turn out to be unsuitable, for instance. Could this level of public engagement turn out to be a mistake?

"Clearly with anything, if you've got the community on side, it enables the project to move forward. But the technical issues around a repository are very significant and it does narrow down the choices," says one consultant working on the scheme, who asked to remain nameless. "This is the process they've decided to go down, but if that's not forthcoming, they need to revisit that strategy."

Keeping the fuel above ground

Not everyone believes it's necessary to bury nuclear waste at all. "I'm a sceptic that any of this stuff needs to be buried underground as if it was a huge threat to humanity," says pro-nuclear environmentalist Mark Lynas. "It's a legacy of irrational policy that anti-nuclear groups have fomented for decades. I don't think any living thing – animal, plant, human – has ever been harmed by nuclear waste nor is likely to be."

Rather than argue about where to site repositories, a debate "that is always going to be poisonous", governments should focus their efforts on recycling spent fuel, says Lynas. Technology to do this, the fast prism reactor, is currently under government review in the UK.

Senior figures in the nuclear industry agree that moving ahead with recycling is key to a nuclear future. Speaking at a WNA conference in September, Kevin Walsh, senior vice-president at GE Hitachi, the firm behind the fast prism reactor, said: "For generations, our industry has viewed this material as an inconvenience. It's possibly the biggest single reason environmental groups haven't embraced nuclear as the clean energy we believe it to be."

Olivia Boyd is deputy editor at chinadialogue

Why I continue to fight the nuclear plant next door

7 November , 2012

Theo Simon

While Britain's green movement remains split over nuclear power, a determined band of campaigners are staging their own protests against a planned nuclear plant in the south-west. Activist Theo Simon gives an insider's view.

In the southwest corner of Britain, where the mighty River Severn flows into the Atlantic Ocean, a small but significant battle rages over energy and the legacy we leave for future generations.

For a thousand years people have trudged down the long lane that leads through windswept coastal farms to the headland of Hinkley Point, where a fresh water spring bubbles up beside an ancient burial mound. Within living memory villagers believed the water had curative powers and was protected by the spirits of the mound. But in the 1960s two nuclear power stations, Hinkley A and B, were built on the site. The Neolithic mound was fenced off, the lane became a driveway for nuclear workers, and the sacred well was covered by their car-park.

Now the two stations are at the end of their operational lives, but central government is supporting plans for French energy giant EDFto build a massive new nuclear plant on adjacent farmland. For the government, it looks like a way to cut carbon-dioxide emissions while still expanding the power supply. For those of us who live in Somerset county, it looks like a massive new hazard on our doorstep, a Fukushima waiting to happen, a bottomless drain on public funds and a future radioactive waste dump for our grandchildren.

If it is built, it will only be because it has been steamrollered over us. So the lane is seeing another kind of traffic now, as police vans monitor coach-loads of protesters opposing the plan with blockades, trespassing and illegal camps.

Public consultation "a sham"

Because the government declared a "National Policy" to build 10 new nuclear plants in Britain, with Hinkley C as one of the likely sites, most local officials feel powerless to resist. They pressured the reluctant landowner into selling the land, then gave EDF permission to begin ripping it up before the project has even been given the go-ahead. Ancient oak woodland has been felled, historic buildings have been demolished and precious wild-life habitats destroyed to make way for the biggest building site in Europe.

Meanwhile, government created a new "consultation process", replacing the old democratic form of public hearings with a National Planning Inspectorate. They will record your objections – so long as you submit them correctly in writing and don't question the safety, toxicity, cost or necessity of nuclear power and its radioactive waste products. This reduces local representatives to showing their resistance through wrangles over bits of road widening or costs to the public purse. People believe that the decision has already been made and the consultation is just an expensive sham.

In the wake of the Fukushima disaster, 10 of us dodged security guards in February 2012 and entered the proposed development site to occupy an abandoned farm. We claimed squatter's rights, raised anti-nuclear banners and flags, talked to the press and TV, broadcast on the internet and invited others to visit us. After three weeks, EDF took us to the High Court and asked the judge for an injunction to forbid all protest at Hinkley C. They didn't get the blanket ban they wanted, but did get an eviction order against the people at the farm. Some of us will now face prison if we are seen going back on the site.

None of this has stopped a growing tide of protest. A blockade by 1,000 people in the spring was followed by mass trespass and disruption to site preparation this autumn. Although the police were mobilised in force, they mainly stood by and chatted pleasantly while filming us, as it is their job to intervene only if there is violence or property damage. They have enjoyed watching us repeatedly outwit the private security guards and dogs patrolling the site.

Many of the police are on our side in their hearts. They are local people themselves, with families who would face evacuation and contamination if there were a nuclear accident, and with children whose great-grandchildren will have to take care of the highly toxic radioactive waste dump which will be remain long after Hinkley C has stopped generating electricity. Recently at a roadblock one officer explained to me that the sea at Hinkley Point has the second highest tidal range in the world and is an ideal place to harvest marine energy – but state investment is lacking. Where nuclear is concerned though, the government now says it may underwrite the construction and fix the electricity price for EDF if that is what it takes to secure enough corporate or foreign state investment to keep the project afloat.

The British state has a historic attachment to nuclear power as a source of nuclear weapons

In spring, 2012, around 1,000 people blockaded the Hinkley site, where EDF plans to build a new nuclear plant. (Copyright: Adrian Arbib)

material and a centralised power system that requires secretive control. While no one seriously doubts the need for urgent and rapid action to cut carbon-dioxide emissions to prevent climate change, MPs have questioned the way the decision to use such hazardous technology was made when renewable energy options of wind, sun and wave-power also exist. They believe that nuclear industry lobbyists have corrupted the democratic process. Even at a local level, the press rely so heavily on money from EDF's advertising that they have effectively become propaganda sheets for the Hinkley C project.

Economic and environmental "blackmail"

Thanks to our protests on the one hand and the reluctance of investors to commit on the other, the nuclear edifice has now begun to crack. Eight of Britain's 10 planned new-nuclear projects have stalled. But it is still an uphill struggle to challenge such large-scale construction when it has full government backing and a supposedly "green" justification. Local people feel trapped. Their resistance is softened by cash handouts from EDF to the community – a kind of legal bribe – and the promise of jobs. One local teacher told me she wanted to visit our camp but felt she couldn't as EDF had given money to her school.

Economic and environmental blackmail makes people reluctant to speak out. "Don't tell anyone in the village I was here," said one man who brought supplies to our farm occupation, and he was typical of many. But through direct action and social media, campaigners are

making local resistance more visible and inspiring self-confidence. At a recent rally in nearby Bridgwater town, we showed that there are alternative ways to cut CO2 while creating a million new "green" jobs. We also brought survivors from Fukushima to remind workers of the terrible cost communities must pay when nuclear goes wrong. As a former senior engineer from the Hinkley B plant explained to the rally, such human mistakes are always possible when there is strong financial pressure to cut corners in construction and no genuine public scrutiny.

Climate change is global, and tackling it will require global solidarity. Globally also, Fukushima has reawakened ordinary people to the hazards of nuclear power. We have had visits from Indian and European campaigners, and we know that our common future lies in the hands of the larger so-called "emerging economies", not with us. But hopefully we can play a small part here by successfully rejecting new-nuclear in Britain, while acting to leave our descendants a world which is as clean and safe as the world our ancestors left for us.

Theo Simon is an environmental campaigner and musician with UK band Seize The Day

UK deliberates its nuclear past and future

on January , 2013

Olivia Boyd

Investor confidence and public opposition to waste storage plans have rocked the British government's hopes for a new fleet of nuclear reactors

It has been a topsy turvy year for the nuclear industry in the UK as investors have fled the market and policymakers sent back to the drawing board on waste storage.

And it's a situation that's continued to change rapidly: as recently as March French firm EDF won planning permission to build the UK's first new nuclear plant in south-west England, but was still locked in knife-edge talks with government over state subsidies.

First Germany was going to build Britain's nuclear future. Then China was going to save it. Eventually Japan stepped in to pick up the pieces, though the public has been left wondering if any investor will stick around.

In March last year, a major blow was dealt to the country's nuclear ambitions when German energy companies E.On and RWE quit the UK market, largely thanks to escalating decommissioning costs back home following Angela Merkel's decision to phase out nuclear power. Their joint nuclear venture Horizon, with plans to build up to £30 billion worth of plants, was put up for sale.

Before the end of the year came another blow when China – thought to be the only player with enough cash to bring the industry back to life – appeared to drop out of the race to buy Horizon. China Guangdong Nuclear Power Group, in consortium with French firm Areva, had been widely tipped as bidders, but when the deadline for submissions from prospective buyers arrived, the group had failed to table a bid.

China's State Nuclear Power Technology Corporation, though touted as a possible partner for reactor developer Westinghouse, was also absent from the final list of contenders.

The Financial Times, writing at the time, called the news a "blow for Britain's nuclear revival" and said the "lack of participation by the Beijing-backed groups" raised questions about how the country could take its nuclear programme forward: "Some industry experts believe only Chinese companies have the financial firepower to shoulder the immense cost of building new reactors," the newspaper said.

China has quickly come to be seen as vital to the future of the nuclear industry. The Chinese nuclear sector is still in its relative infancy (only 1.85% of the country's electricity came from this source in 2011). But the country's growing financial clout, combined with an apparent commitment to continue building nuclear on a large-scale even as others reconsider their positions, has led a nuclear industry struggling to re-orientate post-Fukushima to pin its hopes on Beijing.

Will Japan-UK deal work?

In the end, however, it was Japanese firm Hitachi which offered nuclear supporters brighter news, agreeing in October to buy Horizon for £700 million, and calling its investment a "100-year commitment" to Britain. Though a push to find new opportunities overseas by Japan's ailing nuclear sector is hardly a surprise, the irony of a Japanese firm filling the gap left by Germany's post-Fukushima decision to phase out nuclear power was not lost.

Hitachi, in alliance with US energy giant General Electric, is also behind the nuclear-waste burning fast-prism reactor currently being considered by the British government and seen as a potential solution to the country's plutonium waste stockpile.

Japan now looks heavily invested in Britain's nuclear industry. But will this investor stick around? Already doubts have surfaced. In March, Hitachi warned its UK construction plans could be affected by deadlocked talks between the government and French firm EDF over subsidies for the UK's first new nuclear project in Somerset, south-west England. Though planning permission has been granted for the scheme, a deal has not yet been reached on the level of state financial backing.

Confidence in the UK market was also rocked by Centrica's decision to ditch its nuclear partnership with EDF in January.

Safety fears and waste

Investor disinterest has not been the only thing on the minds of the country's nuclear planners. Waste disposal remains a continual headache. In January, a northern English county rejected proposals to build a £12 billion underground storage facility – leaving the government with no plan

for dealing with its accumulating radioactive waste, now in temporary storage.

The crisis gets to the heart of the problem facing not only British nuclear policymakers but governments around the world struggling to find a solution to the thorny problem of nuclear waste.

Communities have to be engaged to solve the problem, but the idea of hosting large quantities of radioactive material for up to a million years, is no easy sell. Despite its long-standing support for the nuclear industry, Cumbria saw mass campaigns against the dump on grounds it threatened the region's tourist industry and public health. Ultimately, concerns about its geological suitability for the task were cited by the authority in its refusal to take the waste.

The UK has said the latest news will not affect plans to press ahead with a generation of new nuclear plants. But as governments struggle to find a way forward on waste, the world's stockpile of nuclear material in temporary storage grows by 10,000 tonnes each and every year.

Olivia Boyd is deputy editor at chinadialogue

Nuclear Europe: a dream unwinding

7 February, 2013

Steve Thomas

Francois Hollande's election victory is the latest blow to an industry struggling to revive the optimism of pre-Fukushima days. But the seeds of crisis were there well before Japan's disaster, writes Steve Thomas.

image by Greenpeace

Prospects for nuclear power in post-Fukushima Europe are looking grim. Since the reactor meltdown in Japan last year, Germany, Switzerland and Italy have imposed phase-outs or abandoned attempts to start ordering new nuclear plants; the British programme has been delayed and one of the two remaining potential investors has dropped out; foreign investors are walking away from projects in eastern Europe, for example in Bulgaria and Romania; and France has elected a new president on an apparently anti-nuclear ticket.

With the leaders of Germany and France – two of Europe's most powerful economies – now firmly in the "anti" camp, the outlook for nuclear power on the continent more widely is distinctly ropy. The Fukushima nuclear disaster of 2011, it seems on first glance, has been a devastating pill.

But while there is little doubt that the crisis in Japan significantly worsened the chances of a

nuclear-powered Europe, it did so mainly by exacerbating problems that were already there – around cost, finance and public acceptance. It's worth taking a moment to look at how these dynamics are playing out across the continent, and how they might impact Europe's long-term energy agenda.

For Germany, the nuclear phase-out announced in the immediate aftermath of the Fukushima crisis, which will see all nuclear plants closed by 2022, was simply a return to the position that had applied for all but six months of the last decade. It is far from clear that German chancellor Angela Merkel, had she chosen to go a different route, would have been able to do more than extend the life of existing plants by a few years. New power plants, meanwhile, were a long way off. Similarly for Italy, where citizens rejected an ambitious nuclear construction programme in a referendum June 2011, there were always many hurdles to jump before the nuclear industry could get stuck in.

What Fukushima has done for Germany and Italy is to close off the nuclear option forever. All sides now know they must commit fully to energy efficiency and renewables to meet the climate-change challenge. And the environmentalists' claim that nuclear isn't necessary will be properly tested.

Meanwhile in France, the heart of Europe's nuclear industry, it remains to be seen how firm Francois Hollande's position will remain in office. Those with long memories will remember Francois Mitterand coming to power in 1981 on an apparent promise to stop new nuclear, only for a further 10 or so orders to be placed over the following six years.

But the real challenge – regardless of whether Hollande or Sarkozy had won the election – was always going to be what to do about France's existing plants when they reach the end of their lives. Under present plans, these ageing reactors will be retired at a rate of five to six per year from 2017 onwards. The cheaper option for the country's power giant EDF would be to do as the Americans and extend the plants' lifespans from 40 to 60 years, though thanks to post-Fukushima regulatory requirements that existing plants be made more robust for "extreme situations" this is not such a cheap option as it once was.

Such a move would also likely sound the death knell for Areva's problematic European Pressurised Reactor (EPR), the design causing huge delays and cost overruns at Olkiluoto in Finland and Flamanville in France. Both projects are running four years or more late and about 100% over budget. Without new French orders from Areva – a French company – the design would lose all credibility.

On the other hand, if France takes the route of replacing old reactors with EPRs, assuming problems around cost, licensing and construction can be solved, and the EPR remains a viable option, then the cost to EDF of replacing old capacity would be astronomical – far higher than first time around. It is doubtful that France could sustain the logistical and financial challenge of ordering and building four or five EPRs a year for a decade. It would also have to start paying huge

sums for decommissioning existing reactors. That leaves France facing some tough choices.

Then there's the United Kingdom, always the real test ground for the "nuclear renaissance" in Europe. A potentially large, prestigious market, which pioneered electricity market liberalisation, and where the government promised nuclear would receive no subsidies – if nuclear could survive in those conditions, it could survive anywhere.

Since a British nuclear revival was announced in 2005, the challenge has always been squaring commitments not to subsidise and to maintain a competitive electricity market with the need to give plant owners the certainty of income necessary to convince banks to back their schemes. Horizon, the joint venture set up by the two German companies RWE and E.ON has effectively been abandoned, and reports that it will be bought by Chinese or Russian interests look unrealistic.

EDF, the remaining serious developer in the United Kingdom, has more than enough to deal with back home in France, and financing anything other than a very secure investment across the channel looks more trouble than it's worth. As the window when orders can be placed draws closer, negotiations between government and EDF are getting more pointed. And it's looking less and less likely they will manage to sign contracts that are acceptable to the UK Treasury – the contracts will have to be guaranteed by public funds – and avoid falling foul of EU competition law.

In eastern Europe too, there have long been ambitions to build new nuclear plants. But plans have mostly been based on very unrealistic cost estimates and an assumption that the large amount of excess power produced could be sold profitably in western Europe. This has never been a convincing model and finance for projects like Belene in Bulgaria and Cernavodă in Romania has always been a barrier to these projects going ahead.

If Europe's governments have been jolted by the aftermath of Fukushima, the big energy companies have been violently shaken. Nuclear has long been an attractive option for the major operators because the massive demands placed on plant-builders effectively rule out entry by new competitors – unlike smaller-scale decentralised technologies, which allow scope for small companies to join in.

The permanent closing off of the nuclear option in Germany and Italy has left three out of five of Europe's big companies, EON, RWE and Italy's ENEL, with gaping holes in their corporate policies for dealing with the need to reduce their carbon emissions. Francois Hollande's election victory is now likely to rein in the nuclear ambitions of the other two major players, French companies EDF and GDF Suez. And the lack of progress on carbon capture and storage (CCS), the technology needed to make coal environmentally acceptable, means the other preferred option of the "big five" is also looking shaky.

But again, while these firms have been badly bruised by Fukushima, it is worth pointing out

that the fundamental problems the industry faces – around cost, finance and public opinion – were there already. And, most likely, they would have caused the long-promised nuclear renaissance to quickly run out of steam.

A decade or more ago, a new generation of nuclear designs were announced. The French EPR was expected to drive the revival in Europe, while the Westinghouse AP 1000 would lead the charge in the United States. These technologies boasted improved safety and economics and – because they were expected to be simpler – less risk of the cost and time overruns that had long plagued the industry.

On cost, the promise was that these reactors could be built for US$1,000 (6,300 yuan) per kilowatt of capacity. That would bring a 1,700-megawatt EPR in at US$1.7 billion (10.8 billion yuan). At that price, it was claimed their power would be competitive with the cheapest option, natural gas. Today, even before any of these designs have entered service, the cost estimates are five to six times that level, and there is no sign that they have stopped rising.

On finance, the mandatory opening up of European electricity systems to competition has extinguished the assumption that consumers will underwrite whatever costs are incurred. That means the financial risk falls on the owner, not consumers. Financiers don't like that equation, especially for a technology with as poor a record for being built to time and cost and operating reliably as nuclear power. Consumers always pay, but plant owners can go bankrupt losing money lent to them by banks.

It has become increasingly clear that a nuclear-power plant will struggle to find finance if destined to operate unprotected in a competitive market. The disastrous Olkiluoto and Flamanville projects suggest the promise of "buildability" was also fanciful – and will have made financiers even more sceptical.

So, yes, the outlook for nuclear power in Europe is bleak. That has long been the case. But it does not mean this power source is going to disappear from the agenda. Four of the most aggressively pro-nuclear governments – the United Kingdom, France, Poland and the Czech Republic – are reportedly lobbying the European Union for nuclear power to be given the same status as renewables. Crucially, this would allow subsidies to be dished out without breaking EU laws barring direct state aid to industry.

And, no doubt, new technologies will be proposed that promise to solve all the problems of the past, while utilities will fight tooth and nail to keep existing plants online long after their expected life-span is complete.

Steve Thomas is professor of energy studies at the University of Greenwich, in London.

GE boss: "nuclear hard to justify"

30 July, 2012

Olivia Boyd

Nuclear power is so expensive that it has become "hard to justify" in an age of cheap natural gas, the chief executive of GE – a major supplier of nuclear equipment – told the Financial Times this weekend:

"When I talk to the guys who run the oil companies they say look, they're finding more gas all the time. It's just hard to justify nuclear, really hard. Gas is so cheap and at some point, really, economics rule," he said.

Gas prices are now at 10-year lows thanks to the shale-gas "revolution" going on in the United States, while the nuclear industry is languishing in post-Fukushima crisis and faces uncertainties of price, policy and public opinion.

A clear signal that the confidence of nuclear investors is at a low ebb came in March, when German firms RWE and E.On ditched plans to build two reactors in Britain, at a projected cost of £10 billion, blaming the harsh financial environment and surging decommissioning costs in their domestic market, where nuclear is being phased out.

Even the Chinese nuclear market – on which global firms appear to be pinning their hopes for resurgence – is far from a safe bet, as New Century Weekly recently noted in the article "Public fears check Chinese nuclear" (translated by chinadialogue),

All this has led some observers to conclude that gas is a more viable back up for renewables than nuclear. "So I think some combination of gas, and either wind or solar … that's where we see most countries around the world going," Immelt told the FT.

But is unconventional gas risk free?

Well, no. Moves to ban the controversial drilling technique used to extract gas from shale

in jurisdictions from the US state of Vermont to France suggest there are policy risks here too. Meanwhile, vehement expressions of public opposition, including protesters chaining themselves to fences, show that society remains divided over the energy source. Environmentally, there are major concerns, from water pollution during the drilling process to the carbon footprint of gas – even if those arguments aren't swaying current governments, who's to say future governments won't be greener-minded?

And in China, thought to have the world's most plentiful shale-gas supplies, experts aren't even convinced they can easily get at the reserves, as Xu Nan and Wang Haotong wrote on chinadialogue last week:

In China, where the shale gas lies much deeper underground and in tougher terrain than the US, no companies have yet mastered multi-stage hydraulic fracturing. Some say this means China will have to work with American firms. Others worry it will be hard to adapt imported technology and expertise to Chinese geology.

An Economist article from March, entitled "The dream that failed", argued that nuclear power won't go away but may never have more than a "marginal" role globally. It may be too early to tell how the shale-gas dream will end .

Olivia Boyd is deputy editor at chinadialogue.

US regulators freeze nuclear approvals

10 August , 2012

Olivia Boyd

The nuclear sector – already struggling with spiralling costs, cancelled plans and policy uncertainty – had another piece of bad news this week, when US regulators decided to freeze issuing licenses for new reactors while they work out how to comply with a court decision on waste storage. As World Nuclear News reported:

Licences for US nuclear plants - including those for new construction and life extension – will not be issued until the Nuclear Regulatory Commission (NRC) addresses a court decision on waste confidence…On 8 June, the US Court of Appeals for the District of Columbia found that the NRC's rules for the temporary storage and permanent disposal of nuclear waste stood in violation of the National Environmental Policy Act. This requires that either an environmental assessment or environmental impact statement be prepared for all major government agency actions.

The rule under scrutiny is a 2010 update to the NRC's rules on waste, which allows temporary storage of spent fuel on the site of nuclear plants even after their licence has expired.

The World Nuclear Association pointed out that no licensing decisions were expected before mid 2013 in any case and that "all licensing reviews and related proceedings are unaffected" by the freeze. But not everyone was so glib about the impacts on nuclear construction plans – Platts reported that Tuesday's decision could delay Duke Energy's plans for two new reactors in Florida.

Since Fukushima, concerns about nuclear development have focused largely on the potential impacts of natural disaster on an up-and-running plant, adding to mounting scepticism about cost thanks to the massively over budget projects in Finland and France (for more on Europe's nuclear woes see "Nuclear Europe: a dream unwinding"). This news is a reminder that nuclear waste storage is another, major piece of a puzzle that is looking increasingly hard to fit together.

Olivia Boyd is deputy editor at chinadialogue

Calls grow to scrap US nuclear plant

August , 2012

Jan McGirk

A radioactive leak could see permanent closure of the San Onofre nuclear plant, as public frustrations mount. Jan McGirk reports from California.

A radioactive leak may prove to be the swan song for one of California's ageing nuclear-power plants, the San Onofre Nuclear Generating Station, also known by the rather innocuous acronym SONGS. Located in northern San Diego county, and normally able to supply 2.1 million homes with electricity, the pressurised water reactor has been switched off since January 31, 2012 when one of its generators leaked what the plant's operator, Southern California Edison, called "an insignificant or extremely small release" of radioactive steam into the atmosphere. This week, the plant announced plans to lay off a third of its workforce.

The idea of scrapping this nuclear-power plant because of equipment failure is gaining support, particularly after the Nuclear Regulatory Commission ruled in early August to stop issuing any new licenses or renewals to US nuclear-power plants until the environmental impact of storing radioactive waste is addressed.

With no long-term storage solution for spent nuclear fuel, America's 104 atomic power plants must resort to stowing it on site, either triple-stacked in dry casks or dumped into pools which need constant circulation to stave off nuclear meltdown. Allison Macfarlane, a geologist who now chairs the NRC, also wants to re-evaluate the vulnerability of these nuclear facilities to mega-earthquakes before the commission approves any more.

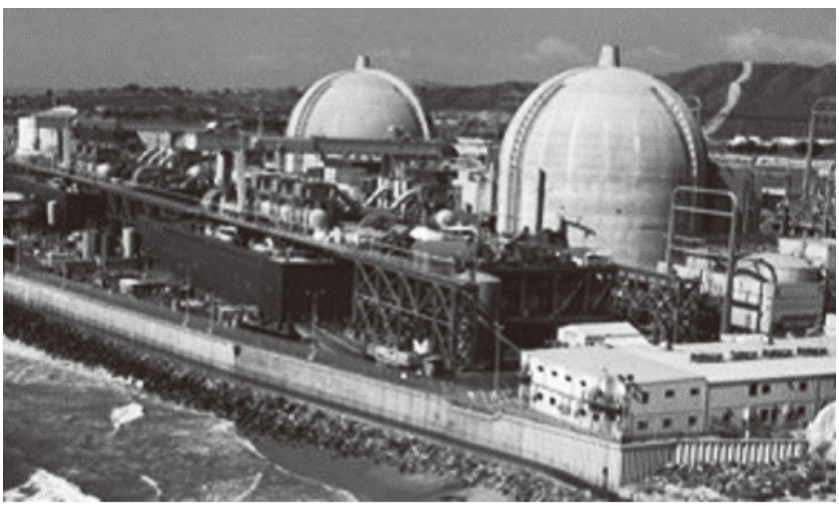
No wonder the eight million Californians who live within a 50-mile radius of the San Onofre reactor are feeling jittery. The Nuclear Regulatory Commission has cited "serious design flaws" in the plant's massive new generator units, caused by an error of computer modelling which resulted in triple the flow rate of liquids.

Fukushima links

Mitsubishi Heavy Industries, which has been closely involved with recovery efforts at the Fukushima reactors that failed during the 2011 tsunami in Japan, had retrofitted the steam generators at San Onofre at a cost of US$671 million (4.3 billion yuan). Bechtel engineers finished installing them last year. But Mitsubishi's paltry US$137 million (872 million yuan) warranty will not even begin to cover full replacement costs.

Edison might be able to recover some of their losses through insurance. But estimates for repairing or replacing the two units are expected to be dismayingly high for a cash-strapped state with frequent earthquakes, and utility rate-payers are demanding that they not be stuck with the bill. The chief executive of Edison International, Ted Craver, told investors recently that it's not certain whether the plant at San Onofre will ever be able to operate at full capacity unless the steam generators that malfunctioned are replaced. The licence is good for another decade. In the meantime, supplementary electricity is supplied from a hastily rehabilitated gas-fired plant up the coast.

The revamped generators at San Onofre had been designated as replacement parts and thus were exempt from the more rigorous inspections required for brand new equipment. Excessive vibrations in these newly refurbished units caused some tubes to wear out prematurely; so far, some 1,317 of 39,000 tubes have been plugged. Any split in these narrow tubes may have resulted in radioactive coolant mixing with steam and escaping from the containment domes to an adjacent building, according to NRC spokesman Victor Dricks. Inadequate support for the heavy equipment during its trans-Pacific shipment from the manufacturer in Japan to San Onofre may also have contributed to the malfunction.



The nuclear power plants are located near San Clemente. Image from AECL

Mitsubishi has built 24 Pressurized Water Reactor plants in Japan, where scientists recently linked a strain of mutant butterflies to the radiation leaks triggered by the tsunami and a Japanese study revealed that 3,281 people living in the vicinity tested positive for cesium radiation - although at levels considered safe. The company also provides essential components for nuclear reactors used in about 30 other countries, including China.

"The top priority of Mitsubishi is the safe and reliable operation of all the plants and components we design, engineer, supply and support," said Patrick Boyle, a spokesman for Mitsubishi Nuclear Energy Systems. "At the time these steam generators were designed, this type of tube wear had not been experienced at other PWRs. For the past four decades, we have used the latest technology and designs to help improve nuclear energy facilities in Japan, the United States and the rest of the world. Steam generators are an important part of safely and efficiently generating electricity at nuclear energy facilities. We will continue to work closely with our customer, Southern California Edison, to conduct a thorough investigation into this issue. We are confident the lessons learned will help the industry maintain and improve its impressive safety record."

Finding a solution to the glitches at San Onofre is a challenge and with the nuclear power industry's reputation still recovering from the tragedy in Fukushima, there's a lot at stake. A landmark carbon-cap and trade law requiring one-third of California's power supply to come from alternative energy sources by the year 2020, will come into force at the start of next year. In addition to parts for "green" nuclear power plants, Mitsubishi also manufactures wind turbines and emissions control equipment, crucial for the new Californian power grid sourced from wind, solar, wave and bio-fuels.

Nuclear shutdown?

Meanwhile, four neighbouring cities in southern California – Irvine, San Clemente, Solano Beach and Laguna Beach – have complained to authorities about the potential public safety risks and excessive costs of this newly controversial nuclear-power plant. Irvine wants to shut it down forever. But after so many years, why all the fuss?

Since the 1970s, the facility at San Onofre has sprawled on the Pacific coast, its pale twin domes looming like a sunbather's breasts over a popular nude beach, a state park and a renowned surfers' break. Camp Pendleton, a military base, is located next door and the late Richard Nixon's erstwhile Western White House is just up the road.

In smog-ridden California, atomic power was long hyped as green, reliable, and comparatively emissions free. Pacific Gas & Electric, a utilities company, once blithely proposed an elaborate necklace of atomic power plants: one every 25 miles down the California coastline, with an extra one bobbing offshore. But opposition from environmentalists mounted as confidence in the technology lagged. In 1977, Bechtel engineers installed the original 420-tonne nuclear vessel

backwards at San Onofre, and occasional blunders have continued since. In fact, San Onofre has one of the worst safety records of any American nuclear power plant. The federal watchdog NRC has substantiated 62 complaints here since 2008.

Anti-nuclear groups consider the commissioners to be more lapdog than watchdog and frequently blame the NRC for lowering safety standards in order to keep the old power plants running. California senator Barbara Boxer warned the federal commissioners: "If the NRC does not do its job, the American people will demand the ultimate protection – the shutdown of old nuclear power plants."

Daniel Hirsch, a lecturer in nuclear policy at the University of California Santa Cruz, takes a rather more cynical view. "The reactor's steam generators were supposed to last 40 years but conked out in just 25. The likeliest scenario at San Onofre is that Edison will propose a restart [of Unit 2] within a few weeks and the NRC will acquiesce, due to economic and political incentives," he told chinadialogue.

"With nuclear power, we have a technology that began in secrecy, and the culture of non-transparency has ossified," Hirsch pointed out. "Right now, presidents appoint the NRC members and senators vet them. The result is that, in effect, the commissioners work for the politicians."

Decisions taken to avoid financial catastrophe might backfire with dire environmental consequences. Edison's suggestion to run their nuclear generators at San Onofre below their capacity as a way to check potential leaks drew Hirsch's scorn. "That's equivalent to finding out a car has deficient brakes and the driver decides to drive at 40 miles-per-hour and just hope for the best."

Jan McGirk is a former correspondent for The Independent (London) who has reported on environmental issues and disasters in Asia, Latin America and the Middle East.

US drought causes nuclear power station to shut down

22 August , 2012

Chris Agass

The drought that has plagued the US this year has filled the news headlines for a number of predictable reasons, but somewhat lesser known has been its impact on electricity generation.

Record temperatures and drought conditions have afflicted power stations that require cool water to produce electricity – particularly nuclear ones - with a reactor in Connecticut forced to close down last weekend.

According to National Geographic, one of the two nuclear reactors at Millstone Power Station near New London, Connecticut, was closed when temperatures in Long Island Sound, the source of the facility's cooling water, reached their highest sustained levels since the facility began monitoring in 1971. No word has yet been given on when the reactor would re-open.

Ramifications of the drought such as low crop yields and rising food prices have been widely reported, but as Barbara Carney of the National Energy Technology Laboratory (NETL) in Morgantown, West Virginia told New Scientist, power plants are often a hidden victim of drought, because they are totally dependent on water cooling and thus susceptible to heat waves and the effects this has in terms of water temperature and water shortages.

New Scientist reported that the average nuclear plant requires far more water to cool its turbines than other power plants. Nuclear plants require more than 2,000 litres of water per megawatt per hour for cooling. In contrast, coal or natural gas plants need, on average, only 1,890 and 719 litres respectively to produce the same amount of energy.

As water levels in the rivers that cool them have sunk too low the power plant – already overworked from the heat – is not able to acquire enough water. In addition, if the cooling water discharged from a plant raises river temperatures above certain thresholds, environmental regulations require the plant to shut down.

According to Natural News, a second nuclear power plant in Illinois was forced to attain special clearance from the U.S. Environmental Protection Agency in July to pump additional water into its cooling pond, which was evaporating and in danger of heating to levels beyond those allowed by its permit.

With the closure of the San Onofre nuclear plant in California, due to a radioactive leak, as reported on in China Dialogue, the news of drought-affected power plants will certainly not be well received by the US nuclear power industry.

Chinese nuclear goes global?

6 June , 2012

Antony Froggatt

From Paris boardrooms to Kazakh uranium mines, the nuclear industry anxiously awaits news from Beijing. A latecomer to the party, China is looking more and more the favoured guest, writes Antony Froggatt. Four months after this article was published, on October 24, 2012, China's State Council lifted a ban on approvals of new nuclear power stations imposed following the accident at Fukushima. It was a cautious restart to China's nuclear programme, however, with official documents calling for a gradual return to normal construction and a freeze on inland nuclear plants remaining in place.

In the space of a couple of decades, China has become a major player in the global nuclear sector. With by far the largest number of reactors under construction of any country in the world, and further reactors on order, it is seen as a vital market for uranium, a testing ground for new reactors designs and, increasingly, a potential partner for nuclear developments across the world.

But the Fukushima crisis in Japan has had a significant – and under reported – impact on Chinese nuclear developments, triggering a freeze on the start of new construction, a re-consideration of the safety standards of domestic designs and unprecedentedly visible opposition to the building of new, inland nuclear plants. While an announcement was made by the State Council last week that the ban will be lifted shortly, the events of the last 15 months will still result in a failure to meet China's current five-year plan on nuclear development and, depending on how things develop, its 2020 objectives as well.

The global clout of China's nuclear sector is such that the impacts of its decisions stretch far beyond the nation's borders. From France to Namibia, from reactor designers to uranium-mining firms, the industry will be waiting anxiously for news from China.

China came relatively late to the civil nuclear industry: it started construction of its first commercial reactor only in 1985. As of May 2012, the country had 16 reactors in operation, which in 2011 provided 1.85% of the country's electricity, the lowest share of any country with nuclear power. But, despite its late arrival to the party, China was – until Fukushima – proving an energetic player, with an impressive recent history of construction starts. Today, it has 26 reactors under construction, representing 39% of global new build.

But Fukushima changed the picture. Three days after the 2011 tsunami triggered equipment failures at the Japanese plant, Xie Zhenhua, vice chairman of China's top economic planning body, the National Development and Reform Commission, was quoted by Bloomberg as saying "[e]valuation of nuclear safety and the monitoring of plants will be definitely strengthened."

Then, an account of a meeting of the State Council, chaired by premier Wen Jiabao, in mid-March 2011 included the following: "We will temporarily suspend approval of nuclear-power projects, including those in the preliminary stages of development....We must fully grasp the importance and urgency of nuclear safety, and development of nuclear power must make safety the top priority." As a result, a new China National Plan for Nuclear Safety with short-, medium- and long-term actions was ordered, and the construction of new plants suspended pending its approval.

May 2012 meeting of the State Council is said to have given provisional approval to both the safety plan and a set of goals for 2020. If implemented, these proposals will require some of the existing reactors to undertake safety modifications to meet new standards on earthquakes and flooding. However, it is still unclear when construction on new projects might begin again, or when the proposal for a new safety standard will be released for public comments.

It is suggested the delay has been partly caused by uncertainty over the strategic direction for future reactor designs, and in particular whether future construction would be dominated by China's second-generation CPR 1000 design or move towards greater deployment of third-generation designs from overseas.

China has not yet fully developed its own third-generation design and would have to rely initially on the European Pressurized Water Reactor (EPR) or the American AP1000 reactor. The potential move towards much greater, or even total, dependence on the most modern design is affected by conflicting concerns: the higher costs of the international design and greater confidence in the safety standard.

Tange Zede, a member of China's State Nuclear Power Technology Corporation (SNPTC), was reported in Nuclear Intelligence Weekly as saying the domestically designed CPR-1000 could not even meet the national safety standards issued in 2004, let alone the most up-to-date international standards. Zede stated that "unless the constructed second generation reactors are renovated, they should not be allowed to load fuel and start operation."

Global reactor designers move in on China

Historically, international nuclear vendors have sought to construct their latest models in China. Russia's reactor-exporting company Atom stroy export provided its latest design, the AES-91, and equipment for units one and two at Jiangsu province's Tianwan power plant, which was completed in 2007. It is said that two further reactors will be commissioned, but no date has been set for construction.

Atomic Energy of Canada Ltd (AECL) built two of its heavy-water reactors at the Qinshan phase-three plant in Zhejiang, on China's east coast, but despite the fact these were completed in

2002 and 2003 respectively, no further orders have been placed. Finally, the French utility EDF was engaged in the construction of two reactors at Daya Bay, south China, which were completed in 1994 using technology from French firm Framatome, now AREVA. Two further reactors at phase one of the Ling Ao plant in Shenzhen, also in the south, were built using Framatome equipment, though with a larger domestic contribution. But by the time it came to phase two, a domestic Chinese design was used.

Today, the world's major international reactor vendors, notably AREVA and Westinghouse, are building their most advanced designs in China. In the case of Westinghouse, the AP1000 is the company's flagship third-generation design, and China is its only sale. The contract, worth around US$5.3 billion (34 billion yuan), is for construction of four reactors, including transfer of both reactor technology and back-end services, particularly waste management.

Construction of these four units, two at Sanmen in Zhejiang province and two at Haiyang, further north in Shandong province, is under way, though delays of six to 12 months are reported. For the first unit at Sanmen, the slippage is said to be due to design changes post-Fukushima. For the remaining three units, supply-chain issues relating to the increased use of local components are blamed. If reports are accurate, use of domestic parts across the series of the four reactors will increase from 30% to 70%, and any future reactors will be built with Chinese components alone.

The estimated construction costs of the AP1000 are also quoted as rising. In 2009, it was said they would cost US$1,940 per kilowatt (12,400 yuan), but the latest figures range from US$2,300 to US$2,600 per kilowatt. While this is far below the estimated costs of any other third-generation project, globally it is higher than the reported costs for China's CPR 1000 at US$1,800 per kilowatt.

In November 2007, AREVA announced the signing of an €8 billion (US$11.6 billion) contract with China Guangdong Nuclear (CGN) for the construction of two EPRs in Taishan, in south China's Guangdong province, and said it would provide all the materials and services required to operate them. The Taishan project is owned by Guangdong Taishan Nuclear Power Joint Venture Company Limited, a hook-up between EDF (30%) and CGN. First concrete was poured in October 2009, and unit one was expected to begin operating in 2013, followed by a second unit in 2014.

Two other EPR reactors are being built in Europe, one in Finland and one in France, but are both running at least 100% over budget and four to five years behind schedule. The delays are such that the Chinese reactors may now be operational before those being built in Europe. Completing the EPRs in China to time and budget will be a vital test for AREVA, which the company will hope can offset its bad experience in Europe. Troubles closer to home are said to be contributing to its lack of sales in other parts of the world, such as the United Arab Emirates.

China is also stepping up its nuclear export activity. The most consistent example is Pakistan, which China has supplied with equipment for two reactors at Chashma in Punjab. Construction of units three and four reportedly began at the end of 2011, with China Zhongyuan Engineering as the general contractor and China Nuclear Industry No. 5 Construction Company as the installer. Finance is also coming from China.

It doesn't stop with Pakistan. In recent months, the Chinese industry has been linked with many other projects around the world. The visit of Turkey's prime minister, Recep Tayyip Erdogan, to Beijing in April was used to discuss China's assistance for a proposed nuclear-power station at the Turkish city of Sinop. Other possible deals include the sale of a plant to South Africa and a nuclear co-operation agreement in Saudi Arabia, while there has been speculation over potential Chinese ownership of the energy company Horizon Nuclear Power, established by utilities Eon and RWE to build nuclear plants in the United Kingdom, but now up for sale.

To fuel the country's expectation of a rapidly growing nuclear sector, two companies – CGN and China National Nuclear Corp (CNNC) – are permitted to import uranium. To meet official fuel requirements, they are set to increase imports from around 3,600 tonnes per year in 2010 to some 10,000 tonnes in 2020. Of the two firms, CGN has been the more successful over recent years and has signed a number of deals. In November 2010, its leaders inked a 10-year agreement for the supply of 24,200 tonnes of uranium from Kazakhstan's Kazatomprom.

In addition, CGN and Chinese equity funds each have a 24.5% share in AREVA's mines in Namibia, South Africa and the Central African Republic, which could provide an additional 40,000 tonnes of uranium starting in 2022. CGN signed another deal in November 2010 with Cameco of Canada for the supply of 13,000 tonnes of uranium through 2025.

More recently, in February 2012, CGN completed a takeover of Extract Resources, which is developing Africa's largest known uranium resource. CGN, together with the China-Africa Development fund paid €2.2 billion (US$2.7 billion) for the company and associated companies, such as Kalahari Minerals. The CGN activity contrasts starkly with the limited success of CNNC, which has secured little supply outside of China despite attempts in Mongolia, Kazakhstan and Niger. Though, in light of its ambition to secure 2,500 tonnes of uranium a year by 2015, CNNC is likely to increase its activity in the market, and there are suggestions it might take a stake in AREVA's new project in Niger.

Prior to the accident at Fukushima, China's 12th Five-Year Plan anticipated 43 gigawatts of nuclear power in operation by the end of 2015. Meeting this target would have required the completion of all reactors under construction at the end of 2010, plus those scheduled to start in 2011. It therefore cannot be met. A report on implementation of the 12th Five-Year Plan, published by the China Electricity Council in March estimated that China's nuclear-

generating capacity would reach 80 gigawatts by 2020. But the suspension of the start of new construction and the uncertainty over the strategic direction for future designs make meeting this 2020 target highly unlikely.

Public opinion could also pose an obstacle. In a poll carried out by research agency Ipsos MORI after Fukushima, 42% of those surveyed in China were supportive of nuclear power – but 48% were opposed. It is also reported that public opposition and environmental concerns have led to the delay in construction of three inland nuclear power sites. In March this year, opposition to the proposed Pengze power plant in Jiangxi erupted into the public sphere on a scale not previously seen when local authority documents critical of the project were posted on the internet.

Given nuclear's small contribution to China's electricity supply, a doubling or trebling of new-build capacity won't significantly alter the electricity mix or, for that matter, Chinese emission trajectories. However, the future direction of its choice of reactor design domestically could fundamentally change the number of orders for a particular manufacturer. This is something global companies are well aware of, though they should note that – so far – China has not deployed any foreign reactor design at scale, rather ordering a couple and then largely carrying on with domestic designs.

Fukushima has already had a significant impact on the Chinese nuclear sector. The questions are now, one, will future orders be placed at the pre-Fukushima rate? And, two, what new design safety standards are required?

The answers to these questions are not only eagerly awaited in Paris and Tokyo, the homes of AREVA and Westinghouse, but also uranium suppliers in Africa and prospective nuclear builders in the United Kingdom, Turkey and Saudi Arabia, to name but a few. China's nuclear developments probably matter more to the rest of the world than they do to China.

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This article is adapted from a section of the "World Nuclear Industry Status Report", by Mycle Schneider and Antony Froggatt.

Public fears check Chinese nuclear

19 July , 2012

Cui Zheng

A new nuclear safety plan for China has been treated as a signal the sector is returning to favour. But old problems still plague the industry, writes Cui Zheng.

In mid-June 2012, following a 15-month moratorium on construction of new nuclear facilities, China published the results of a nuclear safety audit and a fresh nuclear safety plan, signalling a possible end to the post-Fukushima freeze.

Since the days following Japan's nuclear disaster in March last year, the number of countries to halt construction or operation of nuclear-power plants has grown, while the global nuclear industry has pinned its hopes on China coming back into the fray. Is it the case, then, as many believe, that construction will soon restart in China?

An uphill start

The launch of the new safety strategy has certainly had an impact on the industry. Four days after the plan was approved, investors pumped 400 million yuan (US$63 million) of funding into the Pengze nuclear plant in south-east China's Jiangxi province, on which work stopped 15 months ago. CNNC Nuclear Power, a China National Nuclear Corporation (CNNC) subsidiary, passed a pre-listing environmental audit. Market analysts, meanwhile, have started recommending the purchase of nuclear shares.

Despite the flurry of activity, the industry itself appears unusually reticent. The main reason is that an updated "medium to long-term development plan" for China's nuclear power sector – also awaited by the industry – was not released alongside the safety strategy. One CNNC insider who wished to remain anonymous said the firm regards that plan as the key to an industry revival, and is unexcited by the safety materials. The source added that the listing of CNNC Nuclear Power had been long in the planning, and the environmental audit is just one stage in that process.

The original version of the development plan was published in October 2007 and set a target for 40 gigawatts of nuclear-generating capacity by 2020. But after the crisis at Fukushima, the State Council – China's highest organ of state power – imposed changes. Then, on May 10 2012 year, Qian Zhimin, deputy head of the National Energy Administration (NEA), announced that both the safety strategy and the "medium to long-term development plan" had been approved by the NEA and passed on to the National Development and Reform Commission, the country's top economic planner.

But at a State Council meeting on May 31, only the safety plan was passed. There was no sign of the development plan. One expert close to the nuclear policymaking process, who asked to remain anonymous, said it may still be some time before China sees its much touted nuclear spring. "For the sake of stability, nuclear construction is unlikely to get started soon," the source said.

This position is closely linked to public fears over nuclear power, stirred by the Fukushima crisis. Early in 2012, the government of Wangjiang county, near the Pengze nuclear plant, filed an official complaint about the facility being built across the river, suggesting public opinion can affect official attitudes.

Policymakers are acutely aware of the public's concerns. Around the world, whether or not to press ahead with new nuclear has become a deeply politicised question, and with China in the midst of a leadership change, officials are being cautious.

Sign outside Days Bay nuclear plant, south China. Image by DickStock

And so the nuclear industry has been left to stew. Gu Zhongmao, deputy head of the technology committee at the China Institute of Atomic Energy, said nuclear equipment suppliers had been worst hit by the standstill. A stop on their business operations of more than a year has left these players in dire straits. Overseas suppliers have also been affected: Chinese firms are attempting to cancel contracts for equipment for shelved plants under force majeure clauses (which can free parties to a contract from liability in extraordinary circumstances) while the suppliers concerned argue policy change is not something that can trigger force majeure. International mediation is being used to resolve the disputes.

Persisting safety concerns

After the Japanese nuclear crisis, China launched an extensive audit of nuclear safety. Publication of the results was delayed more than once. When the final report eventually appeared, it said that China's nuclear facilities are basically safe, but that vulnerabilities to extreme natural disaster – such as the tsunami which hit the Fukushima nuclear plant – remain.

An experimental reactor 100 kilometres from the site of the 2008 Wenchuan earthquake had to be shut down manually after the quake as it had not been adequately "earthquake proofed", according to media reports. China's new safety plan states that the design of experimental reactors should be revaluated in the light of this, and improvements made where necessary.

Many industry experts and employees agree with the audit's conclusion that the industry is "safe overall" and hope that the report will help get construction back on track. Qian Jihui, former vice-president of the International Atomic Energy Agency, said a wider safety net will be built into China's nuclear-power sector as a result of the new strategy, reducing the already highly unlikely chance of a reactor meltdown, though he noted that construction costs are also likely to rise.

But Yang Fuqiang, a senior consultant to US-based NGO the Natural Resources Defense Council argued that the report has downplayed the challenges. The audit took a long time and was complex process, he said. It's hard to believe the issues it uncovered were so simple. China has more nuclear-power plants under construction than any other nation, but fewer engineers with experience in the nuclear sector than many other countries. "If you start so many projects at once, you can't be sure all the teams doing the work will be up to standard," Yang said.

The audit does not signal major problems with China's level of nuclear technology, he added, but safety is not just a matter of technology.

Regulatory risks

Indeed, the major risks are related to management. Management errors have played a part in all of the world's major nuclear accidents. And, in China, concerns persist over the country's

nuclear regulatory system, emergency response capability and safety culture.

Harvard University research fellow Zhou Yun is a long-time observer of Chinese nuclear reactor risk assessments and nuclear power policy and law. In 2010, she wrote a paper pointing out that China's National Nuclear Safety Administration (NNSA) is subordinate to the Ministry of Environmental Protection, while the big state-owned nuclear power companies are managed by the State Council. This reduces the independence and authority of the regulators, she argued. NNSA does not have its own research department through which to set standards and cannot evaluate and decide on technical situations which are not covered by current law or regulations.

Fukushima pushed nations around the world to beef up their nuclear regulatory regimes. But in China there has been little change. In 2012, Yang Fuqiang passed suggestions for reform to the National Development and Reform Commission, but there has been no response.

Yang said regulators must focus on safety alone, and must not be influenced by development plans. "They should only approve technology when it is ready – targets for generating capacity should not have any impact."

Chinese regulators are also hampered by a shortage of personnel. Fan Bi, an economist focused on the energy sector, has pointed out that China's nuclear regulatory capacity lags badly behind, with too few staff working on nuclear safety at the NNSA and at the Commission of Science, Technology and Industry for National Defense. Regulators are paid much less than power-plant workers, which makes it harder to attract and keep staff.

This article was first published in New Century Weekly, where Cui Zheng is a reporter.

China unlikely to be shining light for nuclear

February , 2013

Steve Thomas

Nuclear power can only survive if it's competitive with alternatives. Even with China in the market, that's unlikely

Even before Fukushima, China's ordering rate of up to 10 reactors a year was putting an unsustainable strain on the supply chain. (Image by: Pessenger Faber)

Two years after Fukushima, a clearer picture of how the disaster has impacted nuclear power's prospects is emerging. For some European countries including Germany, Italy and Lithuania, Fukushima was the last straw. Other developed countries, such as the UK and the US, are trying to carry on as if Fukushima has no relevance to them because their designs are different, their operators more competent and tsunamis not a risk. Developing countries seem the least affected and nuclear ambitions in countries such as Turkey, Vietnam and Bangladesh are apparently as they were.

Safety regulators have started to specify required upgrades to existing reactors, and it is no surprise that the newly reformed Japanese watchdog is asking for significant modifications.

More surprisingly, the French safety regulator was Europe's first and only to issue a list of

required significant upgrades, including better back-up power facilities. For new designs, it will be a long time before they reflect all the lessons of Fukushima. Twenty-five years after Chernobyl, the first post-Chernobyl designs have yet to enter service anywhere in the world.

But the nuclear industry faced formidable problems even before the crisis in Japan: the interlinked problems of poor economics, difficulties obtaining finance and doubts about the viability of the new designs expected to power the "Nuclear Renaissance".

Nuclear construction costs soar

A decade ago, the nuclear industry promised the new generation of reactors, so-called Gen III+, would be safer, but simpler and therefore cheaper and less prone to construction delays, costing no more than US$1,000 per kilowatt of capacity. That would price a 1,000-megawatt reactor at US$1 billion, making nuclear cheaper than natural-gas generation.

While external factors – greater concern about climate change and rising fossil-fuel prices (at least until shale gas started to have an impact) – have moved in favour of nuclear power since then, the economic case has got weaker. Estimated construction costs have increased seven-fold.

The disastrous experience with construction of the first two Gen III+ reactor orders, Olkiluoto in Finland and Flamanville in France, both now running at least four years late and more than 100% over-budget, has badly dented credibility. These both use French company Areva's EPR design.

The other leading Gen III+ design is the AP1000, belonging to Westinghouse, a US-headquartered company, now Japanese owned. Four were ordered in 2012 in the United States, but even before the first concrete has been poured, there are delays, cost over-runs and quality issues.

The rise of nuclear China

The one bright spot for the nuclear industry in recent years has been the emergence of China as a major market for nuclear power. From 2008 to 2010, construction started on 38 reactors worldwide, a much higher ordering rate than in the previous 20 years. However, of these, 25 were in China, six in Russia and three in Korea.

This change in the balance of the world market was also reflected on the supply side. The traditional western market leaders began to lose orders to these newcomers. Russia became the world's leading nuclear exporter, gaining orders in Turkey, Vietnam and Bangladesh, while Korea won a major order for the UAE, comprehensively undercutting the bid of French "champion" Areva.

China has yet to win a foreign order (except for two small reactors for Pakistan) but is constantly spoken of as a major new presence in the market. This seems to be on the basis, with no evidence to support it, that because the reactors were from China, they would be cheap but good quality.

The situation in China is more complex than often imagined.

There are three competing nuclear vendors: Chinese Guangdong Nuclear (CGN), Chinese National Nuclear Company (CNNC) and State Nuclear Power Technology Corp (SNPTC). Most of the recent 18 orders have been supplied by CGN using their CPR1000 design – fundamentally a 40-year-old model, long pre-dating the 1978 Three Mile Island nuclear accident in the US.

There was some evidence, even before Fukushima, that the ordering rate in China of up to 10 reactors per year was putting unsustainable strain on the Chinese nuclear supply chain, while the designs being used were acknowledged to be old. So the halt to new reactor construction starts following Fukushima may have been a blessing.

It was also clear to China that it needed to move to more modern designs and it ordered six Gen III+ reactors in 2007 to 2008, four from Westinghouse and two from Areva. This was a major plus for the western vendors because it was expected to provide a shop-window for the new designs and, because it was China, the reactors would be built to time and apparently to cost.

But as the estimated price-tag of these designs escalated, there was an increasing perception that they were too expensive for China. There are also reports of construction delays and cost overruns of about a year with the AP1000s, prompting all three Chinese vendors to talk of developing their own Gen III+ designs. As these are all some way from being orderable, when China lifted its moratorium on new reactor construction projects in November last year, the two projects approved used old technology.

China's uncertain nuclear future

China is in a difficult position: if it wants to keep its nuclear reactor supply industry busy, it needs a flow of orders. But its new designs are probably several years away from being buildable so it needs to keep ordering the old designs. To secure a place in the world market for nuclear power plants, China will need to go through the lengthy – perhaps five year – process of getting a credible western safety regulator to carry out a comprehensive design review.

Meanwhile, it is exploring alternatives, finally starting the long-delayed Pebble Bed Modular Reactor (PBMR) demonstration plant. PBMR, developed in Germany, has for more than 50 years been seen by devotees as the ideal nuclear technology. But attempts to commercialise it in Germany and more recently in South Africa have come to nothing. Whether China will be more successful in turning its theoretical attractions into a commercial design remains to be seen.

While China is by far the most important market worldwide for nuclear-power plants, nuclear is not important to China and even if it continued to build large numbers of reactors, nuclear power

would still supply less than 10% of China's electricity. The hope from Areva and Westinghouse that China would be a showcase is now fading.

Ultimately, nuclear power can only survive if it is competitive with the alternatives. Unless the trend of sharply rising real costs can be reversed, this will not be the case. Financiers are reluctant to finance new nuclear plants unless the costs of any problems could be passed on to electricity consumers because of nuclear power's poor track record. At worst, this will make new nuclear projects impossible to finance. At best, it will make the cost of borrowing high, pushing the cost of nuclear power even higher.

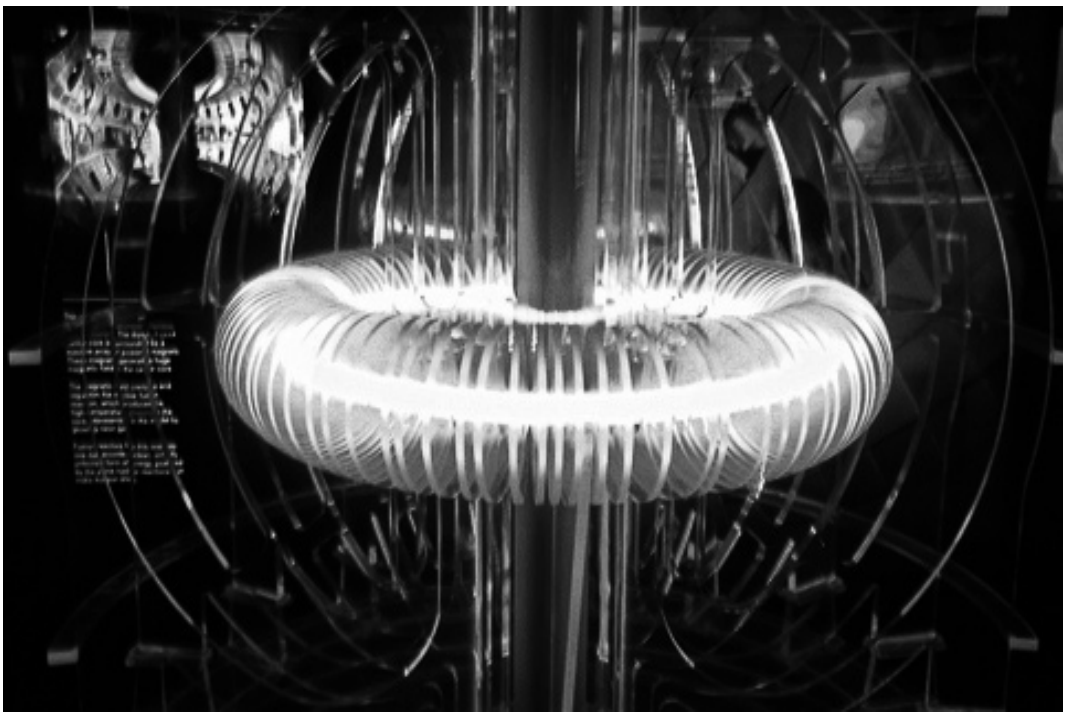
Steve Thomas is professor of energy studies at the University of Greenwich, in London.

Nuclear fusion: an answer to China's energy problems?

12 February , 2013

Olivia Boyd

China could lead the way to a clean and boundless energy supply – if it can ever be made to work. Scientist Steven Cowley talks to chinadialogue.



A nuclear fusion display in the Houston Museum of Natural Science. Fusion could one day meet 25% of the world's energy needs, says Steven Cowley. (Image by kpfellows)

The global nuclear sector has been through something of an apocalyptic patch since the disaster at Fukushima – from power station shutdowns in Japan and Germany to waste-plan chaos in the UK to doubts about China's ability to showcase new reactor designs.

But not everything is grinding to a halt. Research into nuclear fusion, as opposed to the atom-splitting fission technology which powers our conventional nuclear power stations, maintains

momentum. While sceptics joke that a breakthrough for the long-awaited miracle technology is always 30 years away, advocates argue we are inching closer to a clean and almost boundless energy source.

Fusion essentially creates the sun's reactions on earth, using temperatures of 200 million degrees Celsius to get atoms derived from seawater to fuse together, releasing huge amounts of energy in the process. Britain, currently home to the only machine in the world that can actually do this (though it doesn't produce electricity), is stepping up collaboration with one partner in particular: China.

Steven Cowley, director of the Culham Centre for Fusion Energy and chief executive of the UK Atomic Energy Authority, is Britain's leading fusion scientist. He recently completed a tour of China, visiting Chengdu and Hefei – the country's two centres of nuclear fusion research – and holding talks with Chinese counterparts about building a closer partnership. Possible moves include bringing Chinese scientists to work on fusion experiments in the UK. Cowley even looks forward to a future with "Anglo-Chinese fusion reactors".

With his physics-teacher enthusiasm ("I don't have to wake up in the morning and say will this be fun today? It's fun every day.") Cowley is a good front man for the cause. He shrugs off a common line of attack from sceptics that 50 years of trying shows fusion is a dead-end path. "I'm a technical person. I look at the technical things and ask why isn't it working now and what would we need to do to make it work in the future? I don't look at the history of the project and say it's taken us 50 years to get here. It took us 3,000 years to get flight."

Nuclear fusion the "only option" for China

Cosying up to China could prove a deft move. From the US to South Korea, countries around the world are investing in fusion, but China in particular is throwing resources at the problem. Every year, it brings hundreds of new PhD students into the ranks of fusion scientists, and is seen as the best bet to house the world's first electricity-producing reactor.

"It's a stark thing for China," says Cowley. "There aren't really any options to power an economy of that size into the second half of the century, except burning vast quantities of fossil fuels, which we all know will not be good for the world."

Conventional nuclear power is limited by the fact the world's uranium stocks may run out in a couple of hundred years. Fusion on the other hand gets its fuels, deuterium and lithium, from seawater – not only in plentiful supply but easily accessed, a definite bonus for an increasingly energy-insecure China. Moreover, fusion produces no significant waste. Against the background of a global struggle to dispose of toxic waste piles, this is a weighty advantage.

"For an economy the size of China's, especially the size it will be in three decades, fusion is

really the only thing I think you can slip in without producing a long-term legacy of what you've done, whether that's massive CO2 build up, or a lot of nuclear waste to store," says Cowley.

China to leapfrog Europe?

Today, the world has only one operational fusion experiment capable of producing fusion energy: the Joint European Torus, or JET, in England. That won't be the case for long. A multinational effort to build a demonstration fusion reactor in the south of France, the ITER project – though currently a US$19 billion hole in the ground – is expected to start experiments in the mid 2020s. Its backers hope it will be the first fusion experiment to produce more power than it consumes.

In the longer term, the focus is likely to move eastward. China and South Korea, both partners in ITER, have plans to press ahead with their own demonstration projects immediately after completing the European scheme. Having footed the lion's share of the bill for ITER – 45% of the cost as against China's 9% – Europe could find itself left behind. But does it matter who succeeds first?

Cowley is not convinced it does. "Fusion is the perfect way to make energy, except for one thing – it's very hard to do. So let's just get it going and get it on the road," he says. "If China solves the fusion problem and is the first country to produce fusion power stations and these solve the problem of China's emissions, that's a big step. That would help us all."

This kind of camaraderie could dissipate, however, if fusion were to move out of the bounds of a relatively narrow scientific community and into a multi-trillion dollar industry. That's why Europe must keep pushing ahead, says Cowley. "The world energy market is at US$6-7 trillion a year. If you have a method to supply 25% of it, talk about a business! So it's really worth thinking now how you're going to make sure Europe is a player when fusion is a part of the economy."

China's energy needs

Such hopes and fears rest on the assumption that fusion will actually happen at scale. This is far from certain. The question is not whether creating fusion reactions on earth is possible (that's been clear since JET produced the equivalent of 16 windmills' worth of power in 1997) but whether the reactions can be sustained, produce more energy than they consume, and at low enough prices to compete with other power sources. Other critical questions remain unanswered – like what material reactor walls should be made out of so they don't have to be replaced every couple of years.

Progress is complicated by the international nature of the endeavour. At ITER, the need to accommodate the wishes of six countries plus the European Union has created inefficiencies. The vacuum vessel, a component of the reactor, is being part built in Korea, part built in Europe, for instance, because both want a role in production. Delays and lengthy design reviews have seen the estimated cost of the project triple since 2006 and the timetable slip by four years. Many argue the world

would be better off ploughing the funds into alternatives.

China is of course exploring other avenues, including Pebble Bed Module Reactors, another nuclear technology long hailed as the perfect energy source, and thorium – an effort being led by the son of former president Jiang Zemin with a start-up budget of US$350 million and 140 researchers. Outside of the nuclear sphere, shale gas has the potential to transform the domestic energy market.

"China has lots of cash and lots of educated people and I don't think they're going to leave any stone unturned in the search for a long-term stable fuel supply," says Cowley. "Because otherwise, Chinese growth will come to a shuddering halt, and similarly everywhere else."

Olivia Boyd is deputy editor at chinadialogue

Drought and earthquakes pose "enormous risk" to China's nuclear plans

27 February , 2013

Wang Yi'nan

China's nuclear industry is shifting inland, away from the crowded coast. It's a risky move, argues Wang Yi'nan

Before the Fukushima disaster, China had plans for more than 20 inland nuclear power plants (Image by wikipedia)

When the Fukushima nuclear disaster struck, China was building new nuclear power capacity at a rate unprecedented in world history: 40% of all reactors planned or under construction were in China. Targets for installed nuclear generation capacity by 2020 were raised repeatedly – from 40 gigawatts in 2007 to 80 gigawatts in 2010.

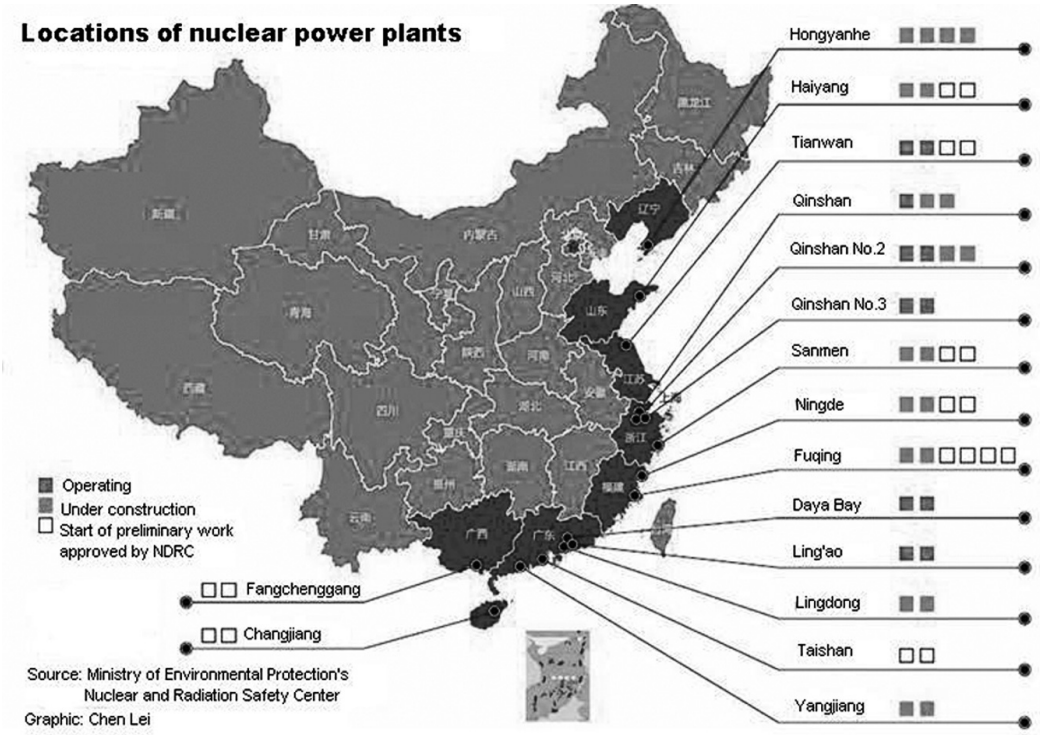
Preparations were also under way for more than 20 inland nuclear power plants. The 41-plus gigawatts of capacity already completed or under construction lies along China's seaboard. Space is running out.

But Fukushima sent shockwaves through the nuclear industry. In China, focus shifted from the speed and scale of expansion to questions of safety and quality. The government placed a moratorium on approvals for new nuclear plants, which lasted for more than a year, a period during which debate on what to do raged – over safety, scale of expansion, technology, site locations and, most crucially, whether or not the process of considering applications to build new inland nuclear power plants should be restarted.

China's nuclear moratorium may have been lifted, but those arguments continue today.

Earthquake risk and water shortages

Advocates of inland nuclear development argue that there are no technological differences between building a nuclear power plant on the coast or inland – that it is simply tougher to choose the right location. The EU and US have built plenty of nuclear power plants away from the coast. In France, 14 of 19 nuclear power plants are in the country's interior.



If China is to hit its original targets for 2020, the argument goes, its nuclear industry too must move inland. And it is making moves to do so: apart from China's remoter regions of Xinjiang, Tibet, Qinghai, Ningxia, Inner Mongolia, Shanxi and Yunnan, all provinces – including the most densely populated – have nuclear power projects under way.

But China's realities warn against inland nuclear development.

Figures from the China Earthquake Administration's Institute of Geology show that, since 1900, China has been hit by almost 800 earthquakes of magnitude six or above, causing destruction in all regions except Guizhou, Zhejiang and Hong Kong. Despite having only 7% of the world's landmass, China – where three tectonic plates meet – gets more than a third of all strong continental earthquakes.

Moreover, China's per-head freshwater resources are only one quarter of the global average. Inland nuclear power plants require a failsafe, 100% reliable and never-ending supply of water for cooling. Even if a reactor stops operating it still requires water to carry off heat. If the water dries up, we could see a Fukushima-style disaster, with terrible consequences: radioactive pollutants released into nearby rivers and lakes, affecting the safety of water on which hundreds of millions rely.

In June 2011, Reuters covered a report by European and US scientists on the vulnerabilities of nuclear and thermal power to climate change. According to the report, "under climate change, a lack of water for cooling is severely restricting generating capacity at nuclear power plants in the EU and US. In the summer seasons of 2003 to 2009, many inland nuclear power plants were forced to shut down due to a lack of cooling water."

The authors predicted that "due to a lack of water for cooling, between 2030 and 2060 nuclear and thermal generating capacity will drop 4-16% in the US, and 6-19% in the EU," and went on to stress that "opting to build nuclear and other thermal power plants by the sea is an effective and important strategy to cope with climate change."

China is densely populated and prone to both drought and earthquakes, making the development of inland nuclear power inadvisable. It has also long sought to emulate the EU and US, regions which have now realised the outlook for inland nuclear power is bleak. China should not make the same mistake.

Insecure uranium supplies

China also faces a huge shortage of uranium.

The 41 reactors already operating or under construction will see China rely on imports for 85% of its uranium – far above the 50% internationally recognised as a "warning line". Security of uranium supply is an even graver problem than that of oil supply.

In 2008, some 43,760 tonnes of uranium were mined worldwide. The world's 440 nuclear reactors use 65,500 tonnes of uranium annually (with the US, France, Japan, Russia, Germany and Korea accounting for 48.203 tonnes of this). Moreover, importing uranium is much harder than importing oil.

Before Fukushima, China had become an all-important market for the nuclear industry, and a proving ground for new reactor technology. But in terms of reactor-years, China has only 1% of the world's experience in running nuclear power plants. It must not blindly expand nuclear power.

Nuclear's potential to inflict harm on humanity means risk assessments must not look only at the probability of an accident, but more importantly the consequences. We cannot relax simply because the Nth generation technology has cut the risk of an accident to a very low level, because if that accident does happen, the consequences would be disastrous.

China has half the landmass of the former Soviet Union, but 10 times its population. An inland nuclear accident would be a disaster. The damage would be far beyond comparison with any coal-mine collapse or high-speed train derailment. Long-lasting radioactive pollution and public panic would threaten political stability, economic prosperity and the environment.

Nuclear power is not yet controlled, not yet tamed, not yet safe, and China cannot take the enormous risks of building nuclear power plants inland.

Safety standards still not being met

Moreover, there are still limits to China's ability to run nuclear power plants.

During the State Council's safety audit of 41 reactors in operation or under construction, some plants and fuel recycling facilities were found not to meet new safety standards for flood and earthquake resilience, while some plants did not have procedures for preventing or mitigating major accidents. Others had not evaluated tsunami risks and responses.

The Taishan Nuclear Power Plant has no guidelines for managing a major accident, for example. The Taishan No.2 reactor, Ling'Ao and Tianwan Nuclear Power Plants have procedures only for certain types of major accident.

Nuclear engineering is a major undertaking. Construction capabilities and staff competencies cannot be raised overnight.

China's 10-plus gigawatts of nuclear power capacity today account for just 1% of the country's total electricity output. China has better and more realistic options to relieve energy shortages and cut emissions. These include more efficient use of resources including coal; the promotion of energy-saving techniques such as the use of energy performance contracting(where energy savings from new buildings systems pay for the cost of a building renewal project) a tool which, if used in China as it is in the EU,

would save the equivalent of several Three Gorges Dams' worth of energy.

Comprehensive clean-energy solutions, incorporating solar power, wind power, bioenergy, pumped-storage hydropower and natural gas peak power plants, can provide China with the clean, reliable and efficient energy it needs for a new type of industrialisation.

China's development must be built on genuinely safe, reliable, clean and efficient energy. Blindly opting for nuclear power in response to energy shortages and emissions pressures is to drink from a poisoned chalice.

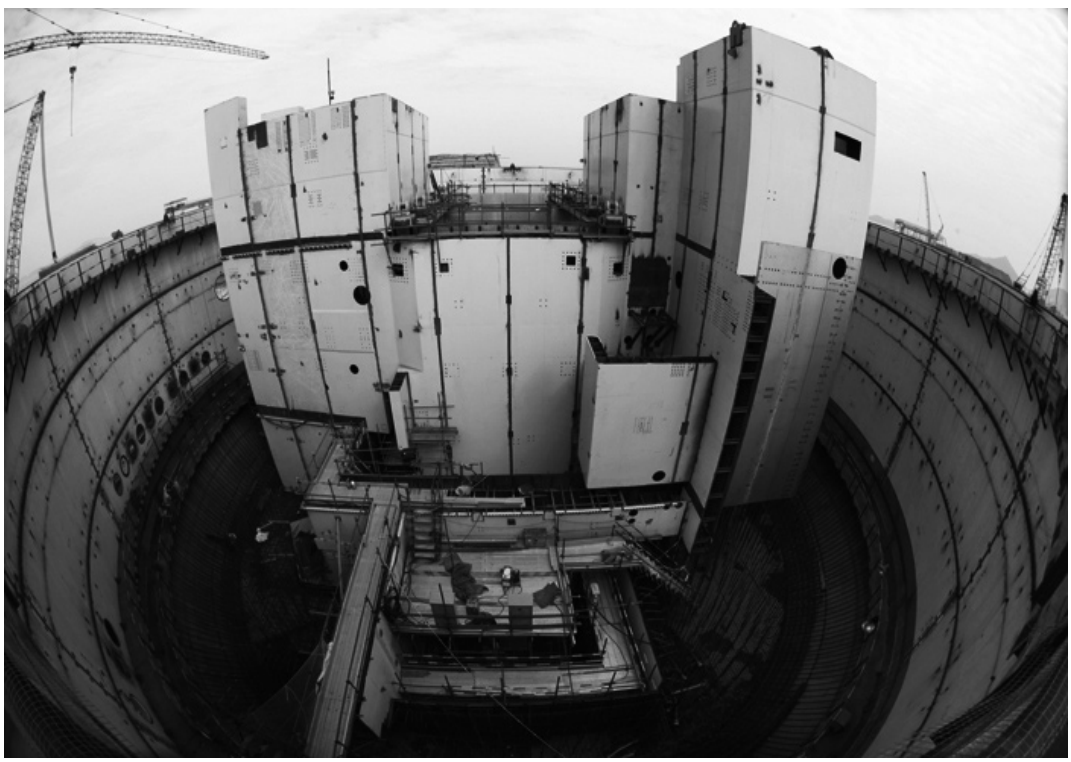
Wang Yi'nan is a researcher at China's State Council Development Research Centre.

Chinese nuclear disaster "highly probable" by 2030

9 March, 2013

He Zuoxiu

China is heading for a nuclear accident if it continues with current construction plans, says former state nuclear physicist and prominent critic He Zuoxiu.



The rush to build a world-leading nuclear industry would make an accident more likely, says a former state nuclear expert (Image by hedianzhan.baike.com)

Some members of the nuclear power industry rely too much on theoretical calculations, when only experience can provide real accuracy.

The lifetime of nuclear reactors is calculated in "reactor-years". One reactor year means one reactor operating for one year. The world's 443 nuclear power plants have been running for a total of 14,767 reactor-years, during which time there have been 23 accidents involving a reactor core melting. That's one major accident every 624 reactor years.

But according to the design requirements, an accident of that scale should only happen once every 20,000 reactor years. The actual incidence is 32 times higher than the theory allows.

Some argue this criticism is unfair. After all, 17 of those 23 accidents were caused by human error – something hard to account for in calculations. But human error is impossible to eliminate, and cannot be ignored when making major policy decisions.

Even if we set aside the accidents attributed to human error, technical failings have caused core melting once every 2,461 reactor-years. That's still more than eight times the theoretical calculation.

Lessons from the US, Russia and Japan

The US and former Soviet Union had been operating nuclear power for 267 and 162 reactor-years respectively before a major accident occurred. Japan managed to get to 1,442 reactor-years before Fukushima struck.

At the time of the Three Mile Island accident in 1979, the US had 52 nuclear power stations, which had been operating for 267 reactor years, or an average of 5.1 years per reactor. At the time of the Chernobyl disaster in 1986, the Soviet Union's power plants had been running for an average of just 3.5 reactor years.

Why did the US and Soviet Union experience accidents so quickly? First, the US rapidly built more than 50 nuclear power stations, and the larger the sample the larger the chances of an incident. Second, as the first country to experience a major nuclear accident, the US was operating with little experience. In the Soviet Union, another factor was also at play – major design failings in the technology used.

After these events, improvements in nuclear safety were made worldwide. The biggest advances came in the US. First, the rate of expansion was slowed, with a complete halt to new plants during president Carter's administration. Second, technological improvements greatly reduced the chances of an accident. Third, there was a strong focus on developing new types of nuclear power stations. Fourth, the US continued actively to export nuclear technology, allowing it to observe nuclear safety at a safe distance. Fifth, safety management was strengthened.

Thanks to these important measures, there has been no major accident in either the US or the former Soviet Union since 1986.

But other countries have suffered.

Despite drawing on the lessons of the past and enjoying a late start, Japan was still hit by a major accident after 1,442 reactor years.

The only country with more than 50 nuclear power plants not to have suffered a major accident is

France, with 58 nuclear power stations and a total of 1,519 reactor-years.

France has a lot of advantages in the nuclear field – a long history of nuclear technology and domestic research, good nuclear fuel reprocessing facilities and comprehensive policies on nuclear development. Moreover, it isn't prone to earthquakes, has a moderate climate and is expected to be less threatened by global warming.

A number of people have predicted that France could be vulnerable to a terrorist attack on its nuclear facilities in the near future, with the potential to cause a major disaster. After Fukushima, security was stepped up at the country's nuclear power stations, but it's too early to say if this will ensure another six decades of safe operation.

How long can China's nuclear industry stay "safe"?

China already has 15 nuclear power stations, and looks set to have 41 by 2015. These have been built using various different models, with technology imported from France, Russia, the US and Canada. There's also the Taishan plant, which uses an adapted Chinese-developed nuclear submarine reactor. Mostly, China's existing nuclear power stations use second-generation technology.

China is projected to have 71 nuclear power stations by 2020. If we use the figure of 4,922 reactor-years as explained above, then China will "most probably" suffer a major nuclear accident within the next 69 years.

Chinese nuclear technology can be regarded as approaching global levels, with similar design, safety and operational standards. But to reduce costs, Chinese designs often cut back on safety. In the past, earthquake-resilience was lower than in Japan, for example. China also has much less experience of this sector than Japan.Qian Shaojun, a member of the Chinese Academy of Engineering, has repeatedly said that nuclear safety relies on experience – you cannot claim something is safe until it has been operating for a certain number of reactor years. Japan has at least 10 times as many reactor-years of experience as China.

China has a similar likelihood of natural disasters to Japan, but the quality of its nuclear staff lags behind.

It's not that Chinese nuclear power technicians fall short in design ability. But they have less design and management experience than their Japanese counterparts.

If we refer to the data from Japan's experiences, China will "most probably" suffer a nuclear disaster around 2050.

But if China sticks to plans to build another 30 third-generation power stations between 2015 and 2020, the risks rocket. No AP1000 reactors – one of the key third-generation designs – have yet been

built anywhere in the world, meaning there are no reactor-years of experience. Only the figures of 267 reactor-years from Three Mile Island's 267 reactor years and Chernobyl's 162 reactor-years can be used as reference. Even if we take the larger of those numbers, that brings the "most probable" period for a nuclear accident in China forward to between 2020 and 2030.

Some may say that "theoretically" third-generation reactors are safer than their second-generation equivalents. In fact, these 30 nuclear power plants will use reactors that have not been operationally tested. They are all being built inland and all face problems with water supply. Several third-generation plants, including Pengze in Jiangxi and Taohuajiang in Hunan, each with six reactors, cheated during the environmental impact assessment process, with no action taken by the National Nuclear Safety Administration.

For safety's sake, it would be better to stop at 41 reactors, a number due to be reached in 2015.

The Great Leap Forward mentality

Why did the US and former Soviet Union see nuclear accidents so soon? Apart from a lack of experience and immature technology, another factor was the Cold War mentality – both were fighting to be the world's number one nuclear power.

Similar attitudes exist in China today. Nuclear decision-makers aim to build up to 500 nuclear power stations by 2050, exceeding the current global total of 443, and allowing the country to claim the world's number one spot.

This is nothing but Great Leap Forward thinking. If these attitudes continue, we are likely to see "most probable" become "actual".

He Zuoxiu is a member of the Chinese Academy of Sciences and researcher at the CAS Institute of Theoretical Physics.

Land-grabbing turns India's nuclear fight into a struggle for democracy

13 November , 2012

Monamie Bhadra

India's anti-nuclear protests demonstrate the challenge of reforming energy supply while most citizens still depend on land and water for their livelihoods.

Villagers have formed human chains in the sea to protest against the Koodankulam nuclear power project. (Image from DiaNauke.org)

When I jumped off the cycle rickshaw near the small coastal village of Haripur, in the Indian state of West Bengal in January 2010, I did not expect to stand in the middle of a dappled canopy of banana, mango and coconut trees, or see the great expanse of young crops of gourds, or smell the acrid cooking fires wafting from neatly thatched houses. I did not expect to hear the constant calling and rustling of birds, the lowing of cows, the whoosh of rice being sifted from stones or the gurgle of water jugs being filled. I was expecting a "barren wasteland," as described by a senior Indian government official, where "most of the land [has] a high saline content and cannot be used for agriculture."

I was searching for Anuradha Talwar, the woman coordinating the opposition to the West Bengal government's attempted land grab to accommodate a 10,000-megawatt nuclear reactor complex in Haripur. Before it was eventually abandoned, this nuclear project was slated to be the largest on the sub-continent, with the potential to evict up to 200,000 farmers and fishermen from a six-kilometre radius.

I found Talwar sitting on a tiled veranda, directing a small army of young women tallying the results of a demographic survey of the villagers of Haripur. Talwar was determined to count every man, woman and child who might lose their homes and livelihoods to nuclear energy. She was not what I expected either. Instead of the lean, young, fiery activist I had imagined, she could have been someone's kindly grandmother – middle-aged, with a plump face, oversized glasses and thinning grey hair.

Talwar, whose surname means "sword" in Bengali, leads the West Bengal Agricultural Workers Union, also known by its Bengali acronym PBKMS, and has spent decades fighting for human rights and sustainable development in sectors as diverse as healthcare, gender equality, labour practices, disaster relief, malnutrition and starvation. Her relationship with the Haripur nuclear scheme is longstanding too: in 2006, PBKMS mobilised 6,000 villagers to create a bamboo barricade to prevent scientists, engineers and police from entering the village to perform soil tests for the Nuclear Power Corporation of India. Their concerns centred on the potential human displacement and the lack of transparency over its consequences.

To Talwar and to the villagers in Haripur, nuclear power is nothing special – it is simply another manifestation of government policies contributing to a list of larger evils. Facing the spectre of the massive nuclear plant, they were not impressed by the prospects of developing a carbon-free energy system that would mitigate climate change, nor drawn into the debate over the risks and uncertainties of generating nuclear energy. For them, what mattered most was that the natural resources their livelihoods and culture depend on – land and access to coastal fishing grounds – were in jeopardy.

Civil disobedience across India

Around India, communities like Haripur are affected by the beginnings of nuclear power infrastructure. They, too, are taking surveys, handing out pamphlets, forming committees, voicing grievances to local papers, staging protests and stymieing government officials. Although the Haripur project has been abandoned with a change in political power, other villages are still mired in protests.

A dramatic case in point is the rising furore over the Koodankulam nuclear plant in the state of Tamil Nadu, at India's southern tip, a project which began in 1989 and is now nearing completion. In the wake of Fukushima in 2011, the People's Movement Against Nuclear Energy (PMANE) escalated

its non-violent protest here after nuclear officials ran an emergency evacuation drill that called for villagers to "to cover their nose and mouth and run for their life".

One of the main protesting villages is currently held under marshal law; the leader of PMANE and followers have been charged with sedition and war against the state; the police have arrested hundreds of villagers engaged in civil disobedience such as fasting, demonstrating and forming barricades; and the police have revoked ration cards for food and cooking oil. The Department of Atomic Energy even sent psychiatrists from the National Institute of Mental Health and Neurosciences in Bangalore to convince protesters that nuclear energy was safe.

Earlier this year, India's prime minister Manmohan Singh invoked the trope of the foreign hand, stating that colonising, transnational NGOs had incited "scientifically innocent" villagers (a term used repeatedly by technocrats, according to one environmental-impact assessment expert) into misguided action, as reported in Science Magazine. In a symbolic act, protesters collected and surrendered 23,000 voter identification cards from nine villages to the district. Currently, the leaders of PMANE are being protected in one of the villages to evade arrest. But these acts have not deterred the protesters, who have emulated Gandhi's practice of satyagraha (insistence on truth) and have taken to the sea, forming a human chain in the water around the nuclear power plant. It remains to be seen whether the ongoing protest will lead to a change in national nuclear energy policy.

Confronting historical legacies

These anti-nuclear protests, far from being isolated cases, are part of longer-term political trends, and very much shaped by historical events. In trying to build nuclear power plants in West Bengal, for instance, the state has been confronted by a number of legacies: the history of local Communist rule; a cultural memory of violent resistance to British colonialism; a movement against Special Economic Zones (SEZs) in response to neo-liberal economic policies in the 1990s; and a deep suspicion of the nuclear establishment.

The Communist Party of India-Marxist (CPI-M), a pro-peasant party that favours rural development over industrialisation, governed West Bengal from 1977 to 2011. But a political sea change in 2006 ushered in policies of economic liberalisation. Attempts to woo a Russian nuclear corporation were seen as a betrayal by the then-Communist government's rural, agrarian voting base. In that tumultuous year, hundreds of people were killed in the villages of Nandigram and Singur, just kilometres from Haripur, as villagers tried to stave off government land grabs for industrial hubs – via the 1984 colonial Land Acquisitions Act – thus sparking the national anti-Special Economic Zone movement.

The fight against building the nuclear power plant in the neighboring village of Haripur was of the same piece. In Nandigram and Singur, community activism was spearheaded by Anuradha Talwar's organisation, PBKMS. The group pursued an independent fact-finding mission to investigate police

atrocities, violence committed by villagers and Communist party infighting.

While the anti-SEZ violence was not directly related to anti-nuclear protests, it nonetheless helps to illustrate how local political and social dynamics, rather than technological issues alone, have an important influence on whether and how the government's nuclear energy ambitions will be implemented.

Nuclear fight: a struggle for Indian democracy

For Indian citizens, the heart of many of these protests is the acquisition and redistribution of land, and the right to participate in a highly technocratic, expert decision-making arena with non-technical knowledge. Nuclear energy is a crucible for a diverse suite of concerns: the risk and safety issues long promulgated by peace activists comingle with trenchant critiques of land grabs for nuclear power plants, and the destruction of livelihoods. Tribal desires to maintain sovereignty over ancestral lands containing uranium sources and preserve communal identity jostle with the lack of energy access in rural areas and the urgent need for economic development. Expert pronouncements on the safety of nuclear energy clash with growing numbers of citizens becoming proficient in scientific and legal matters pertaining to reactor design and due process.

And, with reports of police brutality, charges of sedition levelled against non-violent protesters, and a refusal by nuclear experts to acknowledge ethical and social concerns, the fight against nuclear energy is increasingly a struggle for Indian democracy.

The unrest over a programme intended to boost India's broad economic fortunes and reduce the nation's contribution to climate change is a cautionary tale of what can go wrong when policies are formulated primarily around technological considerations at the expense of profound concerns related to community well-being, culture and justice. Moreover, it illustrates the kinds of political and social challenges a nation faces as it tries to manoeuvre into a sustainable energy future, when most of its population still depend on natural resources like land and water for their livelihoods.

Monamie Bhadra is a PhD candidate in the Human and Social Dimensions of Science and Technology Program at Arizona State University and a junior fellow of the American Institute of Indian Studies. Her research focuses on the political and cultural dimensions of nuclear energy in India.

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HEINRICH
BÖLL
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Heinrich Böll Stiftung (HBS) is one of six political foundations in Germany. It is associated with the German Green Party, but is legally independent and works in the spirit of intellectual openness.

The organisation has its headquarters in Berlin and receives public funding to carry out civic education in Germany and promote mutual understanding between people and countries. Through 28 offices across the globe, Heinrich Böll Stiftung provides a platform for international dialogue on questions around globalisation and security, environment and social justice, democracy and the role of gender in society.

The organisation is named after the German writer and Nobel Prize winner Heinrich Böll, whose promotion of citizens' participation in politics is the model for the foundation's work.

In China, Heinrich Böll Stiftung works in cooperation with the Chinese Association for NGO Cooperation (CANGO). We jointly carry out projects to strengthen civil society development in China and internationally. We also work with other civil society organisations, governmental departments and academic institutions to provide positive motivations for development and reform in China and for a better understanding between China and Germany.

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