

KUDANKULAM MELTDOWN MELTDOWN MELTDOWN MELTDOWN



The spectre of Fukushima continues to haunt the world, forcing governments in most parts of the globe to rethink their plans to tap this controversial source of energy. But it is in India that the world's worst nuclear accident since Chernobyl has had its most serious fallout, with public protests forcing the authorities to delay the commissioning of the ambitious Kudankulam project by almost a year. Fukushima, however, is just the latest spur for the campaign against the Kudankulam reactors which started in 1987, discovers **LATHA JISHNU** as she travels across the villages of Tirunelveli district in Tamil Nadu and meets the people who have been saying no to nuclear energy for 25 years.

ARNAB PRATIM DUTTA and **ANKUR PALIWAL** study implications of Fukushima and the increasing cost of nuclear energy across the world, and the rise of shale gas as an alternative

A sure way of riling the people around the Kudankulam Nuclear Power Project (KKNPP) is to ask why they launched their opposition to the plant just months before the first of its two reactors was set to go critical. Surely they had seen the twin domes of the country's largest nuclear plant rise slowly from the scrubland close to the sea? The reply can range from a passionate cascade of protest to a more polite but scathing "where were *you* sister, all these years?"

These years have been long, stretching to a quarter century of protest. There have been periods of quiet and quite a few explosions (see 'A 25-year campaign') in a movement that started as anti-war, anti-nuclear weapons protest in 1987 because the trade unionists, left wing activists and intellectuals leading it were convinced that the power plant was merely a conduit for piling up plutonium to make weapons. That belief has taken root among some of the fisherfolk who have been the backbone of the protest for two decades. "Don't ask us what we were doing all these years," says Xavierammal of picturesque Idinthakarai village, a couple of kilometres down the coast from the bright yellow domes of KKNPP. She is a strapping woman of 48 whose fisherman husband died a long while ago, leaving her to bring up her two children on her own by rolling *beedis*.

"From Day One we were against the plant. When I was young I took part in the 1989 rally in Kanyakumari to protect the future of my children. Our elders had warned us about the dangers of nuclear energy. The Chernobyl accident had just taken place and the same people (the Soviet Union) were going to set up a similar project in our midst. We were scared and angry," says Xavier-

ammal who is now on a fast unto death, seeking the scrapping of KKNPP. It would seem a doomed undertaking with the state-owned Nuclear Power Corporation of India Limited (NPCIL), which is setting up KKNPP with Russian expertise and funding, resuming work under heavy police protection.

Contract workers, employees and scientific reinforcements from its other nuclear stations have been bused into the plant for the first time since September last year when the protest by the People's Movement Against Nuclear Energy (PMANE) caused high fission and forced most staff to leave, leaving a skeleton force to oversee maintenance. At the time, KKNPP had about 150 Russians, 800 of its own staff and around 4,000 contract workers. All of them will be back soon.

NPCIL chairperson and managing director S K Jain says the corporation would soon approach the Atomic Energy Regulatory Board (AERB) for permission to load fuel in the first unit. Croatian experts are being flown in to check the equipment and the reactor pressure vessel to see if they are in good condition. There is talk of the first unit of the two 1,000 MWe VVER (light water) reactors going critical in just three months.

Is this the end of the road for the local resistance? Will the 45,000-odd people in the 27 surrounding villages who have been making the headlines for eight months be forced to call off their campaign of fasts and rallies under police pressure? An old warhorse in this campaign, Father Thomas Kocherry, who was earlier head of the National Fishworkers' Forum (NFF), says, "There is a big difference in Kudankulam area. The establishment cannot understand us. Here people are organised and determined. They can't be stopped—unless you kill them."

Kocherry, 74, a congregational priest at

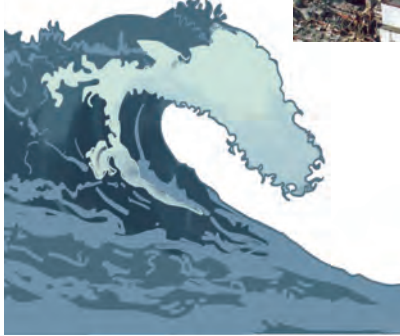


PHOTOGRAPHS: ANRITHARAO STEPHEN

A 25-year campaign

1986

Chernobyl disaster, world's worst nuclear accident



1988

Rajiv Gandhi and Mikhail Gorbachev sign pact on Kudankulam

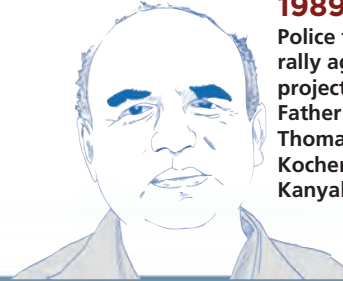
Massive mobilisation in Tirunelveli, Tuticorin districts of fishermen, workers, social & political movements. Rev. Y David in forefront



1987

Soviet Union announces plan to build N-plant in India

Anton Gomez takes lead in building opinion against N-energy



1989

Police fire on rally against project led by Father Thomas Kocherry in Kanyakumari

1998

Russia, India sign supplementary agreement on Kudankulam

NAPM organises workshops against N-power

Manavalakuruchi, some 40 km from the epicentre of the struggle, makes regular trips to Idinthakarai to shore up the spirit of the protestors. He took part in the Save Water, Save Life march across the nation which culminated in Kanyakumari on May 1, 1989. "When it reached Kanyakumari it was an anti-nuclear protest against Kudankulam. Police opened fire and injured seven, including a parish priest," he recalls.

Talk to any fisherman along the Tirunelveli coast and one begins to understand what Kocherry is saying. These are hardy folk used to taking on the administration, the police and the church. Declares Antony Ephraim Joseph, 45, of Perumanal, a small village about 8 km from KKNPP: "We will fight to the end. Let them kill all of us. We have had a tsunami here (2004) and several small tremors recently." Ironically, the tsunami rehab colony abuts the wall of KKNPP!

Loss of livelihood is the most frightening spectre that haunts them. Their traditional fishing grounds, they fear, will be lost once the nuclear plant starts. "Even now guards shout at us. They take away our nets. Soon they will put a 3-km security cordon around the plant. We go fishing at odd hours, at dawn, late at night. What will we do then?" Joseph asks. There is another fear on their horizon: contamination—that they believe is inevitable—of their fishing grounds that will slowly kill marine life and of the air. How do they know this for a fact? Joseph's mate Jesu John Gerald says tartly: "This is the age of computer and TV. Thanks to (former

chief minister) Karunanidhi's gift of free TVs we know what's going on."

Fukushima was watched without a break and also the talk shows that accompanied broadcasts of the world's worst nuclear accident after the Chernobyl disaster of 1986. There is plenty to fuel nuclear fears—and it has galvanised the resistance that NPCIL believed had died down. Some ideas are well entrenched. Gerald, who took part in the Kanyakumari rally as a teenager, is also convinced that nuclear energy comes with the added threat of nuclear weapons. "Nuclear energy is a front for nuclear weapons," he declares. That's because in the early days, those who organised anti-nuclear meetings in the area came from socialist and far left parties who rallied the people on an anti-war and anti-weapons plank. Explains T S S Mani, a former member of CPI-ML, who was one of the earliest to join the campaign: "The initial mobilisation of the fishermen was by Anton Gomez who was head of the Tamil Nadu Fish Workers' Union. There was huge mobilisation of palmyra workers and other labourers in Tirunelveli and Tuticorin districts and in Kanyakumari."

Above, all there was Rev. Y David, a Protestant pastor who led the Social Equality Movement and rallied the downtrodden communities. The mainstream CPM and CPI were strongly in favour of the project (it was by the Soviet Union) and shored up the Congress project. The old stalwarts are now scattered across Tamil Nadu but are still lending support to the campaign

in different ways. The core of the protest comes from the close bonding of the fisherfolk through caste (Paravas) and religion (Roman Catholic).

Martin, a fiery character from Idinthakarai, has just sold the day's catch of sardines worth ₹27,000. In the evening, he will deposit ₹2,700 (10 per cent) with the struggle committee since it is Thursday when the weekly donation is made. Others like Xavierammal contribute ₹200 a month. This is apart from the contribution fisherfolk make to the village community for maintenance that includes upkeep of the parish house and other community facilities. The fisherfolk have done it for centuries, a practice that is unique to the Tamil Nadu coast, and one that keeps the people and church together.

It is not surprising, therefore, that nearby villages have evaded the tight police cordon around Idinthakarai, and have come by the coast to make a contribution of ₹3 lakh on one day. The community kitchen in the struggle hub is feeding 5,000 people three times daily while they guard the 15 activists, led by PMANE convenor S P Udayakumar and its organising genius M Pushparayan, who are on a fast unto death. Foreign money or church money is clearly not needed. Community collections have crossed ₹30 lakh since the fasts began in August last year, and there is still a substantial amount in the kitty after meeting all expenses of the movement, says a PMANE committee member.

"This is truly a people's struggle and not a Church-funded movement,"

2001

Heads of NPCIL and Atomstroyexport sign final agreement

People's movement comes up with comprehensive agenda

2002

Concrete poured for project

S P Udayakumar returns from US; takes over leadership along with M Pushparayan

**2003-06**

Fishermen and farmers protest; water for plant is an issue

2007

Public hearing for KKNPP units 3&4

Kudankulam village joins protest; huge upsurge in campaign

2011

Fukushima disaster stuns coastal villages

Idinthakarai becomes hub; hunger strikes begin. Tamil Nadu says KKNPP cannot start till people's fears are allayed

**2008-10**

KKNPP delayed by hold-up in Russian supplies

Link up with similar protests in Jaitapur

2012

Jayalalithaa gives green signal to KKNPP

Idinthakarai under siege; large numbers arrested in Kudankulam

NAPM - National Alliance of People's Movement; KKNPP - Kudankulam Nuclear Power Project; NPCIL - Nuclear Power Corporation of India Ltd

Even experts were shaken by Fukushima. So people's concerns are genuine

—S A Bhardwaj, director-technical, NPCIL

Xavierammal of Idinthakarai took part in the 1989 anti-nuclear rally in Kanyakumari

Udayakumar, himself a Hindu Nadar, tells *Down To Earth* just before the crackdown started. There was a time when we did not have ₹1,000 to mobilise people for a strike. "Now it's unbelievable. Not even in my wildest dreams did I think it would become such a mass movement," says the PMANE leader who teaches peace and conflict studies in institutions across the world. So how did this happen? Fukushima, of course, and the hot run at KKNPP, he says. While the overwhelming fear is about loss of resources and livelihood, the hot run conducted by NPCIL made the threat to

life very real for the people, he explains.

The hot run has become folklore. Description of the terror that it created varies from village to village. People speak of a frightening noise and smoke in the sky. But it is an event that did take place and one that NPCIL and the Department of Atomic Energy (DAE) rue—because it was conducted without informing the people. The realisation that the nuclear establishment has been indifferent if not arrogant about people's concerns comes in the belated admissions made by senior officials. To start with, the fact that nothing was

done to allay fears post-Fukushima. Admits S A Bhardwaj, director-technical, NPCIL, in a March 10 press conference: "Even nuclear experts were shaken by the Fukushima disaster. So if the general public or locals are asking questions, their concerns are genuine and we have to address them." It is an admission that comes too late; and if it is a message of apology it has not reached the agitating villages. Fukushima, starting with initial dismissal of the seriousness of the disaster by top officials of the nuclear establishment in India, appears to be a nuclear accident that they prefer



Father Jeyakumar supports the 'just cause' of his flock; (Right) S P Udayakumar leads the protest movement

to gloss over. At the September 7 annual general meeting of NPCIL, the chairperson referred to the world's second worst disaster in the following terms: "During March 2011, a significant event of fuel damage at an overseas plant was reported as an aftermath of a natural event of extreme nature." The F word was not mentioned at all.

But NPCIL has been forced to acknowledge the consequences of its hot run at the first unit in August. A hot run entails heating the primary coolant water to the reactor's operating temperature of 280 degrees and above but operating the systems with dummy fuel. Huge amounts of steam are injected into the system in a flushing out operation and let out when the pressure increases. Swapnesh Kumar Malhotra, head of the public awareness division of DAE, admitted months later in an interview published online that they had goofed. "When these valves are opened there is a loud, shrieking sound. Imagine a thousand pressure cookers blowing their whistles at the same time. Anybody would be petrified. We did not communicate this to the locals ..."

Sometimes, those screaming valves were opened during the night, too, startling villagers out of their sleep. Worst of all when people came to meet KKNPP officials, they were not allowed to meet them. This arrogance was probably rooted in NPCIL's desperation to get the 2,000 MWe project running before the end of the 11th Plan ending March 2012 to improve its dismal record: half a century after it began its programme the country has a total nuclear generating

capacity of just 4,780 MWe. KKNPP would have increased this by nearly 50 per cent. Besides, these would have been NPCIL's first large reactors. Its stable of 20 plants consists primarily of 220 MWe units (home grown, though) with a couple 540 MWe plants.

But this haste has been NPCIL's undoing. Apart from the hot run, there was the announcement of an even more frightening event: a mock drill for nearby residents as an emergency preparedness evacuation exercise. People were asked to cover their noses and collect at a certain point for evacuation and collect iodine tablets and stay overnight at a camp 20 km away. That was the last straw; people were convinced that they would have to leave their homes permanently, says Father F Jeyakumar, parish priest of Idinthakarai, where the lovely 105-year-old Lady of Lourdes church is the focal point of the struggle. Jeyakumar was himself on a 12-day hunger strike in August because he believes the livelihood issue is "a just cause". So is the Church behind the PMANE campaign, nurturing it and funding it? Jeyakumar laughs. "We have to be with the people or they will leave us. My predecessor was roughed up by the parishioners because he did not listen to them. He had to leave before his term ended."

And there is a cautionary monument just opposite the Lourdes Church: a small Ganesha temple built by the 25 families who broke away from church and became Hindus because they were unhappy with the church. Reports have it that Bishop Yvon Ambroise of Tuticorin was forced to come down to

the determined Idinthakarai parish of his diocese and back the anti-nuclear campaign after a delegation met him and made their displeasure over the Church's neutral stand very clear. He came for a day, sat with the people and offered them a glass of juice to break fast.

But it is not a protest of Catholics alone, advocate S Sivasubramanian of Kudankulam village, just 2.3 km from the plant, who is a leader of PMANE, told *Down To Earth*. That was three days before he was arrested by the police, one of the 185 picked on the morning of March 19. "People in Kudankulam, mostly Hindus and some Muslims, joined the protest in 2007 after NPCIL's promise to turn the area into mini-Singapore failed to materialise," he says. The disillusionment was particularly bitter because few people had got jobs.

As the protest heads for a showdown with the state, PMANE is emphasising the lack of safety at KKNPP (see next story 'Unanswered questions'). There is little political support for the anti-nuclear movement barring from fringe parties like Vaiko's MDMK and Ramadoss's PMK. Let down by the chief minister, who they assumed would stand by them not least because of their stridently anti-Karunanidhi stance, Idinthakarai is hoping for a political miracle to end their agony. That appears unlikely with the Centre and the AIADMK on the same side of the nuclear divide.

Read 'Chronicles of Kudankulam' and interview with S P Udayakumar and M Pushparayan on www.downtoearth.org.in



UNANSWERED QUESTIONS

The report of the Central expert group has responded to concerns but activists say it has sidestepped environmental issues

Reports have been piling up on the safety and environmental aspects of India's most ambitious nuclear project, the 2,000 MWe Kudankulam Nuclear Power Project (KKNPP), in the wake of the protests that lead to a stoppage of work on the two Russian light water reactors. First, there was the finding of the 15-member A E Muthunayagam Committee, set up by the Centre, which submitted its report in December 2011 and then the report of the M R Srinivasan committee, a Tamil Nadu initiative that its chief minister J Jayalalithaa said was necessary to allay "people's fears". While the first report has been put out by the Nuclear Power Corporation of India Ltd (NPCIL), the report commissioned by Tamil Nadu is not yet in the public domain.

According to interviews given by the former chairperson of Atomic Energy Commission, there is no shadow of Fukushima over Kudankulam. Srinivasan says he looked at issues like "deficiencies in safety at Fukushima reactor, geological factors (earthquakes, tsunami, etc) at Koodankulam" and came to the conclusion that "a Fukushima

mishap will not happen here". In sum, it appears to be an endorsement of the Muthunayagam report since Srinivasan's four-member team concluded that the expert group "has answered all 44 questions raised by protestors".

M Pushparayan, leader of the People's Movement Against Nuclear Energy (PMANE), says this is expected since Srinivasan headed the site selection committee and picked the location for KKNPP in 1988. PMANE's presentation on geographical vulnerability was based on 47 journal articles and seminar presentations, and raised issues such as volcanic eruption near the reactor, Karst formation during the past three years at three locations within 25 km of KKNPP and the potential for tsunami from slumps and

Fisherfolk's main concern is the threat to fish and prawns from heating and contamination of sea water by reactors' effluents

faults in and near the Gulf of Mannar apart from shoreline instability. It also pointed to the possibility of dry intake due to sea withdrawal observed in southern Tamil Nadu coast since 2004.

In spite of the large number of studies, "NPCIL has unfortunately not looked into any of these before or during the construction of the two 1,000 MWe reactors," says PMANE's response to the Expert Group (EG) report. According to the latter, however, none of the issues is serious. Referring to the main worry of the fisherfolk about contamination of natural resources, EG notes that the project draws sea water from intake dykes for condenser cooling. To stop the fish from getting trapped, KKNPP uses "a unique fish protection system" that stops fish from entering the bays and returns them safely into the sea.

The other issue is the rise in sea water temperature and its implication for marine life, including fish and prawns. The approximate quantity of coolant water that will be released is 70 tonnes per day with a maximum delta T of 7 degree Celsius. "In fact the mixing will be very fast due to wave action and other water currents." As a result warm water from condenser will be mixed instantaneously and lead to "a possible reduction of ambient sea water temperature".

But PMANE says the dangers could be immense when all six 1,000 MWe reactors begin operations. The discharge of 7.2 billion litres of hot water into the sea every day by each reactor could well destroy the fish. Besides, there is the question of the chemical and radiological composition of effluents. "The EG provides data which are gross underestimations and contradictory with the information provided by NEERI and NPCIL officials earlier," it notes.

Another charge it makes is that the KKNPP reactors 1 and 2 violate the Atomic Energy Regulatory Board instructions of 1998 that require two sources of water to ensure adequate water supply in the event of a cooling loss accident, which it terms "the largest potential hazards of reactors". Citing independent studies, the collective says the dependence on desalinated water alone is a safety hazard. EG says the storage capacity in tanks is adequate for the reactor for 10 days in case of power failure even though the regulatory requirement is seven days. The debate continues.

FUKUSHIMA'S SHADOW

What the disaster did to nuclear ambitions

A year ago, the triple meltdown at the Daiichi power plant in Fukushima sent a chilling reminder of Chernobyl. No matter how pro-nuclear a country was, Fukushima could not be ignored. The immediate reaction was public protests followed by safety reviews of nuclear plants. Nuclear energy came under a serious threat of being sidetracked, albeit for a short period.

Japan, where nuclear power accounts for a fourth of the total energy production and which planned to increase this share to a half by 2030, altered the future energy roadmap. It now plans to supplant its nuclear programme with renewables and has also displayed intentions of using cheap imported gas for producing power.

Elsewhere, the impact of Fukushima varied from negligible to noticeable. M V Ramana, professor working on nuclear energy and global security at Princeton University in the US, says countries can be categorised into three groups based on their government's reaction. The first group includes those countries that have reiterated commitment to their nuclear plans with very little change. Their plans may be down-scaled because of delays resulting from safety reviews. Good examples are the US and China, Ramana says. The second group consists of countries that have turned away from nuclear power. In many cases, Fukushima only sealed an ongoing process of gradual nuclear phase-out. This group includes Germany, Switzerland and Venezuela. The third group includes those that have temporarily shelved their plans to "continue with, expand, or enter into nuclear power", Ramana says. "They are being held back by public opinion." France and Uruguay fall in this category.

Most of the 50-odd countries with nuclear power have adopted the logic that a massive earthquake followed by

tsunami is an unlikely calamity to befall most of the 453 reactors on the planet, argues Mark Hibbs, senior associate with Carnegie's Nuclear Policy Program, based in Germany, in a paper published earlier this year. These governments had deployed nuclear reactors for strategic reasons and have not veered off their plans. "Political leaders in these countries, despite populations suddenly insecure and restive about nuclear safety, won't hastily foreclose future energy-generating options," Hibbs reports. But he does notice that since March 2011 governments and industry favouring nuclear power have not succeeded in returning to business as usual.

'World Energy Outlook 2011', published by Paris-based International Energy Agency, estimates a more severe

New regulatory measures, especially to safeguard reactors from natural disasters, would delay capacity addition and plant renewal

impact. It says new regulatory measures, especially to safeguard nuclear reactors from natural catastrophes, would delay capacity addition and renewal of old reactors. Nuclear power capacity could fall from 393 gigawatt (GW) in 2010 to 335 GW in 2035. At 2010 levels nuclear commanded 13 per cent share of the total energy market. By 2035 this could reduce to 7 per cent, the report says.

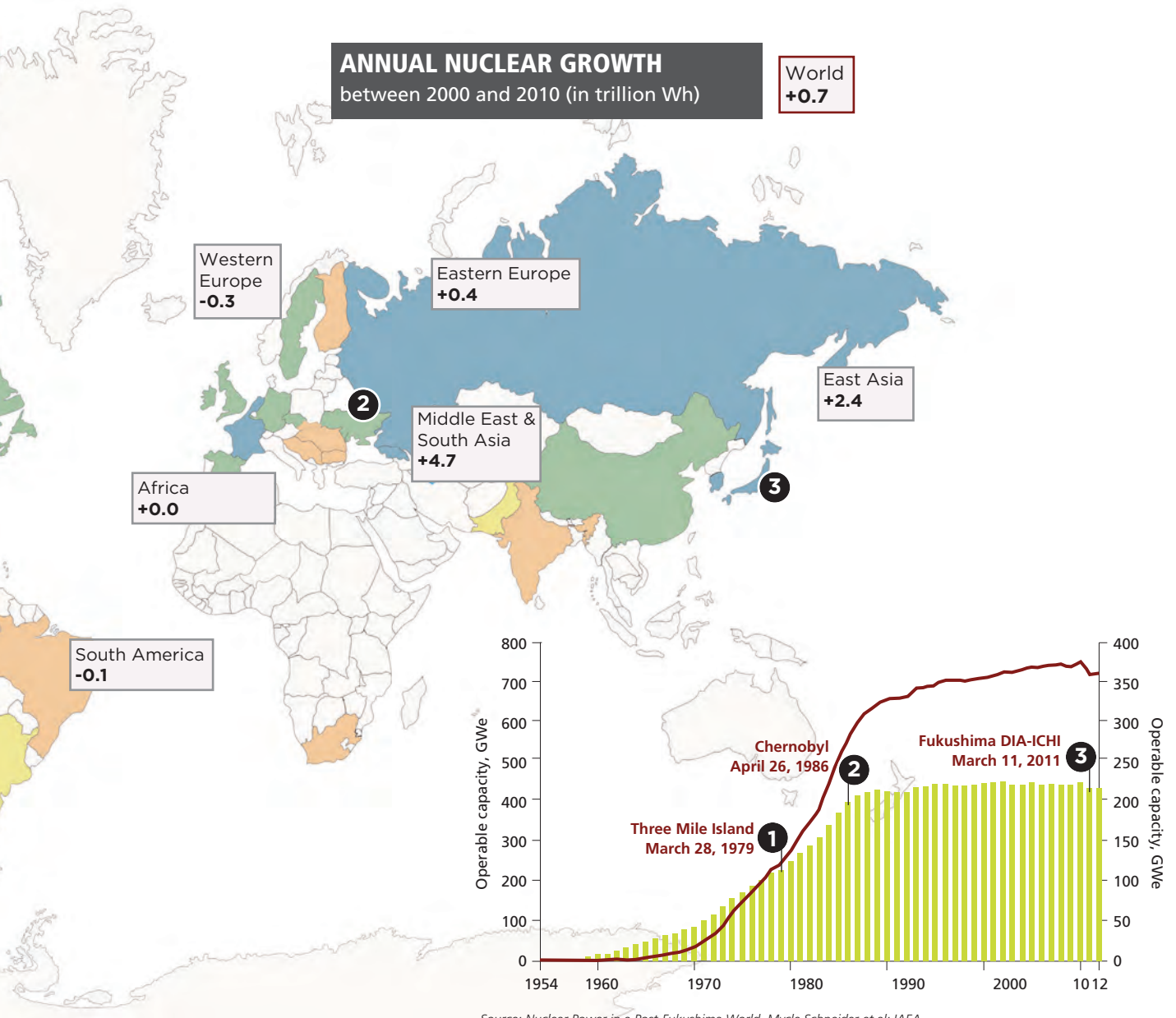
Europe slows down

After Japan announced withdrawal from nuclear energy, Germany, which sourced 23 per cent of its energy from domestic nuclear plants, decided to abandon nuclear energy. Earlier,



Germany was to become nuclear-free by 2021, but in May last year it decided to bring the phase-out dates forward. It will, thus, become the largest bloc in nuclear-friendly Europe to do away with nuclear energy. Following Germany are Belgium, Switzerland and Italy. Switzerland has set 2034 as the year it will be free of nuclear power, while Italy in a referendum held in June 2011 said no to using nuclear energy.

The remaining nuclear powers in Europe intend to split atoms to produce energy, but the way forward could be arduous. France has been the biggest nuclear evangelist extracting 75-80 per cent of its energy from nuclear fusion. But post Fukushima pressure from the



political opposition and the public is beginning to show. The Socialist Party and the Green Party have vowed to close down 24 of the 58 reactors in France by 2024 if voted to power in the April 2012 elections. Opinion polls conducted in November show 40 per cent of the French are hesitant about nuclear energy, while 17 per cent are against it. If France crumbles, the repercussions will be felt in the rest of Europe. French companies Areva and Electricite de France are major providers of nuclear equipment and technology. Britain, Czech Republic, Finland and the Netherlands have strong nuclear links with France and are pursuing plans of increasing their share of nuclear energy despite Fukushima.

Asia stays the course

While Europe is slowing down, Asia is racing ahead. China always stands out from the pack no matter what form of energy one talks about. In terms of installed capacity, it has more wind power, coal-based power and more hydro electricity than any other country. Now it plans to do the same with nuclear. China was reportedly aiming to produce 200 GW by 2030. This is 20 times more than its current capacity and about the same amount of energy that India consumes. But after Fukushima, it temporarily suspended approval of new reactors. These new reactors needed to meet the target are besides the 26 under construction and 51 approved. Given

the size of the Chinese power industry, nuclear share will remain tiny even after this capacity is added. China is trying a cocktail of technologies; nuclear energy is not crucial for it.

Other Asian countries like South Korea and India will enter the next round of nuclear expansion. South Korea currently generates 31 per cent of its power from 21 reactors and stands firm to push this to 59 per cent by 2030. Vietnam has ordered two Russian reactors. Thailand, which was in advance stages of planning a reactor, has postponed it temporarily after Fukushima.

There is another reason—bigger than Fukushima—countries are shying away from nuclear power. It is the cost.

IT COSTS A BUMB

More than Fukushima, it is cost overruns that are impeding nuclear industry

It was widely believed that the 21st century would belong to nuclear energy. The industry had anticipated that the third generation of nuclear reactors would be cheaper to build, superior in thermal efficiency and safer than the second generation ones. Concerns of climate change and talks of carbon tax to fund greenhouse gas reduction technologies too leveraged hopes for this sector. Yet instead of reducing, the cost has risen many times.

In the beginning of this century it was forecast that with third generation technology, a nuclear power plant's overnight cost—expense paid during construction minus the interest on loan—would be about \$1,000 per kW and a 1,000 MW plant would cost about \$1 billion. The current overnight cost of producing a kW of electricity is between \$4,000 and \$5,000. If all costs are included and third generation technologies, like AP1000 or EPR (European pressurised reactor), are used producing a kW could require up to \$10,000.

MIT, which released a report in 2007,

estimated the cost of setting up a reactor at \$4,000. The UK's latest estimate—part of a report prepared by consulting firm Mott MacDonald in 2010—is that first-of-a-kind nuclear reactor could cost \$6,000 per kW. This would gradually reduce to \$4,500 per kW once technology gains prominence and adequate numbers are built, but this is unlikely before 2025. For first-of-a-kind 1,600 MW EPR, the construction cost would be close to \$9.9 billion and for an AP1000 it would be \$7.4 billion. The same year, the Nuclear Energy Agency gave estimates of \$1,600 to \$5,900 per kW.

The only country to keep costs low is China. Its secret is state loans for nuclear projects

Take the case of the first two 1,600 MW EPR. Their construction began in Olkiluoto, Finland, in 2005 and in Flamanville, France, in 2007. Both have seen long delays and cost overruns. It was envisaged that Flamanville would be built at €3 billion (1€=US \$1.3) and commissioned in 2011. The cost was revised in 2011 to €6 billion and the reactor will be ready only by 2016. The cost of the Olkiluoto plant was estimated at €7 billion but has seen overrun of another €2.7 billion.

When Korea Electric Power Corporation won a contract for four reactors

in UAE in 2010, it outbid Areva and Westinghouse's Gen3 technologies. The reported cost of the UAE reactors was \$20 billion. Areva's CEO Anne Lauvergeon said the reason her company lost the contracts was additional safety features that increased cost by 15 per cent. Post 9/11, nuclear reactors have been designed to withstand impacts by commercial jets. But even the Koreans have not been able to control their budgets. Recent reports indicate the cost of these reactors has increased by \$10 billion.

China alone has managed to keep the cost low. Chinese news reports quote costs of about \$1.8 billion for every GW generated through EPR. Through AP1000 the rates are a bit steeper but below \$2.5 billion. Reasons Chinese have been able to keep costs low is tight scheduling—most plants are either on time or ahead of deadlines—a good base of vendors for components and cheaper and more pliant workforce. But the big secret is state loans for most projects. This brings down the interest on loan. In 2010, *China Daily* reported the China National Nuclear Corporation planned to invest close to \$120 billion in nuclear energy projects by 2020, and by 2015 its controlling stake in power plants would be \$75 billion.

The Chinese example is difficult to replicate in the West. In 2008 and 2009, like UAE, South Africa and Canada rejected Gen3 reactors because of the exorbitant cost. Problem arises when investors seek return guarantees, which can push the cost of capital sky high.

Meter shows radiation in Fukushima during an anti-nuclear march in March 2012



REUTERS

SHALE IS THE FUTURE

But the gas has its shortcomings

Unlike in thermal power, financiers have little faith in nuclear plants and hence may charge higher interest.

Mykle Schneider and his team, in a paper on world nuclear energy published in 2011 by the Washington-based Worldwatch Institute, argue the cost of capital is pivotal to nuclear reactor economics. "The capital cost depends in part on the credit ratings of both the country and the power utility in question; countries with more stable economies tend to get lower interest rates, as do utilities that have sounder finances." There are other variables like whether the utility seeking finances is the only player in its area of operation. Companies which have monopolies tend to get cheaper loans as increase in cost can be passed on to the consumer. British Energy, which owns eight nuclear plants in the UK, went bankrupt in 2002 because it operated in a competitive market; the government bailed it out with £10 billion (US \$15.9 billion).

Governments are trying to give financial support to nuclear projects, as guarantors or by using taxpayer's money. The Olkiluoto project has the backing of the governments of both France and Sweden, a co-builder. The first two projects in the US—Georgia Power's Vogtle project for two Westinghouse AP1000s in Georgia, and Maryland-based Constellation Energy's Calvert Cliffs project for an Areva EPR—have also got state guarantees. For Vogtle, the first nuclear plant to be built in 30 years in the US, the estimated cost for two reactors is close to \$14 billion, of which \$8.5 billion is covered under state guarantees. Here the government has gone a step ahead to use money gathered from electricity users in the state through a cess. That's how the financial burden on Georgia Power for the two reactors is only \$6.5 billion.

There has been a call to use carbon tax to fund nuclear energy. John Rowe, former CEO and chairperson of Exelon, the biggest nuclear energy producer in the US, has said that about \$100 per tonne carbon would be required for nuclear energy to break even. The British government is considering imposing tax and preferential tariffs to bring nuclear on a par with renewable energy.

Nuclear energy has too many ifs and buts. Small wonder power companies are now flirting with shale gas.

Power companies, at least in the US, have identified their next big target: shale gas, or methane trapped in clay and rock. Not only is shale gas cheap—about 30 times cheaper than oil—the industry estimates there are enough reserves in the US to last 100 years.

John Rowe, former chairperson of energy giant Exelon, admitted just before his retirement in December that the future of power generation lies in shale gas. Companies are increasingly looking at natural gas—shale gas is categorised as natural gas—for meeting electricity demands. Between 2011 and 2015, close to 260 plants can be built in the US that will use natural gas as the fuel, according to government statistics. The share of shale in the total natural gas production in the US in 2010 was 23 per cent (5 trillion cubic feet or TCF), as per the US Energy Information Administration (EIA) data. By 2035, it may go up to 49 per cent. The US is heavily banking on natural gas. Between now and 2035 the country will add 222 GW of generation—a jump of 20 per cent. Of this expansion, gas will account for 58 per cent. In comparison nuclear share will be 4 per cent and coal will contribute 8 per cent.

Low cost and mature technology make shale more attractive than nuclear. Chandra S Rai of Mewbourne School of Petroleum & Geological Engineering at University of Oklahoma says shale gas has brought down the cost of producing electricity. Reported cost of nuclear energy is between \$6,000 and \$8,000 a kW (International Energy Agency maintains it is \$5,300). For a gas-based plant it is less than \$1,000 per kW. Nuclear projects face long delays, especially for first-of-a-kind plants, but gas-based plants take not more than five years to be commissioned because they are based on matured technology.

Companies, which previously owned nuclear power plants, are slowly

shifting to gas. Virginia-based Dominion Resources Inc, which owns seven nuclear power plants, constructed its first gas-based plant in May 2011. It plans to make two more such plants.

Attractive as it is, shale gas faces certain hiccups. W John Lee of Houston University says just because an area has reserves does not mean all of it can be commercially extracted. In its 2011 Annual Energy Outlook for the US, EIA had estimated the total shale gas reserves in the country at 827 TCF, but has recently revised it to 482 TCF. Marcellus Shale Fields, the largest in the US, was initially said to have about 410 TCF of gas; the revised estimate is 141 TCF.

There is another cause for worry.

Low cost and mature technology make shale gas more attractive than nuclear energy, but it can contaminate groundwater

Recent studies show drilling shale gas can contaminate groundwater. The drilling process called hydro fracturing—shortened to hydrofracking—involves injecting a solution of mostly water and sand, but also pesticides, surfactants and benzene-based chemicals into shale formations. The US Environment Protection Agency has blamed hydrofracking for polluting the groundwater in Pavillion, Wyoming.

The agency's study, released in November 2011, found high levels of benzene and petrochemical-based products in the groundwater. It also found 2-butoxyethanol phosphate, phenols and naphthalene in the aquifers. Another study in early 2011 by Duke University has also blamed the shale gas industry for flammable levels of methane in aquifers. ■