nature

www.nature.com/nature

Vol 451 | Issue no. 7177 | 24 January 2008

Fuel's paradise

The utopian urge to separate the world's nuclear-fuel cycles from national strategic ambitions has merit.

In 1972, Abdul Qadeer Khan, a young Pakistani engineer working at a uranium-enrichment plant in Almelo in the Netherlands, was able to walk out of the lab with the blueprints for advanced gas uranium centrifuges. Khan went on to become the father of Pakistan's atomic bomb, and created a nuclear-weapons black market network, exposed in 2004, spanning from labs and offices in Dubai, Malaysia and South Africa to clients in North Korea, Libya and Iran.

It is difficult to conclude what is most shocking: the shoddy security of the civilian nuclear industry, the unscrupulous scientist-accomplices in Khan's network, or that US intelligence agencies allegedly withheld information for well over a decade to protect US–Pakistan relations.

But they all add up to a stark reminder that the diversion of material from the civil nuclear industry remains the easiest stepping stone to nuclear-weapons prowess. The preventative oversight of the civil fuel cycle cannot necessarily be provided by plant operators, inspectors or governments. There is no regulatory requirement for a nuclear plant to be secure and 'proliferation resistant'.

Where then should efforts be focused to make the civil nuclear industry more secure? The answer is both simple and worrying. It has never been easier for the unscrupulous to construct a weapon. The most urgent challenge is to prevent anyone acquiring or producing the couple-of-dozen kilograms of fissile material required.

There are two points of danger in the nuclear-fuel cycle. One is at its front end: the enrichment of uranium to provide the low-enriched fuel needed to operate a reactor, a technology that is readily diverted to make highly enriched uranium for weapons. The other is at the cycle's back end: the reprocessing of spent fuel, which produces plutonium. Reprocessing is not in vogue and is uneconomic, although its use could grow if demand for nuclear energy puts pressure on uranium resources. For now, the pressing focus should be on uranium-enrichment technologies.

This challenge is all the more acute given that many countries, including Egypt and Saudi Arabia, are now turning to or at least considering nuclear power for strategic reasons that often go beyond their claimed motivations of energy independence and combating climate change. The existing enrichment capacity of countries such as Brazil and Japan makes them virtual weapons states — they could arm in months if they so wished.

Iran has made much of its 'inalienable right' under the 1970 nuclear non-proliferation treaty (NPT) to develop uranium-enrichment technology. Its insistence that this is a purely civilian endeavour rings manifestly false to many expert ears, for good reason. Beyond the various lines of evidence that support this scepticism lies the more general question of why bother. After all, neither Iran nor any other country has in principle any need to create national enrichment facilities. The international market for enriched uranium for civil use is efficient and well served, and good models for multilateral control already exist. Multilaterally owned or operated fuel banks have been on the agenda since the detonation of the first nuclear bomb. The concept of multilateral enrichment facilities provided by existing technology owners is an idea whose time has come: we should embrace it (see page 380).

"The concept of multilateral enrichment facilities is an idea whose time has come."

Such a solution requires a reinterpretation of the terms of the nuclear compromise embedded in the NPT, which offers countries unlimited opportunities for civilian nuclear development in return for forswearing proliferation. If new national enrichment facilities continue to be allowed, any nation that fears international sanctions somewhere down the line would have good reason to develop such facilities regardless of whether it also had military ambitions for the technology, as a matter of energy security. A fuel bank set in some way 'above politics' might help allay such fears — but that carrot would probably not, in itself, be enough. A further necessary condition for success would be that the nuclear-weapon states must themselves keep their part of the disarmament bargain (see *Nature* **451,** 107; 2008).

In general, this journal believes that all nations should be allowed to develop scientific and technological capacities as they wish. There is no merit in developing nations sitting as passive consumers of the knowledge and know-how that the developed world already boasts. But some technologies are exceptional. ■

Competition and noise

Mitt Romney's pledge to plough $20 billion a year into energy research may signal an unseemly bidding war.

It was, some commentators said, the mother of all panders. When Republican presidential contender Mitt Romney told a Detroit audience that he would increase US federal funding in energy research, automotive technology and materials science fivefold, to a cool $20 billion a year, those inside the Beltway shrugged. In the Motor City, though, the idea had more play. Romney's upbeat, go-get-'em approach may have resonated with voters, and he duly won the Michigan primary the next day.

Romney is only one of half-a-dozen viable candidates for this November's presidential election, and his ambitious proposal is unlikely to be put into effect. It is nevertheless significant, because it points to how the United States may choose to respond to the danger of an economic recession that would spread to the country at large the woes already felt by many voters in Michigan.

President Bush and Congress are already scrambling to put together a stimulus package to stave off recession. Strategic responses — such

as Romney's research plan — are now likely to feature prominently in the election campaign. Murmurs about 'competitiveness' that have been around for years will gain new salience

Romney's rhetoric will resonate with many physical scientists and engineers. "We spend $30 billion a year in the National Institutes of Health, and we lead the world in health-care products. In defence, we spend even more. We lead the world in defence products," he told the Detroit Economic Club on 14 January. "Why not also invest in energy and fuel technology right here in Michigan?" These sentiments come straight from the songsheet of the American Physical Society and its allies, which have long been pursuing a more modest proposal to double the amount the federal government spends on research in the physical sciences and engineering. But Romney's pledge of $20 billion promises much more.

This isn't some hick candidate pulling numbers out of the air: a former chief executive of Bain & Company, the Boston management consultancy, Romney knows what $20 billion is. And precedents suggest that a specific, costed commitment such as this one — made in the heat of the primary campaign — will be hard to discard if the candidate who made it is actually elected.

Even so, there is something unreal about Romney's proposal. Notably, it was made as part of a speech outlining the fantasy that the US motor industry can bounce back from its current emaciated state. General Motors and Ford have had some three decades of notice from Toyota, Nissan and Honda that it is time to shape up, and have utterly squandered every opportunity to respond. Significantly, Romney allied his research pledge with a call for looser fuel-efficiency standards — the signature cause of the Detroit industry, which has repeatedly signed its own death warrant by resisting innovation at every turn.

Senator John McCain (Republican, Arizona), Romney's rival in Michigan, promised action on global warming and told voters that their old jobs aren't coming back — a message they probably didn't want to hear. There will clearly be political mileage in the sort of fixes Romney promised to Michigan last week. And as the United States' economic troubles deepen in this election year, there may be more snap prescriptions for industrial revival, some of them based on heavy federal investment in research and development.

"As the United States' economic troubles deepen, there may be more snap prescriptions for industrial revival."

That represents a promise and a threat for scientists and engineers whose disciplines stand to benefit. The promise is considerable. As US physical scientists have been arguing for years, their work can help bolster industrial competitiveness, directly and indirectly. Thankfully, there is an even broader consensus (now shared by Republican and Democrat presidential candidates) that energy research is under-funded.

But Romney's disingenuous $20-billion pledge should be treated with scepticism. It is almost inconceivable that Congress would deliver that kind of money. Romney feebly suggested that it be diverted from federal job-training programmes, but these are scantily funded, and sure to grow, not contract, if recession arrives. And as for the justification of a comeback for Detroit, that particular movie ended decades ago and there will be no sequel. ■

A little less Disneyland

DARPA should focus on its founding values.

It is the ultimate playground for academics with big dreams: $3 billion to do whatever you want, as long as it's in the interests of defending the United States. An open chequebook, and no peer review, has meant great success for the Pentagon's research wing, the 250-strong Defense Advanced Research Projects Agency (DARPA). Over the past half-century, it has been the place where the best and the brightest gather to crack some of the toughest nuts in the defence community: how to build radar-defying stealth aircraft; how to detect hostile missile launches; how to build the best satellite-navigation system so that soldiers can find their way. 'DARPA hard' is the phrase that's used — if it's not hard enough for DARPA to do, it's not worth the agency doing it.

DARPA's accomplishments are legendary, so much so that other areas of the government are hoping to mimic its success with their own DARPA spin-offs (see pages 390 and 403). This is not an easy task but not necessarily a bad idea; at the very least, some parts of the government not known for innovation might begin to think about technological issues from a creative and higher-risk standpoint. But what is the future of DARPA itself?

Its 50-year mark is as good a time as any to take stock. Like the rest of the United States, DARPA can no longer afford to operate under a cold-war mentality; the terrorist attacks of 11 September 2001 and their aftermath have dramatically restructured the country's national defence needs. DARPA stumbled badly in one of its first and most prominent responses to the attacks by setting up an invasive information-mining programme run by a man convicted of multiple felonies (later reversed on a technicality) relating to the Iran–Contra scandal of the 1980s.

Today, some of DARPA's activities remain firmly rooted in its cold-war research past, which led to the unmanned drones flying surveillance missions in Iraq. But, as was on show in a California Disneyland hotel last year, the agency's director, Anthony Tether, has also tried jazzing things up a bit, by sponsoring competitions such as the $2-million 'grand challenge' robot car race. Even his critics note that Tether has managed to draw younger researchers into an agency whose stalwart backers are growing greyer every year.

Such approaches may be useful in helping the government think outside of the box. But DARPA must be careful not to stray too far down that path. The agency's future will depend in large part on the actions of Tether's successor: the position of DARPA director is a powerful one, with the ability to select programme managers and dispense money as he or she sees fit.

The agency's next director must take the agency back to basics, or risk losing the edge that comes from the inspired patronage of risky research. Above all, DARPA needs to concentrate more on projects that could lead to long-term pay-offs in the fight against terrorism, in ways we cannot yet imagine. ■