Under your invitation to comment on the Technology Challenges I wish to draw the Committee's attention to China's present de facto control of the supply of Rare Earth Elements that are used so extensively in wind generator and many of the offshore wave and tidal power prototype designs currently under development.

Much of current wind turbine technology employs such large quantities of REE's that there are now major concerns as to supply being sufficient to continuously support major installation programmes of the scale being addressed in meeting the 2020 renewable energy targets. In addition REE production is neither green, clean, simple nor secure for many reasons, and the world is now facing a major availability crisis.

Today China is virtually the world's only producer - most mining and processing outwith China was scaled down as China scaled up and became able to offer supplies at much lower prices and she now produces 97% of the planet's REE products. This is presently around 100,000 tonnes but she has, in recent years, progressively and massively reduced exports to around 25,000 tonnes currently when demand from the rest of the planet is expected to approach 60,000 tonnes this year with some forecasts of up to 185,000 tonnes demand by 2015.

As a result, of course, the price of most elements have rocketed - notably Dysprosium. Used in hard drives for computers, it reached more than $670/lb mid 2011 compared to around $7/lb a handful of years ago.

Notably too, researchers at Edinburgh University have confirmed that their permanent magnet raw material costs escalated from £77/kg in June last year to £150/kg by last September.

It has been widely alleged and documented in the press, although denied, that China cut off REE supplies to Japan for a time last year during a period of diplomatic friction.

REE's are so widely used across the board in our 21st century equipment such as computers, mobile phones, hybrid cars, televisions, fluorescent lighting, vehicle exhaust catalysts, night sights, missile controls and electric motors as well as wind/offshore and sea bed generators, that they have become strategically vital to all advanced nations.

Some of the larger gearless wind turbines, presently favoured for offshore installations as they have fewer moving parts, (Offshore gearbox replacement costs are regarded as being in the region of £500,000 per turbine) each presently require 500lbs or more of Neodymium which is utilised to lighten the permanent magnets and to enhance their performance.
REE’s are relatively plentiful on our planet but large deposits are very rare, hence the name, and this inhibits large scale centralised excavation. Estonia has found significant quantities of REE’s within the spoil from it’s decades of uranium ore mining and is predicted to become a commercial player sooner than many other countries who are forecast to take years to gear up to tackle the shortfall. European electrical companies are starting to invest in Estonian and Australian mining/refining start ups.

This, of course, will be at huge infrastructure expense.

A recent amendment to the National Defence Authorisation Act that has just gone through the US House of Representatives in December 2011 will give stockpiling powers to the US Secretary of Defence which legislation is designed to guarantee prices to the restarting US producers to assist in securing their national needs.

Radioactive Thorium and Uranium frequently co-exist in REE ore deposits and in addition, toxic acids are utilised in the refining processes and China has been attempting to close down many illegal excavation/production sites because of major environmental issues and concerns.

I attach a recent article published by the Daily Telegraph which graphically records the environmental impact of unregulated Chinese production and I strongly encourage you to read it.

REE’s are not customarily exchange traded on the international markets like precious metals but are generally bought and sold privately and there are presently widespread allegations of the involvement of large scale organised criminal gangs in the industry with some articles claiming as much as 20,000 tons has been exported illegally annually from China in recent years.

Finally, it is worth noting that surveys in the last two years by the US Geological Survey have located large deposits of REE's in Afghanistan with an estimated “street value” of more than $7bn.

They are in Helmand Province.

Principal Areas Of Research

For ease of reference the following table identifies the main current areas of prototype machine research in support of renewable energy generation. As can be seen several are permanent magnet design based and therefore vulnerable to any forthcoming world shortages of REE’s.

It should also be born in mind that all listed, other than onshore and offshore wind generators, are at the very small low power output prototype design stage and therefore a very long way from being brought into reliable service and to making any impact at all to the levels of electrical energy needs of the UK and therefore can to all intents and purposes be neglected as contributors before 2020.

A factor that should be noted is that many of these devices are heavy and therefore at present stage of development have a low power/weight ratio. This presents the concept of “Embodied Energy” which is the energy required to fabricate the unit. This means that
such units need to be run for a considerable time before they have generated more energy than it took to build them and to become a nett provider of energy.

Fabrication of 1Ton of finished steel requires 6000kW hours of energy so a device generating 750kW and incorporating 350 tons of steel will require to be run for 2800 hours at peak output. Given the variable nature of wave generation if we assume the device is generating for 30% of the year then it will require to be operational for 8400 hours to offset it's embodied energy—that is a full year.

<table>
<thead>
<tr>
<th>Device. Description</th>
<th>Description</th>
<th>Permanent Magnets Yes/No</th>
<th>Key Technical Challenges</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floating Turbine (Tidal current)</td>
<td>Hydraulic Power Take Off</td>
<td>No</td>
<td></td>
<td>On Test in Orkney</td>
</tr>
<tr>
<td>Open Hydro Turbine</td>
<td>300kW on Test</td>
<td>Yes</td>
<td></td>
<td>N Ireland On Test in Orkney</td>
</tr>
<tr>
<td>Marine Current Turbine</td>
<td>Up to 1.2 MW</td>
<td>No</td>
<td></td>
<td>Test Sites N Devon/N Ireland (Seagen,Seaflow)</td>
</tr>
<tr>
<td>Direct drive/ Reciprocating 300kW (Oyster)</td>
<td>Added gearbox to reduce costs</td>
<td>No</td>
<td>Needs gearbox to provide 15-20 rpm otherwise equivalent speed only 1 rpm.</td>
<td>On Test in Orkney 120te for 300kW Gearbox a reliability compromise</td>
</tr>
<tr>
<td>Switched Reluctance Machine</td>
<td>Needs power from grid for excitation</td>
<td>No</td>
<td>Needs external excitation power supply</td>
<td>Leeds/Durham/ Newcastle Unis Variable speed -versatile control-basically a DC machine.</td>
</tr>
<tr>
<td>Transverse Flux Permanent Magnet Machine</td>
<td></td>
<td>Yes</td>
<td>Poor Power Factor plus very small air gaps are hard to sustain</td>
<td>Delft /Edinburgh Needs lots of reactive power which means lot of cost is in the power converter</td>
</tr>
<tr>
<td>Device</td>
<td>Description</td>
<td>Permanent Magnets</td>
<td>Key Technical Challenges</td>
<td>Comments</td>
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<td>------------------------------</td>
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<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Sea Snake 750kW (Pelamis)</td>
<td>Wave/ Hydraulic Motor</td>
<td>No</td>
<td>Power/Weigh t ratio poor at one third that offshore wind turbines</td>
<td>Uses conventional technology.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Heavy-approx 700tons(Half is ballast)</td>
</tr>
<tr>
<td>.Archimedes Wave Swing 2MW</td>
<td></td>
<td>Yes</td>
<td>Weighs 40 Tons</td>
<td>Tests in Portugal</td>
</tr>
<tr>
<td>“Snapper”- Linear Magnetic Gearing</td>
<td></td>
<td>Yes</td>
<td>Very early stages</td>
<td>Current/Voltage stability issues</td>
</tr>
<tr>
<td>Oscillating Water column</td>
<td>Air Turbine Seashore Device</td>
<td>No</td>
<td>Hostile environment Noisy</td>
<td>Installed on Islay Design-Queens Univ Belfast.</td>
</tr>
<tr>
<td>Slim/Goliath 250kW</td>
<td>Air Cored</td>
<td>Yes</td>
<td>Less efficient electromagnetically-big size results</td>
<td>Durham/Estonia Research/Dev</td>
</tr>
<tr>
<td>C-Gen 20kW</td>
<td>Air Cored &amp; Linear types</td>
<td>Yes</td>
<td>Upscaling in progress</td>
<td>Edinburgh/East Kilbride</td>
</tr>
<tr>
<td>High Temp Superconducting M/C 36.5MW</td>
<td>Being Developed for US Navy</td>
<td>No</td>
<td>Needs Large cooling Circuit/Equipment</td>
<td>USA Needs work on reliability &amp; lots of development</td>
</tr>
<tr>
<td>High Temp Superconductor</td>
<td>Claw Pole design</td>
<td>No</td>
<td></td>
<td>Edinburgh Development in progress</td>
</tr>
<tr>
<td>Tidal current Direct drive-open hydro-300kW and above</td>
<td>Air Cored Rim Generator</td>
<td>Yes</td>
<td></td>
<td>On test in Orkney Dev in Ireland/Durham</td>
</tr>
<tr>
<td>On Shore Wind Turbines</td>
<td>With G/Boxes</td>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On Shore Wind Turbines</td>
<td>Direct Drive</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Offshore Wind Turbines</td>
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<td>Yes</td>
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David B Watson
28 February 2012
The key to hundreds of modern technologies, from iPhones to smart-bombs, lies in the little-known ‘rare earth’ metals, 95 per cent of which are mined by China. Its decision to slash exports has left the West scrabbling for alternative supplies. By Peter Foster. Photographs by Adam Dean

**Battlefield earth**

Acid tanks and run-off ponds at a heavy rare earth mining facility in Longnan County near Ganzhou, Jiangxi Province, southern China
Tailing lakes at Baotou, which contain waste products from the iron ore industry, can be used in rare earth extraction.

Deng Xiaoping prophetically said, ‘There is oil in the Middle East, but there is rare earth in China’

The Inner Mongolian city of Baotou is like an LS Lowry painting come to life: a faded industrial landscape of chimney-stacks and coal deposits, shunting yards and steel plants. But amid the outskirts of this north China steel town there is one clutch of buildings that are noticeably more modern than the rest. They are home to a research institute that has suddenly become the envy of the world. The showpiece headquarters of the ‘Pioneering Rare Earth Hi-Tech Development Zone’ is home to 400 research scientists who specialise in a group of 17 metals known as ‘rare earths’. Until recently, most people had never even heard of these obscure elements. However, they are the magic ingredient in almost everything that makes modern life possible. They may have exotic-sounding names such as terbium, europium, dysprosium and lutetium, but they also have decidedly everyday applications; from BlackBerry and iPhones to catalytic converters and low-energy lightbulbs.

Known in China as ‘industrial vitamins’, rare earths are an essential component in green technologies such as electric cars, solar panels and wind turbines. Rare earths are not only essential for civilian life; the world’s hi-tech armies also need rare earths for a host of applications from toughening tank armour to guiding smart-bombs and powering night-vision goggles.

Given their global application, it may come as a surprise to know that 95 per cent of world rare earths production is controlled by a single country – China. Last year China’s ministry of commerce announced drastic cuts in the amount of rare earths it would make available for export. Quotas were cut by more than 70 per cent for the second half of 2010 to only 8,000 tons, compared with 29,000 tons for the same period the previous year, at a time when global demand for rare earth elements (REEs) was picking up fast. Analysts say quotas are expected to shrink by a further 11 per cent this year. Rare earths demand has tripled in the past decade to an estimated 136,000 tons this year. By 2014 some analysts are now predicting a 20,000-ton shortfall in key metals. Prices of the most sought-after rare earth metals and oxides have spiked in the international markets, with some dealers reporting that neodymium (used in computers and lasers) is now impossible to obtain outside China. At $72 a kilo, cerium oxide, used in polishing glass and lenses, is now 15 times more expensive than it was a year ago; neodymium has more than tripled in value to $115 over the same period. Analysts do not expect them to cool off for at least two years.

So how did the world come to find itself in a position where it is almost totally reliant on China for its rare earth metals? Part of the answer is to be found in the main entrance at the Baotou complex, where a welcome sign quotes China’s former leader Deng Xiaoping on one of his reform-boosting southern tours of 1992: ‘There is oil in the Middle East, but there is rare earth in China.’ Twenty years on, that has turned out to be a prophetic observation.

China has been focusing on rare earth developments for nearly 50 years, founding the Baotou research institute in 1963 after discovering that they were sitting on the ‘mother lode’ of rare earth deposits at the Baiyunebo iron-ore mine, about 80 miles north of Baotou. It is from the iron-ore tailings (the waste-product from the iron extraction process) that China extracts much of its rare earths, and because it uses waste materials, it does so at unbeatably low costs. Baiyunebo remains by far the largest deposit of rare earths in the world, and even today, industry experts say, China is only using about one-fifth of Baiyunebo’s potential.

In an exhibition hall – with an apologetic smile we are told that foreign reporters are not allowed to meet the scientists themselves or visit their labs and factories or the Baiyunebo mine – we are invited to learn the history of rare earths, which, it turns out, are not that rare. Several of these elements are more abundant in the earth’s crust than lead and nitrogen. Of the nearby 100 million tons of known global reserves that can be economically extracted, the United States Geological Survey (USGS) says 36 million are in China, 19 million in Russia and the states of the former Soviet Union, 13 million in the US, 5.4 million in Australia and 3.1 million in India. South Africa, Mozambique, Vietnam, Greenland, Indonesia, Nigeria, Canada and North Korea also have resources.

Rare earths were first discovered by a Swedish amateur geologist in a feldspar quarry outside Stockholm in 1787. Then only a chemical curiosity, by the 20th century they had been used in an increasing number of industrial applications. Until 1949 India and Brazil produced most of the world’s rare earths, before the baton was taken up by the monazite mines of South Africa. In the 1980s when the electronics industry took off it was America that led production from a mine at Mountaintop Pass in California. The Sony Walkman, that icon of electronic sophistication, was made possible by samarium-cobalt magnets that were the only ones...
It seems incredible that these low-tech, mom-and-pop mining operations are the cradle of some of the world’s most hi-tech gadgets.

light and efficient enough to run a cassette player powered by two AA batteries.

US dominance quickly evaporated in the 1990s when China flooded the market with super-cheap rare earth elements, often mined at huge environmental cost. So cheap were Chinese rare earths that by the early 2000s most of the world’s mines were closed (Mountains Pass was mothballed in 2002), unable to compete with Chinese prices and supply. At the same time, China invested heavily in the complex technologies of rare earth refining and production, discovering far cheaper processes that used hydrochloric instead of nitric acid and refining extraction to 99.999 per cent purity – better by several percentage points than in America.

The result, according to US analysts, is that the rest of the world has sleepwalked into the parlous situation it now finds itself in. ‘We all know the ball has been dropped in this [rare earths] space and not only by the US but by a whole swath of Western economies,’ wrote Christopher Eccleston, of the New York-based investment consultancy Hallgren & Co, in an excoriating report on the issue.

But now the world has, as the US Secretary of State Hillary Clinton observed late last year, had its ‘wake-up call’. America’s Government Accountability Office (GAO) issued a report entitled ‘Rare Earth Materials in the Defence Supply Chain’. It pointed out that even the US’s main battle tank, the M1A2 Abrams, uses samarium-cobalt in its navigation system, as does the state-of-the-art Aegis Spy-1 radar. Rare earths are also used in the motors that power the rudders and tail-fins of the fifth-generation F-22 Raptor, and even the hellfire missiles that target Taliban terrorists from drones above the battlefields of Afghanistan need a chemical produced only in China.

The GAO report estimated it could take 15 years for the West to catch up with China and develop alternative supplies. Karl A Gschneidner Jr, a senior metallurgist at Iowa State University’s Ames Laboratory, has been studying rare-earth materials since the 1960s. ‘There is nearly zero rare-earths mining, processing and research going on in the US,’ he told Chemical & Engineering News.

Several international mining companies are racing to fill the gap, prospecting for deposits in Canada, Australia, South Africa and Greenland. Some, such as Molycorp, the US company that now owns the Mountain Pass mine, plan to restart production next year.

S

o is the world right to be scared about rare earths? After years of careless overexploitation, China argues, it is now simply moving to consolidate production and put supplies of a vital resource on a more sustainable footing. The arguments are partly economic – China’s own burgeoning technology industries and its attempts to lead the world in green technologies will require large amounts of rare earths in the future – and partly environmental.

As well as the Baiyunbo resource, China has rare earths deposits in the southern provinces of Jiangxi and Guangdong, where the metals can be found in high concentrations in clays a few feet below the earth’s surface. As a result the 1990s saw an explosion in the number of poorly maintained local mines that were both wasteful and polluting.

On a visit to the hills of Longnan County in southern Jiangxi, the mines can be seen dotted throughout the densely wooded hillsides. Signs announce that these sites are not open to visitors and on closer inspection it is not hard to see the reason why. ‘Mine’ is really too grand a word to describe the homespun tangle of plastic pipes and roughly constructed chemical holding tanks that are buried into the foot of the hillsides. The tanks, their concrete sides cracked and worn, are set up in tiers; one filled with a bright blue liquid, another with a thicker chocolate-brown solution, and a third with a white powder that shimmers under a clear liquid. As we move closer, the smell of ammonia lifts towards us on the breeze.

It seems incredible that these low-tech, mom-and-pop mining operations are the cradle of some of the world’s hi-tech gadgets. The brown slurry swirling through a Heath Robinson filtration system represents one of the world’s primary resources of the rarer ‘heavy’ rare earth elements. The valley floor is dotted with mines as far as the eye can see, the aquamarine pools studding the rich green landscape like a Bel-Air suburb. The system used to obtain the rare earths is extremely basic. At regular intervals miners dig holes about 5ft deep, into which they drip-feed a concentrated solution of sulphuric acid which sinks down through the clay, leaching out the rare earths elements as it passes. Some of the acid also travels upwards through the roots of the trees, which have curling, sickly-brown leaves. When the rains come the chemicals from poorly managed mines are sometimes swept into the water supply, poisoning drinking water, killing rice crops and, in one case in Guangdong in 2008, wiping out an entire reservoir of fish. Faced with widespread environmental problems, China has already closed hundreds of illegal operations and
has promised to tackle the smuggling gangs, often backed by corrupt officials, that still operate.

Once the raw rare earths clay is extracted, it is trucked off to processing plants across China that separate out the 17 individual elements, and then process them into different rare earths oxides and compounds.

The owners of a private rare earths processing factory in southern China granted us access to their facilities to observe the production process, but asked not to be named, citing the growing sensitivity of the rare earths issue with the Chinese government. Inside, the factory is like a giant industrial chemistry set. The rare earths clay is churned in long tanks of rotating drums with solutions of acid and water, through which each individual element is separated out from the other. As the solvent-extraction process continues, staff buzz about, monitoring the tanks, and checking PH levels and flow-rates until they end up with the raw elements in solution, such as liquid neodymium chloride (NdCl3). In the final stage of the process, the pure elements, by now evaporated off into a white powder, are shoveled into casserole-sized ceramic dishes and baked for several hours at high temperatures. The dishes emerge the color of burnt toast, and their contents are unloaded and packed into drums for delivery.

Back at the rare earths institute in Baotou, Zhang Rihui, a senior economist at Baotou Steel's Rare Earth Elements division, says, 'China has no intention of constraining foreign enterprises from using the rare earths resource,' pointing out that companies can come to China and enjoy unlimited and relatively cheap supplies — as many, including world-leading companies such as Rhodia of France and Showa Denko of Japan, already have. China, he adds, has a legitimate right to protect reserves of some metals, such as neodymium, that are needed for its burgeoning green-tech industry, and according to China's state media, China's government is now creating stockpiles, further unnerving foreign governments. The current steep rises in world prices, Zhang says, without irony, are 'merely an objective consequence of Chinese government policies, not their intention,' repeating the official line that the quotas are necessary to conserve and regulate resources. 'China just wants to run the industry properly, on a sound environmental footing and try to minimise any waste of the resources,' he adds.

'In reiterate, the price of REEs materials is nothing compared to the price of finished products which integrate REEs, so China has made only a tiny proportion of the profits as the REEs provider. This is not sustainable. China welcomes the world to find alternative sources of supply. Western complaints also ignore the fact that while China puts restrictions on the exports of the metals themselves, there are no restrictions on the export of products made in China using REEs.'

Surprisingly, perhaps, foreign industry experts who don't have political axes to grind have sympathy with the Chinese position. They say that a lot of the current fears over rare earths supplies are being blown out of proportion, partly by speculative investors hoping to turn a quick buck on the shares of fledgling rare earth exploration companies, and partly by vested interests in Washington who are looking for subsidies and guarantees for their operations.

'There is a huge amount of hype surrounding rare earth metals at the moment and a lot of it is very frustrating,' says Ian Chalmers, the managing director at Altana Resources, a mining company based in Perth, Australia, that is bringing rare earths deposits on stream in the next 12 to 18 months. 'I've been in this business for 20 years and never seen anything like it. The reality is that China dominates the rare earths industry and it has a very clear policy of seeking to take those rare earths metals into value-added products and that is a concern in many people's minds. But if you look at production coming on-stream in the next 10 years, the situation is not as dire as people make out.'

Nigel Tunn, the managing director of the British-based Metal Pages, a leading industry information provider, is also sceptical of claims of long-term rare earth shortages. China's tight quotas have forced up prices and caused temporary shortages of some metals, he acknowledges, but that in turn will stimulate global production or force manufacturers that don't want to rely on China to look for substitutes. Analysts already expect that the two biggest miners of rare earths, Molycorp of the US and Australia's Lynas, could deliver an additional 60,000 tons to market by 2015. 'China is doing two things with its policy,' Tunn says. 'It is protecting against foreign ownership of strategic resources and at the same time creating incentives for foreign companies to bring their manufacturing to China. The West has grown used to cheap raw materials, but it is going to have to get used to the fact that prices are going up as countries scramble to secure finite resources.'

Ironically, given the fears over a rare earths supply crunch, the concern for many inside the industry is not a shortage of the metals, but a future excess that could drive down prices and once again render non-Chinese mines uneconomic. The
reason, Judith Chegwidden, a leading industry analyst at Britain’s Roskill Information Services, explains, is that the rare earths industry, while vital, is tiny by global standards. Even factoring in recent price rises, the entire rare earths business is forecast to be worth only $3 billion a year by 2014, barely one per cent of today’s iron ore market. What the world will spend on rare earths this year – $2 billion – is roughly equivalent to what China spends on iron-ore imports in a fortnight. ‘There are more than 200 rare earths deposits that are being marketed to the investment community,’ Chegwidden adds, ‘and most of them will never come to anything.’

In such a small market, where prices can fall as rapidly as they have risen, many of the rare earth mining opportunities being explored begin to look dangerously uneconomic. Rare earths may be abundant, but finding them in sufficiently high concentrations to make their extraction economic is more problematic. One Canadian-listed company, Avalon Rare Metals, which hopes to exploit a large deposit in Canada’s Northwest Territories, estimated its start-up costs at $900 million, an astronomical sum, say market analysts, given the value of the entire industry.

The military-strategic fears, while good for headlines, are also somewhat overblown according to industry insiders, a view endorsed in October 2010 by a year-long Pentagon study into how to secure future supplies of rare earths and other critical materials. ‘The quantities are extremely small,’ Eric Noyez, the chief operating officer of Lynas, said on the sidelines of the Critical and Rare Metals Summit III in Washington in October, estimating that the US military would need 10 to 20 tons of

officials in the US, Japan and Europe are now debating whether to lodge a complaint with the World Trade Organisation over China’s export quotas on rare earths. Their concern is that China will have an unfair price advantage as it builds up a green-tech industry that it wants to export all over the world. Last year, the Geneva-based WTO secretariat warned in its bilateral trade policy review that China’s export quotas on rare earths and some other key metals were causing worrying distortions. ‘The resulting gap between domestic prices and world prices constitutes implicit assistance to domestic downstream processors of the targeted products and thus provides them a competitive advantage,’ it said.

Those who doubt China’s motives for its rare earths controls also point to the months-long diplomatic spat between China and Japan last year over the arrest of a Chinese trawler captain in disputed waters in the East China Sea. Reports emerged that China had quietly ordered customs officers not to sign off shipments of rare earths to Japan. Several Japanese traders who had been expecting shipments said they had been stopped without explanation; China denied the allegations.

The world remains to be convinced. Already, Japan, which accounts for 65 per cent of China’s rare earths exports, has announced an inquiry into China’s policies. Toyota, which needs lanthanum, dysprosium and neodymium to make its Prius hybrid cars, has formed a special task force to examine how to secure non-Chinese sources of rare earths, and is seeking supplies from Vietnam. Similar inquiries are being launched in the US, where the House of Representatives has passed the Rare Earths and Critical Materials Revitalisation Act of 2010, which would support the development of a non-Chinese source of rare earths for America, partly through loan guarantees for exploration companies. In Europe, discussions are under way about how to counter China’s dominance, with the German Chancellor, Angela Merkel, describing it as ‘urgently necessary’ for Europeans to invest in non-Chinese sources of rare minerals.

In the end, perhaps, the rare earths debate comes down to that most precious of all global commodities – trust – which is in dangerously short supply when it comes to China’s trade relations with the US, Europe and Japan. In the eyes of many, the case for not relying on China strengthens by the day. As Congressman Bart Gordon, the chairman of the House Science committee, observed when approving the legislation to support US companies exploring rare earths, ‘It would be foolish to stake our national defence and economic security on China’s good will, or hope that it will choose to compete in a fair and open global marketplace for rare earths. The stakes are simply too high.’