for”, says Imperiale, who this time voted in favour of publishing both papers.

Some on the board were also influenced by clarifications to both papers — particularly those suggesting that Fouchier’s viruses were not as pathogenic as they had initially seemed — and by presentations from Kawaoka and Fouchier indicating that some combinations of the mutations generated in their laboratories had already been seen in the wild. But Imperiale says that his vote was unaffected by the revisions. “I don’t think the risks have changed; the authors have changed the host range and transmission properties of a deadly virus,” he says. “I don’t think the benefits have changed either.”

Another factor in the NSABB’s decision was the announcement on 29 March of a new US policy requiring that all publicly funded research on certain pathogens be assessed from the outset by the funding agency for the risk that it may be misused (see *Nature* <http://doi.org/hsp; 2012>). Experts have generally welcomed the guidelines, which they say should, if properly applied, also help to avert future repeats of the H5N1 controversy, in which the NSABB learned of the papers only shortly before their planned publication.

Arthur Caplan, a bioethicist at the University of Pennsylvania in Philadelphia, was one of several speakers at the Royal Society meeting to argue that it would be a “mistake” to think that the issues raised by the papers are now fully resolved. Besides bioterrorism, a major concern is that publishing them will result in worldwide proliferation of similar research, possibly in labs that may not have well developed biosafety cultures and training. Both Fouchier and Kawaoka worked in facilities rated at ‘biosafety level 3 enhanced’, but to expect that all such research would be done carefully everywhere is “utter malarkey”, Caplan told the meeting.

The World Health Organization has recommended that work to make H5N1 viruses more transmissible in mammals, which flu researchers voluntarily halted in January, remain suspended until the relevant authorities have assessed the safety conditions for such research (see *Nature* **482**, 447–448; 2012). US and Dutch authorities are expected to release their verdicts within weeks, which Kawaoka said “would be the time to lift the moratorium”. But others warned that doing so before broader debate, including planned hearings by US lawmakers, would be premature and could be perceived as arrogant.

The challenge for any oversight system will be to avoid discouraging important science while ensuring that work is limited to labs with appropriate safety standards, says one scientist, who criticizes the reluctance of many flu

researchers to admit that such studies carry risks. “You’d have to have your head in the sand not to accept that there are some risks here.” ■

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Despite delays, China’s GreenGen coal-fired gasification power plant in Tianjin is going ahead.

CLIMATE CHANGE

Slow progress to cleaner coal

China moves forward with demonstration power plant as United Kingdom revives carbon-capture programme.

BY JEFF TOLLEFSON AND
RICHARD VAN NOORDEN

With many of the world’s nations dragging their feet on cleaning up fossil-fuel emissions, even slow progress stands out. This spring, China’s state-owned Huaneng Group plans to fire up the first phase of its flagship clean-coal demonstration project, moving the country one step closer to capturing and storing the carbon it emits. Despite being more than a year behind schedule, the GreenGen coal gasification plant in Tianjin puts China at the forefront of global efforts to exploit coal resources without releasing carbon dioxide.

In 2008, leaders of the G8 group of nations called for the development of 20 large-scale projects demonstrating technologies for carbon capture and storage (CCS) by 2010, but countries have been slow to embrace the costly plants. Delays and cancellations have affected all but a handful of high-profile initiatives in Europe, the United States and Australia, whereas China, despite delays of its own, is still pushing forward to develop indigenous technologies.

“GreenGen represents both a high degree of technical sophistication and a real commitment on China’s part to clean-energy

technology,” says Julio Friedmann, head of the carbon-management programme at Lawrence Livermore National Laboratory in Livermore, California. “There can be no doubt that China has achieved something remarkable.”

Originally estimated to cost US\$1.5 billion, GreenGen is being developed by a consortium of Chinese companies, including Huaneng, together with Peabody Energy of St Louis, Missouri. The first phase is a 250-megawatt integrated gasification combined-cycle power plant, which will convert coal into ‘syngas’ — a mixture of carbon monoxide and hydrogen — to be burned in specialized turbines to produce electricity. Waste carbon dioxide from these processes can be separated more easily than in conventional coal-fired power plants.

Huaneng has already begun work on a second phase — a smaller pilot plant that will send a clean stream of hydrogen through fuel cells and turbines to produce electricity, with carbon dioxide being captured for industrial use. The third phase, scheduled for 2015–20, will be a 400-megawatt power plant with full-scale carbon capture and storage in underground rock layers. That represents a substantial delay beyond the original completion date of 2015. Huaneng officials say that they revised the schedule in response to technical issues and delays to ▶

► CCS projects in other nations.

GreenGen was originally seen as a follow-up to FutureGen, the flagship US initiative that was promoted and then cancelled by former president George W. Bush. In 2009, President Barack Obama revived the project, but a business consortium has yet to settle on a home for it. Many are sceptical about whether FutureGen and other US CCS projects will come to fruition, given the inability of Congress to craft a comprehensive programme for reducing greenhouse-gas emissions.

The United Kingdom is also trying to renew interest in CCS. On 3 April, the UK Department of Energy and Climate Change relaunched a £1-billion (US\$1.6-billion) competition for companies to build CCS demonstration plants. An earlier initiative, launched in 2007, fell apart in 2011 when the last remaining consortium pulled out because of concerns over costs. This time, the UK government has encouraged companies by promising that electricity produced by CCS plants can be sold at premium prices, and it will also provide £125 million for CCS research and development.

Many countries still see potential CCS plants as one-off demonstration projects, but the United Kingdom is trying to create conditions for them to become commercially viable, says Stuart Haszeldine, a geologist working on CCS at the University of Edinburgh, UK. So far, seven consortia have publicly announced their interest in the contest, which aims to commission plants in 2016–20 and store carbon dioxide in porous rock under the North Sea.

Other well-advanced initiatives include Canada's Boundary Dam Integrated Carbon Capture and Storage Demonstration Project in Saskatchewan, a 100-megawatt project to retrofit carbon-capture technology to an existing power plant; and the Texas Clean Energy Project, a 400-megawatt integrated gasification combined-cycle plant that could begin operating in 2014. Both plan to sell carbon dioxide to oil companies, which use the gas to flush oil out of reservoirs. In the Netherlands, the Rotterdam Capture and Storage Demonstration project aims to begin storing carbon dioxide in depleted gas fields under the North Sea in 2015.

Howard Herzog, a carbon-storage expert at the Massachusetts Institute of Technology in Cambridge, says that the challenge facing the entire carbon-capture industry is how to turn a profit in the absence of a serious carbon policy that rewards emissions-reduction projects financially. "The question is whether there

is a CCS market anywhere in the world," Herzog says. "If there isn't, why develop the technology?" ■

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BUSINESS

Roche chases stake in medical sequencing

Biotech firm Illumina continues to resist takeover — but analysts suggest that a merger is inevitable.

BY ERIKA CHECK HAYDEN

Gene sequencing has mainly been the province of technology companies catering to researchers, but the pharmaceutical giant Roche, based in Basel, Switzerland, has other plans. It is increasing the pressure on Illumina, a DNA-sequencing company headquartered in San Diego, California, hoping to absorb the firm and use its expertise to capture the growing market in personalized medicine.

Roche proposed a merger in January, offering US\$44.50 per share, which Illumina's board rejected. On 29 March, Roche raised its bid to \$51 per share, for a total acquisition price of \$6.7 billion. Illumina's board rejected this offer, too, and adopted a 'poison-pill' provision that would give present investors the right to buy new shares at a reduced price, thereby diluting the value of Roche's shares if the deal goes through. But many observers say that the merger is all but certain. "If Roche really wants this, they are ultimately going to be able to make this go through," says John Haggerty, a mergers-and-acquisitions lawyer with Goodwin Procter in Boston, Massachusetts.

Roche's interest in Illumina stems from the latter's dominant position in genetic research; it claims that 90% of the world's sequencing is done on its machines. Roche believes that whole-genome sequencing is poised to become a lucrative diagnostic tool, and that Illumina will allow it to break into that market.

Illumina could benefit from Roche's vast sales

force, which would make it more competitive with its major rival, Life Technologies of Carlsbad, California. And Roche's experience in diagnostics and drug development could speed the translation of sequencing into the clinic, says David Ferreiro, a Boston-based analyst at the investment bank Oppenheimer. Manufacturers are eager to move from next-generation sequencing technology into diagnostic technology, and "Roche could do that a lot faster" than Illumina could, he says.

Yet Illumina has fought back, arguing to its shareholders that Roche's offer undervalues the company (see 'Down and up'). Illumina, which started out in the 1990s as a microarray vendor, came to dominate the sequencing market by steadily cutting the cost and improving the speed and ease of use of its products.

However, Illumina now has numerous competitors with new platforms nipping at its heels. The firm is cagey about what technologies could replace its current sequencing machines, even as the newcomers, such as Oxford Nanopore Technologies in Oxford, UK, are promising big leaps in the speed and price of sequencing — with the aim of attaining the \$1,000 human genome. Industry observers question whether Illumina's nimbleness will survive a Roche merger. They point to Roche's 2007 acquisition of sequencing company 454 Life Sciences in Branford, Connecticut, which has since failed to live up to hopes that it would capture a significant part of the market.

To up the pressure, Roche has nominated six people for Illumina's board of directors who, if elected by shareholders at the company's annual meeting on 18 April, might coax the board to work out a deal. But with advisory firms cautioning major shareholders to hold out, Roche will probably continue to raise its price to entice institutional investors and arbitrage traders, who bought Illumina shares expecting Roche to sweeten its offer. "It's just a matter of how much the Illumina board can force them into raising their price before the stockholders start accepting the offer," says Haggerty.

For Illumina, the end could be bittersweet. The company may be in a prime position to dominate the potentially lucrative clinical-sequencing market. But it may also see the end of its glory days as a key innovator in sequencing. ■

DOWN AND UP

Illumina's share price fell last year owing to gloom over biomedical-research funding. Roche's January bid boosted it, but only part way.

SOURCE: GOOGLE FINANCE