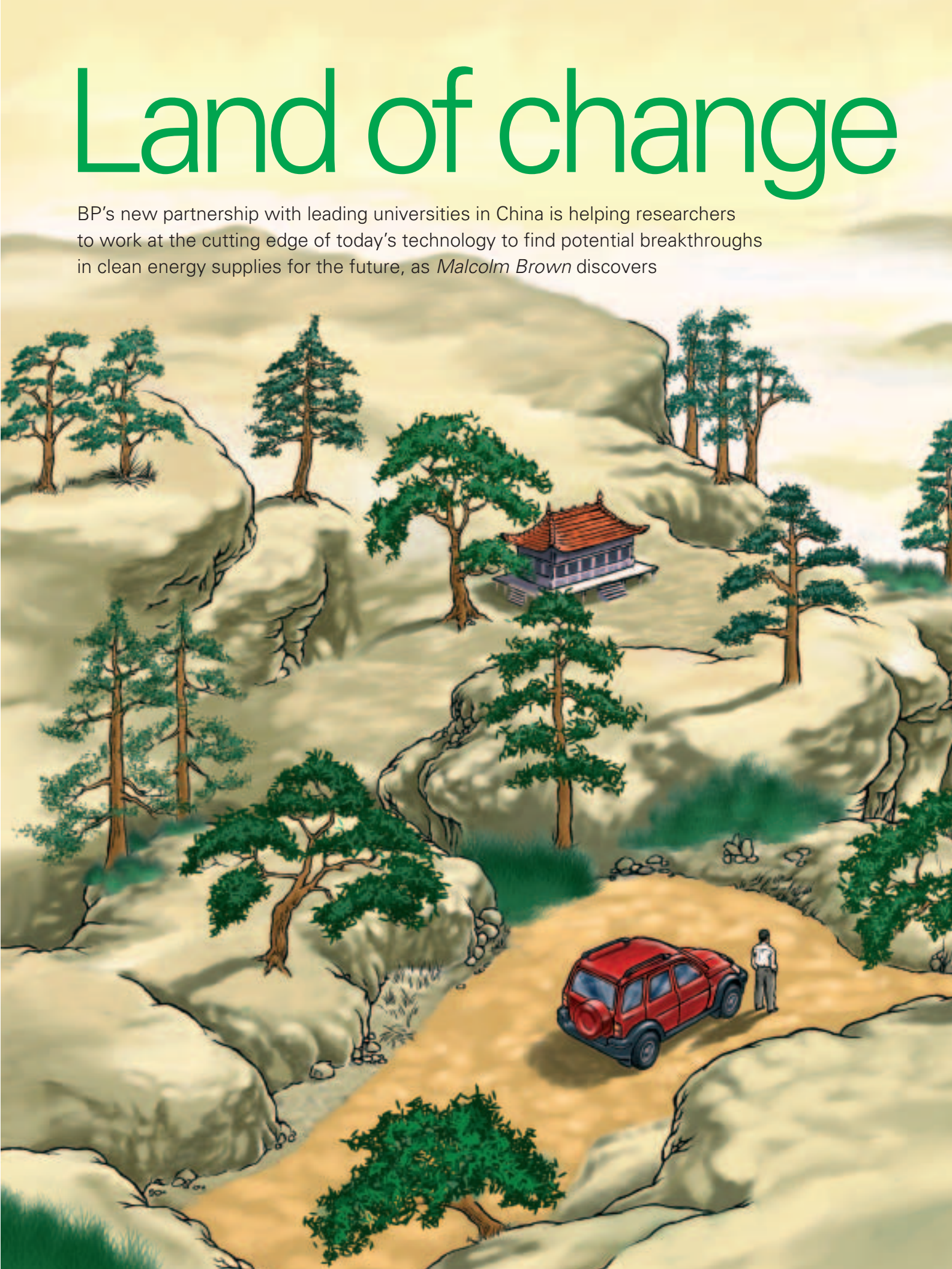
Land of change

BP's new partnership with leading universities in China is helping researchers to work at the cutting edge of today's technology to find potential breakthroughs in clean energy supplies for the future, as *Malcolm Brown* discovers



Give him another 12 months, says Steve Wittrig, and he should be able to carry on a simple conversation in Mandarin, the language spoken by two thirds of the people in China. He already has a vocabulary of about a hundred words and is beginning to understand the nuances of sound and tone that are an integral part of the language. But Mandarin is very difficult for an outsider to master.

'So far I'm just part of the dinner table entertainment, rather than being able to communicate in coherent form,' says Wittrig. 'But I'm working on it.'

He will have plenty of opportunity to practise his skills this year. As BP's link man for a 10-year partnership programme with the Chinese Academy of Sciences and three of China's top academic institutions, he has already made many visits to the country and expects to continue to do so.

China is an exhilarating place for anyone involved in the energy business, he says. There are major challenges and very big opportunities there. The Chinese economy is projected to grow at around six to eight per cent per year for some years to come and will need huge amounts of energy to fuel that growth. But there are constraints. On the one hand, the country is concerned about security of supply, so it does not want to import a large portion of its energy; on the other, its most abundant fuel is coal and heavy use of coal leads to severe pollution across the country.

The question facing China is how to meet an ever-increasing demand for energy without continued degradation of air quality and damage to the environment in general. The answer is technology. China has to find new technologies that will ensure that whatever the source – coal, natural gas or oil – the country's energy will be clean. >>

Traffic on Beijing's busy Chang'an Avenue – research in China's universities may bring clean diesel and fuel cell cars to the nation's highways

>> 'Technology is one of the best levers we have for addressing these balances between competitive growth, quality of life and energy security,' says Wittrig. 'The choices that are made now will have implications for decades.'

It was for reasons such as these that BP's chief scientist, Dr Bernie Bulkin, in collaboration with officials of the Chinese Academy of Sciences and the universities, decided that BP's newest university partnership, called 'Clean Energy: Facing the Future', should concentrate on two areas – energy strategy and new technologies.

'The two are interconnected,' says Bulkin. 'The first part looks at the strategies for meeting energy demand and builds models which ask: if we do this or that, what are the consequences? So there will be a sophisticated energy modelling centre that goes everywhere from local to national level. The second element covers laboratory, pilot plant and engineering work to look at new technologies that can respond.'

National interest

The basic premise is that the best way to solve China's problems is to use the most efficient clean technologies available today, and focus development efforts on stretching even beyond current technology. But to achieve what China wants to achieve needs a sound understanding of what can be done with today's clean fuels and technology, as well as a focus on what can come from the next wave of new technologies.

The strategy part of the programme is based at Tsinghua University in Beijing, where BP's money is helping to fund the new Centre for Clean Energy Policy Studies. The Centre is bringing together economists, engineers and scientists to try to determine what China's energy profile will look like in the future.

'The making of energy policy is now distributed among several ministries and many government agencies,' says Gary Dirks, president and chief executive, BP China. 'The Centre has the potential to be a focal point, drawing together representation from government, industry and academia to develop coherent policy options for consideration of the most senior national leaders.'

The new partnership between BP and China's universities concentrates on energy strategy and new technologies

Tsinghua University is determined to become a centre of excellence in the study of energy policy for China. 'The people we are working with are very well respected and therefore looked to as the experts, not only in the academic community, but by decision makers and those that set state policy as well,' observes Wittrig.

The benefits to China are obvious, but BP expects to benefit too by getting an insight into how China's energy models work and how decisions about energy policy are formed, communicated, and challenged. This should help the company to judge which energy businesses and fuels will be important as China grows. BP has had a presence in China for the best part of three decades through its four heritage companies – British Petroleum, Amoco, ARCO and Burmah Castrol. China is central to BP's core growth strategy and the company has business activities across the full range of its portfolio – in upstream, gas and power, downstream and chemicals. BP is one of the leading foreign investors in China, having spent $4 billion on a number of commercial projects since the 1970s.

Top quality

The technology part of the programme is centred mainly at two institutes of the Chinese Academy of Sciences: the Dalian Institute of Chemical Physics and the Shenyang Institute of Metals Research, both in northeast China.

Some of the projects that BP is sponsoring in the first years of the project are addressing ways of radically improving

the Fischer-Tropsch process for converting coal or natural gas to clean diesel fuel; new methods for hydrogen storage which could make fuel cells for transportation more feasible; and the direct conversion of methane to aromatics and hydrogen.

The Fischer-Tropsch process takes coal or natural gas, breaks it down into synthesis gas (a mixture of carbon monoxide and hydrogen) then reassembles the synthesis gas into long chains of hydrocarbons to make clean diesel fuel (*Frontiers*, December 2002). A team at the Dalian Institute is testing catalysts which could completely eliminate one of the steps in the process and significantly reduce the cost of building conversion plants.

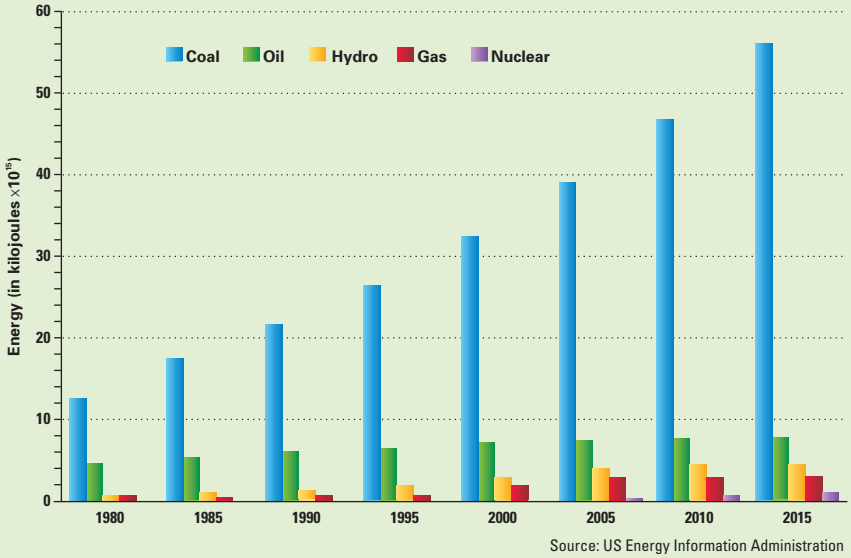
The idea is high risk, says Bulkin, but it could change the economics of the process. 'That's what we look for in some of our university programmes. We don't want purely incremental research. We want something that's really a bit higher risk, but with a big pay off.'

Several of the catalysts look promising and the next step will be to bring them to BP's research laboratories at Sunbury for further testing.

The hydrogen storage experiments, which are taking place at the Shenyang Institute, are exploring the potential of a new form of carbon called nanotubes. Several laboratories around the world are working on carbon nanotubes, tiny cylindrical structures capped at each end, which might be developed into very efficient hydrogen absorbers. Researchers at Shenyang are among the best in the world at producing, modifying and characterising various types of carbon nanotubes. The team there is working on new techniques and nanotube types to optimise their hydrogen storage capacity. Experts believe this could eventually lead to hydrogen powered cars. The hydrogen would be stored in nanotube-filled fuel tanks and fed directly into fuel cells, cutting out the need for an on-board reactor unit to make the hydrogen (*Frontiers*, August 2002).

Madame He Meiying, vice president of Tsinghua University and director of the Tsinghua Education Foundation, and Gary Dirks, president and chief executive of BP China, launch the new partnership

Energy production in China, by fuel type



Source: US Energy Information Administration

The work at Dalian on the direct conversion of methane to hydrogen and aromatics – again utilising novel catalysts – is being led by Professor Xinhe Bao, who is not only Director of the Dalian Institute but also leads the 'Clean Energy: Facing the Future' programme.

Professor Bao says he and his colleagues at the Dalian Institute are proud to be working with BP, which they regard as the leading energy company in the world.

'I'm always impressed by BP's sharp ideas, not only about the details of the programme as such, but also about energy strategy in China,' says Bao.

Polygeneration

Another project, which neatly bridges the work at both Tsinghua and Dalian, is the so-called polygeneration project, co-ordinated by another of Bulkin and Wittrig's key contacts, Professor Ni Weidou of Tsinghua University.

The idea behind polygeneration is to get the optimum mix of products from coal. One of the primary technologies enabling the possible clean use of coal is coal gasification. Coal gasifiers produce synthesis gas which can produce electricity efficiently in modern power plants, or can produce clean fuels and chemicals. The Chinese researchers say we should stop thinking about producing only one product at a time. We should think of systems that utilize the syngas for producing a mixture of products, similar to a refinery.

'Our Chinese partners, in collaboration with researchers BP is supporting at Princeton University in the USA,' says Bulkin, 'have said they want to think about this not as a process for making chemicals, or a process for making fuel, or a process for getting energy out. They want to think about it as a way to do all of these things, optimising whatever situation you're in.

'For example, you might say: the price of fuel has gone up, I want to make more of that relative to these chemicals; or if I need to soak up some of the excess energy I can do that; or if I have a demand for more electricity I might want to sacrifice some of the fuel making, and so on. We can optimise all of these and design for very flexible processes.'

Researchers at Tsinghua are already working on models of what they call Syngas City to see whether coal-based polygeneration could meet all the needs of a large urban area. BP's own expertise and interests in syngas chemistry and its applications should help it determine whether these developments could be important aspects of its business in China in the future.

The 'Clean Energy: Facing the Future' programme is only a year old, but Bulkin is immensely impressed by what has been achieved in that short time. He admits that when he started thinking about the possibility of partnerships with Chinese universities he was not at all sure BP would find the quality of science it wanted.

'When you talk about the institutions we are supporting – Princeton, Cambridge, Imperial College, Caltech, the University of California at Berkeley – these are top, world-class institutions. We said we'd like to do something of an equally high standard in China. We have discovered that the high quality expertise needed to research and develop a clean energy strategy certainly exists in China's universities.' ■

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