[SPECIAL REPORT]

Inside China

The country has raised the hopes of outsiders before – and dashed them – and nowhere has the gap between potential and actual returns been greater. But with the economy booming, Western investors are being lured back, attracted by that elusive creature, the urban consumer

KEVIN FOY / ALAMY

The burning question

Its willingness to find a solution to its massive power consumption has made China the green energy laboratory of the world

BY Emilie Filou

The view from David Dollar's office on the 16th floor of a Beijing tower is of street after street of gridlocked traffic on a smoggy backdrop. What the World Bank country director for China sees from his window has become symptomatic of a country going through an unparalleled energy bender. With economic growth nearing 10% a year over the past 20 years, and similar predictions for the next 15 years, China's energy consumption is of gargantuan proportions. It is now the world's second biggest power user. Its energy consumption has doubled since 1992 and is predicted to repeat the performance by 2020.

The crux of China's energy challenge has always been to find enough fuel for its power-guzzling economy. The answer so far has been coal: it is cheap and China has plenty of it – the world's third largest reserve. The trouble is that it is also the dirtiest fuel available and years of frantic coal burning have come at a considerable environmental cost. Burning coal generates pollutants such as nitrogen oxides, sulphur dioxide (SO_2), particles and ash. It also releases large amounts of carbon dioxide (CO_2), one of the main greenhouse gases contributing to global warming – about 2.9 tons for every ton of coal burnt. In 2004, China burnt 1.9 billion tons of coal; by 2020, it will be 2.9 billion. The increment alone will generate as much CO_2 as 2 billion Ford Fiestas, each driven 10,000km a year – a figure that dwarfs the West's token efforts to cut emissions.

Nitrogen oxides and SO_2 gases generate very high levels of air pollution. China now has 20 of the 30 most polluted cities in the world. Acid rains – caused by a reaction between sulphur dioxide, oxygen and water – are also a common feature. It is estimated that pollution costs the country about 10% of its GDP in health costs and environmental degradation every year. In 2005, that figure was more than $220 billion, the GDP of Greece. China's challenge is two-fold: to secure supplies and to do it green. The country currently obtains 70% of its power from coal, and while there are countless experiments providing clean power at micro or even small scale, China's size pushes the experiment to the boundaries of green energy know-how.

In that sense, renewables are not as obvious an alternative as they sound, although the Chinese government has high expectations of renewable energy and has set ambitious targets (*see box*) in its 11th five-year plan. Klaus Lackner, a geophysicist at Columbia University, is a little sceptical. Renewables, he says, have a finite capacity that is not enough to cope with China's needs. The only exception is solar power, which has the potential to generate about 50,000 times the world's energy needs. Although it is the fastest growing energy sector, solar power is also the most expensive at $10,000 per kW (kilowatt). In comparison, traditional coal burning costs about $500. Large-scale solar power projects are rare, but there has been considerable progress in micro-scale off-grid provision, particularly for water heating. China now accounts for more than 60% of the world's total solar hot water/heating capacity.

Wind power looks a more promising bet. It has the capacity to generate about twice the country's needs and it is relatively competitive at $600-$700 per kW. Installed capacity is only about 1.3GW (gigawatt), but the government is aiming for 30GW by 2020. Conscious of the herculean task of meeting this 23-fold increase, the government passed the groundbreaking Renewable Energy Promotion Law in February 2005 to promote and facilitate investment in renewable energy projects.

It also pledged to spend $188 billion on renewables: that kind of money would buy you an oil firm the size of ConocoPhilip and leave change for several renewables companies in Europe and China. Such pledges have had a very positive effect on the renewables market and alternative energy portfolio managers are having a field day, with major investors such as Morgan Stanley and Goldman Sachs entering the market. Several emerging Chinese players such as Goldwind, Suntech and Yingli Solar are also involved in promising IPOs in the US.

European players are taking advantage as well. Vestas, the Danish company leading the wind power sector, opened its first factory in China earlier this year (to manufacture wind turbine blades) and is scheduled to open three more next summer. "This is our biggest investment outside Denmark," says Thorbjørn Rasmussen, president of Vestas Asia-Pacific. "The new law is a confirmation it really means business. This is one of the reasons why Vestas has invested in manufacturing in China."

Other renewables have not enjoyed as much success. Although hydroelectric power has huge potential (300GW by

Left: David Dollar, country director, China, at the World Bank
Right: Klaus Lackner, a geophysicist at Columbia University

2020, 10 times more than wind), it comes with its own baggage. The Three Gorges Dam can hardly be described as a resounding success: scheduled to be completed by 2009 and generate 18GW of power (just over 3% of China's energy needs), it has already displaced more than 1 million people and will irreversibly alter the environment for hundreds of miles around.

Mike McElroy, professor of earth sciences at Harvard University, says, however, that technologies such as micro-hydro (globally producing less than 100kW, of which more than half the world's capacity is in China), just like solar power, will be invaluable in remote areas where there is no connection to the national grid. In fact, micropower already generates more power worldwide than nuclear, so its scope is substantial.

Transport fuel production from biomass (ethanol and methanol) has been restricted by access to feedstock supplies, mostly corn and soybeans. Philip Andrews-Speed, professor of energy policy at Dundee University, says that a very promising alternative is cellulosic fuel, which uses an enzyme to convert a much larger range of feedstock – from the stokes of corn to hay to wood dust – into ethanol. This implies that pretty much any kind of biomass could be turned into fuel, giving a new strategic dimension to those millions of square miles of grassland.

Nuclear and gas are the other options: China currently has eight nuclear plants under construction, but considering the lead time of nuclear power plants, the astronomical capital investment required and the controversy over its 'green' credits (nuclear waste), most experts are unsure about the fate of nuclear in China. Its target is for 40GW by 2020, which would be just over 5% of its total capacity. As for gas, in 2002, before gas prices tripled, the country had plans to expand its grid and import liquefied natural gas (LNG) from Australia. China has now scaled back on its LNG installations on the east coast and the long-awaited pipeline from Russia has been delayed.

Coal is needed to fill the bulk of China's needs. With oil prices reaching record levels, the economic argument for coal is persuasive, especially considering its plentiful supply. "Under any projection, this country will be relying on coal burning for a long time," says Dollar. "The trick is to make it more efficient."

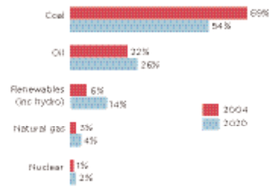
China has scores of antiquated power stations, many just 30% energy-efficient and about as effective in controlling emissions as a sieve. Retrofittings – which consist of upgrading the plant with filters, scrubbers, precipitors and so on – have been used to reduce pollutants, with some success. China is also replacing its most polluting plants at the rate of one new plant every four days, mostly with new Combined Heat and Power (CHP) power stations, which not only pollute less but also use the heat generated during combustion for power generation.

Coal gasification is the latest technology to use coal more efficiently. Integrated Gasification Combined Cycle (IGCC) makes coal react with oxygen and steam to form a 'syngas'. This is then cleaned and burned in a gas turbine to generate electricity and steam, which in turn is fed into a second turbine. IGCC plants are 50% efficient and because CO_2 forms at more concentrated levels than during conventional burning, its capture, with a view to storing it, is easier.

Carbon sequestration (long-term storage) has long been viewed as the only solution that could redeem our planet from our energy excesses. Nick Mabey, chief executive at consultan-

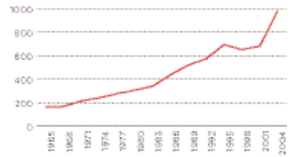
CHINA'S ENERGY

Sources of energy



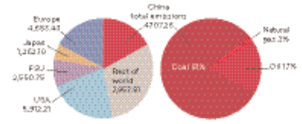
Source: 2004 data EIA; 2020 data World Energy Outlook, 2005 edition, International Energy Agency

Coal consumption (m/tons)



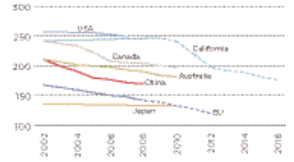
Source: BP Statistical Review of World Energy 2006

CO_2 emissions from energy activities, 2004 (m/metric tons)



Source: EIA International Energy Annual

World car emission standards (g CO_2/km – converted to NEDC test cycle)



Source: Pew Center on Global Climate change, 2004

Left: Amory Lovins, co-founder of the Rocky Mountain Institute
Right: Thorbjørn Rasmussen, president of Vestas Asia-Pacific

The Three Gorges dam, which will generate just over 3% of China's energy needs, has already displaced more than 1 million people

cy e3g, says that the main barrier to turning sequestration into an everyday reality is political, rather than economic or technological. "This is serious industrial geology, but several companies have the technology to do it," he says.

This has only been dabbled with so far: the US has injected CO_2 into the ground for oil extraction and Norway has been storing CO_2 in the North Sea for a few years. Deep sea storage, at depths of 3,000m-4,000m, would also submit the gas to such pressure that it would become gravitationally trapped. "Drilling at these depths is unusual, but not unheard of," says Lackner.

The real next big thing, though, is liquefied coal – or so the Chinese government says. Coal to liquid technologies (CTL) – which turn coal into synthetic fuel for use in motor vehicles – have been around for some time, but have been used on a large scale only in Germany and South Africa. Both countries suffered periods of international isolation during which they could not import oil and had to rely on their own ingenuity to keep the country running. The solution came in the form of coal, of which both countries had plenty.

South Africa has led the way since and Sasol is now the world leader in indirect liquefaction (where coal is gasified first). It recently signed a co-operation agreement with Chinese state-owned coal company Shenhua to study the feasibility of two 80,000 barrels-a-day CTL projects west of Beijing. Shell is involved in a similar project for a plant producing 70,000 barrels a day in the western region of Ningxia. The problem is that CTL releases 80% more CO_2 during the conversion process than is released in the extraction and refinement of liquid fuel production from petroleum. So while it may reduce pollution, it compounds global warming.

Shell wouldn't comment on its 'clean coal' technologies, but in a statement the company pointed out that CTL was in line with the country's energy policy of safeguarding its interests. CTL is a good way for China to use its vast coal reserves while bypassing oil exporters and international oil prices. According to Sasol, 15 CTL plants could replace close to 15% of China's fuel imports by 2020.

The best solution might be to turn the problem on its head and look at it from the demand side. What could China do to reduce its energy needs in the first place? Amory Lovins, a resource analyst and co-founder of the Rocky Mountain Institute, Colorado, says that China spends 20 times more on energy supplies than energy efficiency. "I would like to see that trend flip," he says. "Supply-side investment is grossly uneconomical and environmentally dangerous."

The answer, it appears, comes from changing incentives. Consumers across the world are still rewarded for what they spend rather than what they save. Lovins argues that developers in China should be given incentives to build energy-efficient buildings, such as the utility company paying for the grid connection. Investing in energy efficiency would also provide China with extra benefits, says Lovins. "Electric efficiency takes a thousand times less capital and repays 10 times faster than increasing electric supply. I don't know where else to get macroeconomic levels that big."

Another target of the 11th five-year plan is to reduce energy intensity (energy per unit of GDP) by 20% by 2010, about 4%-5% a year. China has already managed this: between 1977 and 2001, the country cut its energy intensity by 5.2% a year. But to maintain this pace, it will need more than just policy tinkering. Andrews-Speed notes that the country's energy intensity has actually risen by 1.8% this year, owing to the number of large-scale construction projects and the relative cheapness of coal.

Dollar says that environmental standards imposed on new buildings in China are relatively high compared with other countries. The problem is that they are not always enforced: the country is vast and local governments have their own agenda, so it can be hard for central government to keep tags on everything that is going on. "If you are worried about your ability to enforce, then pricing is the solution," says Dollar.

This is exactly what China is doing. It has repeatedly raised the price of energy and been very proactive at making cars more efficient. McElroy says it played a leading role in banning leaded petrol and is considering a ban on MBTE (the lead substitute used to increase the octane rating of gasoline, and now considered carcinogenic and a water pollutant). It has also introduced strict limits on car emissions, much higher than those of California, which is often regarded as a green model (*see graph*).

The country has also ploughed ahead with innovative projects such as a new 'eco-city' (*see box*) near Shanghai. Dongtan will be the world's first sustainable city. Much of its efficiency is down to clever design, but Chris Twinn, one of the project directors at engineering firm Arup, says the political backing Ove Arup received made all the difference. "This would be impossi-

DAVID MARLOW; XU XUEZHE / ALAMY

Dongtan, the world's first eco-city, comprises three villages and aims for an energy-neutral lifestyle for its 50,000 inhabitants

ARUP

ble for us to achieve in Europe," he says. "There are too many checks and balances."

Lovins believes the West should take a leaf out of China's book. "Their culture has 5,000 more years of history, they have five times as many brains as we do, they have a better framework for energy reform than the West and they have more motivation," he says. "China could lead the world in energy."

McElroy also points out that China hasn't always received the right kind of support from the international community. "The relationship between China and the US government is co-operative, but the message they are giving is in coal and clean coal technologies," he says. "It would be better instead if China was getting more help in urban planning and coal alternatives."

The international community can ill afford to ignore China. The US Energy Information Administration predicts that China will experience the largest growth in CO_2 emissions in the world between now and 2030. By exporting its factories to China, the West also exported most of its energy-intensive processes. Li Zheng, founder and director of the BP-Tsinghua Clean Energy Research and Education Centre, says that developed countries have a responsibility to pass on their technological know-how rather than market it to China.

China also has incentives of its own. Local air and water pollution have been an increasing source of discontent among inhabitants, and the country is eager to clean up its act before the 2008 Beijing Olympics and Shanghai's 2010 Exhibition.

If CO_2 had a price, says Lackner, things would be very different. Dollar agrees: "Carbon trading has turned into an unexpected windfall for China." As an emerging country, China is not committed to emission reductions under the Kyoto agreement, but that doesn't mean it can't benefit. In a recent project, the World Bank organised the 'sale' of $900 million worth of CO_2 from a new energy-efficient steel plant in China to the Carbon Trust based in Italy. "We certify emission reductions and pass them on to other countries to 'use'," says Dollar.

Through its willingness to try anything, China has become the world's energy experiment lab. Chinese premier Wen Jiabao trained as a geologist and knows only too well the conflicting interests between the economy and the environment, and the difficulty of converting theory into practice. The question is whether these efforts will amount to anything in the face of China's daunting problems. n

SUSTAINABLE LIVING

Dongtan should be the world's first city to reach the holy grail of sustainability: carbon neutrality. Located on China's third largest island at the mouth of the Yangtze river, it will be about a third the size of Manhattan, with a population of 50,000 to start with and 500,000 by 2040.

The eco-city was commissioned by Shanghai Industrial Investment Corporation (SIIC) and is designed by engineering firm Arup. Most of its efficiency comes down to innovative design. "New developments can multiply consumption by a factor of 10 with modern constructions," says Chris Twinn, one of the project directors. "So we've tried to keep energy needs to more modest levels. Then we can consider renewables, which have a more finite capacity."

Dongtan will be a city of three villages. By making the design compact, Arup has ensured that lifestyles will be energy-neutral: people will be able to walk or cycle, and for longer distances, a comprehensive public transport system running off renewables, such as solar powered water taxis and hydrogen fuel-cell buses, will be available.

Arup was also careful to include the city's hinterland in the project; for instance, Dongtan's main power station, a CHP plant, will use the husks of rice produced around the city. The power station is predicted to generate 40MW; the remainder will come from a large on-site wind turbine.

Twinn says that the project would not have been possible without the political backing of the local government. "That's why we have been able to do things that had only been dabbled with before. We pretty much wrote the building regulation, which allowed us to reduce the city's energy demand by nearly three-quarters."

Most modern buildings use electricity even though it is one of the least efficient forms of energy available; it is only 12%-15% efficient to heat water compared with 65% for solar water heaters. Arup is also committed to offsetting the emissions generated by corporate travel over the course of the project to keep in line with the project's sustainability.