BUILDING THE WORLD'S NEW INFRASTRUCTURE

Engineering and technological marvels are cropping up all over the world as ambition and demand for ever-more advanced infrastructure grows, writes Silvia Pavoni

Infrastructure projects span from the economically catastrophic Channel Tunnel – which cost double initial estimations, was almost two years late and had an overall negative impact on the UK economy – to the Guggenheim museum in Bilbao, Spain, delivered on time, on budget and now generating twice the revenue anticipated. But these are the extremes and the monumental projects that have been developed in recent times are both pushing the boundaries of modern engineering and have shown improved risk assessment, management practices and financing abilities.

The need for infrastructure is evident in the developing world and the need for its continued modernisation has become apparent too. The Organisation for Economic Co-operation and Development says that spending for basic infrastructure alone (which does not even include developments such as airports) will account for 3.5% of global gross domestic product (GDP) each year through to 2030. "In terms of scale, infrastructure development is one of the big challenges of the 21st century," says Nick Chism, KPMG's partner and global head of infrastructure. KPMG estimates infrastructure spending will be between 4% and 6% of global GDP in the same period, which would total more >>

than $30,000bn. Furthermore, the sector seems not to have been significantly affected by the credit crunch.

"There has been some spread widening in project finance but not as much as what we have seen on the corporate side," says Zahid Qureshi, senior vice-president of Mizuho's project finance team for the Americas. "What we have seen is a tendency to work on a club basis, rather than single-bank underwriting – if you are looking at deals greater than $500m there aren't so many banks that are willing to fully underwrite on a standalone basis, especially in current markets."

Others are slightly less optimistic. "For projects of reasonable size, financing is not an issue," says Oliver Delfour, managing director and global head of global infrastructure and project finance at Fitch. "For the big tickets, it is a bit more of an issue as the capital markets are not very active at the moment." But the current credit market troubles seem a temporary, minor hurdle compared to the driving forces and ambitions behind some projects. Megaprojects have been coming to the market more frequently and this trend is unlikely to end.

"We see more and more megaprojects and larger megaprojects," says Professor Bent Flyvbjerg, who teaches planning at Aalborg University in Denmark, chairs the infrastructure policy and planning department at the Delft University of Technology in the Netherlands, and has studied more than 300 infrastructure projects worldwide. "This has been the trend over the past two decades and I don't see anything that would stop that right now."

This trend is driven by various factors. First, there is a technological drive, as the engineering ability to develop larger projects is growing. Second, financing sources are increasing. "The capabilities to finance megaprojects have exploded over the past few years," says Professor Flyvbjerg. This is true for both the public and the private sector, with geographical variations – in China the explosion comes from public money: China is now building more roads than the rest of the world combined. "[Despite regional differences] in total, globally, there is more money than there has ever been before."

Record breaking

The most powerful dam in operation, the Itaipù Dam on the border of Brazil and Paraguay, stretches across 7.7 kilometres (km), has an installed capacity of approximately 14,000 megawatts (MW) and was built for a total cost of $18bn. Although some transparency issues on the accounting of the project have still to be resolved, the dam retains its engineering record. The record, however, first achieved in 1991, is being challenged by even more ambitious plans, by not one but two hydroelectric projects: the Three Gorges Dam with a planned capacity of 22,400MW by 2011 (18,000MW by 2009) and an estimated construction cost of $25bn; and the Grand Inga dam in the Democratic Republic of the Congo (DRC), with a planned capacity of 39,000MW at an estimated cost of $80m. Grand Inga would include the existing Inga I and II dams, which operate at a low capacity – and it would increase their output and create a third hydroelectric station. The development is at the centre of a partnership between a number of African countries, which envisions the interconnection of electric grids of the DRC, Namibia, Angola, Botswana and South Africa.

Both of these projects have serious social, environmental and political issues that must be solved before they can be launched and considered for international financing. The Three Gorges Dam has attracted substantial concerns about environmental damage and the displacement of local populations. "International banks would find it difficult to finance projects such as the Three Gorges Dam if they are signatories to the Equator Principles," says one senior banker. "Local banks might have different views." The Grand Inga project, on the other hand, has been in the pipeline for many years without coming to fruition. This is not surprising given the DRC's turbulent history and ongoing instability, and the government's poor track record regarding project oversight, infrastructure maintenance and revenue management. But there is also an agreement between China and the DRC, which was recently announced, whereby China would help the DRC to develop its infrastructure, including dams, in exchange for 10.62 million tonnes of copper and 620,000 tonnes of cobalt. The deal is valued at $9.25bn and would have to overcome significant operational challenges in a country as big as western Europe, left in conflict and political turmoil by decades of dictatorship, and with fewer than 5000km of tarred roads.

> **'We see more and more megaprojects and larger megaprojects. This has been the trend over the past two decades'**

The financing of projects is also becoming increasingly ambitious and involves new skills and knowledge that allow lenders to get involved with riskier structures. Remaining in the hydroelectric power sector, the 360MW Magat hydroelectric power plant in the Philippines disappears next to the Itaipù Dam in terms of size, but its $530m privatisation has nonetheless broken some significant ground. A group of international and local banks and some development banks, including HSBC, China Banking Corporation and Banco de Oro, have taken commercial risk on the project – the first time that this has been done in a competitive electricity market in Asia, excluding Singapore. The $380m financing has a non-recourse structure, no shareholder guarantee, no political risk insurance and no insurance for commercial risk beside standard covers. Following the success of the deal, which financially closed in 2007, two other privatisations were launched.

On a bigger scale is the Nam Theun 2 hydroelectric project in Laos, which has a cost of $1.25bn and has a 1070MW power capacity. Although in the minor league of megaprojects, this development highlights a characteristic of many such ventures: a significant contribution to the national GDP and a cross-border nature. Nam Theun 2 will sell 95% of its electricity production to Thailand, representing a significant step in the co-operation between the two countries, and it is expected to contribute an extra 10% to Laos' GDP.

"A big, successful infrastructure project can have a huge impact on the economic development of the host country," says Conor McCoole, managing director and head of >>

TOP 10 MOST DARING PROJECTS OF THE MODERN WORLD

WHETHER OPERATIONAL OR under study, these projects are fine examples of the infrastructure ambitions of modern times. Engineering and technological marvels, these projects had or will have to take commercial and environmental considerations into account, however, to be fully successful.

TRANS-TEXAS CORRIDOR PROGRAMME

The Trans-Texas Corridor (TTC) is a proposed multi-use, statewide network of transportation routes in Texas that will incorporate existing and new highways, railways and utility right-of-ways. The aim is to form a connection between Mexico and the Gulf coast on one hand and Oklahoma and Louisiana on the other hand. Specific routes for the TTC have not been determined yet.

Status: planning. **Total cost:** $185bn. **Sponsor:** Texas Department of Transportation. **Completion:** 2058.

PANAMA CANAL

Project to widen the canal and increase its capacity, as many modern tankers are now too large for the 80km route. It is estimated that 5% of the world's trade passes through the canal and demand for the 'post-panamax' vessels has increased significantly in recent years due to efficiencies gained with containerised cargo. The project will facilitate the fast-rising flow of Asian products to the US market on the Atlantic coast. Mizuho is advising Panama's government and bids are being put forward.

Status: negotiation. **Total cost:** $5.25bn. **Sponsor:** Autoridad del Canal de Panama. **Expected financial close:** end of 2008.

SIX ECONOMIC CITIES IN SAUDI ARABIA

Project to build six new cities in Saudi Arabia, attract industry and create one million jobs. The country is hoping to attract non-oil foreign direct investment with this development and the cities are expected to contribute $150bn to the kingdom's gross domestic product. The King Abdullah Economic City on the Red Sea coast north of Jeddah was the first to be launched and will be the biggest. The 'knowledge' city on the edge of Medina; Jizan city near to the south-western tip; and Hall, which lies in a remote area in the north, have also been launched.

Status: under construction. **Total cost:** $170bn (for all six cities). **Sponsor:** Saudi Arabian General Investment Authority (Sagia). **Completion:** end of 2008 for first city.

MASDAR ZERO-CARBON CITY

A zero-carbon, zero-waste city, Masdar aims to prove that technologies now available, such as carbon capture and storage, biofuels and solar energy, are viable and cost-effective options. The 6.5 sq km district aims to attract 1500 businesses and 50,000 residents. Fosters and Partners are the appointed architects.

Status: under construction. **Total cost:** $22bn. **Completion:** 2016.

MESA POWER'S WIND PROJECT

Wind farm in Texas, which, with a capacity of 4 gigawatts, would become the largest in the world and produce as much energy as two commercial-scale nuclear plants, enough to provide power to one million houses.

Status: under construction. **Total cost:** $10bn. **Sponsor:** Mesa Power.

INDIAN NATIONAL HIGHWAY DEVELOPMENT PROGRAMME

The programme plans to build about 31,755km of roads in India, which are essential to the country's economic development. The project was launched about 10 years ago and has seven phases. The Golden Quadrilateral, linking four major cities, and an east-west corridor running the breadth of India, is almost complete.

Status: under construction. **Total cost:** $71bn. **Sponsor:** National Highways Authority of India. **Financing details:** government funds and market borrowing. **Completion:** first phase has been completed; the final phase, phase seven, and ancillary works on previous phases, will be completed in 2015.

OLKILUOTO III

First new nuclear plant to be built in Europe in the past 20 years. Uses the latest European pressurised water reactor technology, which is considered among the the safest in the world. The project also offers an interesting example of an innovative financing structure through the adoption of the Finnish 'Mankala' principle.

Status: under construction. **Total cost:** €3bn. **Sponsors:** TVO. **Financing details:** €1.95bn syndicated revolving credit facility arranged by BayernLB, BNP Paribas, Handelsbanken, JPMorgan and Nordea and €550m-worth of bilateral loan commitments; €587m facility guaranteed by French export credit agency Coface was arranged. **Completion:** 2011.

ITAIPÙ DAM

This is the most powerful hydroelectric development in operation. On the border of Brazil and Paraguay, the dam stretches across 7.7km and shifted the course of the world's seventh largest river, the Panama River. It has 18 generators and an installed capacity of approximately 14,000MW.

Status: operational. **Total cost:** $18bn. **Sponsor:** Itaipù Binacioal. **Other investors:** Beside Paraguay and Brazil governments, investments came from local and multinational corporations including the US, Argentina and Italy. **Completion:** 1984.

BAKU-TBILISI-CEYHAN (BTC) PIPELINE

An extremely complex project involving Azerbaijan, Georgia and Turkey, the BTC pipeline solves a crucial energy transport problem by taking oil from the Caspian Sea to the Mediterranean instead of using tanker transport along the Black Sea and the highly congested Bosporus, obviating 350 tanker cargos a year through this narrow waterway.

Status: operational. **Total cost:** $3.7bn. **Sponsors:** BP, Socar, Unocal, Statoil, Turkish Petroleum, ENI, TotalFinaElf, Itochu, Inpex, ConocoPhillips, Delta Hess. **Financing details:** $2.6bn of debt financing; ABN AMRO, Citigroup, HVB, Mizuho, Royal Bank of Scotland, Société Générale are the lenders; Deal financially closed in 2004. **Completion:** 2005.

CHANNEL TUNNEL

An engineering marvel, the 50.5km tunnel, running 40 metres below the seabed, provides high-speed rail links between the UK and France. The project has had a tumultuous commercial past.

Status: operational. **Total cost:** $14.7bn; $9.65bn for the first phase. **Sponsors:** the managing company is Eurotunnel. The initial sponsors were Railtrack, Ove Arup, Virgin Group, National Express Group, SBC Warburg, Sir William Halcrow, Bechtel, London Electricity, Systra. **Financing details:** the deal was financially closed in 1998 through credit facilities and bond issues at a total value of £3.35bn ($6.55bn).

project finance, Asia, for Standard Chartered, which participated in the deal. The other eight international banks that have provided financing are ANZ, BNP Paribas, BOTM, Calyon, Fortis, ING, KBC and Société Générale. Furthermore, "if a country is supplying energy to its neighbour or allowing a pipeline through its territory, this binds both countries together", says Mr McCoole.

Cross-border and national influence

The impact on the national economy and on international relations is indeed a characteristic of infrastructure projects, even more so for megaprojects. The Baku-Tbilisi-Ceyhan (BTC) pipeline project does not only directly affect the land of three countries, it also impacts upon their economies and strengthens political relationships. The pipeline takes oil from the Caspian Sea to the Mediterranean instead of using tanker transport along the Black Sea and the highly congested Bosporus, obviating 350 tanker cargos a year through this narrow waterway. The project was a much-needed solution to the energy transport problem in the area.

The $3.6bn project's total cost was not as staggering as some of the other newly planned developments but its complexities still caused a few headaches to the lenders involved. The project involved 12 sponsors, seven export credit agencies, two development banks and 15 banks. "It was the most complicated project I had ever seen," says Robin Baker, Société Générale's global head of project and reserve-based financing for the energy sector. Mr Baker recalls that at the first bank meeting there were 76 people. "The general rule is not to try to do a deal with so many parties because you think it will never get closed," he says. But he adds that the strong rationale of the project, the robust political support and the sponsors' household names (BP, Socar and Chevron among others) helped the project to take off.

The co-operation among lenders helped too. Besides Société Générale, the other mandated lead arrangers were ABN AMRO, Citigroup, BNP Paribas, Calyon, Dexia, HVB, ING, Intesa Sanpaolo, KBC, Mizuho, Natixis, Royal Bank of Scotland, UniCredit and WestLB. The development banks involved were the European Bank for Reconstruction and Development and the International Finance Corporation.

Following this project, two further transport arteries are already under way: the Baku-Tbilisi-Erzurum gas pipeline that will serve a similar purpose to BTC, and the Baku-Tbilisi-Kars railway project. The railway link is considered of regional importance as it will enable Chinese goods to reach the European market in a faster and cheaper way, according to Heydar Babayev, Azerbaijan's minister for economic development. There are also talks about Turkey's plans to build a tunnel for a rail link to Europe.

Also of enormous cross-border significance is the $5.25bn Panama Canal project. After years of debate and a 2006 referendum in favour of the development, preliminary works started in September 2007 to widen the canal and increase its capacity. Many tankers are now too large for the 80km route and the project's supporters say that the modernisation is vital to maintain trade and it will create 7000 jobs. Opponents, however, have attacked the development, saying that it will damage the environment and have a negative economic impact on the country's poorest people. It is estimated that 5% of the world's trade passes through the canal and demand for the 'post-panamax' vessels (those too large to pass through the existing locks) has increased significantly in the past few years due to efficiencies gained using containerised cargo – half the ships being ordered by the largest shipping lines are post-panamax. The project will facilitate the fast-rising flow of Asian products to the US market on the Atlantic coast. Vessels often have to endure long queues on either side of the canal before the nine-hour passage through the waterway. Waiting can cost a large container ship up to $50,000 a day, which has generated a complex bidding system through which vessels can jump the queue for the right price. It has been reported that a British oil tanker paid a record $220,300 to jump ahead of 83 other ships. Such payments are in addition to the transit fee.

Several bids have been lined up and financial closure is expected by the end of this year, with completion due in 2014. Mizuho is advising the Panama Canal authority.

Some cross-border megaprojects have however endured notoriously bumpy rides. The infamous $21bn Channel Tunnel project, between England and France, which became operational in 1994, is a prime example. An engineering marvel (50.5km long, 40 metres below the seabed) the development resulted in a catastrophic economic failure, not just for the companies directly involved. Research carried out on behalf of the UK's Strategic Rail Authority and published in 2005 reveals that the UK economy would have been better off if the tunnel had never been constructed. The companies involved have also suffered serious financial hits and it is only now, after 22 years and a series of seemingly vacuous restructurings, that Eurotunnel, the managing company, has finally got its books out of the red, with a $1m profit.

A banker with a close knowledge of the latest Eurotunnel restructuring work casts doubts on the quality of previous restructurings, suggesting that in the past banks just tried to buy time, with the aim of minimising write-offs for the lenders and investors involved. The initial £6.2bn ($12.3bn) debt, which rose to £9.18bn over the years, dropped to £5.85bn after the recent restructuring. Goldman Sachs' infrastructure fund underwrote €800m in deferred Eurotunnel shares, issued in March, and was left holding €650m-worth of them. It will probably control about 20% of the company after 2011, when a series of transactions following Eurotunnel's restructuring are completed. A €915bn rights issue announced in April would pass company ownership from private shareholders to institutional investors. Some €725m of the issue will be fully underwritten by ABN AMRO, HSBC, Lazard, Natixis, Lehman Brothers and UBS.

A competitive game

Just as the Channel Tunnel is turning in a profit, its engineering record might be smashed by plans of an even longer tunnel, spanning the Bering Strait between Cape Dezhnev in Chucotka, Russia and Cape Prince of Wales in Alaska, US, which would supply oil, natural gas and electricity to the US and Canada from Russia. (A slightly longer tunnel than the Channel Tunnel, and current record holder for projects of this kind, is the 53.85km Seikan Tunnel in Japan, a railway tunnel partially underwater that opened in 1983 but which did not have much success as a passenger rail link due to speed and cost.) The tunnel across the Bering Strait would be 103km, twice the length of the Channel Tunnel, at a total cost of $65bn. The project includes a rail and pipeline link and it is anticipated that it would save North America >>

and far-east Russia $20bn in transport costs. The project is still under discussion and there is an alternative plan for the tunnel: three suspended bridges via the Diomede Islands across a total distance of 80km whose two long spans would compare in length to the world's longest bridge, the Lake Pontchartrain Causeway in southern Louisiana, US. The Causeway is formed by two parallel bridges, originally opened in 1956 and then extended in 1969 – the longer of the two bridges measures 38.42km. The lower estimate for just a road bridge on the Bering Strait is $15bn, whereas the cost estimates of a highway, double-track rail and pipelines have been as high as $105bn.

Traditional and green infrastructure

Among the projects that do not have cross-border qualities but have a significant domestic impact is India's National Highway Development. It plans to build approximately 31,755km of roads, of which the Golden Quadrilateral, linking four major cities and an east-west corridor running the length and breadth of India, is almost complete. The project was launched about 10 years ago and is being executed in seven phases, at a total cost of $71bn. The third phase has been approved and will cost $20bn. The project is being financed by a combination of budgetary assistance, soft loans from multilateral organisations such as the Americas Development Bank, commercial loans and private investments.

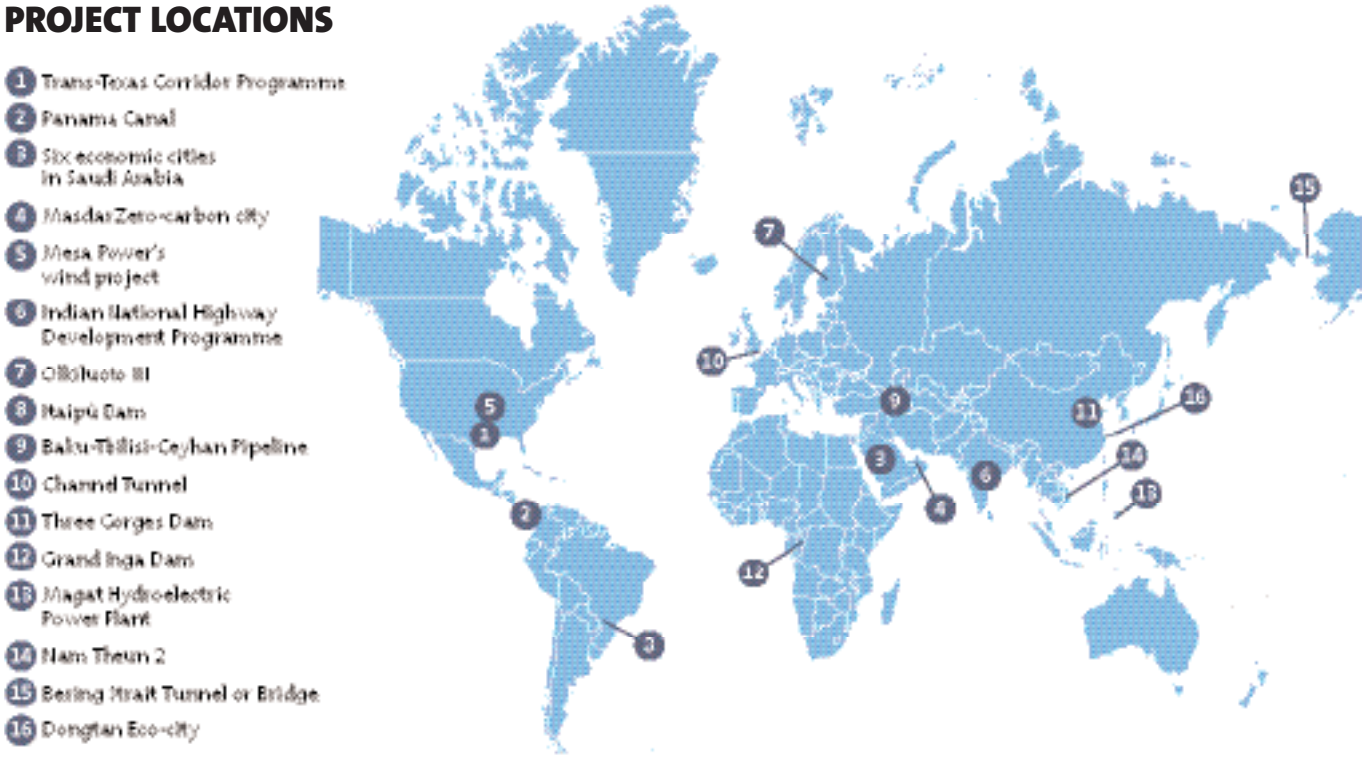
At an even higher cost is the $158bn Trans-Texan Corridor Programme, which would link the north and the north-east of the state to its Mexican border. The project is driven by a 60% population growth in the state in the past 30 years, which is expected to grow by a further 60% in the next 30 years. Road use has also risen and is expected to increase by 200% during the next three decades. The programme would initially involve highways but will also include freight and commuter rail, and a utility corridor for water, oil and gas. The development is still at a very early stage and has been envisaged as a partnership between the public and private sectors. Ownership issues will have to be resolved as Texas has put a two-year moratorium on agreements between the Texas Department of Transportation and the private sector.

Also in Texas is a different and possibly more adventurous project. Billionaire T Boone Pickens, head of the BP Capital hedge fund – which has $4bn under management – is developing a colossal wind farm project. With a total capacity of 4 gigawatts, it would become the largest in the world and produce as much energy as two commercial-scale nuclear plants combined – enough to provide power to one million houses.

Mesa Power, Mr Pickens' company, is set to start buying land and ordering 2700 wind turbines this month. Mr Pickens has wide experience in the oil and energy markets and made about $1bn in 2006 through betting on the commodity and equity markets. A self-declared environmentalist, he is not simply launching such a project to save the planet. He is also expecting to make a healthy return through government incentives on green energy, increasing energy demand and higher oil prices. He expects a yearly 25% return from the wind project.

A sector that could almost be considered green is nuclear energy. A CO^2 emission-free energy source, nuclear power is still not considered a renewable source due to the risks of accidents and waste storage. "Nuclear is going to be a key sector," says Charlie Seymour, managing director and head of power utilities and project finance, EMEA, for HSBC. "There are a number of new technologies, all with pros and cons. Financing nuclear power is, in principle, fine for the

PROJECT LOCATIONS



international community but banks will approach nuclear projects on a case-by-case basis."

Nuclear technology is improving and the latest technology has been used for Olkiluoto III in Finland, the first reactor to be built in Europe in 20 years. It uses European pressurised water reactor technology, which is considered the safest. The project also offers an interesting example of an innovative financing structure, based on the Mankala principle whereby TVO, the sponsor company, sells electricity to its owners at cost, which, in turn, are severally liable to cover the plant's fixed costs. These include the capital costs and a fixed portion of operation and maintenance costs. The variable operating and maintenance costs, including fuel, are passed to the shareholders according to the amount of electricity that they off-take, making the project more palatable to financiers. The €3bn project was financed by BayernLB, BNP Paribas, Handelsbanken, JPMorgan and Nordea.

Aspirational projects

Infrastructure and real estate developments are often interlinked, and never more so when entire, new cities are built. The Middle East has been a prolific area for such plans, some of which have been greeted with scepticism by the international community. Construction on others is already under way.

The most prominent is a $170bn project to build six new cities in Saudi Arabia. The plan is to leverage on the abundant resources and geographical location, attract industry and create one million jobs. Construction has begun on the biggest of the six cities – King Abdullah Economic City, situated on the Red Sea coast, north of Jeddah. Three of the others have also been launched: a 'knowledge' city on the edge of Medina; Jizan city, near the south-western tip; and Hall, the most controversial as it lies in a remote area in the north. The country is hoping to attract non-oil foreign direct investment with this development and the cities are expected to contribute $150bn to Saudi Arabia's GDP.

Pushed by the need to show the world a smaller carbon footprint and encouraged by Abu Dhabi's visionary plans, the Masdar zero-carbon, zero-waste city aims to prove that technologies now available, such as carbon capture and storage, biofuels and solar energy, are viable and cost-effective options. The 6.5 square kilometre (sq km) district, designed by legendary architectural firm Foster and Partners, is aiming to attract 1500 businesses and 50,000 residents and to house international business and top professionals in the field of sustainable and alternative energy. Masdar's research institute, founded in partnership with the Massachusetts Institute of Technology, aims to develop into an alternative energy cluster for Masdar's businesses. The total project investment is $22bn and completion is set for 2016.

The Middle East is not the only part of the world to pursue the green dream: China has its own plans for a carbon-free city. In vivid contrast with the mainland's highly polluted capital, Beijing, the Dongtan Eco-city will be located on China's third largest island, at the mouth of the Yangtze River. The urban area will occupy one-third of the 86 sq km site, which is adjacent to a wetland area. The remaining land will be retained for agriculture. Engineering firm Arup is designing the city for the Shanghai Industrial Investment Corporate and aims to create a sustainable city from environmental, social, economic and cultural viewpoints.

The dangers of ambition

Mega infrastructure projects are as ambitious as they are fragile. Transportation projects, public buildings, power plants, dams, water projects, oil and gas extraction projects and many others tend to follow a general pattern of cost underestimation and overrun. Furthermore, it is estimated that the average delay cost for a project of the size and complexity of the Channel Tunnel is about $350m a year.

The Channel Tunnel, which created high-speed rail connections between the UK and France, is a prime example of such a pattern: the project was completed at a cost of 60% more than the construction budget (99% more than the initial 1985 cost estimates) and 140% more than the financing budget. The overrun record, however, still goes to the Suez Canal, built almost 140 years ago, which went 1900% over budget.

Infrastructure projects are not built simply to serve the local or international community or trade. They also have a strong emotional tie with the developers. As Professor Flyvbjerg puts it, there are three elements that feed into the monumentality of megaprojects: the political sublime, the technologically sublime and the aesthetically sublime. Big projects have a strong political appeal, they challenge engineers' abilities and give architects the chance to design the future. Traditionally funded through taxpayers' money, the rigour of project due diligence has been questioned and remained questionable, until another group of players – banks and private investors – took a direct interest in the developments. The fact that international banks are entering into this field has created a new discipline as they put their own money on the line and tend to be more aware of risks than governments, which can always go back to taxpayers for more funding.

> 'Financing nuclear power is, in principle, fine for the international community but banks will approach nuclear projects on a case-by-case basis'

While the Suez Canal holds the record for the highest ever cost over-runs, the second place for this unwanted prize goes to the Sydney Opera House in Australia. The cultural development exceeded its A$7m ($6.56m) budgeted cost by 1300% and was delivered at a total cost of A$102m. By direct comparison, a shining example of a project delivered on time, on budget and that generated more revenue than expected is the Guggenheim Museum in Bilbao, which cracked the equation linking political, engineering and design prowess with economic and business success. Repeating this formula should be the next big ambition of the infrastructure industry. TB