Sustainability in Action

"Humanity can find a real approach to sustainable development for higher life quality and lower impact on the environment."

—— Zhang Yue, BROAD Chairman & CEO

On New Year's Day 2012, BROAD Sustainable Buildings Co. Ltd (BSB) released a time-lapse video on YouTube showing how it built a 30-storey hotel in just 360 hours (15 days). http://www.youtube.com/watch?v=Hdpf-MQM9vY That video has since been viewed over 5.8 million times. People were amazed at the speed of this accomplishment; however Zhang Yue, Chairman & CEO of BROAD Group of which BSB is a subsidiary, however, is more focused on the building's sustainability credentials. Third party tests conclude that it can withstand an earthquake of magnitude 9 on the Richter scale; heating, cooling and lighting the building uses only 20% of the energy consumed by a traditional hotel; its internal air is 20 times purer than the atmosphere outside; it costs between 10% and 30% less to build compared with conventional methods, using about 30% less steel and 85% less concrete. It was also built without accident of any kind and with less than 1% of the construction waste discarded in traditional methods. All of the materials used in the building are free of toxic materials such as formaldehyde, lead, or asbestos and are mostly recyclable.

In early 2014 BSB started production of an 88-storey building using similar technologies. BSB now plans to build its first "Sky City" a 202-floor building that at 838 metres would be the world's tallest. Sky City aims to provide housing for over 30,000 residents as well as 300,000 m^2 as for offices, schools, hospitals, entertainment and sports venues, 8,000 m^2 of open "sky gardens", and 86,400 m^2 of vertical organic farms. Since 2008, for the first time in history, more than half of the world's population lives in towns and cities and the UN estimates that by 2030 the urban population will swell to almost 5 billion. Zhang Yue views the sky city approach using BSB technologies as the key to urban sustainability in the future reducing city sprawl, proliferation of vast parking lots, and the need for commuter transport. He believes that we have already most of the technologies necessary to enable sustainable and happy living at our disposal if only we are willing to deploy them. Others question this optimism and believe we need to look for other ways to put sustainability into action.

BROAD's Beginnings: New Wine in Old Bottles

On June 5, 1988, using US$ 3,000 BROAD was registered in Chenzhou, Hunan by Zhang Yue and his younger brother, Zhang Jian, to develop heating equipment. At university, Zhang Yue had majored in fine art and his brother in thermo dynamics. The founders recognised that safety concerns and the need for permits were constraining the market for pressurised hot water boilers. So they developed a pressure-free hot water boiler, winning a China Gold Prize for invention in 1990 and an award at the Salon International de L'invention de Paris in 1991. It was an instant market success in China and provided the company with the capital to develop its next idea. Once again the concept arose from observation of frictions in China's rapidly developing economy: huge numbers of high-rise buildings that required air conditioning were being constructed, but there was shortage of electricity to power them. The brothers conceived of a solution that was simple, yet profound: non-electric air conditioning. They were so convinced of the idea that they were prepared to put all their money into backing this vision.

Non-electric air conditioning was not new. It uses absorption refrigeration technology that was invented by the French scientist Ferdinand Carré in 1858 and was deployed during the American civil war to preserve food to supply the troops. The underlying principle is simple: a lithium bromide solution is heated to create a vapour; the vapour is then condensed into a liquid. The water in this liquid refrigerant is then evaporated in vacuum conditions, thus extracting heat from its surroundings. The resulting water vapour is then absorbed (dissolved) into a concentrated lithium bromide solution, reducing the pressure in the evaporator and allowing more water to evaporate. The diluted lithium bromide solution is then reheated to continue the cycle.

This technology was not completely forgotten: Sweden's Electrolux AB for example, deployed it refrigerators for caravans in the 1960s. After the oil crisis in the 1970s the local gas companies promoted it in Japan for air conditioning, subsequently spreading to Korea. But it never took off to become a mass market application and languished on the proverbial " back shelf " of the air conditioning industry.

BROAD revitalised the technology and by 1992 had completed the design for its first direct-fired absorption chiller. In that year the company relocated to a purpose-built "campus" in Changsha, capital of Hunan Province, to start producing large scale, non-electric central air conditioning chillers. In the course of designing the equipment, more than one hundred patents were developed by BROAD. Zhang Yue described it as: "pouring new wine into old bottles."

Retrieving Gold From the Fire

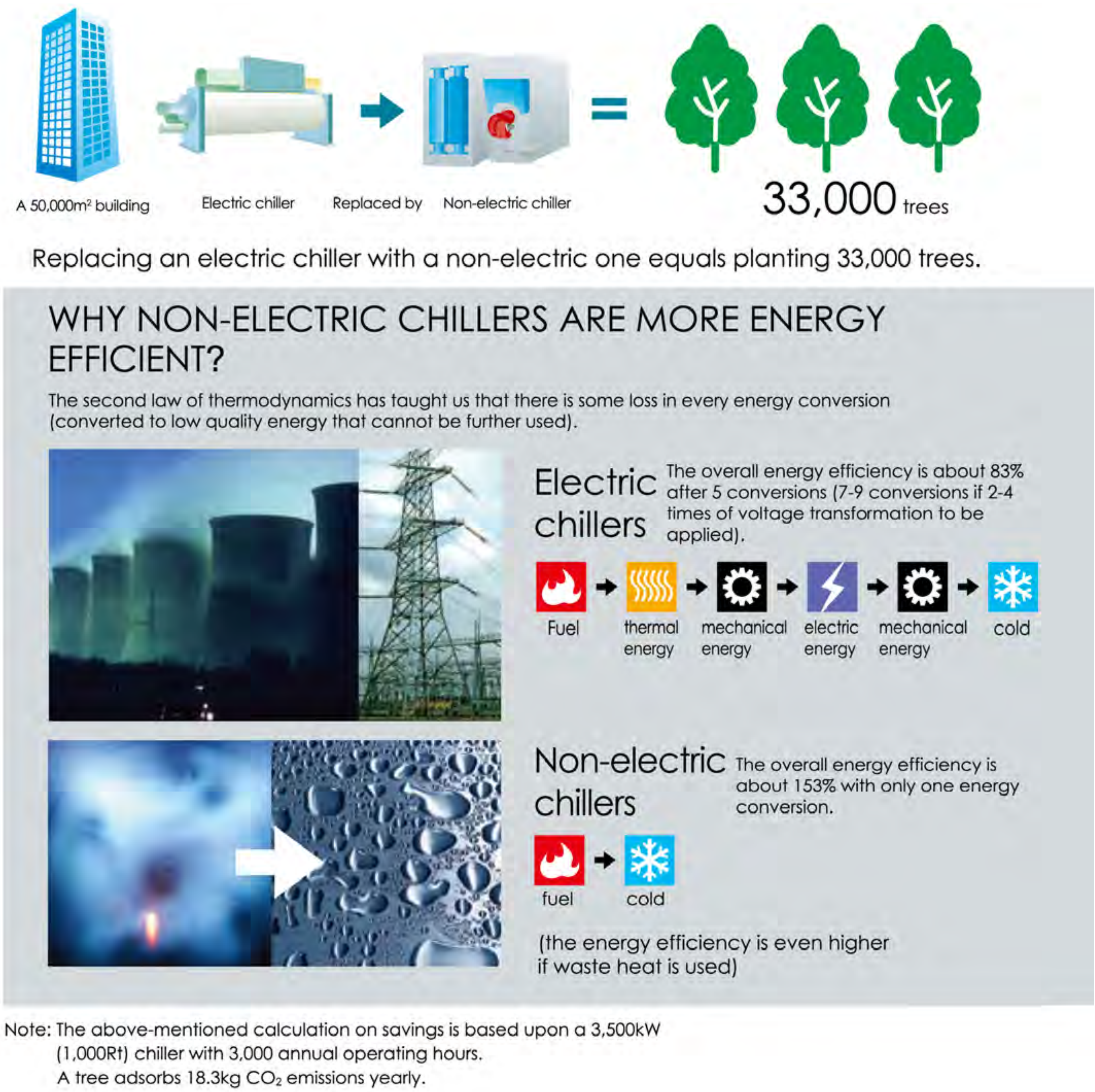
Typical electric air conditioners use an electric motor to drive a compressor. This compresses the refrigerant gas into a liquid in a high-pressure coil. It is then pumped through a valve into a low-pressure coil, allowing the refrigerant to evaporate back into a gas, taking heat in the surrounding air with it. A fan then blows the cooled air into the room.

Electric chillers, therefore, require five energy conversions to produce the cool air. They are fuel→thermal energy →mechanical energy→electric energy→mechanical energy→cold air.The direct-fired absorption chillier, by contrast, involves just one energy conversion: from fuel to cold air. Any source of heat can be used to do the job: gas, biofuels, solar, or waste heat–in fact, any source that can maintain at least 95° C.

Now the second law of thermodynamics tells us that there is a loss in every energy conversion that takes place. So with one conversion required (rather than five using electricity) the absorption technology can achieve nearly twice the energy efficiency of conventional air conditioning. And where it is possible to use waste heat to drive the process, the air conditioning comes practically for free. Stripping away the technical jargon, Zhang Yue sums it up this way: "If you use electricity to make cooling, you throw gold into the fire; if you adopt natural gas to make cooling, you burn your currency notes; if you utilize waste heat to make cooling, however, you pick up gold and currency notes from fire".

Absorption chillers also have significant environmental benefits. BROAD's non–electric air conditioning produces only one quarter of the greenhouse gas of conventional electric air conditioners and rather than requiring the use of chlorofluorocarbons (CFCs) that have a global warming potential about 1,800 times higher than CO_2, the absorption chillers use the environmentally friendly salt–like lithium bromide and water as a refrigerant. Based on these benefits BROAD has calculated that replacing an electric chiller with a non–electric one has the same impact in reducing greenhouse gases as planting 33,000 trees. The capital cost (inclusive of energy supply terminals), meanwhile, is around 30% less than systems powered by electricity (see Exhibit 1).

Exhibit 1: Efficiency and Climate Benefits of Non–Electric Chillers



Continuous Cycles of Innovation

After the first generation of BROAD's non-electric air conditioners were installed Zhang Yue was convinced that there was a great deal of room for improvement in the technology. He therefore focused on building up the company's R&D and innovation capabilities. Designers were hand-picked and trained by Chairman Zhang. Equally important was BROAD's decision to base its R&D on feedback and maintenance data from the performance of their products in the field. Innovation was based not so much on looking for discontinuous breakthroughs but on upgrading the equipment in rapid cycles of improvement. BROAD went from the first generation of equipment in 1992 to a tenth generation in 2010. The tenth generation of equipment was more compact, with much improved energy efficiency, and with more intelligent control systems embedded to monitor performance and signal the need for servicing and maintenance. (see Exhibit 2).

Exhibit 2: BROAD's Modular Package Air Conditioning System

Back then BROAD employed over 300 full−time R&D and service air conditioning engineers working on mechanical engineering improvements, and enhanced process and equipment design. It continually re−invested more than 5% on average of its sales revenue into R&D. Zhang Yue estimated that he spent 70% of his time on R&D: mainly "contributing ideas that others in the team can help me work on" as he put it. He admitted that while some people found innovation painful, he was passionate about the potential of new technology: "Im a technology fan the same way as some people are football fans." Zhang Yue commented.

Today, BROAD has its air conditioning equipment installed in more than 80 countries right around the world with high shares of non−electric air conditioning systems in many markets, such as 40% in China,45% in the US, 55% in India,75% in Australia, 80% in Turkey and Russia separately. Its equipment is found in applications as diverse as Madrid Airport, Istanbul International Airport, and Korea's Central Government through to the tallest building in South America: the Costanera Center in Santiago, Chile. All 250 pavilions at Expo Shanghai 2010 used BROAD non−electric air conditioning that in 184 days saved 180 million kWh of electricity, and cut CO^2 emissions by 73,000 tons (equivalent to planting 4 million trees) compared to conventional electric air conditioning. This was an important contribution to Shanghai's goal of delivering a low−carbon Expo with the theme "Better City, Better Life".

Extending the Product Line

The application of its vision for "preserving life" led BROAD to focus on the problem of air pollution. Its research quickly ascertained that today no air in any city is clean. It found that the US Environmental Protection Agency estimated that air pollution causes over 20,000 deaths every day across the world (that's equivalent to over one hundred plane crashes everyday without a single survivor). It also discovered that many scientists had argued that global life expectancy would be extended by 30 years if there were no air pollution and that sociologists had pointed out that the physiological and mental impact of air pollution had actually reduced the human happiness index by 30%.

In 2003 BROAD began to develop simple and inexpensive technology that could produce clean air. The result was a range of affordable "air quality" products with for capabilities for cooling, electrostatic cleaning, active carbon detoxification, and oxygen deficiency protection. This equipment was capable of filtering out particles smaller than a single human cell, eliminating 99.9% of the articles less than 2.5 micrometres in diameter (PM2.5) in the air (mainly produced by combustion in motor vehicles, power plants, wood burning, and certain industrial processes) that are believed to pose the greatest health risks because they can lodge deep in the lungs.

Developing Sustainable Buildings

In order to calculate the right specifications for its air conditioning equipment BROAD had to collect data on the amounts of heat buildings generated, absorbed from sunshine, and leaked out into the atmosphere during colder months. As its database expanded, by 2004 BROAD was able to systematically compare these data for different types of buildings across its customer base. It noticed something interesting: buildings with the same floor area in the same city or subject to a similar climate, showed widely different levels of energy consumption. Further investigation showed that the main cause of these differences was the quality of thermal insulation (or lack of it) in the building.

Looking into this issue Zhang Yue discovered that heating and cooling consume 30 to 40 per cent of the world energy and that much of this wasted through poorly insulated exterior walls and windows. Realising the gravity of this problem he immediately ordered the renovation of the insulation in a dozen of BROAD's own buildings, giving them 15−cm insulation layers and triple−glazed windows. By 2009 BROAD began to offer training for customers on how to use thermal insulation to reduce their air−conditioning bills by up to 80%, hoping others would follow their lead.

Despite the thermal insulation technologies BROAD proposed being simple and relatively inexpensive compared with the saving in energy cost, few customers were interested. Most construction companies and developers, wishing to sell the building on, were unconcerned with the future costs of running the building and saw insulation as an additional cost and burden they could do without. Others were sceptical of BROAD's motives: why would a company selling air conditioning want to promote insulation that undermined demand for its products?

As time passed with so little uptake Zhang Yue became frustrated because he had come to believe that thermal insulation "should be the world's most pressing and prioritized issue. Why? Because it requires no fancy high tech, yet sadly people pay little attention." The only solution, he concluded, was for BROAD to start constructing buildings for its customers itself. So in 2008 Zhang Yue set a team of BROAD's engineers the task of coming up with a building with improved thermal insulation such that the energy required for cooling or heating would be cut by 80%. Later the same year a 7.9−magnitude earthquake hit China's Sichuan Province, causing the collapse of poorly constructed buildings and killing some 87,000 people. In the aftermath, Zhang began to think about the problems of building design more generally. Just as with thermal insulation his first approach was to try and convince developers to retrofit existing buildings to make them both more stable and more sustainable. Again he was to be disappointed: "People paid no attention at all". So Zhang increased the size of the research team to over 300 with a brief to work out how to build cheap, environmentally friendly structures that could also withstand a severe earthquake.

Within six months Zhang Yue and the team had concluded they would never reach their goal using traditional techniques: "Traditional construction is too chaotic so we took construction and moved it into the factory." This solution, where BROAD aimed to undertake 90% of the work of constructing a building on a production line had many advantages: BROAD could deploy much of the manufacturing experience it had gained in producing large air−conditioning plants; costs, waste and quality could be tightly controlled; specialised machinery could be developed and deployed more easily, and rather than using the casual labour that formed most of the workforce on a construction site, the factory could hire, train up and retain a permanent workforce of skilled technicians. At the same time the inefficiencies associated with multi−layered subcontracting, idleness due to poor organisation, and opportunities for corruption could be almost eliminated.

Taking up this challenge, over the next 18 months BROAD's engineers developed designs and a production system to make prefabricated sustainable buildings. During development the ideas were piloted with the construction of a 3−storey sustainable residence built in one day on the BROAD campus on August 24, 2009. Then in early 2010, BSB erected the 15−storey New Ark Hotel in just 6 days. The New Ark used triple−glazed plastic framed windows, 15 cm thick thermal insulation for walls, exterior solar shading, and fresh air heat recovery (that captured heat from exhaust air in winter and outside air intake in summer) to meet the target of reducing the energy consumption by 80% compared to a similar building without these technologies.

The New Ark Hotel was also much more efficient in its use of construction materials. It used just kilos of steel and125 kilos of concrete for each square meter of construction – comparatively, the conventional building used 70 kilos of steel and 900 kilos of cement for each square meter of construction. That reduced the carbon dioxide related to building construction from 883 kilos of CO_2 per square meter of construction to 147 kilos of CO_2 for the New Ark Hotel.

To test the concept further BROAD decided to erect a 2,000+m^2, six–storey BROAD Pavilion on the site of Expo Shanghai 2010. From the start to completion the building was erected in just 24 hours–something that amazed the whole world (see Exhibit 3). Wishing to gain international exposure for its sustainable buildings concept BROAD then shipped the components for a two–story building with floor space of 1,060 square meters to UN Climate Change Conference in Canc ú n in November 2010. The building was assembled in just 8 days. Mexican President Felipe Calderon inaugurated COP16 BROAD Pavilion on Dec.10, 2010, declaring it: "a new revolution in the world architectural industry".

Exhibit 3: BROAD"s Early Sustainable Buildings

March 6, 2010
"BROAD Pavilion in World Expo" built in one day

June 2010
"New Ark Hotel" built in one week

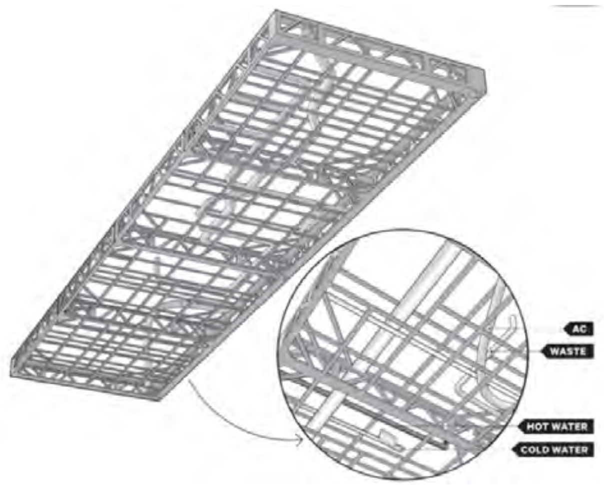
December 2011, the T30 Hotel constructed in 15 days. Photo: Lloyd Alter.

Developing a Scalable Production System

BSB continued to develop its designs and manufacturing processes. As mentioned above, 2011 saw the completion of T30, a 30–storey hotel, in just 15 days. The build cost was less than US$1000 per square metre, compared with around US$1,400 per square metre for high–rise buildings in China constructed using traditional methods. The T30 Hotel utilised 20–cm thermal insulation materials and four–paned glass windows (two doubled–glazed panels with an air pocket in between)It used LED lighting, auto power–generated lifts (that captured energy as the lift descended in full capacity and ascended without any load), external solar shading that automatically adjusted to sun conditions, saving 80% of energy in summer, and a smart metering and electronic energy control system that automatically controlled the lighting and curtains depending on outside temperature and occupancy. The T30 Hotel also incorporated a chute recycling system for 8 different kinds of waste, In May 2012 a 12 floor, 14,000m^2 building was completed by BSB in Shandong province in China. The building skeleton was constructed in just 62 hours. Up till now, more than 30 similar BSBs were completed with 30cm–thick thermal insulations.

BSB had refined its manufacturing process so that it could efficiently produce the fundamental building blocks (or "main boards" as BSB termed them) of 60m^2. Each module was manufactured with anti–corrosion treated, structural steel. The corrosion proofing provided a life of 60 years before it had to be reapplied. The flooring, ceilings, and water, electricity and HVAC supplies and waste disposal systems were all pre–fitted into each module in the BSB factory (see Exhibit4). Each module was designed with a 45cm hollow to allow subsequent access for maintenance personnel. The necessary pillars, diagonal bracings, doors, windows, wall panels, and sanitary and kitchen wares are all then stacked on the main board pre–sequenced for efficient assembly. A truck can then transport two of these completed main boards to the building site (see Exhibit 5).

Exhibit 4: BROAD"s Main Boards Illustration: Jason Lee



Constructing the main boards in BSB"s Xiangyin Factory, Photo: Timothy O'Rourke for The New York Times

Exhibit 5: Transporting BROAD"s Main Boards to Site

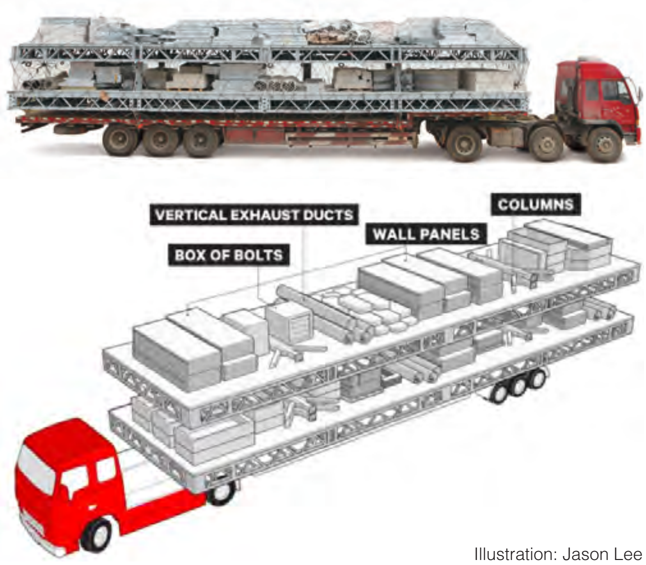
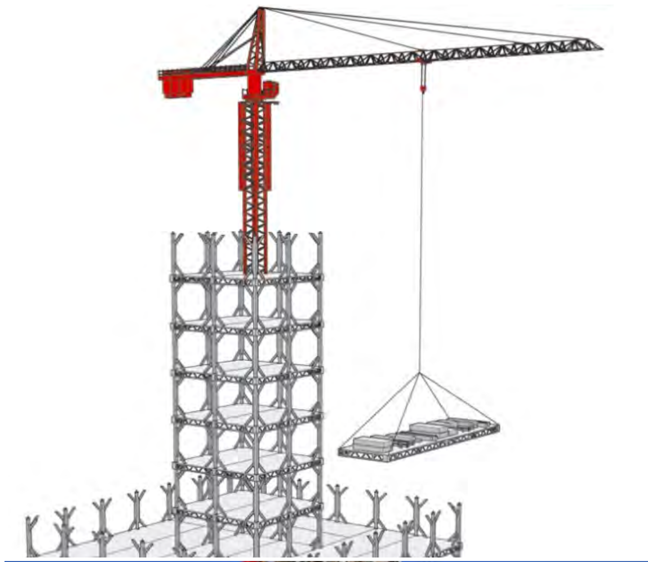


Illustration: Jason Lee

The main boards are hoisted into position using a bevy of self–climbing cranes that move upwards as the building is constructed (see Exhibit 6). They are then connected together with huge bolts. The construction crew then fixes the panels in place, connects up the services between the main boards and completes the painting and fit–out. Less than 10% of the total activity necessary to construct the building occurs on–site. A much faster, higher quality and safer construction process with much reduced wastage can therefore be achieved.

Exhibit 6: Assembling the BSB On Site Illustration: Jason Lee



20 sets of self–climbing cranes work around the clock. Photo: Noah Sheldon

To achieve these innovations in building technologies BSB had worked with a number of partners. The General Manager of BSB Mr Hu recalled, for example, that the decision to use four–pane glass to save energy presented a problem of reduced window transparency. BSB therefore worked with a glass manufacturer to upgrade its product and production process to deliver "super transparent" glass panes that would not distort or cloud the view even through a thickness of four panes. The company cooperated with Tianjin Fire Research Institute (China's leading fire research institution), the China Academy of Building Research (who conducted the earthquake tests), the China Research Institute of Structural Engineering and Disaster Reduction, and the China Electronics Engineering Design Institute, as well as numerous government certification agencies. BSB also maintained a large testing laboratory at its headquarters in Xiangyin to test whether the products of all its potential suppliers were "environmentally friendly" (ensuring, for example, that they did not contain any toxic materials) and met BSB's standards for quality and energy–conservation performance. BSB had not yet been able to develop the complex system necessary to trace the amount of energy used in producing the materials and fixtures supplied to it, but it had taken steps to dramatically reduce the use of energy–intensive materials such as cement in its buildings (as noted above).

BSB also continued to work on improving its buildings. This included investigations into how to reduce the amounts of materials required and to enable more choices of configuration and finish. It was also working on how to add more "intelligence" to its buildings by using improved sensing, monitoring, and regulating technologies linked together using the new possibilities being opened up with the advent of cloud computing. The company had over 150 staff dedicated to R&D (divided between BROAD Town and Xiangyin), as well as a further 450 staff working on experimentation and piloting of new technologies and ideas and one production line in its factory solely allocated to these activities. With five other production lines at its factory BSB's capacity was planned to reach 10 million m^2 per annum (equivalent to 60 buildings each of 80 storeys) and land was available on the site to expand to up to 10 production lines.

BSB had also appointed six franchisees in China. At first it had focused on recruiting property developers or investment conglomerates, including a number of State–Owned Enterprises. BSB found, however, that manufacturing capabilities and experience were key ingredients for a franchisee to be successful. Franchise partners also needed to employ a stable workforce that could acquire the necessary skills rather than casual, day labourers. BSB was now focusing on helping to bring together consortia of partners with different skills including finance, manufacturing, and property and land acquisition and development to act as franchisees. The company provided training for its franchisees bringing around 20 managers and 80–100 production employees for on–the–job training over 2–3 months (depending on experience) at BSB's own facilities. Its aim was to increase the number of franchisees in China by 2– 4 annually.

In parallel BSB had also set itself goals of developing franchisees around the world to provide the capacity to construct 700 million m^2 of floor space annually by 2020. Juliet Jiang, Senior Vice President of Broad Group, who was also in charge of BSB's overseas franchising, noted that this would take time and investment because BSB was "revolutionising the construction industry". In pursuit of this goal BSB offered to provide training to franchisees for free (only asking the franchisee to cover the minimal costs of accommodation and meals at BSB for its employees). In developing markets, however, BSB had generally found that its sustainability values carried less weight in the purchase decision, while the perceived risk of pioneering a new technology for use in a long–lasting asset weighed heavily.

In international markets, meanwhile, legacy rules and regulations drafted with traditional construction techniques in mind could prove a barrier.

While the main board underlying BSB's pre–fabricated building system would provide the standard platform for sustainable buildings constructed overseas, internal designs and decoration could be tailor–made to fit local tastes. Likewise the facades and external cladding could be adapted for local climate conditions and preferences (by varying the thickness). Juliet Jiang also pointed out that BSB's modular buildings could be more easily reconfigured for changes of use (from offices to residential accommodation for example) compared with those constructed using traditional methods. This was another sense in which BSB's buildings were more sustainable compared with their predecessors that generally had to be demolished and completely rebuilt to accommodate a new use.

Towards a Sustainable City: The Sky City Project

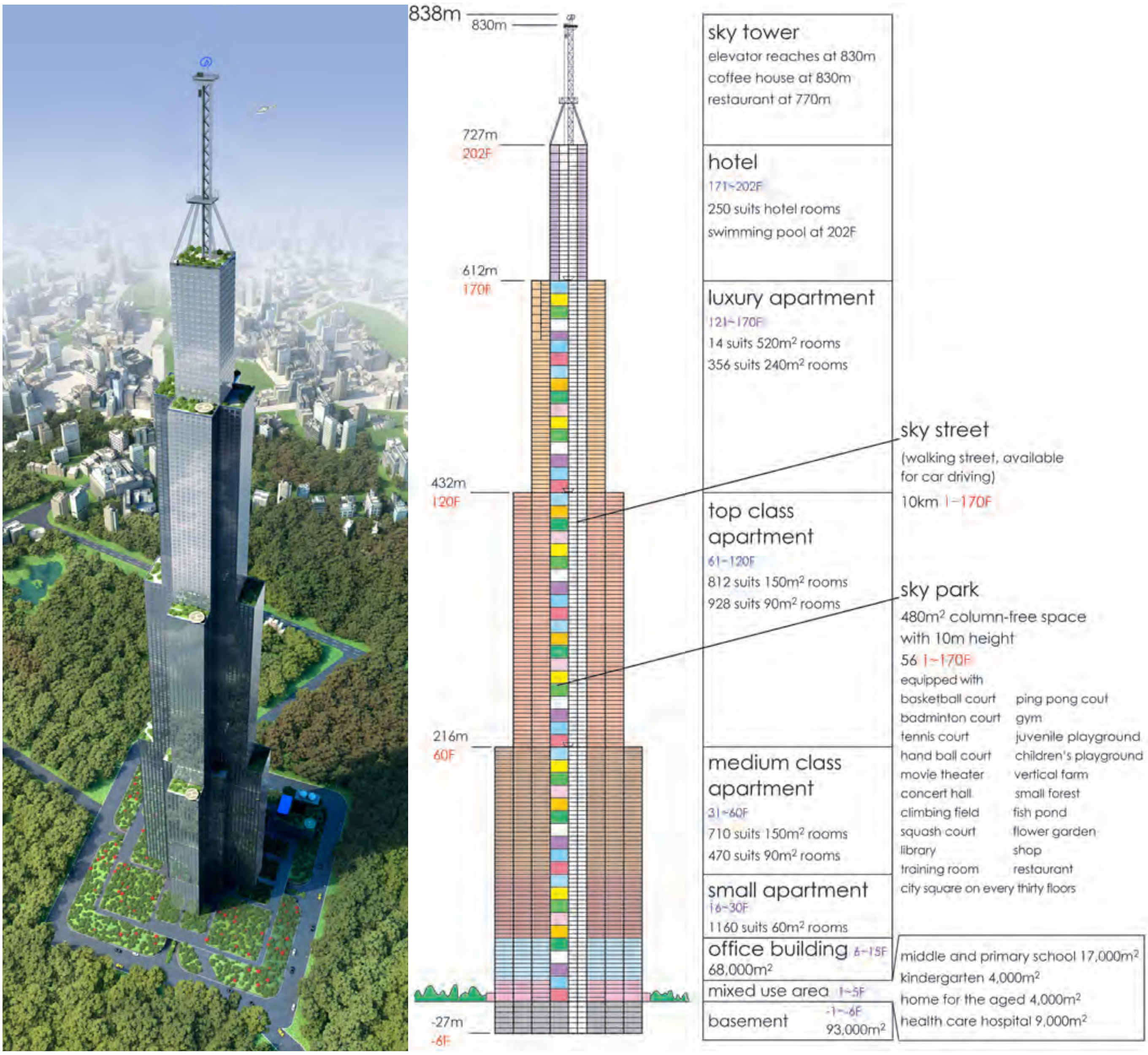
Having developed, refined and proven this innovative technology in constructing over 30 sustainable buildings, Zhang Yue began to plan his largest project yet: the 202–storey Sky City.

Zhang Yue's vision for the Sky City project began with thinking about how to find a sustainable solution to meet China's urbanisation needs as the next wave of Chinese consumers began to think about owning their own homes. By 2013 some 54% of Chinese were urban dwellers (roughly the same level as the United Kingdom in the 1850s, the United States in 1915, and Japan in the 1950s). Government targets aim for another 270 million people having the chance to move to Chinese cities over the next decade. According to the World Bank, in 2014 China was gaining 1.8 million new urban residents every month.

If China continues expanding her urban areas using current densities and building designs, each new urban resident would occupy 500m^2 of land area. That would mean 135 thousand km^2 of new urban sprawl over the next decade (an amount larger than the total land area of Greece). Hence Zhang Yue's first rationale for conceiving of such a tall building was to conserve land: the Sky City plan requires only 4m^2 of land area per person, including the green parkland surrounding it (see Exhibit 7). It would accommodate 4450 families and a total of over 30,000 residents.

The second rationale was to minimise the need for transportation

Exhibit 7: Plans for Sky City



and associated urban congestion. BSB estimated that because most residents would live, work and take their recreation at Sky City, some 2,000 fewer vehicles would be needed compared with a conventional city design. Open-air sky gardens, vertical organic farms, 56 column-free spaces larger and higher than a basketball court, and a 10km ramped street running directly to the 170th floor would all enhance Sky City's liveability.

The third consideration underpinning Sky City's design was energy conservation. Sky City would be equipped with: 20cm thick thermal insulation in the walls, reducing the normal heat loss by 70%; four-paned glass windows; and external solar shading. Sky City would use BROAD's combined heat and power (CHP) system in which a gas turbine would provide electricity while its exhaust would provide cooling, heating and hot water using BROAD's non-electric air conditioning technology. It would also be equipped with LED lighting throughout, 93 auto power-generated lifts and BROAD's proprietary fresh air heat recovery system. BSB calculated the building's reduced energy consumption would equate to a saving of 120,000 tonnes of CO^2 emissions per annum (equivalent to planting 6.5 million trees).

A fourth consideration in Sky City's design was the avoidance of so-called, "sick building" syndrome by installing technologies to protect human health. World Health Organization reports suggest up to 30% of new and re-modelled buildings worldwide may be subject of health complaints related to poor indoor air quality. Sky City planned to utilise BROAD's air purification technologies (described above) with three-stage filtration that removed 99.9% of PM 2.5 contaminants, supplied 100% fresh air (compared with the usual 70% recycling in large buildings), and provided 40m^3 of fresh air flow per person per hour. Every household would be provided with an air quality monitor measuring particulate matter (PM), volatile organic compounds (VOCs) and CO_2 levels.

A fifth consideration in the Sky City design was safety. Like other BSB projects, the building was reviewed & certified by China Transfinite High-rise Building Expert Committee capable of avoiding collapse during a magnitude 9 earthquake and the design had been tested in a wind tunnel by four competent bodies capable of comfort during a strong gale. Ten fire escape routes would allow the whole building to be evacuated within 15 minutes in case of fire.

Finally, Sky City would utilise BSB's factory-built, main-board technology to ensure high construction quality at low cost. BSB estimated that to produce the modules for Sky City over a period of six months. Installation would require around 3,000 people working for a further 3 months (after excavation) on site. Some question its construction speed. Zhang saw this as "going back to the past" noting that the Empire State Building took only 13 months to build starting in 1930. "Did humanity have to regress?" he asked.

Leadership and Vision

Virtually every aspect of development of BROAD's business is underpinned by Zhang Yue's vision of the future. He recalls that back in 1992 when he developed the first direct-fired absorption chiller with his brother they were motivated by money. One of the benefits that came from the wealth he generated was the ability to indulge his passion for flying. Back in 1997 Zhang Yue attracted media attention when he spent over US$10 million to purchase his first Cessna jet, becoming the first Chinese entrepreneur to own his own plane. He subsequently bought another five aircraft. He was also the first businessman in China to hold a helicopter pilot's license.

Then came an epiphany that Zhang Yue described this way: "One day I learned that a tree can absorb 18.3 kilograms of carbon dioxide every year. It would take eight trees 60 years to absorb the carbon emitted by my plane during a single return trip between Changsha and Beijing. I was shocked." He sold three of his planes. The others were put in hangars. From 2008, Zhang Yue has mainly taken commercial flights, even if means “the searches, the waiting, the delays, the hard seats." His midnight blue Rolls-Royce stretch limousine and canary-yellow Ferrari also went into storage.

He began to worry "how can our children survive?" in the face of global warming and since 2006 began to focus all his energies on promoting energy conservation. Zhang Yue is proud that, as he puts it: "BROAD has broken all preconceived notions to enhance our life quality. This philosophy came to permeate all aspects of the business leading to BROAD's "seven 'No' + one 'Without' Principles" for corporate responsibility: "No environmental polluting, no technology plagiarizing, no customer cheating, no vicious competition, no chain debts, no tax dodging, no bribery, without evil on our conscience."

Under the leadership of Zhang Yue BROAD continues to reaffirm its mission to put sustainability into action by replacing as many inefficient products and production processes as possible with new technologies and new ways of applying existing knowledge technologies that reduce energy and resource consumption, manage toxic materials, and promote lifestyle and happiness. It will do so by delivering products and services that "others cannot make and deliver a quality of service others cannot provide. "Cynics, however, remain unconvinced, questioning whether BROAD's business model would prove equally sustainable.