



INDEPENDENT ENVIRONMENTAL ASSESSMENT
BEIJING 2008 OLYMPIC GAMES



UNITED NATIONS ENVIRONMENT PROGRAMME

Independent Environmental Assessment: Beijing 2008 Olympic Games

Published by the United Nations Environment Programme (UNEP) in February 2009

© 2009 UNEP

ISBN: 978-92-807-2888-0

Job Number: DCP/1017/NA

Produced by the UNEP Division of Communications and Public Information

Cover design:

© BOCOG. Based on the visual concept of passion, vigour, culture and celebration, the torch relay graphic for the Beijing 2008 Olympic Games featured the traditional Chinese phoenix pattern and the lucky cloud pattern. Graphic courtesy: Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG).

This post-Games assessment takes an impartial look at Beijing's work to fulfill its environmental commitments for the 2008 Summer Olympic and Paralympic Games. The report builds on the data and findings of *Beijing 2008 Olympic Games: an Environmental Review*, published by UNEP in 2007. The extent to which new findings and recommendations are included has been influenced by the available data at the time of publication.

This publication may be reproduced in whole or in part and in any form for educational or non-profit purposes without special permission from the copyright holder provided acknowledgement of the source is made. No use of this publication may be made for sale or for any other commercial purpose whatsoever without prior permission in writing from UNEP. The designation of geographical entities in this report, and the presentation of the material herein, do not imply the expression of any opinion whatsoever on the part of the publisher or the participating organizations concerning the legal status of any country, territory or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries.





Uniting sport, culture and the environment,
the Olympic Games ignite passion and emotion
like no other major event on Earth.





An iconic venue of the Beijing 2008 Olympic Games, the National Aquatics Centre – or Water Cube – is an environmental design showpiece.



INDEPENDENT ENVIRONMENTAL ASSESSMENT: BEIJING 2008 OLYMPIC GAMES

CONTENTS

ACKNOWLEDGEMENTS

FOREWORD

| | |
|---|-----------|
| CHAPTER 1: THE BEIJING 2008 GAMES | 12 |
| 1.1 INTRODUCTION | 13 |
| 1.2 THE BID COMMITMENTS | 13 |
| 1.3 COMPELLING CASE FOR SUSTAINABLE GAMES | 18 |
| CHAPTER 2: AIR QUALITY | 24 |
| 2.1 CHINA'S AIR QUALITY STANDARDS | 26 |
| 2.2 BEIJING POLLUTION CONTROL MEASURES | 27 |
| 2.3 IMPACT ON BEIJING'S AIR QUALITY | 29 |
| 2.4 ANNUAL TRENDS IN AIR QUALITY | 29 |
| 2.5 AIR QUALITY IN THE PERIOD LEADING TO AND JUST AFTER THE GAMES | 30 |
| 2.6 ATTRIBUTING CHANGES TO EMISSION CONTROLS | 32 |
| 2.7 COMMENTS AND RECOMMENDATIONS | 34 |
| 2.8 APPENDIX | 37 |
| CHAPTER 3: TRANSPORT | 40 |
| 3.1 VEHICLE EMISSION CONTROL STRATEGIES | 42 |
| 3.2 PUBLIC TRANSPORT | 43 |
| 3.3 TRANSPORT MEASURES DURING THE GAMES | 44 |
| 3.4 COMMENTS AND RECOMMENDATIONS | 45 |
| CHAPTER 4: ENERGY | 50 |
| 4.1 CHANGES IN ENERGY STRUCTURE | 52 |
| 4.2 IMPROVED ENERGY EFFICIENCY | 53 |
| 4.3 RENEWABLE ENERGY | 53 |
| 4.4 COMMENTS AND RECOMMENDATIONS | 55 |
| CHAPTER 5: GREEN COVERAGE AND PROTECTED AREAS | 58 |
| 5.1 URBAN AREAS | 60 |
| 5.2 MOUNTAIN AREAS | 64 |
| 5.3 'FIVE RIVERS AND TEN ROADS' PROJECT (THE PLAIN AREA) | 64 |
| 5.4 PROTECTED AREAS | 66 |
| 5.5 COMMENTS AND RECOMMENDATIONS | 66 66 |
| CHAPTER 6: WATER | 70 |
| 6.1 WATER SOURCES | 72 |
| 6.2 SOURCE WATER PROTECTION | 73 |
| 6.3 WATER TREATMENT AND DISTRIBUTION | 74 |
| 6.4 WATER CONSERVATION, RECYCLING AND REUSE | 76 |
| 6.5 SURFACE WATER QUALITY | 76 |
| 6.6 WATER AT OLYMPIC VENUES | 76 |
| 6.7 FULFILMENT OF OLYMPIC BID COMMITMENTS | 77 |
| 6.8 COMMENTS AND RECOMMENDATIONS | 77 |

| | |
|--|------------|
| CHAPTER 7: SOLID WASTE | 80 |
| 7.1 DOMESTIC SOLID WASTE | 82 |
| 7.2 MEDICAL AND RADIOACTIVE HAZARDOUS WASTE | 83 |
| 7.3 WASTE IN OLYMPIC VENUES | 83 |
| 7.4 COMMENTS AND RECOMMENDATIONS | 83 |
| CHAPTER 8: OLYMPIC SITES AND VENUES | 88 |
| 8.1 VENUE PLANNING AND MANAGEMENT | 90 |
| 8.2 OLYMPIC VENUES: ENERGY | 90 |
| 8.3 OLYMPIC VENUES: WATER | 94 |
| 8.4 OLYMPIC VENUES: ECO-FRIENDLY MATERIALS | 95 |
| 8.5 ENVIRONMENTAL MANAGEMENT AT BUILDING SITES | 96 |
| 8.6 ENVIRONMENTAL MANAGEMENT DURING THE GAMES | 96 |
| 8.7 COMMENTS AND RECOMMENDATIONS | 97 |
| CHAPTER 9: CLIMATE NEUTRALITY | 102 |
| 9.1 CLIMATE NEUTRALITY AND SPORT | 104 |
| 9.2 BEIJING 2008 GAMES CARBON FOOTPRINT | 105 |
| 9.3 CARBON FOOTPRINT REDUCTION MEASURES | 106 |
| 9.4 COMMENTS AND RECOMMENDATIONS | 107 |
| | 107 |
| CHAPTER 10: ROLE OF GAMES PARTNERS | 110 |
| 10.1 ROLE OF SPONSORS | 112 |
| 10.2 SPONSOR SELECTION PROCESS | 112 |
| 10.3 SPONSOR INITIATIVES AND CAMPAIGNS | 112 |
| 10.4 ROLE OF SUPPLIERS AND CONTRACTORS | 113 |
| 10.5 COMMENTS AND RECOMMENDATIONS | 114 |
| CHAPTER 11: NGO PERSPECTIVE | 118 |
| 11.1 NGO INVOLVEMENT | 121 |
| 11.2 NGO FEEDBACK | 122 |
| 11.3 COMMENTS AND RECOMMENDATIONS | 123 |
| CHAPTER 12: COMMUNICATION AND EDUCATION | 126 |
| 12.1 COMMUNICATION CAMPAIGNS | 128 |
| 12.2 EDUCATION | 129 |
| 12.3 COMMENTS AND RECOMMENDATIONS | 130 |
| BIBLIOGRAPHY | 132 |
| INDEX | 134 |

ACKNOWLEDGEMENTS

Chapter authors:

Gregory R. Carmichael, Associate Dean for Research and Graduate Studies, University of Iowa, USA

Soon-Chang Yoon, Professor, Atmospheric Sciences, School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea

Cy Jones, Senior Associate, People and Ecosystems Program, World Resources Institute, Washington DC, USA

Christian Hochfeld, Member of the Executive Board, Oeko Institute – Institute for Applied Ecology, Berlin, Germany

Theodore Oben, Chief, Sport and the Environment, UNEP, Nairobi, Kenya

Produced by the UNEP Division of Communications and Public Information

Director of Publication: Satinder Bindra

Layout and design: Enid Ngaira

Printing: UNON, Publishing Services Section, Nairobi, ISO 14001:2004-certified.

Sections of report reviewed by:

Mark Radka, Elizabeth Khaka, Niklas Hagelberg, Mary M'mukindia; Nick Nuttall, Surya Chandak, Janet Macharia, Lo Sze Ping, Tore Brevik, Julie Marks, Arjun Kohli

Discussions and interviews with the following:

Yake Xu, Deputy General Manager, Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG), Beijing, China

Yu Xiaoxuan, Deputy Director, Environment and Construction Department, BOCOG

Ms Yu Jianke, Deputy Division Chief, Construction and Environment Department, BOCOG

Chen Tian, Deputy Director, Professor of Engineering, Beijing Environment Protection Bureau, Beijing

Ming Dengli, Deputy Director, Science and Technology and International Cooperation Division, Beijing Environment Protection Bureau, Beijing

Li Kunsheng, Vice Director and Chief Engineer, Beijing Vehicle Taipipe Emissions Management Centre, Beijing Environment Protection Bureau, Beijing

Dermot O'Gorman, Country Representative, World Wide Fund for Nature (WWF), Beijing

Simon Lewis, Global Cities and 2012 Programme Manager, WWF-UK

Deborah Seligsohn, Director, China Program, Climate Energy & Pollution Program
World Resources Institute, Beijing

Hou Fei, Community Program Coordinator, Global Village of Beijing, Beijing

Xinbin Yu, Director of Office, Global Village of Beijing, Beijing

Liang Xiaoyan, Executive Director, Friends of Nature, Beijing

Hu Huizhe; Head, Education and Activities Department, Friends of Nature, Beijing

Aster Li Zhang (PhD), Program Director, Conservation International, Beijing

Sun Shan, Executive Director, Conservation Center, Beijing

Cris Tuñón (PhD), Senior Programme Management Officer, World Health Organization, Beijing

Wu Shuang, Program Officer, Global Environmental Institute, Beijing

Hanqian Zhang, Research Assistant, World Resources Institute, Beijing

Peng Ren, Program Officer, Global Environmental Institute, Beijing

Whitehead Douglas Fraser, Communication Officer, Global Environmental Institute, Beijing

With thanks also to:

DOE, Argonne National Laboratory, USA

NASA Goddard Space Flight Center, USA

University of Iowa

Beijing 2008



Foreword

The Beijing 2008 Olympic Games were widely acclaimed as one of the most spectacular sporting events ever held, not least as a result of the sumptuous and dazzling opening ceremony and the high standards of competition from athletics and swimming to horse-jumping and yachting.

But what of the environment which along with sport and culture is the third pillar of Olympism? How did these Olympic and Paralympic Games rate in terms of sustainability and their contribution to a green legacy for Beijing, China and beyond?

This report discusses the environmental measures taken by the organizers and assesses their effectiveness and lessons learnt, all of which will be useful for those planning future Olympic and other sporting events.

It compares the commitments made in Beijing's 2000 bid to the actual outcomes and sets these within the challenges of a rapidly emerging economy that in recent years has seen double digit growth.

The report, compiled by independent United Nations Environment Programme (UNEP) experts in consultation with non-governmental organizations, the Beijing Municipal Government, the Beijing Environment Protection Bureau and the Beijing Olympic Organizing Committee, concludes that many of the promises were met, if not exceeded in some cases.

In addition, a lasting environmental legacy has been left in terms of new, energy efficient and eco-friendly buildings and venues. Some 90 per cent of the city's wastewater is now treated as a result of a \$17 billion investment. Some 200 factories have switched to new kinds of cleaner production.

New roads, railway and metro lines have been built in an effort to encourage cleaner public transport systems. Fifty thousand old taxis and 10,000 buses have been scrapped and replaced with new ones. The city invested in a 4,000-strong fleet of buses powered by natural gas – among the largest in the world. And 30 million trees and rose bushes were planted in an effort to green the city, among many other initiatives.

Air quality, a major worry for both the organizers and the athletes at the time, was dealt with via a mixture of forward-looking planning measures backed by short-term ones such as controls on private and public vehicles.

Whether these air quality gains can be maintained into the future remains a key challenge for the authorities. Certainly one innovative measure introduced for the 2008 Games—subsidized fares for public transport—is being maintained through 2009.

I believe this assessment will also be essential reading for the International Olympic Committee and the organizers of Vancouver, London and Sochi as they strive to realize their Olympic goals and set the environmental record-breaking bar ever higher.



Achim Steiner
United Nations Under-Secretary-General
Executive Director, UNEP

Achim Steiner

Chapter 1

THE BEIJING 2008 GAMES



1.1 INTRODUCTION

UNEP's involvement with the Beijing Games started in November 2005 when it signed a Memorandum of Understanding with the Beijing 2008 Organizing Committee of the Olympic Games (BOCOG). The agreement laid the foundation for UNEP to support BOCOG on the greening of the Games. As part of the agreement, UNEP conducted a review and published a report on the environmental performance of BOCOG in October 2007. The report reviewed the environmental efforts of the Committee in meeting its commitment to organize a "Green Games" and concluded that Beijing was on track for achieving the promises it laid down in its 2000 bid.

UNEP also pledged to conduct a final assessment to review the impact of the environmental measures that were implemented by Beijing for the Games. The findings of the assessment are contained in this report.

UNEP staff responsible for sport and the environment visited Beijing several times to observe the environmental performance of BOCOG. They engaged in discussions with BOCOG, the Beijing Municipal Government and non-governmental organizations (NGOs) to collect data. UNEP sent a high level delegation to the Olympic Games, led by its Executive Director, to observe first hand some of the impacts of the environmental measures that were undertaken by Beijing for the Games.

In early December 2009, UNEP sent a delegation of experts to Beijing to collect data and hold final discussions with relevant staff of the Beijing Municipal Government, BOCOG and NGOs. The only comprehensive data that was available on the Games was from the Beijing Municipal Government and BOCOG. This report is therefore



UNEP Executive Director Achim Steiner, (right) and the Director General of Beijing's Environmental Protection Bureau, Shi Hanmin, on board a compressed natural gas bus during the Games.

based almost exclusively on data from these two organizations. UNEP's team of experts have however, tried to provide objective analysis, comments and recommendations based on this data. It should be noted that in some instances, required data was not available.

The Olympic Games and the environment

The International Olympic Committee (IOC) has been a pioneer and leader in its efforts to green sport. As far back as 1994, at the Olympic Games in Lillehammer, Norway, environmental management has been a major focus. Several greening projects were implemented by the organizing committee during the preparation and staging of the 1994 Games. That same year, at the Centennial Congress of the Olympic Movement, the environment became the third dimension of Olympism alongside sport and culture. A Sport and Environment Commission was established in the IOC to advise the Executive Board on the integration of environmental

issues in the Olympic Games. The environment also became one of the criteria for evaluating bids for Olympic Games and for assessing the preparation and staging of Olympic Games.

The environment and the Beijing 2008 Games

When Beijing was awarded the Games in 2001, the IOC Evaluation Committee noted: "Beijing currently faces a number of environmental pressures and issues, particularly air pollution. However, it has an ambitious set of plans designed, which are comprehensive enough to greatly improve Beijing's overall environmental condition. These plans and actions will require a significant effort and financial investment. The result would be a major legacy for Beijing from the Olympic Games, which include increased environmental awareness among the population."

In 2001, Beijing's Gross Domestic Product (GDP) was growing 11 per cent a year. The city had a population of over 12 million people and because Beijing was

heavily dependent on coal power and the number of vehicles on its roads had increased by 13 per cent, the city was grappling with severe air quality issues. Only 50.7 per cent of the days that year were considered 'blue sky days' according to Chinese air quality standards. Beijing, like most other cities in the developing world, was under severe water stress.

1.2 THE BID COMMITMENTS

Beijing had a very ambitious programme: to offer a 'Green Olympics' to the world. Several targets of the Beijing 'Environmental Master Plan' (an environmental protection programme developed by the Municipal Government for the period 1996-2015, funded by the World Bank) were integrated into the bid with accelerated deadlines. Some targets, originally scheduled to be achieved in 2010, were moved forward to 2008, the year of the Games.

Table 1.1 shows the 20 key environmental goals set by the city of Beijing. These are examined in detail throughout this report.

TABLE 1.1: ENVIRONMENTAL GOALS FOR BEIJING BID COMMITMENTS

| | Goal | Area of focus |
|----|--|----------------------------------|
| 1 | Construction of the second Shan-Jing natural gas pipeline with a transport capacity of 4-5 billion m ³ /year, by 2007. | Energy |
| 2 | Conversion of coal burning boilers in the urban zone; increased use of clean fuels and energy structure readjustment. | Energy |
| 3 | District heating supply to over 50% of the urban civil residential area. Electricity and geothermal heating coverage up to 16 million m ² . | Energy |
| 4 | Improvement of transport infrastructure and construction of key roads. | Transport |
| 5 | Improvement of the public transportation system, including use of clean fuels in 90% of the cities public buses and 70% of its taxis. | Transport / energy / air quality |
| 6 | Implementation of a vehicle emissions standard equal to Euro II for light vehicles by 2004. | Transport / air quality |
| 7 | Improvement of the management of flying dust in building sites and road construction. Prohibition of any kind of open air incineration. Coverage of outdoor storage areas of waste and other materials. | Air quality |
| 8 | Protection of Miyun and Huairou reservoirs (sources of drinking water) and improvement of their water quality. Implementation of the silt elimination and water clarification project in Guanting reservoir. | Water |
| 9 | Technical transformation and renovation of the Jingmi canal to improve water quality and flow. | Water |
| 10 | Readjustment of the agricultural structure to promote development of high quality, high efficiency and water saving agriculture. Strengthened efforts to reduce flying dust in the agricultural sector. | Water / air quality |
| 11 | Improvement of the city sewage network and wastewater treatment system. A pledge to create a 2.8 million m ³ /day wastewater treatment capacity by 2007. | Water |
| 12 | Construction of hazardous waste disposal facilities with a total capacity of almost 10,000 tons/year (including medical and radioactive waste processing and disposal plants). | Waste |

| | | |
|----|---|---|
| 13 | Implementation of a safe urban domestic waste disposal system by 2007. Establishment of processing facilities for non-hazardous urban waste in the Beijing suburban area. | Waste |
| 14 | Reduction and control of industrial pollution. Implementation of industry pollution registration, monitoring and licensing system. Closing down of the most highly polluting, high energy consuming and resource-wasteful enterprises. | Industry/waste /water / air quality / energy |
| 15 | Relocation of more than 200 industrial enterprises from within the Beijing Fourth Ring Road. Readjustment of industrial structure. Relocation, closure or renovation of heavy polluting and energy consuming plants in the Beijing southeast area and Shijingshan district. Phase-out of old technologies. Improvement of environment quality in the southeast suburb and Shijingshan district. | Industry /waste /water / air quality / energy |
| 16 | To ensure 40% of green cover in the urban area. Establishment of a green belt alongside the Fourth Ring Road (100 m wide green belt on both sides of the road except for those sections running through already built up areas). | Ecosystem |
| 17 | Realization of the Five River Ten Road green belt. Accomplishment of nearly 50% of forest coverage rate. Realization of three green ecological belts in the mountain, plain and urban areas respectively. | Ecosystem |
| 18 | Strengthening of natural preservation zones and the establishment and management of key conservation areas (such as wetlands, forests and bird habitats 8% of the municipal area to be natural protection areas. | Ecosystem / protected areas |
| 19 | Formulation and implementation of an action plan to phase out Ozone-depleting Substances (ODS). Achievement of the target by 2005. | Air quality / ozone |
| 20 | Implementation of cutting-edge environmental technologies in the design of Olympic venues. Use of natural resource-efficient, non-polluting and recyclable materials for facilities and equipment. Preservation during the construction of Olympic venues of indigenous vegetation and ecological ecosystems. Protection of cultural relics. Improvement of green coverage. Promotion of public transportation and clean fuel vehicles in the Olympic transport system. | Venues design / natural resources / forestation / transport |

Additional commitments

The Beijing Olympic Games Organizing Committee (BOCOG) made some additional commitments over and above the bid commitments in its efforts to stage a truly 'Green Olympics'. The commitments included supporting environmental education and large scale awareness raising, cooperating with environmental NGOs, instituting environmental management systems, sustainable transportation during the Games, eco-design for the venues, green procurement (environmentally-friendly purchasing of materials), green accommodation, tree planting and green marketing.

The 'Green Olympics' concept was launched by BOCOG and the Beijing Municipal Government to promote the environmental sustainability of the Games. It was part of the more general 'One World One Dream' concept, which underlined BOCOG's commitment to Olympic values, among which sustainable development was a key element.

The 'Green Olympics' concept was reflected in the five Olympic Mascots: four were animals representing natural elements. The mascots promoted environmental awareness and underlined Beijing's commitment:

- Beibei - a flying fish and represented 'clear water'.
- Jingjing - a panda, conveyed the messages of environmental protection and 'Green Hills'.
- Yingying - a Tibetan endemic protected antelope showcased Beijing's commitment to Green Olympics and the 'Grass-covered Ground' idea.
- Nini - a flying swallow, represented the concept of 'Blue Sky'.
- The fifth mascot, Huanhuan, symbolized the Olympic Flame.

Beijing's investment in the environment

Overall, it is estimated that the authorities in China invested over US\$17 billion on environmental projects. The following projects listed in Table 1.2 benefited from the investment.

福娃 Fuwa



Mascots from left to right: Beibei, Jingjing, Huanhuan, Yingying and Nini © BOCOG.

TABLE 1.2 BEIJING'S ENVIRONMENTAL INVESTMENT, 2001 – 2007

| Investment | Chinese Yuan | US Dollars |
|---|------------------------|-----------------------|
| Total | 119,160,430,000 | 17,433,000,000 |
| I. Investment in urban environmental infrastructure | 87,496,350,000 | 11,923,000,000 |
| 1. Sewage treatment project | 12,741,270,000 | 1,864,000,000 |
| 2. Gas supply and distribution project | 10,385,710,000 | 1,519,000,000 |
| 3. Heating supply project | 11,553,330,000 | 1,690,000,000 |
| 4. Afforestation/Greening | 14,620,020,000 | 2,138,000,000 |
| 5. Solid waste treatment | 6,356,960,000 | 930,000,000 |
| 6. Other pollution control projects | 31,839,060,000 | 4,658,000,000 |
| II. Investment in pollution sources control | 17,823,860,000 | 2,607,000,000 |
| 1. Industry pollution sources control | 5,046,360,000 | 738,000,000 |
| 1.1 Sewage treatment | 670,110,000 | 98,000,000 |
| 1.2 Air pollution source control | 3,807,250,000 | 557,000,000 |
| 1.3 Solid waste treatment | 90,760,000 | 13,000,000 |
| 1.4 Noise control | 24,040,000 | 3,000,000 |
| 1.5 Other pollution control | 454,220,000 | 66,000,000 |
| 2. Environmental investment along with new construction projects | 12,777,500,000 | 1,869,000,000 |
| III. Pollution control facilities operation cost | 11,447,310,000 | 1,674,000,000 |
| 1. Sewage treatment plant; domestic solid waste and dangerous waste treatment plant | 5,167,600,000 | 756,000,000 |
| 2. Other pollution control facilities | 6,279,710,000 | 918,000,000 |
| IV. Investment in environmental management capacity building | 2,392,910,000 | 350,000,000 |
| 1. Monitoring | 549,870,000 | 80,000,000 |
| 2. Supervision and information system | 267,100,000 | 39,000,000 |
| 3. Publicity and education | 77,030,000 | 11,000,000 |
| 4. Research and technical system | 127,290,000 | 18,000,000 |
| 5. Others | 1,371,630,000 | 200,000,000 |

Source: Beijing Environmental Protection Bureau



Workers clean the outside of the National Aquatics Centre prior to the Games.

The Organizing Committee and the greening of the Games

Organizing the Games was a massive undertaking for Beijing and China. The main body responsible for the organization of the Games was the Beijing Organizing Committee (BOCOG). The Organizing Committee was established in December 2001. It had 27 departments, one of which dealt with construction and the environment. The Construction and Environment Department had nine divisions, two of which focused on environmental issues – environmental management and environmental engineering. A Deputy Director of the Department of Construction and Environment was responsible for environmental activities of BOCOG.

At the time of the Games, BOCOG had around 8,000 staff with 14 of them working on environmental issues. The Games had 1.7 million volunteers, the highest ever in the history of the Olympic Games. The volunteers ranged from young people and students to elderly citizens of China.

It should be noted that the greening of the Games was a shared responsibility between BOCOG and the Beijing Municipal Government. The Construction and Environment Department of BOCOG coordinated environmental issues in the construction and operation of the venues across all cities, and in the organization of competition activities. The Beijing Municipal Government handled city-wide environmental improvement efforts including pollution

control measures, renovation and expansion of public transport and the overall greening of Beijing.

1.3 COMPELLING CASE FOR SUSTAINABLE GAMES

The Olympic Games provided an opportunity for Beijing to think about its developmental priorities. With such great citizen participation and media attention on all Games-related activities, the affects of activities on the environment, the health of the population and of the surrounding ecosystems became common-speak. For the average citizen of Beijing, environmental issues that might have, in the past, been taken for granted became major concerns. People began to appreciate the impact of these issues on their quality of life.

Air quality, more than any other environmental concern, dominated media reports on the Games, mainly because of the direct impact on the health and performance of the athletes. Government officials, athletes, sport officials and fans were all drawn into the debate on whether the air quality of Beijing would be safe for Olympic sport, particularly for endurance events. It created a media-frenzy in which journalists and media houses debated contrasting view-points and led to a general probe on the validity of official data released by the Beijing Environment Protection Bureau (EPB). Several other issues including energy, water and public transport also attracted media coverage, and thereby helped in kickstarting another debate and raised public awareness on these issues.

BEIJING 2008 OLYMPIC AND PARALMPIC GAMES**Key Facts**

| | |
|---|---|
| Number of years planning | Over 7 |
| Olympic Torch Relay | 21,880 torch bearers over 137,000 kilometers |
| Event dates | Olympic Games: 8-24 August 2008 Paralympic Games: 6-17 September 2008 |
| Venues | Beijing: 31 venues Shanghai, Hong Kong, Tianjin, Qingdao, Qinhuangdao and Shenyang: 1 venue each |
| Olympic athletes | 11,468 |
| Paralympic athletes | 4,000 |
| Olympic events | 302 events (165 men's, 127 women's and 10 mixed) |
| Paralympic sports and disciplines | 20 |
| Olympic sports and disciplines | 28 |
| Paralympic awards and records | 1,429 medals. 279 world records and 339 Olympic records. |
| Olympic awards and records | 926 medals to winners from 87 countries and territories. 38 world records and 85 Olympic records broken |
| Countries represented | 204 |
| Olympic spectators | 6.7 million |
| Paralympic spectators | 3.45 million |
| Television audience | 4.7 billion viewers watched over 500 hours of Olympic footage broadcast in over 220 countries |
| Number of journalists, Olympics | 26,298 accredited journalists, 5,980 non-accredited journalists |
| Number of journalists, Paralympics | 10,300 accredited |
| Olympic Officials, Coaches and Staff | 9,175 |
| Paralympic Officials, Coaches and Staff | 2,500 officials and coaches from 143 countries |

Sources: Beijing Environmental Protection Bureau.

THE GAMES AND THE ENVIRONMENT

1896 Athens: first modern Olympic Games with athletes from 14 nations

1900 Paris

1904 St Louis

1908 London

1912 Stockholm: athletes represent all five continents

1920 Antwerp

1924 Paris: "Swifter, Higher, Stronger" officially adopted as Olympic motto

1924 Chamonix (winter)

1928 Amsterdam

1928 St. Moritz (winter)

1932 Los Angeles

1932 Lake Placid (winter)

1936 Berlin

1936 Garmisch-Partenkirchen (winter)

1948 London

1948 St. Moritz (winter)

1952 Helsinki

1952 Oslo (winter)

1956 Melbourne/Stockholm

1956 Cortina d'Ampezzo (winter)

1960 Rome

1960 Squaw Valley (winter)

1964 Tokyo

1964 Innsbruck (winter)

1968 Mexico

1968 Grenoble (winter)

1972 Munich

1972 Sapporo (winter)

1976 Montreal

1976 Innsbruck (winter)

1980 Moscow

1980 Lake Placid (winter)

1984 Los Angeles: air pollution a concern for athletes

1984 Sarajevo (winter)

1986 IOC President suggests the environment as the third pillar of Olympism

1988 Seoul

1988 Calgary (winter)

1992 Barcelona: green designs used in the Olympic Village

1992 Albertville (winter)

1993 Sydney wins 2000 bid on the basis of strong environmental commitment

1994 Lillehammer (winter): first green winter Games

1994 "Environment" becomes the third pillar of Olympism

1994 UNEP and IOC sign agreement of cooperation

1995 IOC form a Sport and Environment Commission

1996 Atlanta

1998 Nagano (winter)

1998 IOC decides the Paralympic and Olympic Games will be held in the same host city and venues

1999 IOC adopts the Olympic Movement's Agenda 21, for sustainable games

2000 Sydney: first "Green Games"

2002 Salt Lake City (winter) 3 million trees, composting and recycling

2004 Athens: Narrow range of environmental commitments

2006 Turin: Creates a green legacy (winter)

2008 Beijing: Raises the bar for green ambitions

© Getty Images



The Olympic Flame summits Mount Everest, 8 May 2008.



Share the Dream


Share the Dream

Beijing 2008
Olympic rings









Chapter 2

AIR QUALITY

Addressing Beijing's poor air quality was a top priority in planning for the Games. It was easily the most prominent environmental issue BOCOG and Beijing municipal authorities had to manage.

© Getty Images

Concerted efforts to improve Beijing's air quality began well before the Games.

Health concerns among athletes and officials over air quality attracted international media coverage before and during the Games, earning headlines like these:

- ‘Citing Pollution, Gebrselassie Opts Out of Olympic Marathon,’ *The New York Times* (March, 2008), and
- ‘Olympians air a gripe about Beijing,’ *LA Times* (March, 2008).

The air quality in Beijing is a result of the city’s geography – it is surrounded on three sides by mountains which do not allow pollutants to disperse – compounded by the city’s rapid population growth and economic expansion.

Beijing’s bid included goals and commitments related to air quality covering the industrial, agricultural, transport and energy sectors as follows:

- Reduce and control industrial pollution;
- Improve dust control at building sites, during road construction and in the agricultural sector;
- Prohibit open air incineration, and implement the coverage of outdoor storage areas for waste and other materials;
- Relocate more than 200 industrial enterprises from within the Beijing Fourth Ring Road, and relocate, close and renovate polluting industries in southeast suburbs and Shijingshan district;
- Reduce and control vehicle emissions;
- Improve Beijing’s public transport system;
- Improve the environmental performance of the energy sector, including converting

coal boilers in Beijing’s urban areas to clean fuels, and

- Formulate and implement an action plan to phase out ozone depleting substances (ODS) by 2005.

2.1 CHINA’S AIR QUALITY STANDARDS

Pollution control measures for the Games were evaluated against Beijing’s air quality targets. Beijing is party to the Standard Ambient Air Quality Standards (GB 3095-1996), which sets limits for SO₂ (Sulphur dioxide), CO (Carbon Monoxide), PM10 (Particulate Matter with a diameter of 10 microns or smaller) and nitrogen dioxide (NO₂).

The Chinese air quality standards set separate limits for different types of areas:

- Class I applies to special protected areas such as

natural conservation areas, scenic spots, and historical sites;

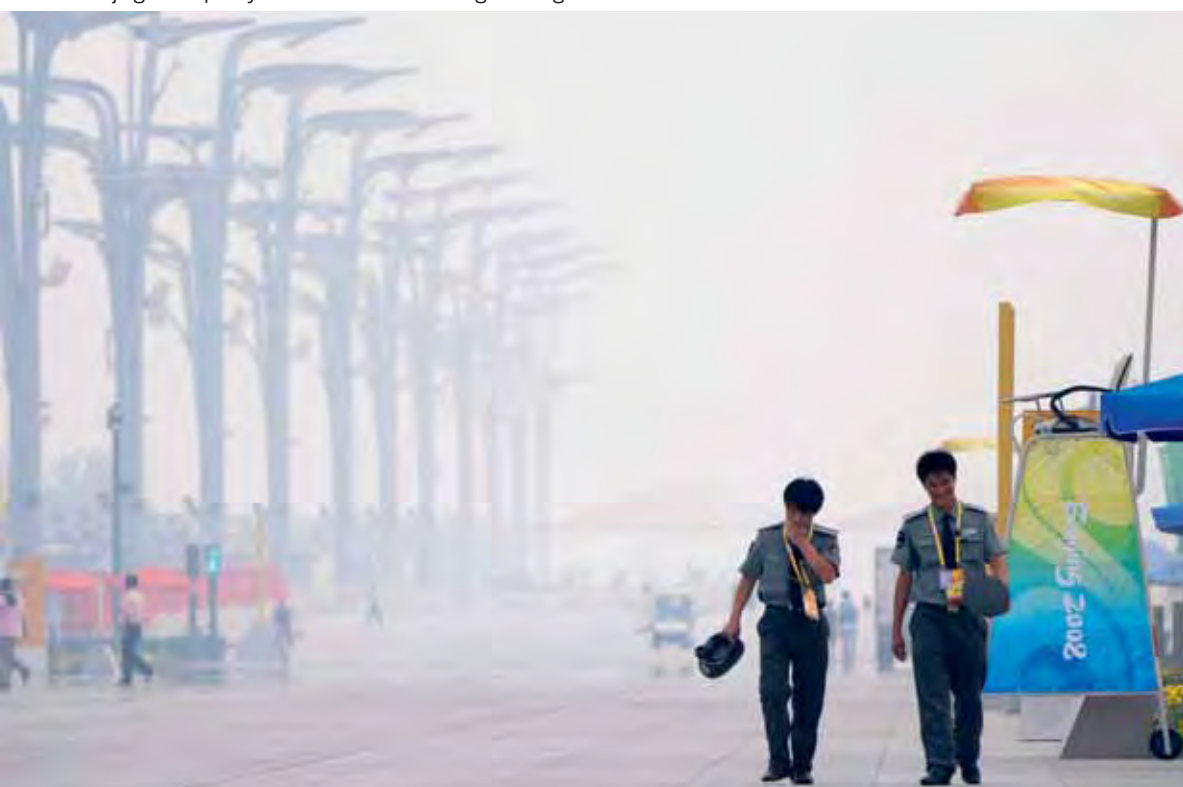
- Class II applies to residential areas, mixed commercial/residential areas, cultural, industrial, and rural areas, and
- Class III applies to special industrial areas.

The standards are most strict for Class I and least strict for Class III areas. Beijing is designated a Class II area. In setting China’s air quality standards, the authorities were guided by the World Health Organization (WHO) 2000 Air Quality Guidelines. The Chinese Class II air quality standards are summarized in Table 2.1. The WHO 2000 guidelines, as well as the 2005 Global Update WHO Air Quality Guidelines, are also presented (see also Appendix).

Air quality is also measured against an air pollution index (API). The API is an index for reporting daily air quality to the general public. China uses the term ‘Blue Sky Day’ to describe days with an API value of 100 or less. The higher the API value, the greater the level of air pollution and the greater the health concern. The relationship between the Chinese API and the ambient pollution levels are shown in Table 2.2. While China has an air quality standard for ozone, ozone is not included in the API.

As discussed in this chapter, during the period of the Olympic Games, the API was dominated by PM10 levels. These particulates arise from a variety of sources including motor vehicles, industrial operations, construction sites, windblown soil, cooking and heating from wild fires and waste burning.

Beijing’s air quality was at times a challenge during the Games.



© AFP Photo DDP / Michael Kappeler

TABLE 2.1: CHINA'S STANDARD II NATIONAL AIR QUALITY STANDARDS

| Pollutant | Mean Level | China's Upper Limit of Class II | WHO EU 2000 Air Quality Guidelines | WHO 2005 Air Quality Guidelines |
|------------------|--------------|---------------------------------|------------------------------------|---------------------------------|
| SO ₂ | Annual Mean | 60 | 50 | None |
| | 24-hour Mean | 150 | 125 | 20 |
| | Hour Mean | 500 | 500@ | 500@ |
| PM ₁₀ | Annual Mean | 100 | ~ | 20 |
| | 24-hour Mean | 150 | ~ | 50 |
| NO ₂ | Annual Mean | 80 | 40 | 40 |
| | 24-hour Mean | 120 | 120+ | None |
| | Hour Mean | 240 | 200 | 200 |
| CO | 24-hour Mean | 4,000 | 10,000+ | 10,000 + |
| | Hour Mean | 10,000 | 30,000 | 30,000 |

(quantities in µg/m³)
 @ ten minute mean
 + eight hour mean
 ~ not set in the WHO EU 2000 Guidelines

TABLE 2.2: CHINA'S AIR POLLUTION INDEX AND AIR QUALITY GRADING

| API scope | Daily Average Pollutant Concentration (mg/cubic meter) | | | AQ level | AQ Condition | Notes on Health effects |
|-----------|--|-----------------|------------------|----------|-------------------|---|
| | SO ₂ | NO ₂ | PM ₁₀ | | | |
| 0-50 | 0-0.05 | 0-0.08 | 0-0.05 | I | Excellent | Daily activities will not be affected. |
| 50-100 | 0.05-0.15 | 0.08-0.12 | 0.05-0.15 | II | Good | Daily activities will not be affected. |
| 100-200 | 0.15-0.8 | 0.12-0.28 | 0.15-0.35 | III | Slightly polluted | The symptom of the susceptible is slightly aggravated, while the healthy people will have stimulated symptoms. |
| 200-300 | 0.8-1.6 | 0.28-0.565 | 0.35-0.42 | IV | Moderate polluted | The symptoms of the patients with cardiac and lung diseases will be aggravated remarkably. Healthy people will experience a drop in endurance and increased symptoms. |
| >300 | >1.6 | >0.565 | >0.42 | V | Heavy polluted | This exercise endurance of the healthy people drops down, some will have strong symptoms. Some diseases will appear. |

Source: Beijing Environmental Protection Bureau

2.2 BEIJING POLLUTION CONTROL MEASURES

Concerted efforts to improve Beijing's air quality began well before the Games. A Master Plan for 1998 – 2008 was established, and during this decade the Beijing Municipal Government implemented more than 200 environmental measures in 14 stages.

The Beijing 2008 Olympic Games provided added incentive to accelerate the improvement in air quality. The measures taken generally fall into the following five areas.

Energy structure, efficiency and fuels

During the preparatory period leading up to the Games,

measures were directed first at reducing the rate of growth of energy consumption and secondly at increasing energy efficiency. China uses large amounts of coal. Many of the strategies focused on the impact this had on ambient levels of SO₂ and particulates. Initiatives were implemented in Beijing's inner urban area and the surrounding suburbs and counties.

One outcome was that the use of natural gas increased four-fold from 2000 as a result of efforts made to replace coal fired boilers and family stoves with natural gas, and to replace coal heating with electrical heating.

There was also an increase in the use of low sulphur coal. Greater efforts were made to advance



© V. Venturi/Das Fotoarchiv/Still Pictures

Air quality issues are not confined to Beijing although the problem is not as acute in other cities like Qingdao (pictured).

pollution controls and there was a stiffening of compliance monitoring and enforcement. Six sets of desulphurization facilities were built at the coal fired power plants and oil smoke emission limits were placed on local restaurants.

Industrial sector

Energy-related measures had a positive impact on emissions from the industrial sector. In addition, activities focused on major polluting industries, such as the closure of cokery units at Beijing Coke and Chemical Plant; closure of cement, lime and brick plants; and the closing down of production lines at Capital Iron and Steel Company. The production at the Capital Iron and Steel Company facility was expected to decrease by 4 million tonnes by the end of 2007 and by another 4 million tonnes in 2008, resulting in a reduction of PM emissions of 18,000 tonnes per

year.

Efforts were also made to better manage industrial emissions and promote cleaner production. These included screening of emissions at small and medium sized enterprises, which resulted in some closures and went hand in hand with improved in-stack monitoring of emissions at large-scale industrial boilers. Lastly, efforts were made to relocate enterprises out of the Beijing area resulting in the relocation from the city of approximately 200 factories between 2000 and 2006.

Transport sector

The transport sector is a major contributor to Beijing's air quality. Transport measures related to air quality focused on five key strategies, namely; new and stringent vehicle emission standards; improvement of fuel quality to meet the new emission standards; inspection, testing

and labelling of in-use vehicles; restricted vehicle access into the city and an accelerated schedule to retire old vehicles combined with improved access to public transport. These are discussed in Chapter Three.

Dust and construction

The Beijing Municipal Government implemented various strategies to reduce particulate pollution related to industry. Measures targeted construction and road dust and, from 2001, involved better supervision and management at construction sites. As a consequence, precautions were taken before burning waste at the sites and measures were made to reduce splashing from construction vehicles. Eighty sandstone storage areas within the city were permanently closed. In 2006, the government also established environmental standards for construction

sites, which included additional measures for road sweeping and sprinkling, urban forestation (see Chapter Five) and better management of bare ground.

Beijing Games air quality assurance measures

Special short term measures further restricted access to Beijing city for the period leading up to and through to the end of the Olympic Games. Implemented progressively in three stages, the measures included limiting the use of government owned vehicles, halting industrial production, suspending construction and effecting controls to curtail evaporative emissions at gas stations.

All 'high emitting' (identified through yellow tags) cars and trucks were banned from entering the city. In addition, 50 per cent of privately owned vehicles were stopped from entering the city for

certain days of the week through an odd and even number plate permitting system. In the run up to the Games power generation facilities operated at 30 per cent capacity and contingency plans were implemented for fuel switching (to natural gas) to further reduce emissions. The final stage involved additional measures to reduce emissions in targeted sectors in the neighbouring provinces of Tianjin, Hebei, Shanxi, Shandong, and Inner Mongolia. (Refer also to the UNEP 2007 Environmental Review and BOCOG's 2008 report).

In addition to these measures directed at reducing air pollution, action was taken to protect the stratospheric ozone layer. This included strict enforcement of the national regulations and rules on the phase-out of ozone depleting substances (ODS) in Beijing. The UNEP Ozone Action Programme provided BOCOG with guidance to help them avoid the use of ODS in the Olympic facilities and venues.

The combined effect was that the average daily API in Beijing during the Olympic Games was 36 per cent lower than the average of the preceding eight years.

Beijing expanded its air quality monitoring and modelling capacity, put in place vehicle emission and fuel quality standards that were on par with Europe, took thousands of old polluting vehicles off the road permanently (not just for the Games), introduced compressed natural gas (CNG) fuelled buses, retrofitted over 5,000 buses and expanded and upgraded its public transport system. In addition, more than 200 polluting industries were relocated, more than 16,000 small coal-fired boilers were converted to natural gas and the use of natural gas for power generation increased fifteen-fold.

The measures and improvements – many of them permanent – in air quality management implemented by Beijing municipal authorities will benefit the population well beyond the Games. Several of the permanent measures have become part of national policy in China. They are now also being adopted in other cities in the country.

The Beijing Games successfully avoided the use of HCFC-based refrigeration and air conditioning equipment more than 30 years ahead of the schedule as stipulated under the Montreal Protocol.

2.3 IMPACT ON BEIJING'S AIR QUALITY

Significant efforts have been made over the past decade to improve the air quality in Beijing. In order to assess the impact of these measures on the air quality of Beijing an analysis of air quality monitoring data in Beijing was performed for this report. The analysis was conducted using CO, PM₁₀, SO₂ and NO₂ data provided by the Beijing Environmental Monitoring Center.

The Beijing Environmental Protection Bureau (EPB) operates a network of air quality monitoring

stations, which consists of 27 stations that measure the four criteria pollutants (CO, PM₁₀, SO₂ and NO₂), as well as meteorological variables (wind speed and direction, temperature and relative humidity). The results below depict trends in ambient levels of pollutants since 2000 and during the Olympic Games. This helps to assess the effectiveness of the various measures on Beijing's air quality. Improvements in air quality are compared with the Chinese air quality standards.

2.4 ANNUAL TRENDS IN AIR QUALITY

The network-wide annual mean concentrations of the four priority pollutants for the period 2000 – 2008 are presented in Figure 2.1. (Note the 2008 mean values do not include December data. The coloured arrows depict the annual air quality standard for the various pollutants).

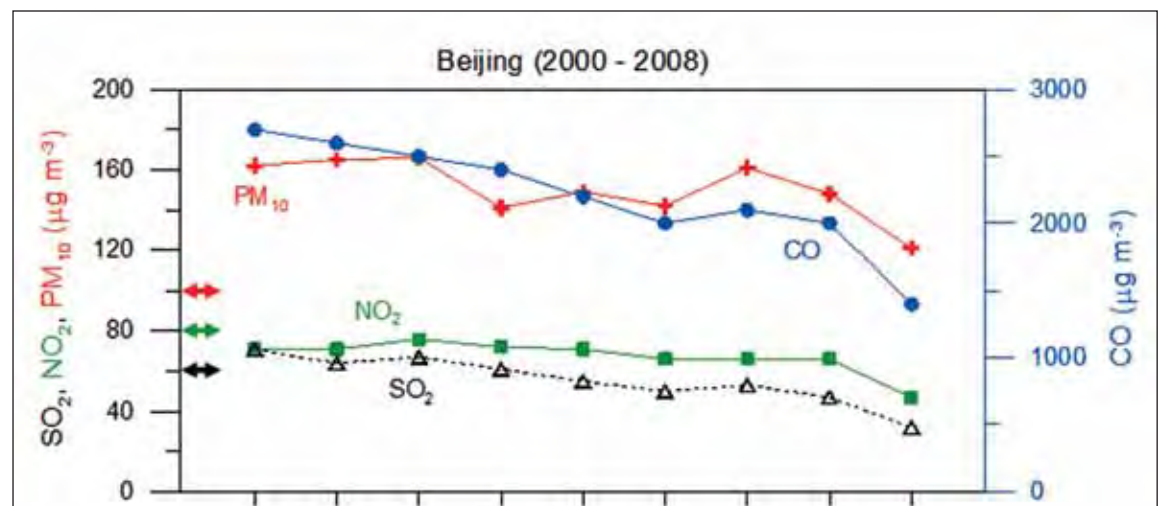
The data shows that the ambient levels of CO and SO₂ decreased in this period and that the current levels are below the annual Chinese air quality standard. Between 2000 and 2007 NO₂ concentrations decreased more slowly than SO₂ levels, and

through 2007 were slightly below the annual air quality standard. The values in 2008 decreased substantially below the air quality standard. The PM₁₀ concentrations show no clear trend from 2000-2007. They increase slightly until 2002, then come down between 2003 and 2005, then increase again in 2006. Thereafter they decline. The PM₁₀ values substantially exceed the annual air quality standard, indicating unhealthy conditions.

In general these trends show that the efforts directed towards energy structure and replacement of coal had an impact. The decreases in SO₂ and CO levels are the best indicators of this impact. The impact of transportation measures taken is also evident and is apparent when the ambient NO₂ and CO (sources of CO include all types of combustion including those from traffic and industrial boilers) levels are plotted against the number of vehicles (refer Transport chapter). The NO₂ and CO levels have declined even though the number of vehicles has grown substantially within the same period.

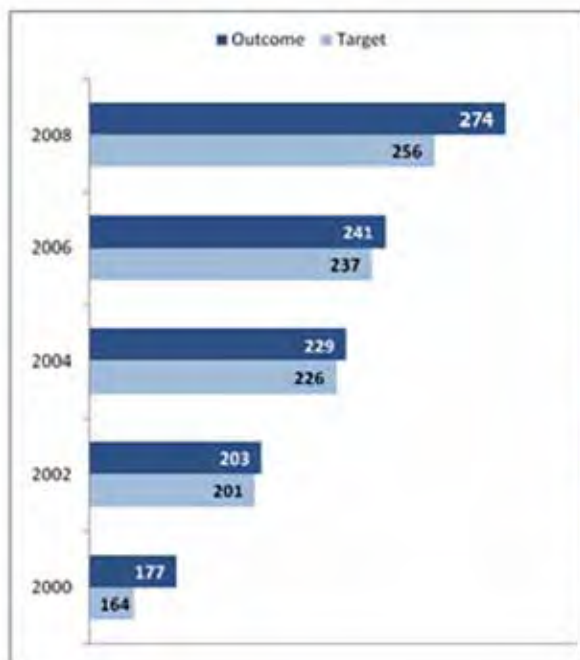
Before Beijing won the Olympic bid in 2000, air quality in the

FIGURE 2.1: NETWORK-AVERAGE ANNUAL MEAN CONCENTRATIONS OF THE MAIN POLLUTANTS IN BEIJING, 2000 – 2008



Source: Beijing Environmental Protection Bureau

FIGURE 2.2: TREND IN 'BLUE SKY DAYS', 2000-2008



Source: Beijing Environmental Protection Bureau



Since 2000, Beijing's 'Blue Sky Day' targets were met or exceeded.

capital met the standards less than 50 per cent of the time. The number of days in compliance has since grown steadily, exceeding 75 per cent in 2008. Figure 2.2 shows that the city's 'Blue Sky Day' targets were either met or exceeded each year since 2000.

It is also instructive to look at the seasonal variations in air pollution levels in Beijing. Figure 2.3 shows the network-wide monthly mean values of the criteria pollutants for 2000, 2006, 2007 and 2008. Two primary pollutants, CO and SO₂, show a distinct seasonal cycle, with peak values in winter and minimum values in summer.

The peak values in winter reflect both emissions and meteorological factors. Mean winter temperatures in Beijing are cold (below 0° C). Beijing has a 4 month heating season (Mid November through Mid March), during which coal related emissions from heating are at a maximum. In winter, Beijing also experiences a high number of winter days with temperature

inversions, which trap pollution within the city resulting in higher pollution levels. As a result of these factors, air pollution levels in Beijing are at their highest in winter.

This is best illustrated by the SO₂ concentrations in January and February in 2001, where the monthly mean values exceed the daily Chinese air quality standard for SO₂ (which is 150 g/m³). In fact in 1998, Beijing had 106 days, or 79 per cent of the days during the four-month heating season where the airborne sulphur dioxide exceeded the air quality standard.

The impact of efforts to convert small coal-fired boilers in houses and restaurants to natural gas and electricity can be seen in the steep decreases in the monthly mean SO₂ values in the heating season months shown in Figure 2.3, where the monthly mean SO₂ values have declined by nearly 50 per cent between 2001 and 2008 during the heating season.

The lower pollution levels in the summer reflect a shift in wind direction with transport patterns from the south and an increase in frequency and amount of precipitation (e.g. Beijing gets around 75 per cent of its total rainfall between June and August).

The increase in precipitation scavenges particles and SO₂ from the air, thus reducing their pollution levels. SO₂, CO and NO₂ are also removed from the atmosphere by photochemical reactions, which reach maximum rates in the summer, and these reactions contribute to the summer minimums.

PM₁₀ shows a slightly different seasonal cycle, with peak values in the spring, which reflect the significant contribution of particulate matter from sand storms originating in the arid and semi-arid Taklimakan and Gobi regions.

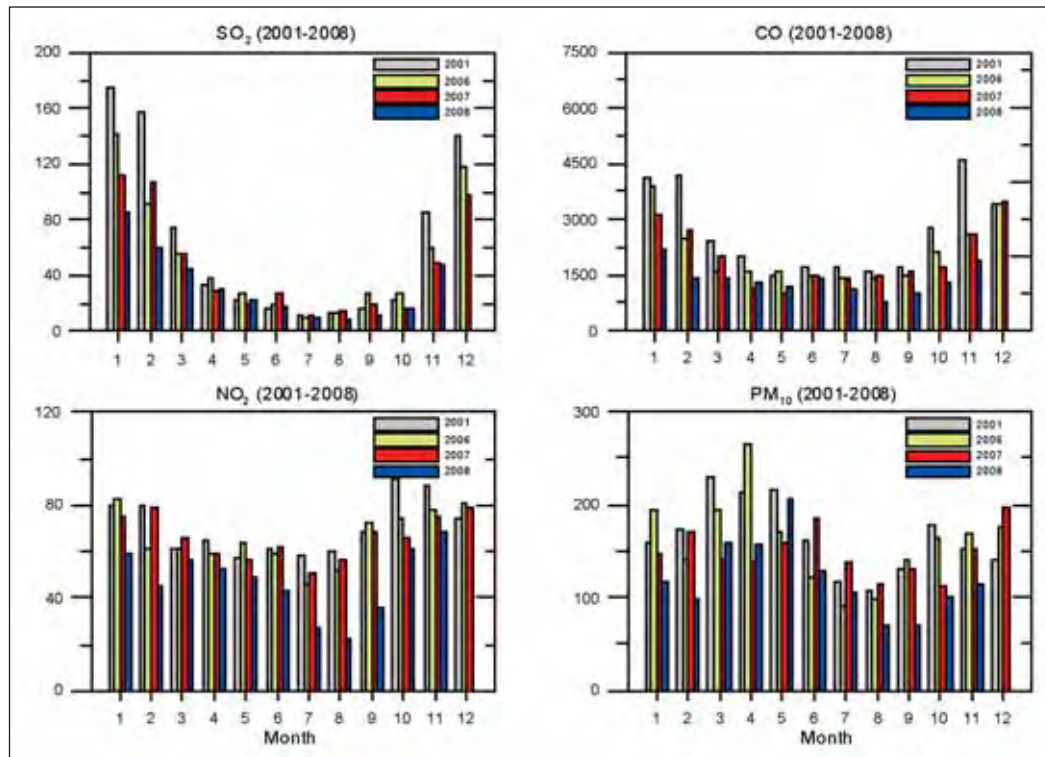
The inter-annual trends in the monthly mean values for the

most part show a systematic decrease between 2000 and 2008. However there is also appreciable inter-annual variability as illustrated in the SO₂ monthly mean values for February, where the values for 2007 are higher than those for 2006 and 2008, and for PM₁₀ in April, where 2006 exceeds all other years. This variability reflects the significant impact that year to year changes in meteorology can have on air quality.

2.5 AIR QUALITY IN THE PERIOD LEADING TO AND JUST AFTER THE GAMES

The daily pollution levels in Beijing in the period leading up to and just after the Games were also analyzed to see the effects of the temporary measures on air quality. The network-averaged daily pollution levels from July to October 2008 are shown in Figure 2.4. The grey line shows the daily (24-hour) mean air quality standard of 150 g/m³ for SO₂ and PM₁₀ and the daily air quality standard for both pollutants.

FIGURE 2.3: NETWORK-WIDE MONTHLY MEAN CONCENTRATIONS OF CO, SO₂, PM₁₀ AND NO₂ IN BEIJING FOR 2001, 2005, 2007 AND 2008

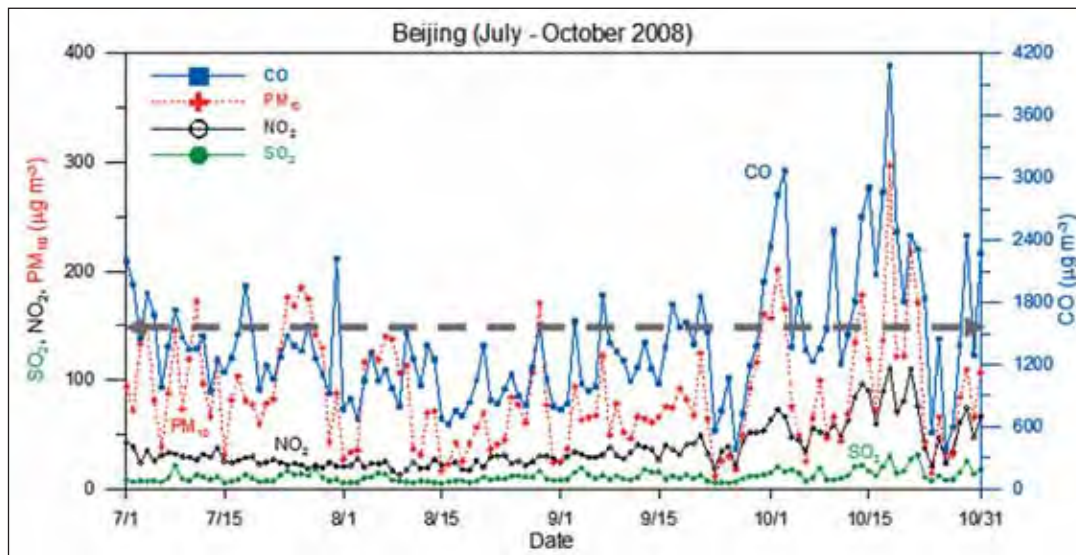


Source: Beijing Environmental Protection Bureau

(Note the values presented are the average of all 27 monitoring sites and that the values at an individual site may be higher or lower than those shown).

The SO₂ levels were significantly below the air quality standard for the entire period. The average PM₁₀ levels from July to October 2008 fell below the air quality standard most of the time, with only a few days in early and late August where the values were near or above the

FIGURE 2.4: NETWORK-WIDE DAILY (24 HOUR) MEAN CONCENTRATIONS OF CO, SO₂, NO₂ AND PM₁₀ IN BEIJING, 1 JULY – 31 OCTOBER 2008



Source: Beijing Environmental Protection Bureau

standards. During the Olympic and Paralympic Games (from 8 to 24 August and 6 to 17 September respectively) data provided by the Beijing EPB shows PM10 levels were within the required parameters.

Air quality monitoring via satellite

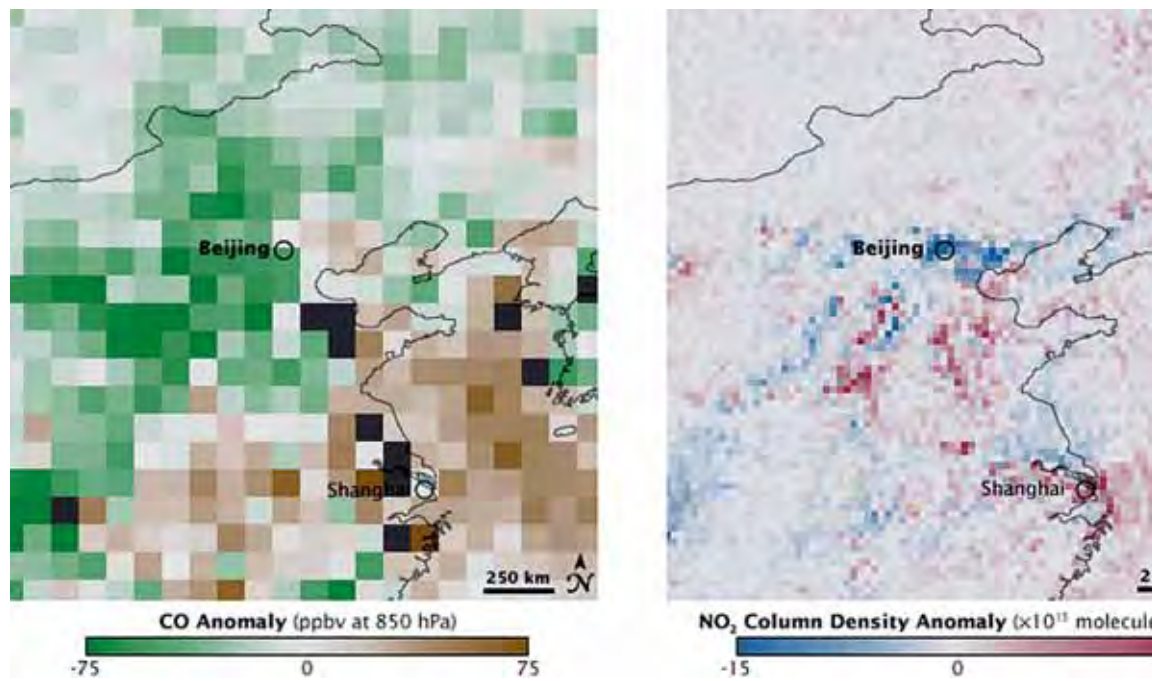
Changes in Beijing’s pollution levels during the Games period were also detected from space by sensors mounted on satellites. Unlike a ground-based sensor, which records the composition of the air immediately around it, the satellite sensor measures wide swaths of the atmosphere.

The left image in Figure 2.5 shows the change in CO concentrations over the North China Plain as observed by the Measurements of Pollution in the Troposphere (MOPITT) sensor on NASA’s Terra satellite in August 2008. (Each square represents an area about 100 kilometers wide).

Areas that are green indicate a decrease in CO compared to average values observed during the month of August in 2005, 2006 and 2007. Brown areas show where CO concentrations were higher than average. The figure shows CO concentrations decreased by 20 per cent in the area immediately around Beijing.

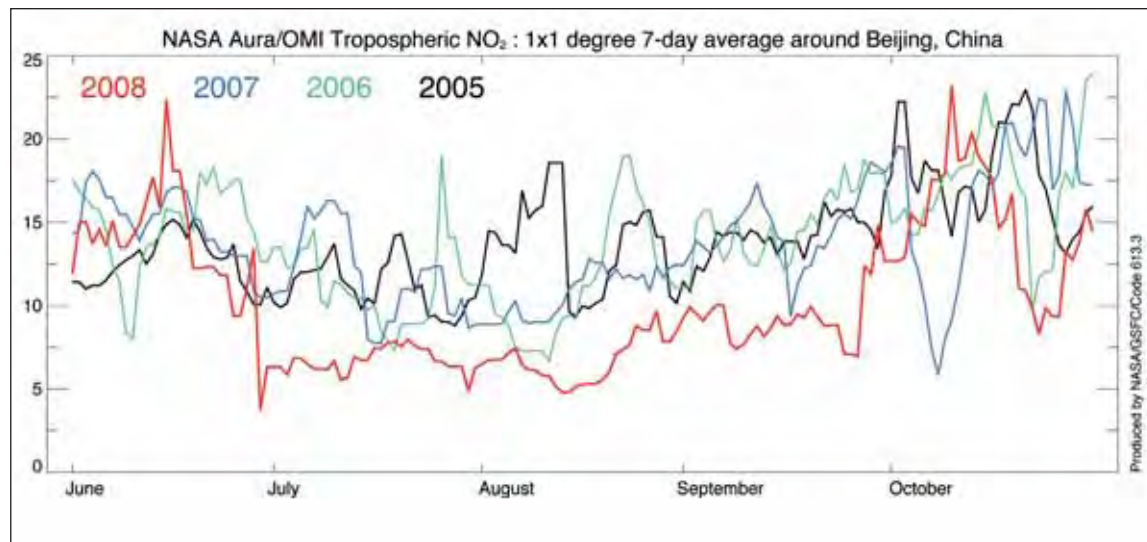
The right image in Figure 2.5 shows NO₂ levels fell by 50 per cent. The image was made using data collected by the Ozone Monitoring Instrument (OMI) on the Aura satellite. The image compares average NO₂ concentrations observed in August 2008 to the average values observed in August 2005, 2006, and 2007. Above average concentrations are red while lower concentrations are blue. Each square is approximately 25 kilometers wide. Again, the drop in NO₂ concentrations is centered on Beijing, where restrictions were greatest.

FIGURE 2.5: SATELLITE DETECTION OF POLLUTION CHANGES OVER BEIJING, AUGUST 2008



Source: NASA image created by Jesse Allen using MOPITT CO data provided by the National Center for Atmospheric Research and the University of Toronto [MOPITT Teams](#) and Aura OMI data provided by the Aura OMI science team

FIGURE 2.6: MONTHLY MEAN-TIME SERIES OF TROPOSPHERIC NO₂ COLUMNS, BEIJING



Source: Witte et al., 2008 as observed by the Ozone Monitoring Instrument (OMI) on the Aura Satellite

Figure 2.6 shows the seasonal variation in satellite NO₂ columns. The significant decrease in the column amounts track the time periods of enhanced controls, and the variations detected by the satellite are generally consistent

with those shown in the air quality monitoring data in Figure 2.3.

2.6 ATTRIBUTING CHANGES TO EMISSION CONTROLS

During the Games period, various atmospheric components in Beijing decreased dramatically compared to those during the same month in previous years.

However, these decreases may be linked not only to the implementation of control measures, but to the weather conditions during August.

For example, there was higher than average rainfall in Beijing during the Olympic Games. The accumulated precipitation from 8 – 24 August was 151.7 mm in the plain area of Beijing. This was 90 per cent higher than the 30-year average (80 mm).

According to data from the World Meteorological Organization, there were four widespread rainfalls across Beijing and another four local precipitation events resulting in five days with 10 mm of daily rainfall. Rain affects air quality by removing particles and soluble gases, such as SO₂, from the air. The higher than average rainfall led to the more efficient removal of particles and soluble gases, and

this contributed to lowering the pollution levels.

To assess the impact of the emission control measures it is necessary to isolate and remove the effects of meteorology on Beijing air quality during the Games. A preliminary analysis that removed the meteorological effects has been performed by the Beijing Meteorological Bureau using air quality and meteorological data collected by the Chinese Meteorological Agency (CMA) during the Games.

After removing the effects of weather conditions, it was found that from 1 – 19 July 2008, various reactive gas concentrations closely linked to vehicle emissions (e.g. NO₂) dropped by about 40 per cent. In addition, total PM10 concentrations dropped by between 10 per cent and 25 per cent, and traffic related particulate

black carbon concentrations decreased by between 25 per cent and 30 per cent. Furthermore, SO₂ concentrations over Beijing also decreased though to a lesser extent than the traffic related pollutants.

During the period of the additional control measures, from 20 July until the end of the Games, the ambient levels of vehicle gaseous pollutants, such as NO₂, dropped by an additional 15 per cent. Total PM10 particle concentrations showed no further changes, but black carbon was reduced further by 10 – 20 per cent.

An additional way to test the effectiveness of the pollution control measures is to evaluate whether the observed changes in pollution levels since 2000 and during the Olympic Games period are consistent with expected changes in emissions

resulting from the various imposed measures.

Emission estimates for Beijing for the various years were not obtainable from official sources. There are, however, estimates of China's pollution emissions in the scientific literature. For example, one study (*Streets et al., 2004; Zhang et al., 2008*) has produced emission inventories by province for 2001 and 2006.

By these estimates, the emissions of CO and SO₂ in Beijing decreased in this time period by 20 per cent and 30 per cent respectively, while NO_x emissions increased by 40 per cent. The estimates are generally consistent with the observed trends in Beijing air quality data for SO₂ and CO, as shown in Table 2.2. However, they are inconsistent with the observed trends in ambient NO_x concentrations which show a slight decrease in contrast to the

Traditional lifestyles continue amid the pressures confronting modern Beijing.



© Ullstein · Ecker/Still Pictures

study's finding of a significant increase.

There are ongoing efforts to estimate the expected changes in emissions in Beijing due to the special measures put in place between July and September

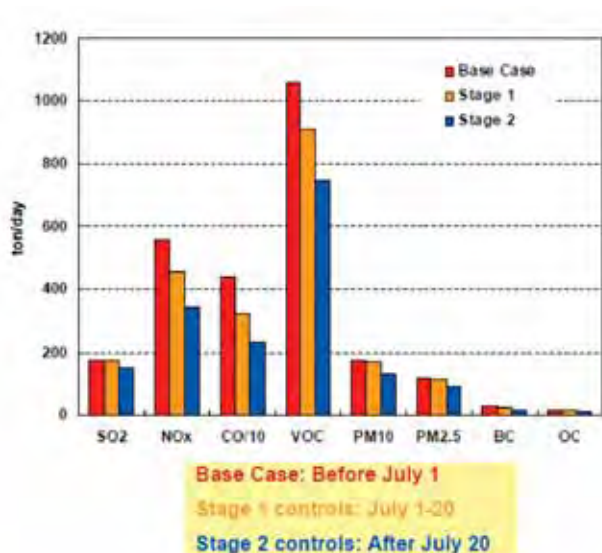
2008. This work is being lead by Tsinghau University.

Preliminary estimates of changes in emissions prepared by Argonne National Laboratory and Tsinghau University are shown in Figure 2.7. These estimates

find that the special measures associated with stages one and two reduced emissions in the following ways (from largest to lowest reductions): CO: 47 per cent; NO₂: 38 per cent; VOC: 30 per cent; PM10: 20 per cent; and SO₂: 14 per cent (*Streets et al.,*

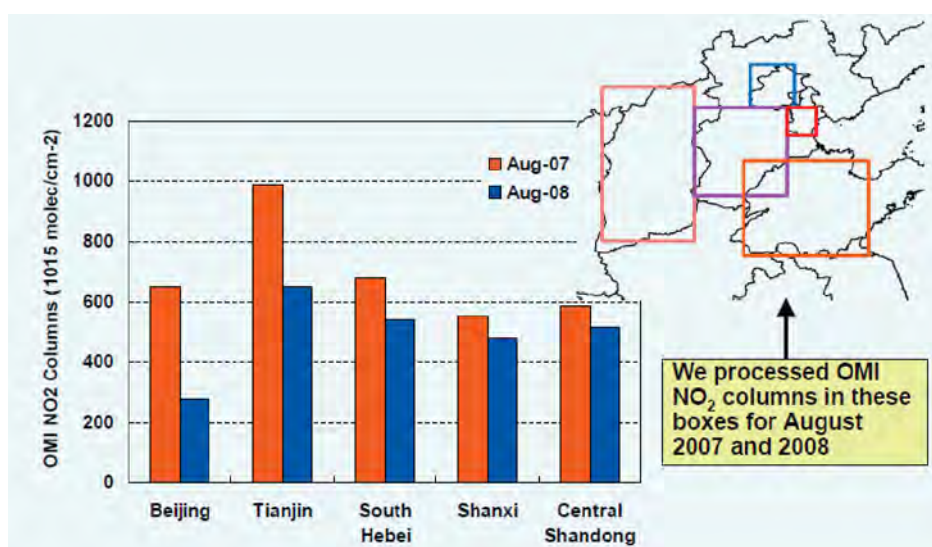
2008). These estimated changes in emissions indicate that the biggest changes in pollution levels should be seen in CO and NO₂, with the smallest changes in ambient SO₂ concentrations. This is generally consistent with the observed changes in ambient pollution levels for Beijing discussed previously. The largest changes were found in NO₂ and CO levels.

FIGURE 2.7: PRELIMINARY ESTIMATES OF CHANGES IN EMISSIONS



Source: Argonne National Laboratory and Tsinghau University

FIGURE 2.8: COMPARISON OF MONTHLY MEAN NO₂ COLUMN OBSERVED BY OZONE MONITORING INSTRUMENT (OMI) ON AURA SATELLITE FOR AUGUST 2007 AND 2008 FOR BEIJING AND SURROUNDING REGIONS



Source: (*Streets et al., 2008*)

The satellite analysis was also extended to look at the changes in NO₂ in the surrounding regions. These results are shown in Figure 2.8. The largest change, of close to 60 per cent, was found in Beijing. Smaller reductions in NO₂ ranging from 10 per cent to 20 per cent were detected in the surrounding regions. These changes are consistent with the air quality measures which targeted first and foremost the emissions within Beijing, but included regional actions as well.

2.7 COMMENTS AND RECOMMENDATIONS

Significant efforts before and during the Games were focused on improving Beijing's air quality. As a result, air quality improved significantly. The air quality during the Olympic Games benefited from favourable weather conditions as well as anti-pollution measures.

There are important lessons to be learned from the Beijing experience.

The Games as a catalyst

The Beijing 2008 Olympic Games accelerated efforts to improve air quality and provided new perspectives on environmental protection. Beijing authorities had long term plans in place to improve air quality, but the Games gave added impetus for aggressive implementation.

Examples include the rapid adaptation of new Euro vehicle standards, improvements to fuel quality and the introduction of

cleaner vehicle technologies, all of which are discussed in the Transport chapter.

The range of temporary measures for the Games provided opportunities to target and implement short term source reductions, and the experience gained will be of considerable value in the development of future air quality management plans.

Public awareness

The Games greatly increased public awareness of air quality. Beijing residents and visitors enjoyed the results of emission controls and, in some cases, played an active role in helping with the measures.

Improved air quality during the Games proved to the public that control measures can have an immediate impact on air quality. As such the public are pressing for continued efforts to sustain the improved quality of life experienced during the Games. Short term measures, such as the restricted use of private cars, have been extended. This public partnership with the EPB should have long-term benefits, even though the precise effect of the new regulation is yet to be quantified as people have taken to buying two cars – one with an odd numbered plate for use on odd numbered days and one with an even numbered plate for use on even numbered days. (See also Transport chapter).

Regional collaboration

The Games lent support for the implementation of regional control strategies. In the build up to the Olympics discussions began to gauge the extent to which surrounding sources contributed to Beijing air quality. *Streets et al.*, (2007) published a study based on the US EPA's Models-3/CMAQ model simulation over the Beijing region. They concluded that controlling only local sources in Beijing would not be sufficient to

© Ullstein - Eckel/Still Pictures



Anti-pollution measures and favourable weather conditions combined to let Beijing get on with the show

attain the air quality goal set for the Beijing Olympics.

These findings are confirmed by a follow-on modelling study which found that regional emissions from industries and power plants had the biggest impact on Beijing pollution levels. However, it was found that in the periods with the highest pollution levels the local emission sources played a more important role. It was recommended that long-term control strategies should be based on regional-scale collaborations, and that emission abatement of local sources may be more effective in lowering the PM_{10} concentration levels on the heavy pollution days.

Better air quality therefore could be attained during the Olympics by placing effective emission

controls on the local sources in Beijing and by controlling emissions from industry and power plants in the surrounding regions. This sentiment was reflected in the measures implemented during the Beijing Olympic Games period. The regional nature of air pollution is expected to be important in other regions in China (e.g., the Pearl River Delta) and will be an important element in future air quality management plans.

The need for regional strategies in controlling Beijing's air quality is gaining recognition. However it is not clear what the impacts of the controls within Beijing had on the air quality of the surrounding areas. This assessment would provide valuable information regarding regional air quality management.

A case study for others

The Beijing Olympic Games experience produced a valuable case study to help other cities in China (and elsewhere) manage their air quality. As other cities address their air quality problems, the lessons learned in Beijing are of direct value. Of particular value are lessons learnt from the implementation of permanent measures focused on the transport and energy sectors.

They also include the experiences associated with the leveraging of important high profile events to accelerate air quality improvement efforts. Many cities are planning for high profile events and will benefit from the Beijing experience. Such events include the Asian Games in Guangzhou, the EXPO-2010 in

Shanghai, the Commonwealth Games in Delhi (2010), and the World Cup in South Africa in 2010.

Ozone

Emerging air pollution problems such as ozone need to be addressed. A cause of respiratory problems, ozone is the primary constituent of smog and is found in elevated concentrations around most major cities during the warmer months.

Data for ambient ozone levels in Beijing was not available so it was not possible to evaluate changes to ozone levels in the city since 2000 or during the Games. However, it is almost certain that ozone levels within Beijing at times are high, and that ozone will become a priority pollutant.

In undertaking effective ozone control measures, it is essential to understand what factors affect Beijing's ozone levels. This is not straight forward as ozone is a secondary pollutant and the ambient levels depend on both the absolute and relative amounts of NO_x and VOC precursors. If NO_x is the limited precursor, then emission reductions of NO_x will lead to lower ozone levels. However, if VOCs are limited, then changing NO_x emissions may have little (or negative) impact on ozone levels. Under these conditions reductions of VOCs are needed to lower ozone.

The limited information available on ozone levels in Beijing during the Olympics (that is, the CMA analysis of observations discussed earlier) suggests that ozone

information during the Games was VOC-limited. This implies that future efforts to reduce ozone levels will need to focus on additional and more effective VOC reduction measures. This conclusion is consistent with the findings of the studies by Wang Z. (2008) and Chou et al., (2009) that also found that summertime ozone in Beijing is VOC-limited.

In a similar vein, while China does not have an air quality standard for PM_{2.5}, it is likely that future air quality concerns in Beijing relating to particulates will focus more attention on the smaller particles (PM_{2.5}), as the health effects are more closely related to smaller particles. An analysis of the impacts of the control measures on observed levels of PM_{2.5} in Beijing over time and during the Olympic

Games would provide valuable insights into the development of strategies to reduce PM_{2.5} levels. It is useful to note that Beijing EPB plans to begin monitoring PM_{2.5} from 2009.

There is also a growing need to examine the impact of the various control measures on CO₂ emissions. The pollution control measures put in place since 2000 were focused on the priority pollutants and did not consider their impact on CO₂ emissions.

However, there is growing emphasis on the effects of measures to curb CO₂ emissions. The ideal would be to find and implement measures that reduce pollution levels and CO₂. Many of the measures adopted by Beijing had positive implications for CO₂ levels in the atmosphere (e.g., the increase in the use of natural gas, the improved energy and fuel efficiencies). It is recommended that the impact of the established pollution measures (permanent and temporary) on CO₂ emissions be estimated. This information will be of value in the development of future air quality and climate change management plans.

Ongoing management of air quality

The great efforts to reduce pollution levels in Beijing during the Games present an opportunity to further evaluate the control strategies employed.

The improvement in air quality during the Games was a combination of the measures employed by Beijing municipal authorities and favourable meteorological conditions. More detailed analysis of the observations of air quality and meteorology should produce valuable insights into the effectiveness of the control strategies.

Continued efforts to document activities are also recommended to see if permanent measures

Despite improvements, there is still significant scope to improve Beijing's air quality.



remain in place and are enforced, and to assess the extent to which other factors, such as the economic climate influence emission reduction actions, such as plans for relocating or closing industrial plants.

Meanwhile, as shown in Table 2.1, the PM10 air quality standard in Beijing remains a concern. Over time, the standards are likely to become more stringent and will need to be if pollution levels are to be reduced substantially – by an additional 50 per cent (based on the data in Table 2.2).

China faces great challenges in the battle to improve air quality, both in Beijing and nationally. While the evidence presented in this chapter shows pollution levels have decreased and the city’s residents and visitors have enjoyed more Blue Sky Days, there remains significant room to improve Beijing’s air quality.

2.8 APPENDIX

WHO guidelines

The current Chinese Air Quality Class II Standards set concentration targets at or slightly higher than the 2000 WHO guidelines. However, for CO2 the Chinese standard is lower, or therefore more strict. The Chinese standards are significantly higher, or less strict, than the 2005 WHO guidelines, and are also higher than the interim values (except that the SO2 24-hour mean is equal to the Interim-1 WHO value).

Particulates

PM10 is a key contributor to violations of air quality standards in the summer (i.e. when the Games took place). A comparison between China’s annual PM10 air quality standard and those of other Asian countries, the USA, the European Union (EU) and the 2005 WHO guidelines is presented in Figure 2.9. It shows China’s PM10 standard is the

same as Japan’s but higher than those for India, the EU and the USA.

Air Pollution Index

In China the term ‘Blue Sky Day’ describes days with an API value of 100 or less. Note that in all countries using API systems, the value ‘100’ designates good air quality. However, the associated levels of the pollution that are designated ‘good’ are determined by the air quality standard, which can vary considerably between countries. For example, an API value of 100 in the EU would correspond to a maximum daily PM10 concentration of 50 g/m3, while in China an API of 100 could have a PM10 concentration as high as 150 g/m3. Therefore, ‘good’ air quality, as defined by the API, is relative.

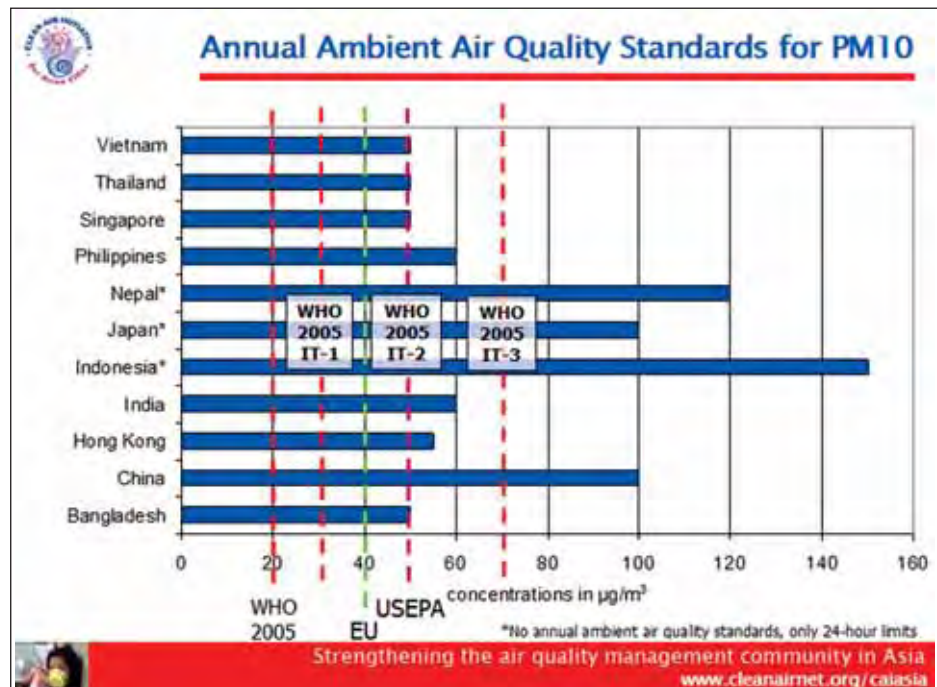
China began adopting stricter auto emission standards to tackle traffic congestion.



A ‘Blue Sky Day’ in Beijing.



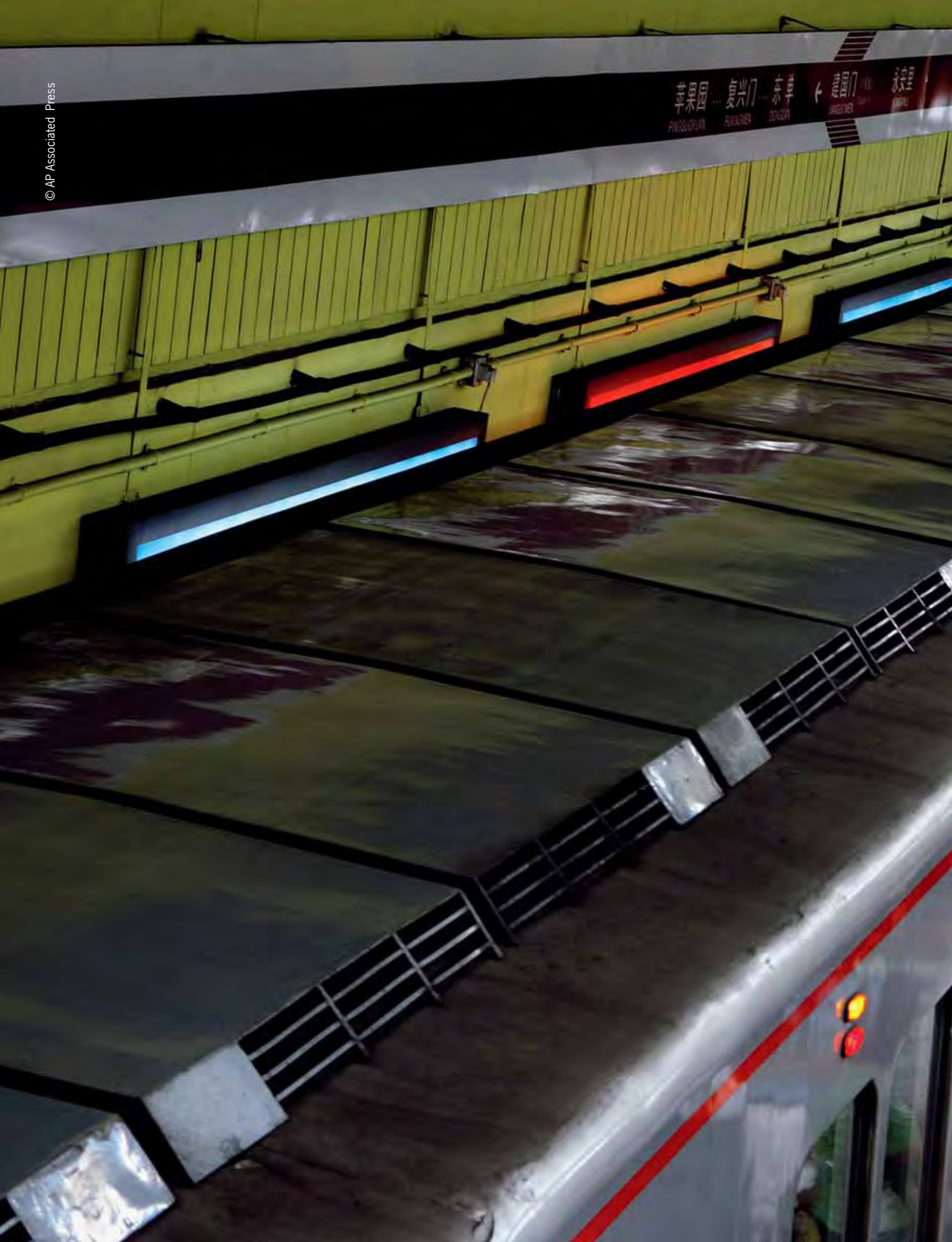
FIGURE 2.9: COMPARISON OF AMBIENT PM10 AIR QUALITY STANDARDS



Source: WHO Air Quality Guidelines. Figure from BAQ 2006







苹果园... 复兴门... 东单
PINGGUOYUAN... FUXINGMEN... DONGDAN
← 西直门... 永定门
XIZHIMEN... YONGDINGMEN





Chapter 3

TRANSPORT

Once known for its chaotic roads teeming with bicycles, Beijing is now home to around 3.5 million vehicles.¹⁸ Strong commitments to solve the traffic and related pollution problems featured in the city's Olympic bid.

Games ticket holders benefitted from free public transport, including on Beijing's expanded metro system.

Beijing is a sprawling city. The urban area occupies 1,040 km² but the city itself spreads across a vast 16,000 km², posing a range of transport challenges for China's capital and its 16 million citizens.

Beijing's goals to improve public transport and related infrastructure, and curb emissions from motor vehicles were:

- Improve transport infrastructure by constructing new roads;
- Promote public transportation by creating a new Olympic Transport System, and
- Promote and improve the city's existing networks.

In addition, the Beijing Municipal Government made a pledge to:

- Use clean fuels in 90 per cent of Beijing's public buses;
- Use clean fuels in 70 per cent of Beijing's taxis;
- Implement the Euro II standard for light duty vehicles by 2004, and
- Use clean fuel vehicles in the Olympic Transport System.

3.1 VEHICLE EMISSION CONTROL STRATEGIES

Vehicle emissions contribute to poor urban air quality. The main pollutants from vehicles are carbon monoxide (CO), unburned hydrocarbons or volatile organic compounds (HC or VOC), nitrogen oxides (NO_x), and particulate matter (PM).

Since 2000, the number of vehicles in Beijing has doubled. However, due to a concerted effort by Beijing authorities and residents, the concentrations of CO and nitrogen dioxide (NO₂), has not increased.

Emission control regulations imposed on new and existing vehicles, combined with clean fuels technology, were major contributors to reducing pollution from vehicles. Financial incentives and new traffic planning strategies were also created to help Beijing's environment cope with a growing car population against the backdrop of a 'Green Olympics'.

Transport measures related to air quality focused on five key strategies.

Vehicle emission standards

The first strategy was the gradual introduction of new vehicle emission standards. Between 1998 and 2008, Beijing moved from the Euro I to Euro IV emission standards.

In 1999, the Beijing Municipal Government implemented the National First Phase Emission Gasoline Standards equivalent to Euro I. In 2003, the National Second Phase Emission Standards (Euro II) came into force. The third phase of this project was implemented in September 2006 (Euro III) by Beijing and Guangzhou. In 2008, the National Fourth Phase Standards equivalent to Euro IV were introduced, along with a Euro IV standard for heavy duty vehicles.

Fuel quality improvement

To meet the new emission standards, improvements to fuel quality were critical. Reduced sulphur levels in fuel, moving from what is commonly referred to as 'dirty' fuel, cuts direct emissions of both sulphur oxide and sulphate particulate matter from all vehicles, old and new.

Sulphur also poisons or reduces the effectiveness of vehicle emission control technologies resulting in increased vehicle emissions of CO, NO_x, PM and hydrocarbon (HC). This was a key strategy, and the Beijing Olympics provided the stimulus to achieve this improvement with remarkable speed.

Beijing's Euro 1 equivalent regulation limited the sulfur content in gasoline to a maximum of 800 ppm (parts per million), while Euro II equivalent regulations of 2004 limited sulfur content to a maximum of 500 ppm in both diesel and gasoline.

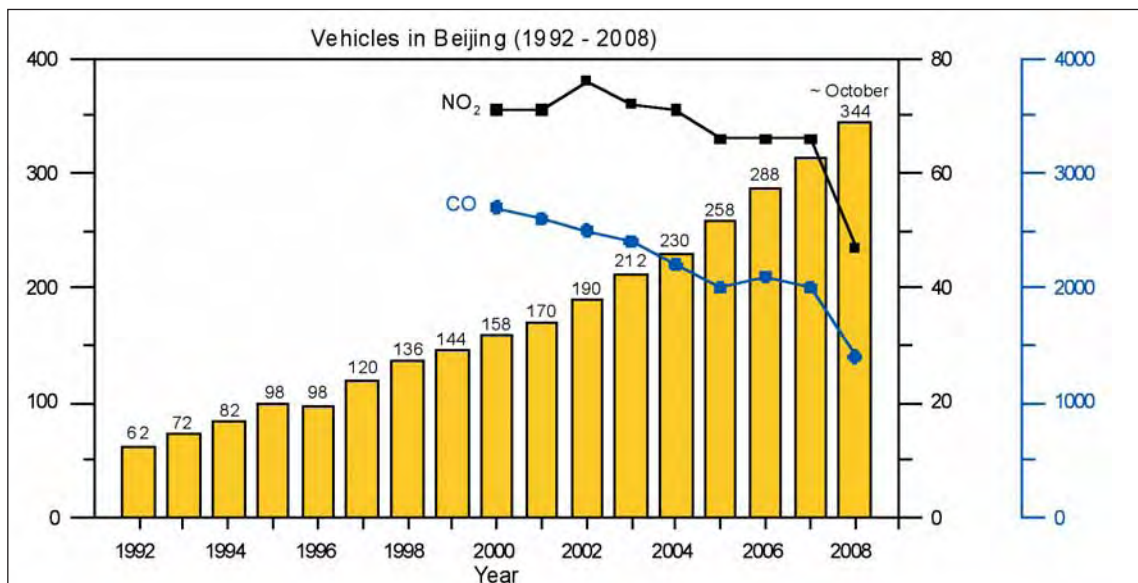
Euro III equivalent emission regulations further reduced levels to 150 ppm in gasoline and 350 ppm in diesel when introduced in September 2006. Finally, in January 2008, with the introduction of Euro IV equivalent emission regulations, the sulphur levels in gasoline and diesel were down to 50 ppm, qualifying for classification as 'low sulphur'.

According to the Beijing EPB, this was a 90 per cent reduction from 2004 standards. It also meant the sulphur levels met the global target for the UNEP Partnership for Clean Fuels and Vehicles (PCFV) program, an initiative which assists developing countries to reduce vehicle air pollution through the promotion of lead-free, low sulphur fuels and cleaner vehicle standards and technologies.

Vehicle inspection and testing

The third strategy was to increase efforts in managing, inspecting and testing of in-use vehicles. In 2001 Beijing introduced a Vehicle Environmental Labeling System. Green labels were issued for vehicles which meet the emission standards, and yellow labels for vehicles which did not meet the emission standards. Vehicles without labels were not allowed to enter Beijing.

FIGURE 3.1: NUMBER OF VEHICLES AND NO₂ AND CO CONCENTRATIONS IN BEIJING, 1992-2008



Source: Beijing EPB and Traffic Management Bureau

Official inspection centres issued the environmental labels after vehicles were tested. By 2006, 218 test lines were in operation by 2006, with a capacity to test up to 3 million vehicles per year.

On-road inspectors and centres were positioned at major gateways leading into the city. Checks and inspections also took place within the city itself. In 2001, 651,000 vehicles were inspected when they entered Beijing. Of these, 490,000 were non-local vehicles entering the city. In 2002, 510,000 vehicles from outside Beijing were inspected out of a total of 592,000 road vehicles. In 2004, 570,000 vehicles were inspected. Tests resulted in vehicles being taken off the road, while others were sent for improvement or given stickers.

In 2004, 12,000 old vehicles were eliminated. In 2005, 4,827 diesel buses and 32,000 old taxis were

taken off the road. In 2005, 2,335 more buses and 15,000 more taxis were pulled off the road. These vehicles were replaced by new buses using compressed natural gas (CNG) and taxis complying with the environmental regulations. In total, 3,759 CNG buses were put into operation by 2006. CNG buses emit lower emissions compared to equivalent diesel buses, especially particulates, NO_x, CO and HC when using catalytic converters. CNG buses also have lower engine noise levels and are lower cost compared to diesel.

In addition 500 ppm sulphur fuel presented the opportunity to use emission control technologies. Over 5,000 heavy duty vehicles including buses and postal vehicles were retrofitted. The low sulphur fuel enabled the use of distillate particulate filters further reducing emissions by up to 90 per cent.

Restricted vehicle access

Information gathered from the management, inspection and testing program was used in the fourth strategy which focused on restricted access to the city for highly polluting vehicles (and later, vehicles in general) as well as an accelerated schedule to retire or replace old vehicles.

Measures were implemented to prevent pollution caused by ancient fuel storage and filling methods. In 2001, gas recirculation devices were implemented in urban filling stations, oil storage centres and petroleum refineries. In addition, sealing systems were added to fuel storage tanks. Close to 100 petrol stations in Beijing installed recycling fuel nozzles and improvements were made to curb emissions from VOCs at the unloading stage.

3.2 PUBLIC TRANSPORT

The fifth strategy focused on improving Beijing's public transport system and access to it. It included plans to expand the subway network and increase the bus fleet and the use of clean fuels in new buses.

Infrastructure improvement

Major programmes were rolled out to create an environmentally sound transport system that could cater for the Olympic Games and beyond. Seventy-seven new roads and bridges were constructed. Most new roads were built in the northern part of the city around the Olympic Green (see Figure 3.2 on page 46).

An additional 200 km of railway track was constructed, bringing the total number of railway tracks

Beijing now has one of the largest compressed natural gas bus fleets in the world.



from four to eight. By 2008, the operating capacity of underground and above-ground urban railways was 4 million passengers a day. The total number of buses doubled to a total of 20,000 between 1991 and 2007.

Vapour recovery facilities at petrol pumps in service stations (which reduced VOC emissions) also helped ensure in-service buses and taxis met emission standards.

3.3 TRANSPORT MEASURES DURING THE GAMES

Temporary transport measures were also introduced to help curb vehicle emissions and promote

greater use of public transport. Immediately prior to the Olympic Games, starting from 1 July until 20 September 2008, efforts were stepped up to get more vehicles off the roads.

A total of 400,000 yellow-labeled vehicles were not allowed on the roads in Beijing, and almost half of the 3.4 million registered vehicles were restricted to run on alternative days by the 'odd-even alternative day-off rule'. The rule stipulated that vehicles with odd numbered license plates could only be driven on odd numbered days only, and vice versa for number plates ending in an even number. Buses and taxis were exempt.

In addition, during this period, only 30 per cent of the total government office vehicle fleet was allowed on the road.

If 400,000 yellow labeled vehicles are included, 2 million vehicles daily were not supposed to operate during this period.

In order to fulfill the bid commitments, BOCOG provided low or zero emission vehicles with low noise to transport Olympic Family members at the Olympic Park and Olympic Villages.

Free public transport for ticket holders

To encourage the use of public transport during the Games, all ticket holders had free access to public transport (metro and public buses) for 24 hours on the day the ticket was to be used. Guests and spectators with Olympic accreditation also had free access to public transport throughout the Games.

The cost of the metro and public buses in Beijing is much cheaper than public transport in other cities in China. A metro ride in

The 'odd-even alternative day-off' rule put in place ahead of the Games may have prompted some Beijing residents to buy a second car.



© Getty images

Beijing costs 2 yuan (\$US0.30) while the same ride in Shanghai costs 5 yuan (US\$0.75) or more. These measures ensured that less people relied on the use of personal vehicles during the Games.

Post-Games measures

The Beijing Municipal Government has extended some of the temporary measures until April 2009. These include:

- Vehicles with yellow labels are not allowed beyond 5th Ring Road (an express highway that encircles the city in a 14 km radius from the city centre);

- Heavy duty vehicles that do not meet the Euro III emission standards are not allowed in the city between 6:00 am and 9:00 pm, and
- The 'odd-even alternative day off' rule has been adapted to a 'one day off a week rule' whereby vehicles are not allowed on the road one day per week, according to their odd or even number plate. For example vehicles with license plate numbers ending in one or six are not permitted on the road on Mondays. Weekends are not included.

3.4 COMMENTS AND RECOMMENDATIONS

The Games played a crucial role in convincing oil refineries to begin producing fuel to meet new Euro III and Euro IV-equivalent emission standards for Beijing. This laid the groundwork for a greener future for Beijing after the 2008 Olympic and Paralympic Games.

The integrated approach taken in fuels and vehicles on emission reduction should be pursued not only to buses and trucks but also on off-road vehicles such as construction vehicles given that there are thousands of construction projects taking place

at any one time in Beijing. This should also include marine vessels and locomotive engines.

With 1,000 new vehicles registered daily, and a heavily crowded public transport system, Beijing needs to further expand its public transport capacity by constructing more subways or railways.

To curb vehicle emissions, the following policy options should be considered:

- provide tax cuts for clean vehicles and increase taxes on more polluting vehicles);



- ensure that old, inefficient vehicles will be replaced by smaller, more fuel efficient vehicles;
- impose heavier taxation for owning additional cars;
- charge congestion fees to curb passenger cars from entering crowded areas, and
- provide incentives to boost the purchase of cars fueled by hydrogen or other clean fuels, and develop measures to promote greater use of electric vehicles.

Beijing will be impacted by vehicles coming in from other regions and conversely its vehicles will move outside of Beijing and be harmed by 'dirty' fuels available in other regions. It is therefore recommended that the integrated approach involving fuels and vehicles taken in Beijing be pursued at the national level.

The number of registered heavy duty vehicles in China is forecast to reach 400 million by 2030, an eight-fold increase from 50.08 million in 2005. Heavy duty vehicles therefore offer significant scope to achieve improvements in air quality. China should consider synchronizing the national emission standards for fuel prior to the introduction of Euro IV nationally in 2010, as announced by the Central Government. This would allow expansion of the Light Duty Vehicle national roadmap to cover heavy duty vehicles which currently dominate the vehicle segment at 88 per cent and are forecast to remain dominant at 53.5 per cent by 2030.

Expanding the Beijing Municipal Government's successful experience on sustainable transport system and vehicle emission control to other cities with forthcoming major international events such as Guangzhou, venue of the 2010

Asian Games, and Shanghai, venue of World Expo 2010, will be of regional and national benefit. Both cities are working to improve air quality, for example by cleaning up their vehicle fleets, and could learn from the Beijing experience.

Contribution to emissions reduction

In August 2008, the concentration of NO² was 60 per cent less than at the same time in previous years, while SO² levels were down by 30 per cent. The temporary transport-focused measures may be credited for reducing these emissions, particularly for NO² (see Figure 2.3). As discussed in Chapter 2, the weather contributed to improved air quality during the Games in tandem with the suite of pollution reduction initiatives implemented by BOCOG and other Beijing authorities.

© Getty Images

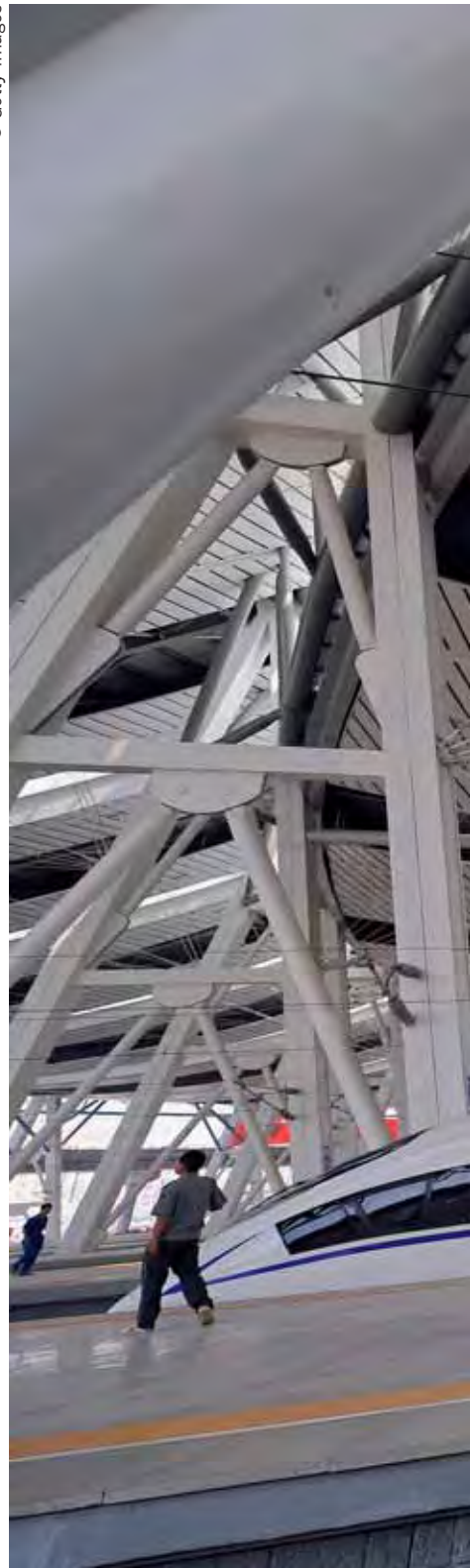
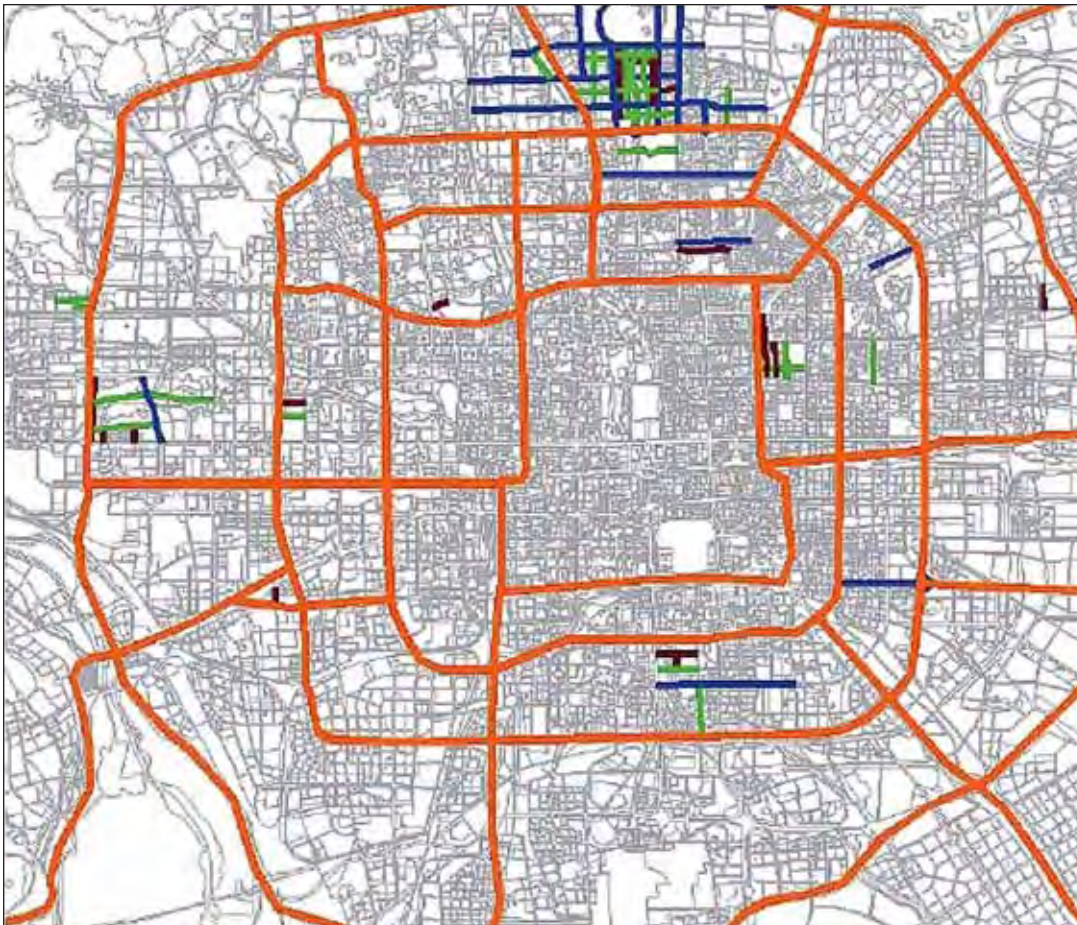


FIGURE 3.2: NEW ROAD AND BRIDGE CONSTRUCTION, BEIJING



(Roads: green. Bridges: blue)

Source: Beijing Transportation Research Centre



Visitors walk past bullet trains at a station in Beijing in July 2008 the latest high-speed intercity railway transport between Beijing and Tianjin.

Although levels of air pollutants met national standards during the Olympic period, the contribution of each measure to the overall reduction in emissions is not clear. This is because there has not been an objective evaluation of each measure.

For example, the effectiveness of limiting the number of cars on Beijing's roads via the 'odd-even alternative day-off rule' and 'one day off a week rule' is unclear because there is growing evidence the rules may have prompted some residents to buy a second car.

UNEP concludes the Games contributed a great deal to increasing public awareness of the benefits of reducing vehicle emissions, which should smooth the way for the Beijing authorities and China's Central Government to implement future sustainable transport initiatives.





**CLEAN
ENERGY
NOW!**

**綠色
和平**
GREENPEACE

WWW.GREENPEACE.org.cn

**鼓
動
風
潮**



Chapter 4

ENERGY

Energy was an important element in Beijing's pursuit of a 'Green Olympics'.

In 2001, when Beijing was awarded the Games, its skyline was dominated by coal-fired power plants and millions of households and businesses depended on coal-fired stoves.

Many activists called upon China to harness clean energy for the Games.

Reducing Beijing's dependence on coal and improving energy efficiency and air quality were a priority for the Games' organizers. Among the key Olympic commitments set by Beijing, the following were on energy:

- Construction of a second Shan-Jing gas pipeline with a transport capacity of 4-5 billion m³ per year by 2007;
- Conversion of coal burning boilers in urban areas, increased use of clean fuels and energy structure readjustment;
- Extending district heating supply to over 50 per cent of the urban residential area and increasing electricity and geothermal heating coverage to 16 million m²;
- Clean fuels would be used by 90 per cent of Beijing's public buses and 70 per cent of all taxis;
- The reduction and control of industrial pollution, for example by closing down enterprises deemed to be heavy polluters or high energy consumers, and
- Relocation, closure or renovation of heavy polluting and energy consuming plants in the Beijing southeast area and Shijingshan district.

To fulfil its commitments, Beijing's Municipal Government conducted a city-wide overhaul of its energy infrastructure. It implemented several measures to reduce the city's dependency on coal and to improve air quality, and some of these are discussed in chapters two and three. Beijing also used the Games venues and sites to showcase and promote up-to-date renewable energy innovations and efficient uses of energy.

4.1 CHANGES IN ENERGY STRUCTURE

According to the Beijing Reform and Development Commission,

during the Tenth Five Year Plan (2001-2005) Beijing's economy grew by 12 per cent every year. As such, the total energy consumption in the Chinese capital increased by 5 – 10 per cent each year during this period (Figure 4.1). Total emissions of air pollutants also increased.

In order to develop sustainably and meet the city's Games commitments, Beijing's energy system needed to be diversified. The Beijing authorities stepped up an ambitious programme to

reduce coal use and switch to cleaner energy such as natural gas, geothermal energy, district heating networks, wind energy and other renewable options.

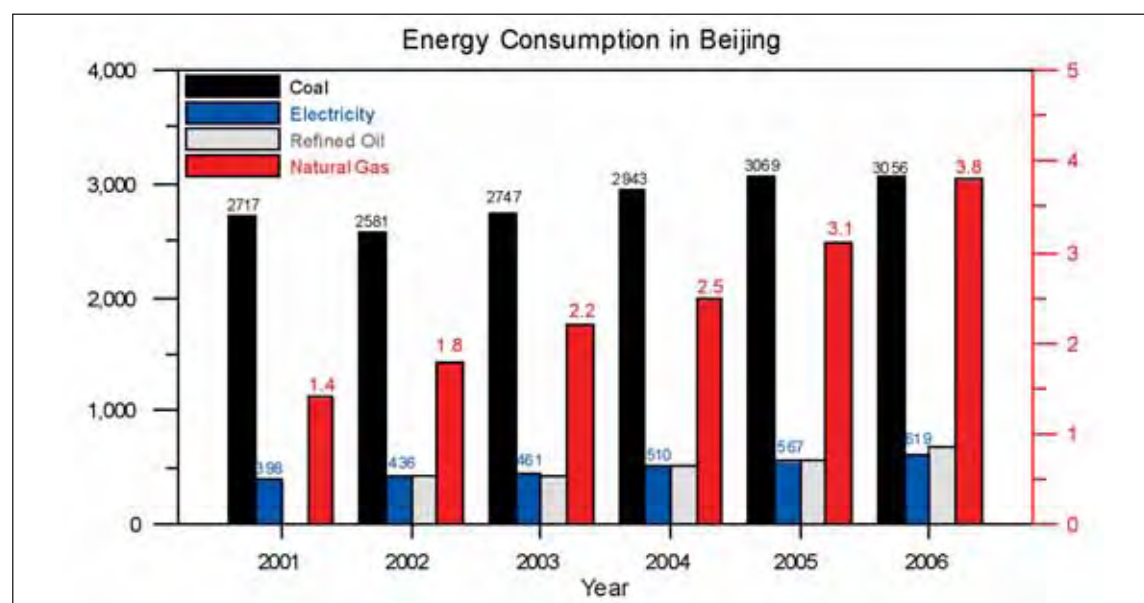
Coal-burning boilers had long been a major source of air pollution in Beijing. The Beijing Environment Protection Bureau (EPB) identified two strategies to reduce emissions by coal-burning boilers: conversion to clean energy for small-scale plants and the complete technical renovation of larger-scale plants.

Small coal-burning boilers (those

with an annual consumption of 20 tonnes or less) were switched to cleaner fuels. In the year 2000, 6,829 boilers and 44,000 coal-fired furnaces and stoves were converted. As shown in Table 4.1, more than 15,000 boilers out of a total 16,000 in Beijing were renovated by the end of 2006.

Natural gas supply expanded from 1 billion m³ in 2000 to 3.8 billion m³ in 2006. The total length of city's gas pipeline reached 11,000 km and 3.5 million households were connected to natural gas in

FIGURE 4.1: ENERGY CONSUMPTION IN BEIJING, 2001-2006



Source: Beijing Municipal Bureau of Statistics and Beijing Energy Conservation and Environment Protection Centre

TABLE 4.1: COAL-BURNING BOILERS RENOVATED AND THERMAL HEATING AREA AND NATURAL GAS SUPPLY, 2000-2006

| Year | No. of coal-burning boilers renovated (less than 20 tonnes of coal per year) | Total thermal heating area (million m ²) | Natural gas (billion m ³) |
|------|--|--|---------------------------------------|
| 2000 | 6,829 | - | 1.0 |
| 2001 | 2,041 | 5.36 | 1.4 |
| 2002 | 1,763 | 13.67 | 1.8 |
| 2003 | 1,914 | 76.52 | 2.2 |
| 2004 | 1,037 | 87.77 | 2.5 |
| 2005 | - | - | 3.1 |
| 2006 | 1,479 | - | 3.8 |

Source: Beijing Municipal Bureau of Statistics and Beijing Energy Conservation and Environment Protection Centre

TABLE 4.2: PRIMARY, SECONDARY, TERTIARY INDUSTRY RATIO, BEIJING

| Year | Primary industry | Secondary industry | Tertiary industry |
|------|------------------|--------------------|-------------------|
| 2000 | 2.5% | 32.7% | 64.8% |
| 2006 | 1.0% | 28.0% | 71.0% |

Source: Beijing Municipal Bureau of Statistics and Beijing Energy Conservation and Environment Protection Centre

TABLE 4.3: TOTAL ENERGY CONSUMPTION PER 10,000 YUAN OF GDP

| Year | Total Energy Consumption (10,000 ton of SCE) | | Terminal Consumption (10,000 ton of SCE) | | Energy Consumption per 10,000 yuan GDP (ton of SCE) | | Decrease Rate of Energy Consumption per 10,000 yuan GDP (%) | |
|------|--|------------|--|------------|---|------------|---|------------|
| | Amount | Equivalent | Amount | Equivalent | Amount | Equivalent | Amount | Equivalent |
| 1996 | 3734.5 | 3416.8 | 3578.4 | 2966.0 | 2.09 | 1.91 | 2.75 | 2.99 |
| 1997 | 3719.2 | 3358.4 | 3568.3 | 2921.0 | 1.79 | 1.62 | 9.60 | 11.11 |
| 1998 | 3808.1 | 3437.9 | 3654.9 | 2990.1 | 1.60 | 1.45 | 6.88 | 6.25 |
| 1999 | 3906.6 | 3558.6 | 3749.0 | 3099.5 | 1.46 | 1.33 | 7.38 | 6.67 |
| 2000 | 4144.0 | 3713.5 | 3946.3 | 3171.7 | 1.31 | 1.17 | 5.07 | 7.14 |
| 2001 | 4229.2 | 3767.0 | 4036.6 | 3241.1 | 1.14 | 1.02 | 8.40 | 8.55 |
| 2002 | 4436.1 | 3922.1 | 4234.1 | 3384.4 | 1.02 | 0.91 | 5.83 | 6.54 |
| 2003 | 4648.2 | 4122.7 | 4475.9 | 3610.6 | 0.93 | 0.82 | 6.19 | 6.00 |
| 2004 | 5139.6 | 4521.9 | 4928.0 | 3928.5 | 0.85 | 0.75 | 2.83 | 3.19 |
| 2005 | 5521.9 | 4825.1 | 5323.1 | 4232.5 | 0.80 | 0.70 | 3.88 | 6.67 |

Note: Energy consumption per 10,000 yuan GDP is calculated at current prices, and decreasing rate is at comparable prices.

Source: Beijing Statistical Yearbook (2006)

2006 compared to 1.3 million in 2000.

In addition, the Beijing EPB launched a project to convert to electricity the many coal fired stoves operated by restaurants, businesses and households. As a result, more than 6,000 restaurants and 11,000 households switched from coal to electricity for heating between 2003 and 2006. In the Historic Old Beijing Protection Area, in Old Hutong, 90,000 households were converted to electric heating by 2008.

A total of 288 million yuan (US \$38.37 million) was invested in the project. About 90,000 families benefited from the conversion process by the end of 2008.

Unlike the small scale burners which were converted or replaced, large coal burning facilities still exist. Beijing implemented measures to ensure that the large scale boilers adopted high efficiency dust removal technologies; controlled dust in coal storage

facilities, and installed end-of-pipe desulfurization systems to reduce pollution.

Also, as a strategy to ensure better air quality for the Games, an aggressive programme was implemented in which heavy polluting factories were either shut down, renovated or relocated.

The overall energy structure in Beijing changed with shifts in the city's economic structure. As more of the economy moved from raw production (primary industries) to service industries (tertiary industries), pollution decreased in the city (see Table 4.2).

4.2 IMPROVED ENERGY EFFICIENCY

National standards for energy-saving buildings were implemented on a mandatory basis for new buildings. Accordingly, the following new techniques and products were adopted in new buildings:

- heat conservation and insulation techniques for outer walls;
- new types of energy saving windows and doors, and
- combining the supply of heat, power and cooling utilities.

Olympic venues showcased these techniques. According to BOCOG, all the venues had energy saving fencing structures with insulation and thermal storage. The National Indoor Stadium, Olympic Village, Media Village, Wukeson Indoor Stadium and Tennis Centre adopted "LOW-E" double glazing, which lowered energy consumed by air-conditioning and improved thermal comfort for athletes, officials and spectators. Reclaimed water from the Qinghe Sewage Treatment Plant was used to provide cooling and heating for the Olympic Village.

Government offices took the lead in energy conservation. In 2005, 54 government departments reduced

their consumption by 11 per cent through renovations to existing office buildings and improved energy-saving behaviour by staff. In 2006, 10 government departments were selected for energy saving and technical renovation pilot projects.

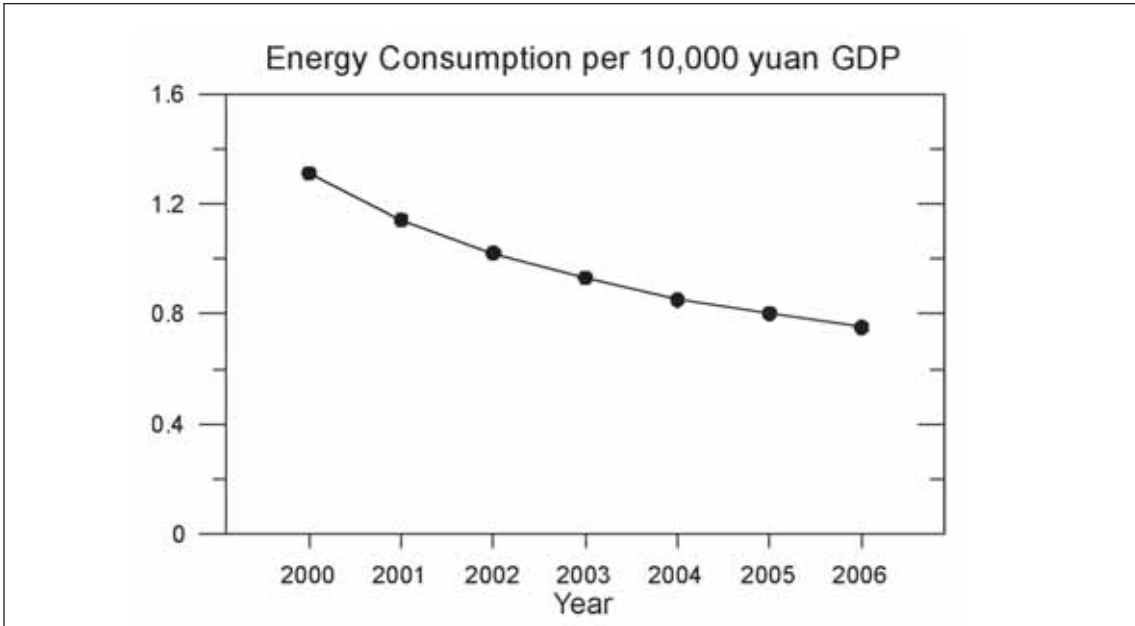
Switching to clean energy and improving energy efficiency had a positive effect. Energy consumption per 10,000 yuan of GDP in Beijing decreased gradually to 0.75 TCE (tonnes of coal equivalent) in 2006; 43 per cent less in 2006 than in 2001, an annual decrease of 7 per cent (see Table 4.3 and Figure 4.2).

4.3 RENEWABLE ENERGY

To improve air quality and achieve its energy saving goals for the Games, the Beijing Municipal Government accelerated the development of renewable energy.

By 2006, solar power was the city's main source of renewable energy (Figure 4.3). The use of solar heaters

FIGURE 4.2: ENERGY CONSUMPTION PER 10,000 YUAN GDP, 2000-2006



Source: Beijing Statistical Yearbook (2006) and 2007 Beijing Energy Development Report

in Beijing reached 3.4 million m² in 2006, an increase of 17.6 per cent from the previous year.

The size of solar photovoltaic projects reached 775 kilowatts, generating 1.13 million kilowatt-hours of electricity.

Over 120,000 solar powered street lamps (among the highest number in the world) were installed in Beijing, particularly around the Olympic venues. Solar panels were a standard feature in Olympic venues and generated power for lighting and heating.

The Beijing authorities also invested in geothermal heating demonstration projects. Between 1999 and 2006, 174 new geothermal wells were constructed, of which 141 provided heating to the city. By the end of 2006, a surface area of 6.6 million m² had been connected to the municipal geothermal well system. This removed the need to burn an estimated 180,000 tonnes of coal each year, thus reducing annual sulfur dioxide emissions by more than 5,000 tonnes.

A 50,000 kilowatt-capacity wind farm at Beijing Guanting,

completed in 2007, supplies almost 100 million kilowatt-hours of electricity to Beijing. According to Greenpeace, clean wind energy accounted for 20 per cent of electricity used in the venues during the Games. Construction of a second wind farm at Guanting is due to be completed by 2010.

The Beijing Environment and Sanitation Group and French company, Veolia, cooperated in the construction of Asuwei landfill marsh gas electricity generation project in 2006. The project supplies now electricity to 17,000 households each year.

By the end of 2006, the use of renewable energy amounted to an equivalent of 892,000 tonnes of standard coal. This was a 35.6 per cent increase from 2004. Asuwei can manage 13 million m³ of methane each year to generate 20 million kilowatt-hours of electricity, which has an effect of reducing 100,000 tonnes of carbon dioxide emissions annually. The use of solar power equates to 570,000 tonnes of standard coal, accounting for 63.9 per cent of the total renewable energy consumed. Use of geothermal energy equates

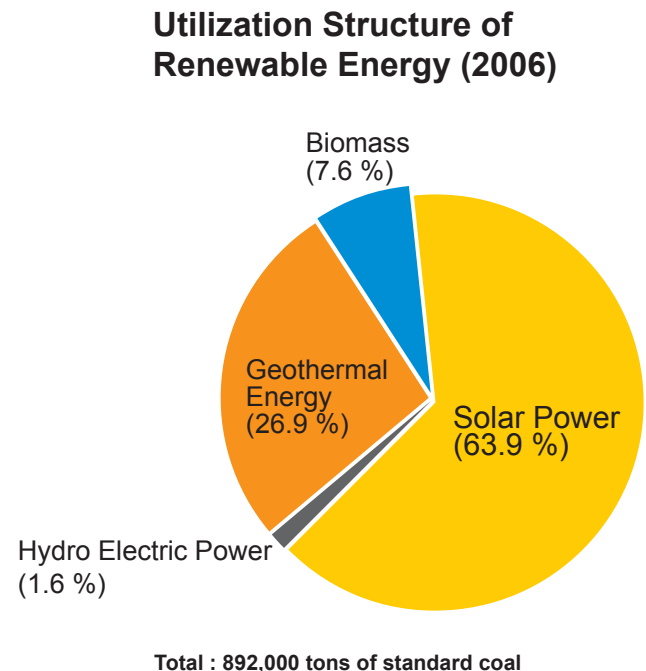
to 240,000 tonnes of coal, and small hydroelectric power equates to 14,000 tonnes of standard coal (See Figure 4.3).

Green Lighting Project

To achieve further energy savings, a green lighting project was launched in Beijing in 2004. According to the Beijing Development and Reform Commission, through the program 1.8 million energy-efficient lights were in use in Beijing by 2006. Greenpeace cooperated with BOCOG to promote the switch to energy-efficient lights in schools. Over 1.5 million lights were installed in 2,000 primary and secondary schools, and 300,000 lights in government buildings, hotels, restaurants and universities.

The Development and Reform Commission estimates that the project now saves 39 million kilowatt-hours of electricity annually, which in turn has the

FIGURE 4.3: RENEWABLE ENERGY STRUCTURE IN BEIJING, 2006



Source: 2007 Beijing Energy Development Report

effect of reducing 1,164 tonnes of SO₂, 1,700 tonnes of NO_x (Nitrogen Oxides), and 38,700 tonnes of CO emissions every year.

4.4 COMMENTS AND RECOMMENDATIONS

Since 2001, the Beijing Municipal Government has pursued a range of energy-saving policies and measures. Achievements include converting more than 15,000 coal-burning boilers to cleaner energy and developing the renewable sector. An area of over 100 million m² benefited from a thermal heating network and high energy-consuming enterprises were relocated.

It is clear the Olympic Games accelerated the introduction of efficient energy infrastructure in Beijing. The Games venues were used to showcase best practices in renewable energy and energy efficiency, and provided a basis for organizers of other mass events to learn from. More than 20 per cent of the total electricity consumed in all the venues was supplied by renewable energy.

Beijing's energy infrastructure has undergone massive restructuring, with a gradual transition from heavy dependence on coal to cleaner energy sources. Although not all measures were specific to the Olympics, they contributed

to creating a greener backdrop for the 2008 Olympic Games.

In the meantime though, the city remains heavily reliant on coal and total consumption has increased, apart from during 2006. Its portion, 40 per cent, of total energy consumption, is still high and this has major environmental consequences, ranging from local air pollution to the long range transport of toxic elements such as mercury.

A more deliberate effort should be made to reduce coal consumption in Beijing, in tandem with increasing the supply of clean and

renewable energy, and promoting greater energy efficiency of industries and buildings.

Future energy-saving policies in Beijing must stress low-carbon sustainable strategies to reduce CO emissions and air pollution. Low-carbon emitting industries could lead China's future economic growth. The Chinese Central Government could consider offering incentives to such industries.

Greater public awareness of the need to reduce household carbon emissions is also recommended for Beijing and other parts of China.

Many Games venues harnessed solar power.

© Sinopictures/Xinhua/Still Pictures











Chapter 5

GREEN COVERAGE AND PROTECTED AREAS

Beijing's bid to host the 2008 Olympic and Paralympic Games included ambitious plans for enhancing ecosystems in and around the city.

The vision was to transform Beijing into a greener city with fresh air and more harmony between human beings and nature. It was part of a comprehensive plan to integrate sustainability into the development of the city's economy and society, for the Games and beyond.

Extensive tree planting and landscaping created a 'green lung' in the heart of Beijing.

Included in Beijing's bid (see list of environmental goals on page 14) were the following specific goals for green coverage and protected areas:

- Achieve 40 per cent green coverage in the urban area (defined as the area covered by lawns and the shadow of trees and bushes);
- Establish a green belt alongside the Fourth Ring Road;
- Realize the 'Five River Ten Road' green belt project;
- Accomplish close to a 50 per cent forest coverage rate;
- Strengthen natural conservation and protection zones, such as wetlands and bird habitats, by establishing protected areas over more than eight per cent of the municipal area, and

- Conserve indigenous vegetation and ecosystems during the construction and operation phases at all Olympic venues.

To achieve these goals, various projects were developed, including more than 150 actions specific to the Games. These actions, important elements in the 'Green Olympics' strategy, were designed to have a long term impact on the city's aesthetic beauty and quality of life for its 16 million residents.

The measures centred on establishing three green ecological belts, in the mountains, plains and urban districts. They were implemented by the Beijing Municipal Bureau of Parks and Forestry, within the General Office of Capital Forestation Commission, according to a document entitled General Planning of Beijing Municipality.

TABLE 5.1: TOTAL AREA COVERED BY THE CITY OF BEIJING

| Area | Surface (km ²) |
|-----------------|----------------------------|
| Mountain | 10,400 |
| Plain | 4,000 |
| Urban districts | 2,000 |
| Total | 16,400 |

Source: Beijing Municipal Administration Commission and Beijing Municipal Bureau of Parks and Forestry

5.1 URBAN AREAS

The Games were clearly a catalyst for ecological endeavours in Beijing. From 2001 to 2008, extensive tree planting and other landscaping was carried out across the Host City, including the central urban area, newly developed areas and small towns on the city's outskirts.

In the central urban area, which was home to the main Olympic venues, green belts were

integrated into an ambitious landscaping vision, which involved greening roads, railways and residential areas. Water bodies, in various forms, were included in the overall landscape design.

Green spaces were established along 100 roads, including both sides of the Second, Third, Fourth and Fifth Ring Roads.

Greening works were also carried out along walls, and in high-rise

Landscaping the green vision.





同一个世界 同一个

One World One





© Getty Images

areas and car parks. Adding to the scale of Beijing's greening initiatives, planting took place in 700 old residential areas and on one million square meters of rooftops.

Between 2001 and 2007, a total of 720 green spaces were created in the central area of Beijing. Approximately 8,800 hectares of green space was developed using more than 30 million trees and rose bushes. The area of green space in the city increased by 10,000 hectares, including 46.5 million square meters of lawn.

The planting and care of flowers in the city became an important feature of greening Beijing. Gardens and green spaces were established in areas where people gathered, enabling everyone to see a green space within a 500 meter radius. There are now 178 registered gardens in Beijing, 70 per cent of which have free public access.

For 22 years, Tiananmen Square featured flowers to celebrate China's National Day and to add to the festive atmosphere during holidays. During the Games, an estimated 40 million flowers decorated the city and welcomed international visitors.

The public green space per capita increased from 9.7 square meters to 12.6 square meters. One legacy of the Games is that trees and flowers now form rings of green belts around the city.

Green coverage in the urban districts in Beijing increased from 36 per cent in 2000 to 43 per cent by the end of 2008, exceeding the Olympic bid goal of 40 per cent.

The Olympic Green

Landscaping was a priority at Games venues. The showcase precinct was the Olympic Green, where 900 hectares was landscaped using drought-resistant and indigenous species.

An Olympic Forest Park, covering 580 hectares, was also established. The park, which features a wetlands zone, was created to present a variety of landscapes to the public.

5.2 MOUNTAIN AREAS

The mountainous region around Beijing covers approximately 62 per cent of the city's administrative

area. It is therefore an integral part of Beijing's natural environment. Reforestation efforts in the mountains intensified during the 10th Five Year Plan period (2001-2005), when the focus was on increasing the amount of land covered by forests and establishing nature, water and soil conservation areas.

The success of these efforts is summarized in Figure 5.2. According to the Beijing municipal official inventory for 2000, forest coverage in the mountain region was 57.2 per cent. By the end of 2004, this figure increased to 67.8 per cent. By 2008, the total coverage of forested area in the mountains reached 70.5 per cent.

5.3 'FIVE RIVERS AND TEN ROADS' PROJECT (THE PLAIN AREA)

Launched in 2001, the 'Five Rivers and Ten Roads Project' was a central part of the strategy to improve the ecosystems and overall environmental quality of the suburban and plain areas of Beijing.

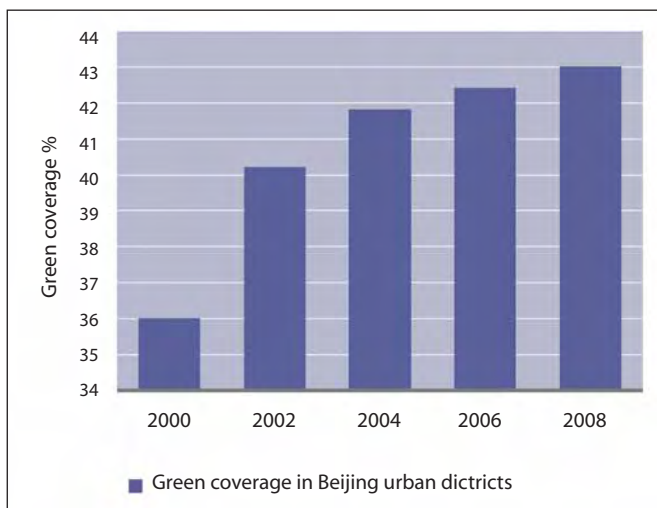
The five rivers involved were the Yongding, Chaobai, Dasha, Wenyu and the northern section of the Great Canal. The 10 roads included Beijing-Shijiazhuang, Beijing-Kaifeng, Beijing-Tianjin-Tanggu, Beijing-Shenyang, Shunyi-Pinggu, Beijing-Miyun,

Beijing-Zhangjiakou and the second outer ring road.

Railways were also included, namely the Beijing-Jiujiang and Datong-Qinhuangdao lines.

Through the 'Five Rivers Ten Roads' project, green belts were created along roads and rivers. The green areas are 200 metres wide and have an inner permanent green zone of 20-50 metres where arboreal and herbaceous plants are cultivated. The remaining area is reserved for intensive cultivation, including projects that feature intensively managed plantations, forests and nurseries.

FIGURE 5.1. GREEN COVERAGE IN BEIJING URBAN DISTRICTS.



Source: Beijing Municipal Bureau of Parks and Forestry

FIGURE 5.2: FOREST COVERAGE RATE IN BEIJING'S MOUNTAIN REGION

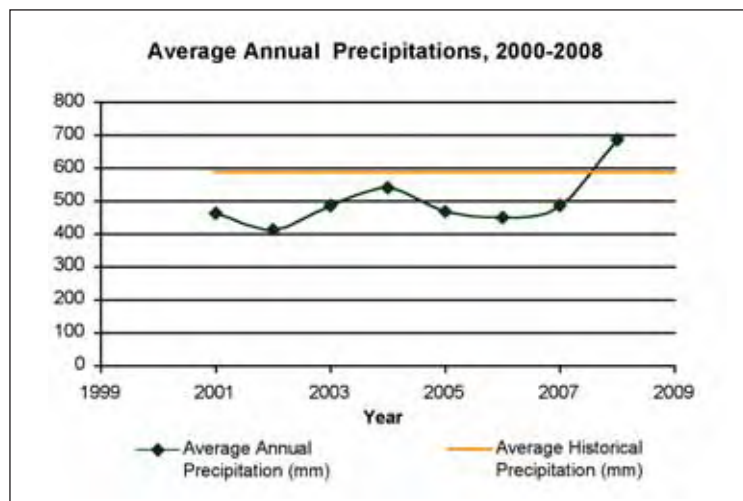


TABLE 5.2: 'FIVE RIVERS AND TEN ROADS PROJECT' (2001-2007)

| Year | Green belt length (km) | Green belt area (ha) | Total area (ha) |
|-------|------------------------|----------------------|-----------------|
| 2001 | 240 | 7,006.67 | 7,006.67 |
| 2002 | 398 | 9,706.67 | 16,713.34 |
| 2003 | 238.46 | 6,689.40 | 23,402.74 |
| 2004 | 60.78 | 1,407.68 | 24,810.42 |
| 2007 | 60.55 | 346.65 | 25,157.07 |
| Total | 997.79 | 25,157.07 | |

Source: Beijing Municipal Bureau of Parks and Forestry



Aerial view of the Zhaoling Mausoleum in Liqun County.

By the end of the project's first phase, in September 2004, the Municipal Government had established green belts with a total length of 937 km and a total forested area of 24,810 hectares. A second phase, which involved rehabilitating the Beijing-Chengde Highway, was completed in 2007. This increased the green belt by 61 km and added a further 347 hectares. In total, the 'Five Rivers Ten Roads' project increased the green area by 25,000 hectares (Table 5.2).

The planting of trees benefited the city in several ways. The forestation activities included

projects aimed at reducing sandstorms and soil erosion, and improving the air quality in and around Beijing. Sandstorms, which have plagued Beijing for decades, are linked to overgrazing and other land-use activities. Five sandstorm areas were targeted. In addition, "no-till" practices to limit ploughing on bare farmland were established.

Forestation projects were also launched in sandstorm-prone areas in Hebei and Shanxi provinces and in the Inner Mongolia Autonomous Region. Beginning in 2001, the projects aimed to tackle sandstorms

which had plagued Beijing for many years. The coverage of forests and grasses in these areas increased significantly, helping to reduce the frequency and ferocity of sandstorms, which in turn contributed to improving air quality by reducing the levels of small particulate matter (PM10) during the peak sandstorm months of March and April. (See chapter 2 for more details).

Community engagement

Large-scale public participation in green coverage activities helped realize the vision of a 'Green Olympics, High-tech Olympics and People's Olympics'

There was active community participation in tree planting, following the annual tradition of Beijing's Tree Planting Day, held on the first Sunday in April.

In Beijing, 44,000 trees are now under personal custody, whereby individuals take responsibility for their care. Government organizations and public service units worked together to create garden-style working places, and a total of 4,951 garden style units were created.

Student volunteers from schools across Beijing planted trees in Beijing's nearby mountains



Olympic Forest Park : a visibly greener Beijing greeted athletes and spectators for the Games.

5.4 PROTECTED AREAS

As outlined in UNEP's 2007 review, the Municipality of Beijing established its first two nature reserves at Songshan and Baihuashan in the early 1980s. In 1986, the Songshan Nature Reserve was declared a National Nature Reserve.

By late 2006, Beijing was home to 20 nature reserves, seven of which were created after 2000. The reserves cover an area of 134,200 hectares and account for 8.18 per cent of Beijing's total land area.

Twelve nature reserves were created to protect forests, wild plants and animals, covering an area of 107,400 hectares; six reserves were created for the protection of wetlands, covering an area of 21,100 hectares; and two nature reserves were established to protect geological formations, covering an area of 5,700 hectares.

5.5 COMMENTS AND RECOMMENDATIONS

Beijing's bid to host the Games included a series of 'greening' goals for Beijing and the Olympic venues. The city also established reforestation goals as part of its

11th Five Year Plan (2006-2010). All of the goals were reached, even those planned for 2010.

For example, official data indicate that at the end of 2000, as a result of 50 years of urban forestry activities, Beijing had a forested area of 930,000 hectares and a forest coverage ratio of 41.9 per cent. Since winning the bid to host the Olympic Games, there was a dramatic expansion in total forest coverage to 70.5 per cent.

In 2008, the green area in the urban, mountain and plain areas of Beijing combined, reached 51.6 per cent.

As a result of these achievements, those involved in designing and implementing the greening activities gained confidence in their ability to integrate ecological considerations into city planning. Furthermore, citizens and visitors to Beijing now feel the city is greener and will reap the benefits of the enhanced quality of life for years to come.

However, there remain some concerns and challenges for the future. For example, a Greenpeace report, *China After The Olympics*, commented that: "although Beijing...made efforts to 'green' the city through reforestation projects to provide a



© XINHUANET



Student volunteers from schools across Beijing planted trees in Beijing's nearby mountains.

© Getty Images

undertaken in Beijing are sustained. The long term survival of the trees planted remains a major concern. Additional efforts are needed to document the survival rates according to species and habitat.

© BOCOG

Documenting the impact of Beijing's greening projects on carbon dioxide (CO₂) levels is important as such activities will be vital in future attempts to document and manage net (difference between carbon sources and offsets) CO₂ emissions. Therefore, an estimate of the carbon footprint associated with the various greening activities is recommended.

It is also important to build upon the lessons learned in Beijing and to capture the experiences through establishing green coverage guidelines that can be used to institutionalize best practice in the integration of greening efforts with city planning and construction.

more livable urban space and these efforts are to be commended, this cannot be substituted for policies that conserve ancient forests and complex ecological systems”.

Greenpeace also sites a report which raises concern that planting activities may have introduced exotic species to the region, namely *Rhus typhina* L. They point out that in any landscaping plan it is important to pay close attention to the selection of species, irrigation requirements, use of pesticides and fertilizers, and the impacts these choices will have on the environment.

Another important challenge is to ensure greening efforts

Citizens of all ages took part in greening the host city.







Chapter 6

WATER

Hosting the Olympic and Paralympic Games in 2008 placed additional demands on Beijing's limited water supply and added pressure to improve water resource planning and management.

Beijing made commitments to improve and protect the city's water resources.





K. W. AUGUSTIN

adidas

Lettmann

Water is the critical factor in Beijing's continued development. Decades of economic and population growth, coupled with limited water resources, have caused chronic and increasingly severe water shortages.

A lack of water may ultimately limit the city's population growth. This reality led to sustained action by all levels of government designated to better manage Beijing's water resources. Hosting the Olympic and Paralympic Games in 2008 placed additional demands on Beijing's limited water supply and added pressure to improve water resource planning and management.

In its Olympic bid, Beijing made commitments to:

- ensure an adequate supply of safe drinking water during the Games;
- improve and protect the water quality of the city's water supply reservoirs, and
- improve the city's sewage network and wastewater treatment system.

The latter included treating at least 90 per cent of the city's wastewater by 2008.

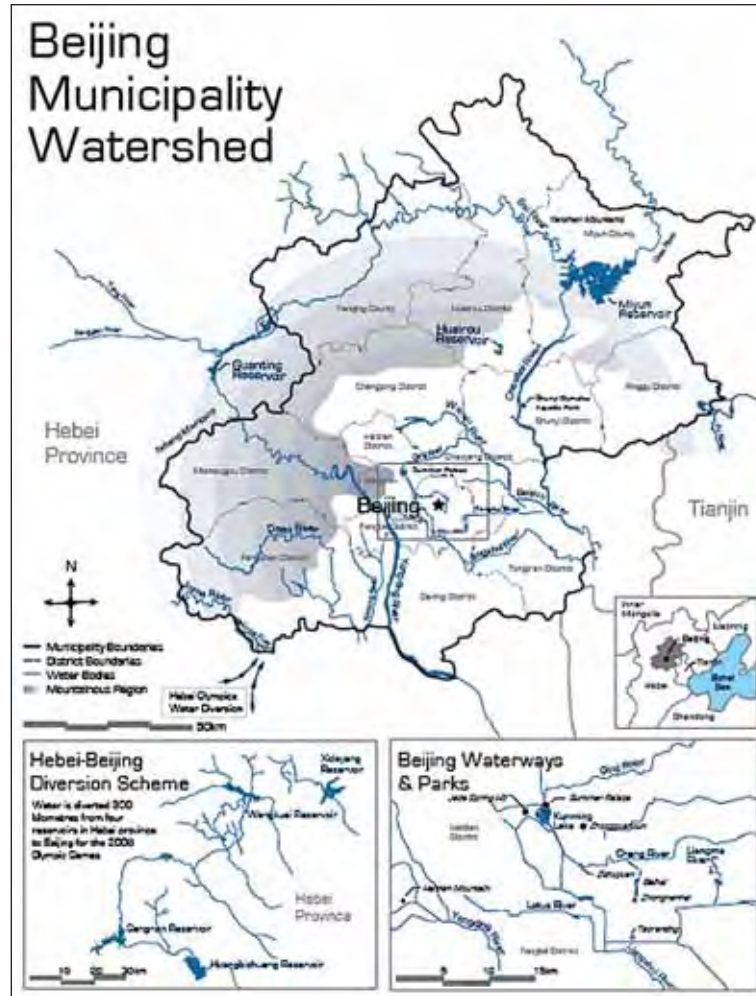
Staging the Games and striving to meet these commitments gave Beijing authorities an opportunity to initiate many projects and activities designed to improve the sustainability of the city's strained water resources.

6.1 WATER SOURCES

Beijing relies on surface water, groundwater and water from the South-North transfer project. Currently, about two-thirds of the city's water comes from groundwater and one-third is from surface water and the South-North transfer, as shown in Figure 6.1.

According to a United Nations Food and Agriculture

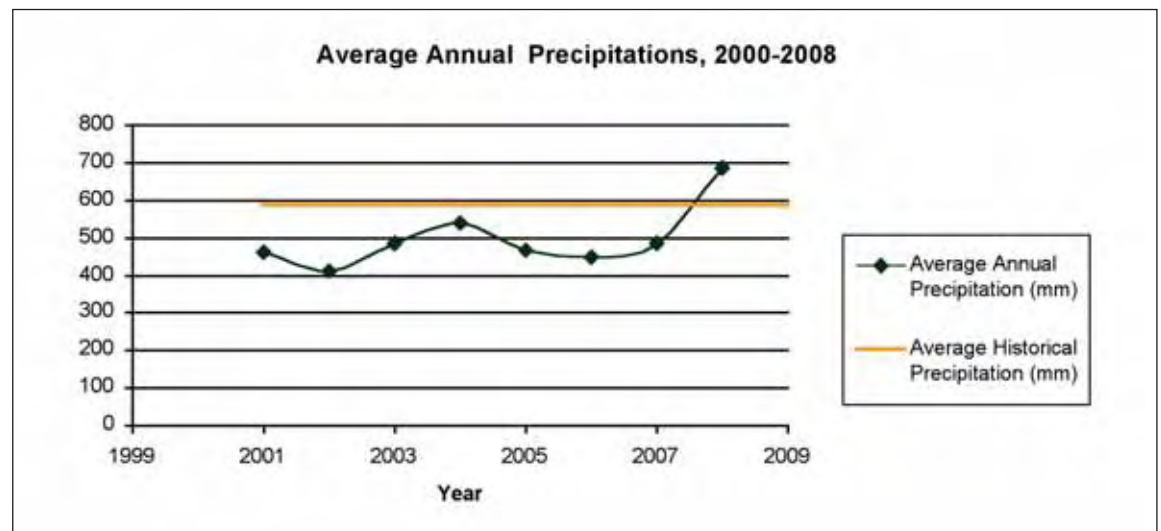
FIGURE 6.1: BEIJING CATCHMENTS AND SURFACE WATERS



Organization (FAO) standard, if the availability of renewable water is below 1,000 cubic meters per capita, social and economic development and environmental protection will be severely

constrained. Water availability in Beijing has decreased from 1,000 cubic meters per capita in 1949, to less than 230 cubic meters per capita in 2007.

FIGURE 6.2: BEIJING RAINFALL, 2000-2008



This represents about 11 per cent of China's national average, and 3 per cent of the world's average per capita availability of renewable water resources.

Beijing's groundwater table is depleted, and current withdrawal rates from the table are unsustainable. Compounding the problem, Beijing recently experienced seven consecutive years of below-average rainfall, as shown in Figure 6.2. The city's historic annual average rainfall is 585 mm per year. The average annual rainfall between 2001 and 2007 was just 460 mm.

Fortunately for Beijing and the Games, in excess of 600 mm of rain fell during the first 11 months of 2008, including during the Games, helping to replenish water supply reservoirs and provide additional water for Beijing's lakes and rivers.

Surface Water: Miyun and Huairou reservoirs

With a surface area of 188 square kilometers and total storage capacity of 4.3 billion cubic meters, Miyun Reservoir is Beijing's largest reservoir. It was constructed in the 1960s to assist with flood control and to supply water for Beijing, local agricultural irrigation and power generation.

TABLE 6.1: CHINA'S ENVIRONMENTAL QUALITY STANDARDS FOR SURFACE WATER

| | |
|-----------|---|
| Class I | Mainly applicable to Headstream water and National Nature Protection Zones. |
| Class II | Mainly applicable to First-class Protection Zone of Surface Water Resources for Drinking Water, Rare Aquatic Organism Habitat, Spawning Grounds for Fish and Shrimp, Swimming Areas |
| Class III | Mainly applicable to Second-class Protection Zone of Surface Water Resources for Concentrative Drinking Water, Wintering Grounds, Migration Channels |
| Class IV | Mainly applicable to Water Resources for General Industry, Water Resources for Entertainment without Direct Human Contact. |
| Class V | Mainly applicable to Water Resources for Agriculture and General Landscape |

Due to the region's low rainfall pattern, only about one billion cubic meters of water currently remain in storage. The annual inflow to the reservoir is about 200 cubic meters, while the outflow approaches 300 cubic meters. Thus the water level continues to decline. Huairou Reservoir also supplies some water to Beijing.

Surface Water: Guanting Reservoir

The Guanting Reservoir, in the northwest part of the city, was constructed in 1954 for the purposes of flood control, water supply, agricultural irrigation, and power generation. It has a storage capacity of 4.16 billion cubic meters. Because of water shortages and pollution in its catchment area, by 1997 water quality in the reservoir was so degraded that it was reclassified as Class V, suitable only for agricultural use. However, a number of actions were taken to improve its water quality

and protect its catchment area, including dividing the reservoir into two parts. As a result, one part, Guanting Reservoir, was reclassified as Class IV in 2006. The other part, Sanjiadian Lake, supplies water to users and was changed to Class III. Guanting Reservoir no longer plays an important role in supplying Beijing with water.

The Ming Tomb Reservoir in the Changping District of northern Beijing was the venue for the Olympic triathlon. The swimming took place in the reservoir, while cycling and running were held around the main dam.

6.2 SOURCE WATER PROTECTION

Beijing authorities have taken significant action over the past 20 years to protect the city's surface and groundwater resources. In the 1980s, the municipal government launched a series of policies and regulations designed to protect

source waters. The "Master Plan of Sustainable Use of Water Resources in Beijing in the Early 21st Century" was adopted to guide upstream local governments on water management and planning matters.

Measures to protect Miyun, Huairou and Guanting Reservoirs were implemented throughout their catchments. A concept of 'clean sub-watersheds' was initiated with the goal of protecting water supplies while improving the livelihood of local communities by promoting economic development. The effort, carried out in 547 small catchments, focused on domestic wastewater treatment, solid waste management, water way and environmental remediation, water quality protection, and economic development.

The initiatives were designed so that the surface waters would meet water quality standards, even under low-flow conditions.

Specific measures to protect surface waters included:

- Establishment of protective zones around the reservoirs and relocation of residences from Class 1 zones;
- Protective fencing around reservoirs;
- Prevention of erosion;
- Removal of agriculture and conversion of farmland to forest and other natural lands;
- Relocation of animal farms;
- Promotion of phosphate-free detergents;
- Elimination of fish-farming in the reservoirs;
- Seasonal restrictions on recreational fishing in the reservoirs;
- Promotion of biological pest management; and

TABLE 6.2: WATER QUALITY IN MIYUN AND HUIAIROU RESERVOIRS, 2001-2007

| Parameter | Water Quality Standard mg/L | Miyun Reservoir mg/L | Huairou Reservoir mg/L |
|-----------|-----------------------------|----------------------|------------------------|
| CODMn | Less Than 4 | 2.98-3.50 | 2.30-3.80- |
| BOD5 | Less Than 3 | 1.10-1.20 | 1.00-1.30 |
| NH3-N | Less Than 0.5 | 0.046-0.151 | 0.02-0.083 |



Olympic sailing at Qingdao.

- Retro-fitting sanitation facilities.

As a result, water quality has improved in Miyun and Huairou reservoirs. The standards for three main indicators of water quality are shown in Table 6.2, along with the range of annual average concentrations in the reservoirs from 2001-2007.

Groundwater protection measures included the

establishment of protection zones in groundwater recharge areas supplying Beijing. Action undertaken within these protection zones included:

- Limitations on construction;
- Improvements to the sewerage network;
- Upgrading or shutting down of oil storage centers and petrol stations;

- Installation of monitoring and protection wells;
- Relocation of graves; and
- Relocation or strict regulation of polluting industries.

6.3 WATER TREATMENT AND DISTRIBUTION

The city of Beijing committed to providing an adequate supply of safe drinking water to residents, athletes, and visitors during the Olympic and Paralympic Games.

Well before this commitment was made, Beijing authorities had worked to increase the capacity and capability of its water treatment plants. Three major drinking water plants were upgraded and, as a result, the capacity of Beijing's plants to supply potable water to the core area of the city increased from 2.4 million cubic meters per day to 3.0 million cubic meters, which exceeded Beijing's bid commitment.



In 2007, China adopted new drinking water quality standards that conformed to those recommended by the World Health Organization. They included 106 parameters, expanding the number of regulated parameters in China by 71.

According to the Beijing Water Authority, the drinking water plants now produce potable water that meet all of the new standards. Moreover, Chinagate.

com reported that in 2007 Beijing became the first Chinese city with tap water safe to drink without boiling.

There was no shortage of potable water during the Olympics. The Beijing Water Authority confirmed that all residents of Beijing had safe drinking water by the end of 2008.

While water treatment plant operators sample water quality

at the plants, the Beijing Health Department samples drinking water quality in the city by taking samples at the tap in houses and businesses. In some cases, water quality in homes is worse than at the plant, due to the materials used and age of portions of the water distribution system. To address this problem, Beijing authorities have initiated a programme to replace old, substandard pipes in parts of the distribution system.

Wastewater treatment

Between 2001 and 2007, Beijing made large investments in sewage treatment plant capacity. In this period, the number of plants increased from four to nine, with a combined treatment capacity of 2.5 million cubic meters per day. This capacity was sufficient to provide treatment of 92 per cent of the sewage produced in 2007, thereby meeting the Olympic bid commitment to treat 90 per cent.

The plants meet the discharge standards shown in Table 6.3.

Over this period, Beijing also paid increasing attention to management of sludge from wastewater treatment plants. Facilities were built to ensure safe treatment and disposal, composting, incineration, and brick production. Beijing plans to develop more such facilities in the near future.

6.4 WATER CONSERVATION, RECYCLING AND REUSE

The size of the city of Beijing may ultimately be determined by water availability. Therefore, policymakers recognize they must promote water efficiency. Water conservation, recycling, and wastewater reuse are crucial tools the city's government has used to meet increasing water demand.

More efficient use of water by households and industries was encouraged and water consumption has dropped over the past decade. Industries were encouraged to recycle water to reduce their use of surface and groundwater. It is estimated that 480 million cubic meters of water was recycled in 2007—about 14 per cent of the total water usage—and it was forecast that 600 million cubic meters would be recycled in 2008.

Water reclamation and reuse was also given a high priority. In addition to the wastewater treatment plants, Beijing built four wastewater reclamation plants and new pipes to carry the

water to the sites where it would be used, including all of the Olympic venues.

The facilities treat wastewater effluent to a high standard so it can be used for urban, industrial, and agricultural purpose. For example, the Qinghe treatment plant reclaims more than 30 million cubic meters of water per year. This facility serviced the main Olympic precinct, including the Olympic village, providing water for flow augmentation, landscaping and irrigation.

Water from the Qinghe facility also supplies the Haidian and Chaoyang districts for urban use, such as road cleaning and watering roadside plants and flowers.

Wastewater effluent from the wastewater treatment plants is being used to augment natural flows in rivers and supply water to lakes.

Close to 500 rainwater-collection projects have also been established across the city, in residential and industrial areas. The projects capture rainwater for use in watering urban landscapes which has added importance given the significant growth in green coverage in the city spurred by the Games. The rainwater collectors have the capacity to provide approximately 40 million cubic meters per year.

6.5 SURFACE WATER QUALITY

The health and capacity of Beijing's lakes and streams have suffered due to 25 years of low rainfall and the heavy demands upon surface and groundwater supplies. Many lakes and streams now contain little natural flow and suffer from degraded ecological conditions. The city adopted improving the water quality and ecological health of its surface waters as a goal, with an initial focus on the city center. The city occasionally used water from the reservoirs to replenish important lakes in the central urban area, but wastewater effluent was increasingly being used for this purpose.

Municipal authorities also recognized that restoring lakes and streams to healthy ecological conditions meant providing adequate water of sufficient quality.

6.6 WATER AT OLYMPIC VENUES

The construction of Olympic facilities and renovation of existing buildings to be used during the Games gave BOCOG and local authorities an opportunity to incorporate state-of-the-art water saving features in venue designs.

The design strategy included minimizing water demand, efficiently using available water resources - including potable water and rainwater - and maximizing water reclamation and reuse. The features serve as an

excellent demonstration of what can be accomplished through an aggressive and creative water management strategy.

Water use was minimized by equipping Olympic venues with water-saving facilities, such as no-flush toilets. Rainwater was captured and used for onsite irrigation as well as augmenting water flow in local waterways.

The Olympic Green and Olympic Forest Park were designed to capture large volumes of rainwater. The wetland in Olympic Forest Park is fed by reclaimed water. Condensation from air conditioners was also collected and recycled. Porous bricks were used to recharge groundwater.

While the tap water at the Olympic Village met all water quality standards, it received additional treatment onsite to reduce its hardness.

Wastewater from the Olympic Village was treated onsite by a biological system which used aquatic vegetation in small tanks. The system treated 2,400 cubic meters of wastewater per day.

The Games also drew attention to China's marine water quality following an algae outbreak at the sailing venue, at Qingdao on China's east coast. Reportedly covering 12,900 square kilometers, the outbreak in late June 2008, attracted international media attention. To contain the algae, officials in Qingdao reportedly installed a fenced perimeter in the sea that was more than 50 km long.

TABLE 6.3: DISCHARGE STANDARDS FOR WASTEWATER EFFLUENT AT BEIJING WASTEWATER TREATMENT PLANTS

| Parameter | GB 18918-2002 Standards | |
|-----------|-------------------------|--------------|
| | Class A mg/L | Class B mg/L |
| COD | 50 | 60 |
| BOD5 | 10 | 20 |
| NH3-N | 5(8) | 8(15) |



Cleaning up an algae outbreak at the sailing venue at Qingdao was a community effort.

The International Herald Tribune reported that: "Water quality has been a concern for the sailing events, given that many coastal Chinese cities dump untreated sewage into the sea. At the same time, rivers and tributaries emptying into coastal waters are often contaminated with high levels of nitrates from agricultural and industrial runoff."

6.7 FULFILMENT OF OLYMPIC BID COMMITMENTS

The commitments relating to water that Beijing made as part of its Olympic Games bid were all met.

There were adequate supplies of drinking water during the Games. The drinking water produced by the city's treatment plants met China's new water quality standards, consistent with World Health Organization guidelines.

Substantial and permanent source-water protection measures were implemented in the catchments of Beijing's

reservoirs, resulting in improved water quality which met the main indicators for water supply in China.

Beijing expanded and improved its wastewater collection and treatment system. In 2008, the city achieved the capacity to treat 92 per cent of its wastewater.

Many of the water-related measures taken by BOCOG and Beijing authorities set high standards for efficient water use. They serve as an international example of creative and aggressive measures that can be taken to minimize water use, maximize the efficient use of existing water resources and protect the water ecosystems. The measures taken at Beijing Games sites stand out in this regard, with the Olympic Village design in particular advancing urban water management.

6.8 COMMENTS AND RECOMMENDATIONS

The following recommendations are based on information

presented in this chapter and a review of recommendations made by various environmental NGOs.

Recommendations for the Beijing Municipal Government

The Beijing Municipal Government should consider the following:

- Continue to build on water management achievements during the Games by ensuring that innovative water-efficiency measures employed in Games venues – including stormwater capture and reuse – are increasingly applied throughout the city, especially in all new buildings and developments;
- The implementation of water rate structures that would encourage water use reductions;
- Requiring individual metering at all households, businesses, and industries;
- Minimizing leakage in the city's water-related infrastructure; and
- Continuing and enhancing efforts to improve tap water quality by replacing old, substandard water

distribution system pipes.

The city should also consider the long-term sustainability of its water supply strategy. As Beijing continues to grow, its rate of water withdrawals from aquifers and water supply reservoirs will become unsustainable. The current long-distance water transfers may also not remain sustainable.

Finally, the ecological needs of Beijing's natural surface waters should remain important. Beijing authorities and residents should strive to ensure that local catchment management efforts balance both human and ecological needs.

Recommendations for the International Olympic Committee

In awarding future Olympic Games, the International Olympic Committee (IOC) should promote a wide application of state-of-the-art water management strategies and technologies throughout the cities hosting Olympic events. The IOC should also strongly promote the adoption of water management strategies that are sustainable in the long-term and will benefit host cities well beyond the staging of the Games.


Water purification facility.











Chapter 7

SOLID WASTE

Beijing was upgrading its aging waste management system well before the city was awarded the Games in 2001.

Over the past three decades, investment in solid waste treatment and classification facilities combined with new regulations, policy frameworks, technology and education campaigns have transformed the city's approach to solid waste management.

A Beijing canal with visible pollution photographed on 2 August 2008, the same week as the Olympic Games Opening Ceremony.

In UNEP's 2007 Environmental Review, waste management was identified as an area where Beijing was close to achieving its goals set during the candidature phase. Of note in the interim is that Beijing experienced its fastest population growth for the past five years in 2007, largely due to an influx of migrant labourers recruited to work on infrastructure projects for the Olympic and Paralympic Games.

The efforts of planners to achieve the city's waste management goals, including supporting the sanitation demands of new arrivals before and during the Games, provide many lessons which can inform similar exercises in areas that are also facing waste management challenges due to rapid population growth.

This chapter provides a final overview of the efforts made in Beijing to keep the city's waste-related Olympic bid commitments in two areas—domestic solid waste and medical and radioactive hazardous waste. Bid commitments are listed for each area, and existing and planned programmes and infrastructure are evaluated according to their

contribution towards achieving the commitments. An additional section discusses waste management in Olympic venues.

7.1 DOMESTIC SOLID WASTE

The Beijing bid committed to the establishment of a safe urban domestic waste disposal system capable firstly of sorting, or classifying, 50 per cent of all domestic solid waste in the city, and secondly, able to recycle 30 per cent of all domestic solid waste produced within the city by 2008.

Infrastructure and programmes

Beijing's waste management system has been transformed from traditional open-air storage to a system of sanitary landfills and integrated treatment facilities.

Solid waste treatment improved substantially when A-suwei landfill opened in 1991. A-suwei was influential in ending open-air waste storage and established a new waste management standard which triggered the construction of several other landfills,

incineration and composting facilities. Figure 7.1 indicates the number of waste treatment facilities, including composting and incineration facilities, increased from 17 in 2003 to 32 in 2008.

In addition, the city invested in waste classification facilities. Two waste sorting lines were recently completed in downtown Chaoyang District—one, built in Xiaowuji transfer center, is a spectral imaging-based sorting line with a daily capacity of 150 tonnes, and a second, built in Datun transfer center, is an automatic sorting line with a daily capacity of 100 tonnes. Both centres are situated within 3 km of the Beijing National Stadium, the 'Bird Nest'.

New regulations and policy frameworks compliment the improvements to Beijing's physical infrastructure. Certain shops are now required to charge for plastic bags, which has led consumers to reuse cloth bags. A domestic waste compensation mechanism, introduced in 2007, has made solid waste collection more efficient. Under the

programme, waste-generating areas pay 50 yuan (US\$7) to waste-disposing areas for every tonne of waste to be treated.

Technological improvements and education campaigns also contributed to advancements in waste management. Research conducted in preparation for the Games resulted in a series of technological breakthroughs, including ultra-fine powders produced from rubber tires and chemical paints produced from plastic wastes.

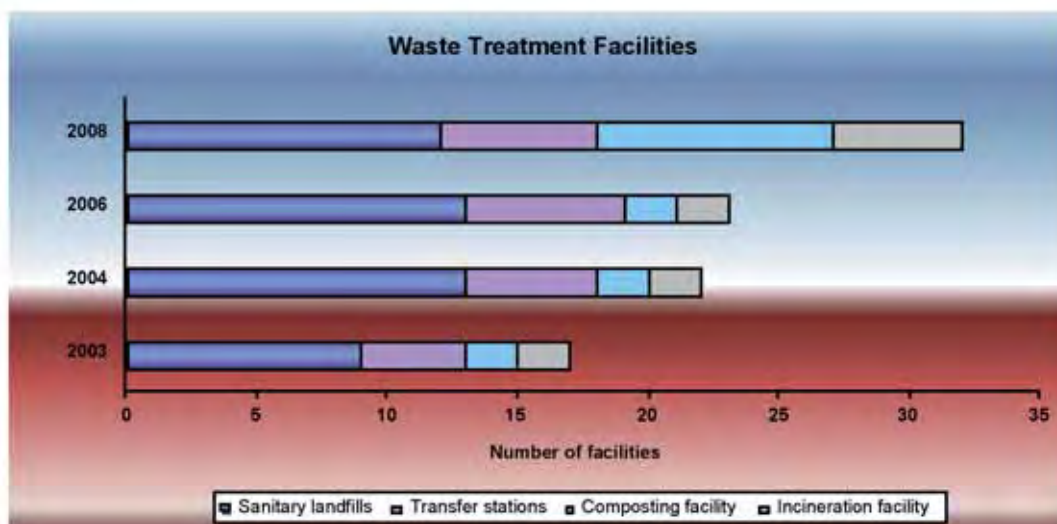
Education programmes and campaigns included a Recyclable Waste Collection Day that showcased successful recycling experiences, a creative Olympic public service advertisement that encouraged people to do small things on a daily basis to protect the environment and school environmental programmes that allowed students to exchange used paper for flower seeds, pencils and notebooks.

Fulfilment of Olympic bid commitments

Beijing made progress towards developing a safe urban domestic waste disposal system. The rate of safe disposal (i.e. landfill, incineration and composting) declined sharply in 2003, but has since increased as shown in Figure 7.2).

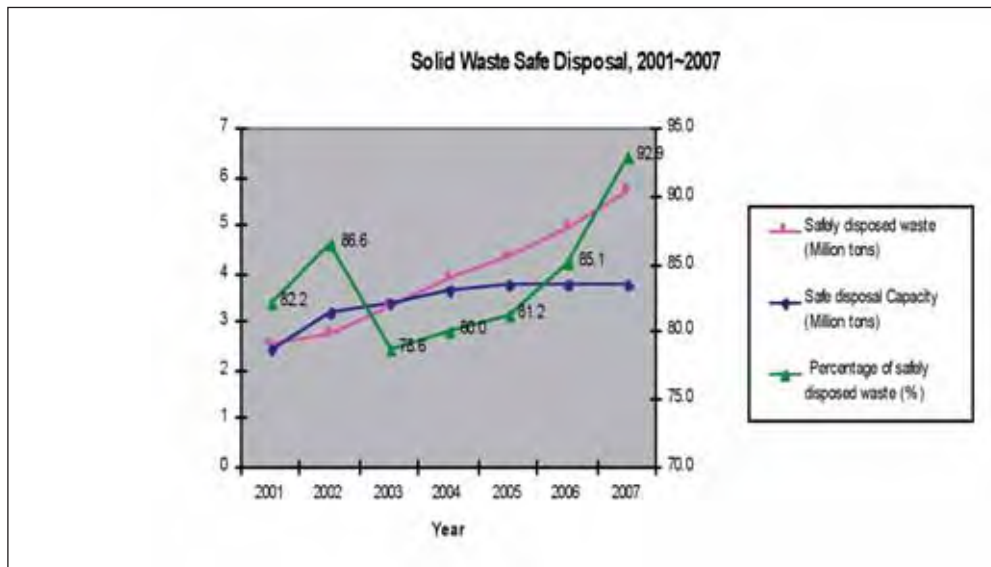
In 2004, approximately 81 per cent of waste generated in the city was disposed of safely, while 93 per cent was disposed of safely in 2007. However, the amount of safely disposed waste exceeded designed treatment capacity because safe disposal capacity remained constant from 2005 levels while waste production continued to increase. This has resulted in a gap between the treatment capacity and actual treated amount. For example, the designed daily capacity in Liulitun landfill is 1,500 tonnes but the facility accepts up to 2,500 tonnes on a daily basis. The

FIGURE 7.1: WASTE TREATMENT FACILITIES IN BEIJING MUNICIPALITY, 2003-2008



Source: Beijing Environmental Protection Bureau

FIGURE 7.2: SOLID WASTE SAFE DISPOSAL



Source: Beijing Environmental Protection Bureau

lifetime of the Liulitun landfill has been shortened by seven years as a result.

Nevertheless, Beijing surpassed the Olympic bid goals for waste classification and recycling. In 2007, the waste classification rate reached 52 per cent and the recycling rate reached 35 per cent. The achievement of this goal is almost certainly related to waste classification and recycling efforts. By 2007, waste classification and recycling services in 2,255 residential communities, high-rise buildings and industrial areas covered 27 per cent of the population of the city.

7.2 MEDICAL AND RADIOACTIVE HAZARDOUS WASTE

The Beijing Olympic bid contained a commitment to construct hazardous waste management facilities, including medical and radioactive waste processing and disposal plants, with an annual disposal capacity of approximately 10,000 tonnes.

Infrastructure and programmes

Beijing has invested heavily in medical and hazardous waste treatment facilities over the past

seven years. There are currently eight certified hazardous waste treatment plants in Beijing, of which two are for medical waste and six for hazardous waste.

In addition, the Beijing Environment Protection Bureau (EPB) conducts clean production audits at steel plants, funds the processing of spent battery and exhausted commercial lights at Eco-Island hazardous waste treatment plant and relocates high polluting factories away from the city.

Fulfillment of Olympic bid commitments

Of the 40,000 tonnes of hazardous waste produced in Beijing in 2008, approximately 30,000 tonnes were incinerated and 10,000 tonnes were recycled. This is a major accomplishment considering annual hazardous waste treatment capacity was 2,000 tonnes in 2001.

The disposal capacity in 2008 clearly exceeds the Olympic bid commitment. However, authorities attest that the total production of hazardous waste is much larger than the treatment capacity of certified facilities. In order to partially fill unmet demand, two new facilities are

undergoing pilot tests and are expected to be in full operation later this year. In total, there will be ten hazardous waste treatment facilities in operation by the end of 2009.

7.3 WASTE IN OLYMPIC VENUES

In addition to domestic solid waste and hazardous waste commitments, the city established a goal to classify 100 per cent and recycle 50 per cent of all waste generated in Olympic venues. Beijing attempted to reach these goals through initiatives led by the city and Olympic sponsors. No information was available about steps taken at Olympic venues outside Beijing.

Much of the progress toward achieving Olympic venue commitments occurred because of the efficient processing of food waste. Upon signing an agreement with the Beijing Municipal Administration Commission in 2007, 155 participating governmental organizations, Games contracted hotels, and 31 venues committed to standardized food waste collection and disposal practices.

The Coca Cola Company, a Worldwide Partner of the

Games, formed a joint effort to send all waste beverage containers generated in the venues to Yinchuang waste treatment plant for recycling. All garbage containers in the venues were made of recyclable and biodegradable materials.

Approximately seven per cent of food waste was composted in on-site facilities through microbiological processes, and the products were used as fertilizer, manure or animal feeds. The remainder of food waste was transferred to certified food waste treatment facilities outside the venues for safe disposal and reuse.

Olympic organizers achieved their goal of 100 per cent waste classification and 50 per cent recycling in venues. All competition and non-competition venues practiced 100 per cent solid waste classification and 4,688 tonnes of waste generated in the venues was recycled. This is a 73 per cent recycling rate.

7.4 COMMENTS AND RECOMMENDATIONS

Beijing achieved its domestic solid waste, hazardous waste, and Olympic venue classification and recycling commitments. Waste classification and recycling goals were exceeded by 2 per cent and 5 per cent, respectively. Further, hazardous and medical waste treatment facilities were expanded and updated, all solid waste was sorted in venues, and the in-venue recycling rate was 23 per cent higher than the committed level.

It is still difficult to determine whether or not Beijing has a safe urban domestic waste disposal system. However, efforts by city planners are resulting in progress toward this goal. The waste classification and recycling rates for the city are expected to reach 60 per cent and 40 per cent respectively by 2010. It is further



BOCOG passed the ISO 14001 (ed.196) certification audit in September 2005 and one year later was also certified according to the new standard.

expected that the safe disposal rate for downtown and suburban districts will reach 99 per cent and 90 per cent respectively by 2012 and that the recycling rate will reach 45 per cent.

These goals will be met, at least partially, by four new waste disposal plants expected to be completed by 2010. The first two are located in Liulitun and Gao'antun and will service the eight downtown districts. The remaining two are located in Nangong and Dongcun and will service the eight suburban districts.

Despite these estimates and new facilities, additional policies and infrastructure could be used to increase waste treatment efficiency and capacity. Planners should pay particular attention to the suburban districts of Beijing municipality that have experienced rapid growth in recent years. The growing population produces an increasing amount of domestic waste which strains sanitation processing capacity. Even greater financial resources may be needed to improve waste classification, recycling and safe disposal in these areas.

Planners should also develop economic incentives to compliment waste reduction,

classification, and recycling education programmes. One possibility is to reform the refuse disposal fee programme. Fees in areas practicing waste classification are the same as areas that do not practice waste classification. Since fees are charged based on the cost of waste transfer, the full cost of waste treatment and management is not borne by the waste generators. This leads to two problems: First, the waste management department receives less revenue, and second, waste treatment is not fully valued by the public. As a result, waste management improvements are slow to occur.

Additional possible steps in the area of waste reduction, classification and recycling include more comprehensive policies and regulations, increased economic incentives that facilitate engagement by more stakeholders, and better performance analysis and evaluation methods. Beijing could also increase safe disposal capacity of domestic and hazardous waste within the city.

A cleaner rides a special bicycle with a recycled waste container.

Beijing's Beishenshu Landfill is the first in China to feature a Water-Biogas Associated Treatment System.



© BOCOG

© Sinopictures/CNS/Still Pictures







Chapter 8

OLYMPIC SITES AND VENUES

World-class venues provided the stage for world and Olympic record-breaking performances in seven cities during the Beijing 2008 Olympic and Paralympic Games.

Games organizers dedicated special attention to environmental considerations during the design, construction and operational phases of the 37 competition venues and other Games sites.

With meticulous attention to detail, BOCOG ensured the Olympic spirit was on show at sites across Beijing.





Thirty-seven competition venues were used for the Beijing 2008 Olympic and Paralympic Games. Of these, 31 were situated in Beijing while six venues – for football preliminaries, sailing and equestrian competitions – were in other Chinese cities (Shanghai, Hongkong, Tianjin, Qingdao, Qinhuangdao and Shenyang).

Of the 37 venues, 14 were newly built, 14 were renovated and nine were temporary structures.

The National Stadium (the so called Bird's Nest) and the National Aquatics Centre (the so called Water Cube) were stunning architectural showpieces and quickly became iconic Olympic venues. BOCOG dedicated special attention to the environmental aspects of the Olympic Village design. Innovative technologies included heat pump system, photovoltaic panels, beam-pipe illumination, solar collectors, water saving devices, and rainwater collection.

Admired by athletes and spectators alike, these and other new venues in Beijing created a permanent legacy of the Games on several levels.

Prominent in Beijing's bid commitments were the following goals for sites and venues:

- Implementation of cutting-edge environmental technologies in the design of Olympic venues;
- Use of natural resource-efficient, non-polluting and recyclable materials for facilities and equipment, and
- Preservation of indigenous vegetation and ecological ecosystems during the construction of venues.

This chapter reviews the extent to which the design and construction of Olympic sites and venues contributed to forming a sustainable legacy from the Games.

8.1 VENUE PLANNING AND MANAGEMENT

The Beijing Municipal Government set up a Project Construction Headquarters Office to oversee and coordinate construction of the venues and related infrastructure. The 2008 Headquarters Office was responsible for designing, planning, managing venue construction, coordinating venue feasibility studies and managing administrative issues in conjunction with BOCOG.

As outlined in UNEP's 2007 Environmental Review, BOCOG developed three documents in close cooperation with the 2008 Headquarters Office to ensure the sustainability of the design and building phases:

- Environmental Protection Guidelines for the Olympic Projects;
- Environmental Protection Guidelines for the Renovated or Expanded Olympic Projects, and
- Environmental Protection Guidelines for the Temporary Projects.

The guidelines, which provided recommendations on venue planning and design, focused on energy conservation in buildings, eco-friendly materials, water resources protection, waste management and noise pollution. They also contained information about the ongoing environmental management of venues.

All newly-built competition and non-competition venues, plus training grounds and other affiliated facilities, had to comply with the guidelines. The 2008 Headquarters Office controlled and monitored building site compliance with safety, quality and environmental standards, in conjunction with BOCOG.

Considerable effort went into deciding where the venues could

best be located. According to data released by the 2008 Headquarters Office, environmental impact assessments were carried out for all Games venues. The venues were spatially distributed in Beijing according to a design of 'one centre plus three areas'. This design encompassed one central Olympic Green and three districts: the University District, the Western Community District and the Northern Scenic District.

Beijing's ambitious venue construction programme began in December 2003. Most venues were completed by the end of 2007.

The post-Games use and management of permanent sites and venues was considered in the early planning stages. Since the Games, the Beijing Municipal Government has assumed control of the largest venues. The ownership and management of renovated venues passed to the State Sport General Administration and to various district government administrations, such as the Fengtai District Government and the Haidian District Government. Beijing University and Beijing University of Technology were among several universities which also inherited venues.

(Refer to Table 4.1 in UNEP's 2007 review for a list of venues and their post-Olympic uses. See also Table 4.2 for a list of environmental technology incorporated into Olympic venue designs).

8.2 OLYMPIC VENUES: ENERGY

The application of energy saving design and the promotion of renewable energy in Games venues were impressive achievements for Beijing.

Energy efficiency

All construction projects were subject to an energy conservation assessment based on national

energy-saving standards in China (DBJ01-621-2005) which were released in 2005 but did not come into force until 2008. The standards imposed a 65 per cent reduction in energy use for residential buildings (JGJ 24-86) and a reduction of close to 50 per cent in public buildings (JGJ 26-86).

According to information from BOCOG, a total of 168 measures were implemented to reduce energy demand in venues during the Games and beyond. Here are some outstanding examples:

- The Water Cube hosted the swimming and diving competitions. A unique heat circulation system was installed, which collected the heat generated from spectators and transferred it to a heat exchanger to heat the water in the swimming pools. The spectators were cooled as the heat was siphoned off, and the athletes benefited from warm water. In this way energy consumption was reduced.
- Reclaimed water from Qinghe Sewage Treatment Plant acted as an energy source for cooling and heating the Olympic Village (a 400,000 square metre area). The innovative recycling system was designed to save 45,000 m³ of water in summer alone, to reduce CO₂ emissions by 8,600 tonnes compared to coal-burning heaters. The energy produced equalled to 3,600 tonnes of standard coal, or about 2.7 million cubic meters of natural gas.
- Where possible, venue designs focused on lighting indoor areas with sunlight, creating an aesthetic connection between the interior and exterior while reducing energy consumption. An example was the Water Cube where the ceiling and walls featured a translucent membrane to allow natural light in. By changing the colour and thickness of the

The greening of venues is part of the Games' legacy.





OLYMPIC SITES AND VENUES

OLYMPIC SITES AND VENUES

OLYMPIC SITES AND VENUES

membrane, different shades of light were achieved to meet the specific needs of each event.

- In other venues, such as the National Indoor Stadium and the Laoshan Velodrome, the designers used transparent polycarbonate panels which were insulating, age-resistant and anti-ultraviolet.
- In addition, beam-pipe illumination technology was applied in the lighting design of underground spaces. This technology used pipes to guide the sun's rays into underground facilities, providing light for corridors, toilets and parking lots in several venues including the Olympic Green.

Renewable energy

The Olympic Green Tennis Center and Laoshan Velodrome were among nine projects which incorporated solar water heating systems. Seven venues, including the Bird Nest and National Indoor Stadium, featured photovoltaic power generation systems. The systems had a combined generation capacity of more than 460,000 kilowatt-hours of electricity per year.

Soil-source heat pump systems served an area of 99,000 m² at four venues, including the Peking University Gymnasium. The total heat load from the systems at the four venues was more than 7,800 KW, and their cooling load was more than 7,100 KW.

Three projects established water-source heat pump systems, serving an area of 34,000 m². Their combined heat load was 2,000 KW, with a cooling load of 2,500 KW. In addition, geothermal energy technology was used at two venues, including an inventive reclaimed water heat pump system at the Olympic Village.

Solar panels were installed in some Olympic venues to heat water for showers, dressing rooms and swimming pools. All the apartments and auxiliary buildings, including a kindergarten in the Olympic Village complex, were connected to a 6,000 m² solar water-heating system. The vacuum glass-tube solar collection systems installed on the rooftops were an integral part of the housing design and give an interesting and unique look to the buildings. The 2008 Headquarters Office estimated that this solar heating system would save nearly 2,400 tonnes of coal per year.

Energy efficient lighting

Solar powered devices were chosen to light lawns, courtyards and streets at several venues. Two systems were used: photovoltaic panels were placed on top of streetlamps to power the light bulbs, and traditional streetlamps were connected to the photovoltaic grid in the venues.

Solar energy was used at the Feng Tai Baseball Stadium, which featured a 27 KW photovoltaic system, and at the Bird Nest where a 130 KW photovoltaic system powered the stadium.

The roof of the Olympic Village bus stop also functioned as a solar energy system to power the air conditioning in the athlete's dining hall. It provided an energy saving of 30 per cent.

The Beijing Olympic Village is the first Olympic Village to receive LEED certification, and as part of the pilot programme, it is one of only eight developments – and the first international project – to thus far achieve certification under LEED for Neighbourhood Development.

Bird's eyeview of Beijing's Fengtai softball field.

LEED Award for the Olympic Village

Last year BOCOG received a gold rating and the related certificate of the Leadership in Energy and Environmental Design (LEED) for Neighbourhood Development Rating System, which was awarded by the U.S. Green Building Council.

The Rating system assesses a building's performance in the categories:

- Smart Location and Linkage (19 from 30 points)
- Neighbourhood Pattern & Design (16 from 39 points)
- Green Construction and Technology (21 from 31 points)
- Innovation and Design Process (4 from 6 points)



OLYMPIC SITES AND VENUES

Martin Braud (left) and Cedric Forgit at Beijing's new Shunyi Olympic Rowing-Canoeing Park.

8.3 OLYMPIC VENUES: WATER

Fifteen venues featured rainwater collection and recycling systems, capable of collecting a total of one million m³ of water per year on average. Six projects included independent sewage treatment and recycling systems, each capable of treating more than one million tonnes of sewage annually.

Nearly 2,400 m³/day of sewage was treated and reused in the Olympic Green for landscaping and irrigation purposes. The water for the Olympic Green was supplemented with grey water

(more than three million m³ annually). BOCOG also provided non-flush temporary toilets at those sites without water supply systems during the Games.

In addition, a variety of water-saving techniques were implemented in the Olympic Village and competition venues. These focused on saving and reusing water in the bathrooms, and in gardening and irrigation activities. Among other water saving features in venues were:

- Intelligent irrigation systems to control the irrigation time and frequency;

- Preferential use of rainwater collected in dedicated tanks;
- Water-saving sprayer and micro-irrigation or drip-irrigation systems, and
- Night-time irrigation to reduce evaporation.

In some water sports venues, the designers used anti-penetration concrete designed to prevent water from leaking out and being wasted. Such material was used to line the National Aquatics Centre and the Peking University swimming pool.

For the first time in Olympic history, rowing and canoeing

venues were combined in one facility - the Shunyi Olympic Rowing-Canoeing Park - to economize building construction. The inaugural 10 km swim for men and women was also held at the venue, which is situated next to the Chaobai River and surrounded by forests and farmlands.

To minimize soil disturbance at the site, the nearly 2,000,000 m³ of excavated earth was completely re-used within the building site for backfill and landscaping.

The water body has a total volume of about 1,760,000 m³ and had to



Chantal Petitclerc victorious in the 1,500 m - T54 at the Bird's Nest.

be refilled through a pipe system since the Chaobai River, which runs close to the venue, was dry due to the drought. The water had therefore to be supplied from the Miyun Reservoir, the current main drinking water source for Beijing, representing a significant consumption of this precious resource. High-density polyethylene (HDPE) anti-penetration film was used to line the water body of the Shunyi Rowing-Canoeing Park.

Rainwater collection and reuse

Water-penetrating materials, such as permeable blocks, were

used to pave outdoor spaces as a way of collecting rainwater. The materials prevent and control flooding from heavy rains while providing landscapers and gardeners with rainwater for future irrigation.

In the Olympic Green, a total area of 144,000 m² was equipped with permeable rain water collection materials. In the National Aquatics Centre, 10,500 m³ of rainwater can be collected and reused every year through the 29,000 m² collection area on the building rooftop. In the Olympic Media Village, at least 3,000 m³ of rainwater will be captured

using water permeable bricks, pipes and wells installed on the building roofs as well as on roads and green areas at the site.

Other examples include Fengtai Sports Centre Softball Field, which uses the water from the swimming pool and rainwater to irrigate the green belt in the football ground and the softball ground. This measure saves 50,000 m³ of water every year.

8.4 OLYMPIC VENUES: ECO-FRIENDLY MATERIALS

The set of Environmental Protection Guidelines issued by BOCOG to guarantee the

sustainability of the Olympic venues (new, renovated or temporary) provided the main framework for the choice of building materials. They also included special recommendations for green building materials.

Construction efforts focused on the environmental aspects of painting and design materials. For example, wooden panels avoided the use of substances with high contents of formaldehyde. Alternative materials, such as wooden and plastic composites were considered in all phases of construction in an effort to avoid ozone-depleting substances.

A composite material made of wooden and plastic waste was widely used in structures in the Olympic Village and the Olympic Green. Because of its anti-corrosive and weather-resistant characteristics, the composite proved particularly suitable for decorating the facades of buildings, lining floors and constructing window shutters. It was also used as a substitute for wood, thus reducing timber use, and for picnic tables and shelters in the Olympic Green area, and for lining concrete bridges.

8.5 ENVIRONMENTAL MANAGEMENT AT BUILDING SITES

In 2007, each venue was assigned an environmental manager. BOCOG and the 2008 Headquarters Office, together with the Beijing EPB and Beijing Municipal Construction Committee, audited environmental practices at construction sites and in 2007 approved qualification of all sites.

Relevant departments of the Beijing Municipal Government, in close cooperation with BOCOG, regularly inspected and monitored the construction sites of the Olympic venues to guarantee that the environmental management guidelines were implemented and the construction materials corresponded to the

set requirements. In addition, ISO 14001 compliant systems were established in all Olympic construction sites by multi-level management organizations.

Dust and noise control

To reduce noise pollution, working hours in the building sites were restricted and high volume activities were prohibited from 10:00 pm to 6:00 am. In exceptional cases, noise was authorized by the relevant Municipal Government Departments, but with a given limit of 55 decibels. Contracted building companies were also requested to use low-noise vibration machines and saws and to insulate loud machinery.

Quarterly inspections were carried out jointly by the Office of Municipal Construction Commission, the Beijing EPB, and the BOCOG Construction and Environment Department since 2001 to check that construction companies implemented required dust control measures. These included:

- Covering rubble and earth heaps with matting;
- Use of vegetation at construction sites;
- Watering the building sites,

for example to harden roads, and

- Cleaning vehicles at building site exits.

To control road dust pollution, Beijing increased investment in road sweeping and cleaning equipment. The Municipal Government published new standards for road sweeping and cleaning in the city: “to facilitate the long-term development of managing and controlling the dust of our city”.

To further control dust in the city, stringent administrative licenses for solid waste transport vehicles were enforced, and solid waste transport activities were checked regularly.

8.6 ENVIRONMENTAL MANAGEMENT DURING THE GAMES

BOCOG had direct responsibility for managing the waste generated in the venues during the Games. Their goal was to have 100 per cent of waste sorted and 50 per cent of waste recycled or reused. In order to achieve this, the Construction and Environment Department of BOCOG developed the ‘Olympic Venues Cleaning and Waste Management Plan.’

The overall strategy was outlined

in three different documents:

- The ‘Venue Cleaning and Waste Management Strategic Plan’ (February 2005);
- The ‘Venue Cleaning and Waste Management Operation Outline’ (August 2005), and
- The ‘Demonstration Venue Virtual Plan’ (late 2005).

According to the plans, the owners of Olympic venues were directly responsible for the cleaning and management of waste generated by the Games, while the Beijing Municipal Administration Commission was in charge of waste transport, processing and final disposal. All parties had to operate in accordance with the recommendations, policies and procedures issued by BOCOG.

The strategy was tested during the 11th World Softball Championships held in September 2006 at the Fengtai Sport Centre.

Algae bloom

In June and July 2008, BOCOG and Qingdao municipal authorities overcame an algae outbreak which at one point covered approximately one third of the coastal waters designated

Anti-penetration concrete was among the water saving features at the Water Cube (below and right).



for the Olympic sailing regatta. China's official news agency, Xinhua, reported that around 1,000 boats were deployed to scoop algae out of the Yellow Sea off Qingdao. In addition a 50-km long barrier was laid out in the sea to contain the outbreak.

The issue attracted widespread international media attention, including this report from Agence France-Presse: "China's pledge of a 'Green Olympics' has taken on a worrying meaning at the sailing-venue city of Qingdao, where an algae bloom has coated the coastline, according to witnesses and Chinese media".

The environmental hazard was completely cleared by late July. Despite close scrutiny of the issue by the IOC and others, the BOCOG website did not provide information about the algae bloom.

8.7 COMMENTS AND RECOMMENDATIONS

Without a doubt BOCOG, in close cooperation with Beijing's municipal authorities, achieved remarkable results in incorporating an array of environmental elements into the planning, construction and management of Games venues.

However, the achievements are hard to quantify as there is no systematic environmental footprint analysis available that makes it possible to assess the environmental benefits of the measures during the Games or afterwards.

There is data available for some environmental measures. These attempt to illustrate energy savings, reduced greenhouse gas emissions and water savings. As the baseline of the calculations is often unclear, it makes it hard to assess the measures in a scientific way. Therefore it would be very helpful to have a foot-printing initiative in place from the very beginning of planning for an Olympic and Paralympic Games, to ensure that environmental measures can be recorded and assessed throughout the process and that such information is available to interested groups and the public.

The use of quantifiable and reliable environmental objectives would have been valuable, building on the environmental bid commitments.

Olympic venues: energy

The incorporation of energy saving design and the promotion of alternative energy are key achievements for Beijing. The

use of such technologies as geothermal and photovoltaic systems represents a necessary and welcome shift from reliance on polluting fossil fuels.

All new buildings now meet the most recent Chinese and Beijing energy efficiency standards, which have been in force since early 2008. A comparison with older national efficiency standards, from 1986 and 1995, illustrates the achieved reduction rates of 65 per cent and 50 per cent for energy use in residential and public buildings respectively.

UNEP hopes the advances in energy efficient design leave a green legacy for future planning of urban infrastructure and buildings in Beijing and across China. The achievements may also inspire the organizers of other mass events to introduce cutting edge technologies in venues. The Beijing experience should be a catalyst for China's building sector as well as for other host cities to take a more proactive approach to promoting the development and diffusion of clean renewable energy.

Olympic venues: water

The Games gave Beijing a great opportunity to improve the efficiency of its water infrastructure to meet increasing

demand which was not just Games-related.

However, in many cases, although water reuse technologies were introduced into venues, they did not go far enough to ensure that the Games had a minimal impact on the city's precious water supply.

The Shunyi water sports venue, the third largest Games venue, is one such example. This venue was designed with water saving features yet still draws a vast amount of water from the Miyun reservoir. The planners of this large, water-demanding venue should have done more to eliminate its reliance on precious sources which may lead to water shortages in other regions.

Olympic venues: eco-friendly materials

Beijing did not appear to have a stringent or mandatory set of timber purchasing guidelines for its Olympic venues. An opportunity was missed to demonstrate China's commitment to sustainable forestry.

The lack of a binding procurement policy and independent auditing meant there was no third party confirmation of timber sources. BOCOG together with the World Wildlife Fund for Nature

The Tianjin Olympic Centre Stadium resembles a water droplet.



© BOCOG





Wind-powered street lamps in Beijing.



Stricter environmental building guidelines are recommended for future Games.

at a very early stage of venue planning tested the processes to purchase FSC-certified timber for the kindergarten within the Olympic Village. Unfortunately this initiative was not extended to other venues.

The guidelines for purchasing materials were in place and provided a good example for the Games. However, as they were only voluntary, the implementation was weak. Greenpeace tried to validate their implementation after the Games but due to a lack of information and third party auditing, was unable to do so.

Environment management at building sites

With the vast amount of construction in Beijing and in China generally, the improved standards prompted by Beijing’s hosting of the Games may have a knock-on effect on the governance

of China’s construction industry. It is still too early to assess whether the measures introduced before the Games will become a common standard.

Environmental management at venues after the Games

BOCOG was responsible for the environmental management of the sites and venues until the end of the Games. UNEP recommends that future operators such as the State Sport General Administration and the Beijing Municipal Government introduce a thorough environmental management system for maintaining and improving the environmental aspects of the venues in the future.

Recommendations for Beijing Municipal Government

Beijing should continue to implement successful

environmental policies and apply the innovative technologies used for the Games more broadly across the city. This should be done for new buildings and for environmentally sound renovations.

Beijing should be commended for its push to develop wind energy and for using solar power and hot water systems in many venues. The promotion of energy efficiency measures such as: insulation, venue design and lighting also deserves merit. The new technologies, namely the geothermal heat pump heating and air-conditioning systems implemented during the Olympics could taken up more broadly beyond the Games.

The Games spurred Beijing to engage in major energy related measures. Investment in developing alternative energy sources, energy efficiency

upgrades and public transport are all commendable steps. However, in order to significantly reduce greenhouse gas emissions and demonstrate a genuine commitment to environmental protection and clean energy alternatives, Beijing needs to move away from coal as its primary energy source.

Water supply for Games venues is a huge burden for any city, even even more so for a city affected by persistent water shortages . After the Games, Beijing should increase efforts to maximize water efficiency, water recapture, treatment and reuse as well as improve existing infrastructure to ensure a secure future for water supply.

The Beijing Municipal Government is in a strong position to further the legacy of the Games by adopting a green procurement policy for



© BOCOG



Laoshan Bicycle Moto Cross venue.

all buildings. In this area, and others, much can be gained from standardized practice. Beijing may also use and further develop the standards and monitoring systems for environmental management at building sites which have been successfully implemented for the Games.

Recommendations for China

As China's economy continues to grow, it is imperative for cities across the country to follow Beijing's lead and reshape energy structures and to introduce successful energy saving technologies such as those used for the Games.

National building standards could also encourage the integration of energy saving and clean energy features into design and building standards. Successful water treatment, re-use and rain collection technologies used at the

Games should be applied widely to other Chinese cities, especially in drought affected areas. Furthermore, China's northeast region should take a critical look at its water projects to ensure that attempts to supply urban centres will not affect access to water for rural areas, agricultural water, water safety and security for future generations.

Recommendations for future Games

The IOC should encourage future Olympic host cities to invest in new, innovative approaches in energy efficient design and technologies, such as micro renewable energy generation; co-generation; radical energy efficient design; rooftop gardens; vertical gardens and smarter building shading.

The IOC should also recommend host cities use existing green

building rating systems that can help them choose low or zero emissions and energy saving technologies. A further option is to provide a credible reporting and evaluation system to measure results.

The IOC should promote a wide application of state-of-the-art technologies to minimize demand on water resources in all future Games venues. Further, it should encourage host cities to consider applying sustainable water management techniques in new infrastructure and buildings in and around host cities.

Cities bidding for or hosting the Games should also be required to adopt mandatory purchasing policies for Games-related construction materials. These procurement policies should be made public, involving open and transparent communication

with independent assessors and NGOs.

Olympic host cities should adopt clear, thorough and accessible construction materials guides. The guides should be made available prior to selecting contractors to ensure environmentally sound materials are widely used.





B30025



Chapter 9

CLIMATE NEUTRALITY

Climate change is one of the main challenges currently facing the global community.

The challenge for BOCOG — as for organizers staging other mass events — was to measure, offset and curtail the amount of carbon dioxide released into the atmosphere directly or indirectly as a result of the Games.

Energy efficiency measures at venues helped offset emissions.

According to recent scientific studies, most notably by the Intergovernmental Panel on Climate Change, the reduction of greenhouse gas emissions by at least 50 per cent of 1990 levels by 2050 is critical in order to limit global warming at up to 2°C by the end of this century.

Over the past three or four years, some studies show China's greenhouse gas emissions have even exceeded those of the United States of America (even if the per capita emissions are still around 20 per cent that of a US citizen). Although they are already high, emissions in China may double by 2030 without an ambitious mitigation programme. This would affect China and the world at large.

In late October 2008, the Chinese State Council presented a White Paper "China's Policies and Actions for Addressing Climate Change". Among other things, the White Paper showed the extent to which global warming is already having

a negative impact on China. China is generally described as one of the countries which is very susceptible to the adverse effects of climate change, mainly in the fields of agriculture, livestock breeding, forestry, natural ecosystems, water resources and coastal zones.

9.1 CLIMATE NEUTRALITY AND SPORT

The amount of carbon released into the atmosphere directly or indirectly as a result of all the activities associated with the Games is what we are challenged to measure, offset and curtail. Arguably, the measurement of the climate impact of an Olympic and Paralympic Games should include the activities undertaken in all phases of the Games, from the early planning stages to Games-time. It should also cover travel, in particular international travel, by athletes, officials, spectators and the media.

A strategy towards achieving climate neutrality for the Games involves:

- Measuring the carbon footprint of the event;
- Reducing energy demand;
- Increasing energy efficiency;
- Expanding the use of renewable energy, and
- Compensating or offsetting "unavoidable" emissions.

The main focus of such a strategy should be to reduce greenhouse gas emissions at the source. Offsetting is only a second best option. Carbon offsets are activities that compensate for carbon or greenhouse gas emissions in one area by reducing them in another, ensuring that there is no net increase in emissions.

Projects that generate carbon offsets typically reduce greenhouse gas emissions by

improving energy conservation, development of renewable sources of energy (including wind, solar, small hydro, geothermal and biomass) and tree planting (which increases CO₂ removal through photosynthesis). They are bought and sold through international brokers, online retailers and trading platforms in the way that stocks, bonds and mutual funds are sold.

Beijing's Olympic bid commitments

Beijing did not explicitly refer to climate change in the Olympic bid it submitted in 2000. However, some of its commitments and goals addressed climate protection. These included:

- Increase in energy efficiency;
- Use of cleaner technologies and fuels in housing, industry and transport sectors;
- Adoption of green commuting policies and practices; and

The use of cleaner fuels in the transport sector was factored into calculations of greenhouse gas emission reductions for the Games.



- Reforestation and greening of the city.

9.2 BEIJING 2008 GAMES CARBON FOOTPRINT

As a consequence of UNEP’s recommendations regarding climate change in its 2007 Environmental Review, BOCOG and the Beijing authorities adopted the following approach and measures:

They commissioned a study* to calculate the additional (incremental) greenhouse gas emissions caused as a direct result of the Beijing 2008 Olympic Games to analyse the expected negative impact on global warming. The study then estimated the positive effects of the environmental measures on the climate and then calculated whether the net balance is positive or negative. (Note calculations for the Beijing Paralympic Games were not included on this occasion).

The study was done by a team of researchers from the Administrative Centre for China’s Agenda 21, the Energy Research Institute of the National Development



Games-linked art competitions helped heighten awareness of climate change and other environmental issues.

Reform Commission of China, the Geography Institute of the Chinese Academy of Sciences and Tsinghua University. The final results are currently not publicly available.

The study considered emissions during the construction and

operation of new venues, emissions from the activities of athletes, officials, spectators and related services for the Games. It also included emissions caused as a result of the torch relay (see Figure 9.1).

According to these figures, the total incremental carbon footprint for Beijing Olympic Games was about 1.18 million tonnes of greenhouse gases.

It should be noted that up until now, none of the major international sport events

TABLE 9.1: CARBON FOOTPRINT OF BEIJING 2008 OLYMPIC GAMES

| Sources | Emission (1,000 tonnes of Green House Gas) | Percentage in total | |
|---------------------------------------|--|---------------------|-------|
| Construction of venues | 24.0 | 2.0% | |
| Operation of venues | 77.0 | 6.5% | |
| International flight trips | International spectators | 680.0 | 57.5% |
| | Media and others | 44.5 | 3.8% |
| | Athletes, Olympic family | 33.6 | 2.8% |
| Domestic flight trips | 139.0 | 11.8% | |
| Other domestic trip and in-city trips | 29.0 | 2.5% | |
| Operation of BOCOG | 0.4 | 0.03% | |
| Accommodation | 144.0 | 12.2% | |
| Waste treatment | 1.5 | 0.1% | |
| Torch relay | 8.9 | 0.8% | |
| Total | 1,181,900 | 100% | |

Source: Beijing Municipal Science and Technology Commission

*Note: The study presented above was commissioned by the Beijing Environment Protection Bureau. However, the EPB has not fully endorsed the findings of the study.

TABLE 9.2: AVOIDED EMISSIONS DURING THE GAMES PERIOD, AUGUST 2008

| Measures | Avoided GHG-emissions (1,000 tonnes of Greenhouse Gas) |
|---|--|
| Clean fuel used in public transportation system | 19.7 |
| Clean fuel buses used in Olympic Green | 0.63 |
| Solar energy power generation | 0.07 |
| Solar energy hot water system | 0.67 |
| Green lighting system | 0.83 |
| Geo-thermal (wastewater) heat pump | 0.45 |
| Total | 22.3 |

Source: Beijing Municipal Science and Technology Commission

included all the above parameters in their calculations, particularly, the impact of international flights taken by spectators, athletes and various officials.

9.3 CARBON FOOTPRINT REDUCTION MEASURES

This includes the emission reductions created by the application of renewable energy and energy efficient products at the sites and venues during the Games.

These figures indicate that greenhouse gas emissions savings of about 22,300 tonnes for the Games' period.

Overall carbon footprint reduction

In addition, the authors of the study also calculated the anticipated effects of all 'Green Olympics' measures and campaigns by BOCOG and Beijing municipal authorities during the preparation and hosting of the Olympic

Games on reducing greenhouse gas emissions. The results of that calculation are listed in Table 9.3.

The results of this calculation shows that approximately 1.2 million tonnes of greenhouse gases was saved by the measures which were related to the Beijing Games bid commitments.

Based on the calculations, comparing the carbon footprint of the Games with the reductions from the measures presented

above, it can be deduced that the 2008 Olympic Games were climate neutral. This may have been one of the reasons why Beijing may not have felt the need to implement additional climate protection or compensation measures to reach the objective of "climate neutrality."

TABLE 9.3: TOTAL IMPACT OF BID COMMITMENTS ON GREENHOUSE GAS EMISSIONS REDUCTION

| Measures | Emission reduction |
|--|--------------------|
| (1,000 tonnes of Greenhouse Gas) | |
| Clean fuel vehicles | – |
| Solar energy power generation | 11 |
| Solar energy hot water | – |
| Green lighting | 17 |
| Application of Geothermal (wastewater) heat pump | – |
| Pollution control in industries | 166 |
| Traffic control during the Games | 802 |
| Greening of Olympic venues | 2.5 |
| City wide greening | 65 |
| Boiler conversion | 119 |
| Total | 1,182,500 |

Source: Beijing Municipal Science and Technology Commission

9.4 COMMENTS AND RECOMMENDATIONS

Beijing's climate neutrality programme has, for the first time for a global sports event, taken into account the carbon emissions from international flights. Based on the calculations by the authors of the study, international flights accounted for over 64 per cent of the emissions of the Games. The authors of the study should therefore be commended for taking a very progressive approach to the issue of carbon neutrality in sport.

However, the calculations that the authors of the study used to arrive at its conclusions do not provide sufficient basis for an in-depth evaluation. They do not provide any detail of the methodology used. The calculation of the impact of the environmental measures on the greenhouse gas emissions reductions raise

questions about whether this was done in accordance with international standards.

The results presented in the tables above were released in May 2008, before the Games. Therefore, the data might not reflect the actual carbon emissions during the 2008 Olympic Games.

The study raises the following questions:

- Which international guidelines were used for the calculations?
- What was the scope of the emissions included?

What primary data from Beijing 2008 did the study draw upon and what was the source of secondary data (i.e. from prior sporting events)?

Given that the study has raised numerous questions, it is

therefore difficult for UNEP to assess the carbon footprint of the Games and the impact of the measures to mitigate and offset the emissions.

An analysis using exact data from the Games period has obviously not been done. If Beijing was to ascertain the carbon footprint of the 2008 Games and the impact of the measures to mitigate and offset those emissions, it might be necessary to have an independent verification.

Organizers of upcoming major sports events (the Olympic Games, the FIFA World Cup, the Rugby World Cup) and sports organizations in general, should be encouraged to seriously look at their carbon footprint and seriously analyse primary data from events. It should be noted that any activity that claims to be climate neutral should have a zero net impact on climate change.

Efforts to mitigate and offset emissions should be a collective responsibility of the organizers, suppliers, contractors, sponsors, spectators, countries and organizations participating in the event.

Organizers and countries hosting mass events are encouraged to look for creative ways of engaging all stakeholders, including the above-mentioned groups, in efforts to reduce their emissions.

As the issue of carbon neutrality is likely to be increasingly important for future Olympic Games, UNEP would offer to assist the International Olympic Committee and other sport organizations to come up with a harmonized standard for addressing this issue in sport.

Beijing Capital International Airport.









Beijing 2008 TM



MARIO & SON AT THE OLYMPIC GAMES



Chapter 10

ROLE OF GAMES PARTNERS

Success in staging a 'Green Olympics' in 2008 also depended on how well BOCOG cooperated with key partners. Recognising the importance of achieving a collective effort, BOCOG set out to engage Olympic Worldwide Partners, other sponsors, suppliers and contractors in its environmental programmes.

Worldwide Olympic Partner, Panasonic, supplied a range of technology and was praised for the high energy efficiency of its recording equipment for Olympic broadcasters.

Success in staging a 'Green Olympics' in 2008 also depended on how well BOCOG cooperated with key partners.

10.1 ROLE OF SPONSORS

The sponsorship strategy for the 2008 Games was comprehensive and involved various tiers of support. The IOC managed the relationships with the 12 Worldwide Olympic Partners. The Beijing 2008 Sponsorship Programme, designed by BOCOG to support the Games at the national level, was comprehensive and comprised the following:

- Beijing 2008 Partners – 11 for the Olympic Games, 19 for the Paralympic Games;
- Sponsors – 10 for the Olympic Games, 10 for the Paralympic Games;
- Exclusive Suppliers – 14 for the Olympic Games, three for the Paralympic Games, and
- Suppliers – eight for the Olympic Games, three for the Paralympic Games.

The Games sponsors and suppliers were integral to promoting Olympism throughout China. They contributed technology, products and services to support BOCOG's operations and helped promote environmental issues to the general public. Other partners included contractors, such as hotels, caterers and 59 licensed manufacturers.

Cooperation on environmental initiatives for the Games involved close liaison between Chinese environmental regulators, BOCOG, the IOC and partners at all levels.

Olympic Sponsor Environment Group

In July 2007, an Olympic Sponsor Environment Group was established as a non-permanent working body and platform



Representatives of BOCOG and the Beijing Yuanpei Century Translation Company at a joint announcement of the Official Translation and Interpretation Supplier of the Beijing 2008 Olympic Games.

which brought national and global sponsors together to coordinate environmental initiatives. The group's aim was to make sure sponsors adhered to environmental laws and regulations, delivered environmentally-friendly technologies, products and services, and developed communication and education programmes.

The members also wanted to use their collective strength to enhance public awareness of environmental issues, help promote BOCOG and sponsors' environmental records and support the 'Green Olympics' concept. However, the reality was that time was limited for this group to make significant inputs to BOCOG's greening efforts.

10.2 SPONSOR SELECTION PROCESS

According to BOCOG, a preliminary step in selecting national sponsors involved

the committee's Marketing Department seeking an environmental assessment of potential partners from the Construction and Environment Department. For example, the paper-making industry was excluded from the sponsorship programme because of environmental concerns, even though numerous paper manufacturers had expressed interest in sponsoring the Games.

After an initial evaluation, potential sponsors had to present their environmental certifications, either local or national. According to BOCOG's Marketing Department, 51 of the 55 Olympic and Paralympic Games sponsors possessed local or national environmental certification of some kind.

Finally, to be accepted as a Games sponsor, each organisation was requested to ensure the materials it procured, its manufacturing

methods and business activities complied with the relevant national or industrial environmental standards. Sponsors also had to commit to maintaining a good environmental public image and to providing environmentally friendly products for the Games.

10.3 SPONSOR INITIATIVES AND CAMPAIGNS

Eliminating HFCs in refrigeration and air-conditioning

One Worldwide Olympic Partner, Coca Cola, was part of a coalition called 'Refrigerants, Naturally', which was launched in 2004. The initiative was supported by UNEP and Greenpeace to promote environmentally-friendly cooling technologies. Coca-Cola ensured that all of its soft-drink coolers (5,658 in total) in the Olympic venues were free of ozone depleting hydrofluorocarbons (HFCs).

Coca-Cola's coolers and vending machines were instead powered by carbon dioxide (CO₂). Ironically, while CO₂ is a potent greenhouse gas, when used as refrigerant it has a negligible impact on the climate especially when compared to the impact of HFCs on the ozone layer. In May 2008, Coca-Cola announced that by 2010, the company would deploy 100,000 CO₂ refrigerators worldwide.

Greenpeace recognized Coca-Cola's efforts to take on the environment-friendly cooling issue beyond the Beijing Games but has maintained that Coca-Cola needs to do much more, as 100,000 coolers represents less than 1 per cent of the company's 11 million refrigeration units.

More eco-friendly air conditioners

China's largest home appliance manufacturer and a Beijing 2008 sponsor, Haier, provided more than 30 products for the Games. Haier was praised for promoting prototypes of climate-friendly and energy efficient solar-based air conditioners.

Haier also provided Coca-Cola with HFC-free coolers. These prototypes, which used water for cooling, were showcased in several venues including the Olympic Village and Olympic Tennis Centre. However, Haier continued to provide commercial coolers using HFCs to other providers, thus most of the Haier coolers used in the venues still relied heavily on HFCs.

General Electric, another Worldwide Olympic Partner, provided solar-powered and water-filtration air conditioning systems for Games venues.

More eco-friendly mobile phones

The official Beijing 2008 Olympic mobile phone was Samsung's first more eco-friendly model

– free of polyvinyl chlorides (PVCs) and brominated flame retardants (BFRs). Samsung, also a Worldwide Partner, launched their new phone at the Games. In support of Beijing's 'Green Olympics' goal, Samsung also promoted its global plan to phase-out in its products BFRs from 1 January 2009, and PVCs from 1 January 2010.

A national-level Partner, China Mobile, initiated a Green-Box Environmental Protection Programme, whereby consumers could recycle used mobile phones and accessories. This was one example of a sponsor initiative which transferred the 'Green Olympics' into everyday life.

The Green Class Tour

The Centre for Environmental Education and Communications joined with the Green Volunteers from Volkswagen Group China to arrange the Green Class National Tour. Launched in June 2007, it was part of the Volkswagen Green Future Environmental Education Initiative.

Volkswagen, a 2008 Olympic and Paralympic Games partner, also supported an Olympic tree planting campaign in Inner Mongolia.

Creativity Competition for the Environment

In early 2008, China Mobile launched a creativity competition with environmental protection and energy efficiency as its themes. Through the competition, Beijing residents could suggest environment protection tips by sending text messages. Unfortunately there was little information available to determine the impact and success of this sponsor initiative.

Reducing the carbon footprint of Olympic broadcasters

Innovative high definition video recording equipment provided for the Games by Panasonic, another Worldwide Partner, was praised for its high energy efficiency. The new technology helped each Olympic broadcaster cut CO₂ emissions by around 2

tonnes compared to conventional video recording equipment. Beijing Olympic Broadcasting's Chief Executive Officer, Manolo Romero, said: "The highly environmentally conscious performance of this [equipment] will help achieve the goal of making the Beijing 2008 'environmentally conscious Olympic Games.'"

10.4 ROLE OF SUPPLIERS AND CONTRACTORS

To improve the overall environmental performance of the Games, BOCOG involved other business partners, namely suppliers, caterers, contractors and hoteliers.

Games suppliers

The Olympic Logistics Centre was responsible for assessing BOCOG's entire purchasing needs. The Centre worked with the Construction and Environment Department to verify that potential suppliers complied with environmental laws and regulations, giving preference to companies with

BOCOG and Worldwide Olympic Partner Coca Cola launched a joint water saving campaign involving students at more than 1,000 primary schools



ISO 14001 or similar standards certification.

Merchandise

The Games licensing sub-programme contracted companies to manufacture and sell merchandise which featured the Beijing 2008 Olympic Games and Paralympic Games logos. Potential licensees were requested to provide evidence of any environmental certifications. The baseline requirement was a certificate issued by the local government that guaranteed the manufacturer complied with all environmental regulations applicable to its products and manufacturing processes.

According to BOCOG's Marketing Department, all 59 licensed manufacturers complied with at least one of these requirements.

BOCOG included an environmental clause in its licensing contract which stated that: "the manufacturer must provide licensed products that meet the governmental and BOCOG environmental requirements and guidelines".

In addition, BOCOG asked its licensed manufacturers to reduce the packaging for licensed products and to use more environmentally friendly materials in their production processes.

Catering

To support the sustainability of catering services during the Games, the Construction and Environment Department developed guidelines entitled, *Environmental Protection Guidelines for Beijing 2008 Catering Services*. The guidelines were implemented in cooperation with the BOCOG Games Services Department which managed accommodation and catering services.

The guidelines provided useful suggestions for catering contractors in the areas of environmental management,

resource protection, pollution control and waste management.

For example, the guidelines suggested that preferential selection of catering companies would apply to companies with ISO 14001 certification. Potential contractors were asked to comply with existing environmental laws and regulations; to use food with green labels, and to take care of their environmental impact, for example by avoiding open air barbecues.

The guidelines also provided energy efficiency advice, suggesting that Games caterers should minimize the use of disposable tableware, cutlery and wooden chopsticks.

The above environmental requirements were met on a voluntary basis, if at all. There is little evidence to confirm how many caterers adopted the guidelines. Furthermore, there was no mechanism in place to monitor the impact before, during or after the Games.

Greenpeace stated publicly that due to a lack of information they were unable to assess whether catering companies used disposable chopsticks, which would have been against the spirit of the environmental guidelines for caterers.

Accommodation

One of the main tasks of the BOCOG Games Services Department was to contract the hotels required to welcome the Olympic Family (i.e. the International Olympic Committee and the International Sport Federation).

In 2004, the Construction and Environment Department developed guidelines for hotels, the *Environmental Protection Guidelines for the Beijing 2008 Hotel Services*. The guidelines included suggestions to improve energy efficiency and water conservation at contracted hotels.

For instance, the BOCOG

guidelines suggested hotels increase the temperature of their air conditioning systems by 1°C in the summer and decrease the temperature of heaters by 1°C in the winter. Hotels were urged to use energy saving light bulbs and were given energy information cards to distribute as part of an initiative by environmental NGO, Global Village of Beijing.

The guidelines were an appendix to BOCOG's standard Agreement on Olympic accommodation and reception services. Again, the environmental guidelines were voluntary, not compulsory. However, to promote their uptake, BOCOG provided training for hotel managers and their staff about environmental aspects of the accommodation sector.

Green Travel Hotel standard

In 2006, the China National Travel Administration launched a new environmental standard, called the 'Green Travel Hotel (LB /T007—2006)' which applied to hotels contracted for the Games. It was designed to strengthen the BOCOG guidelines and increase the environmental performance of the hotel sector.

In October 2006, the Beijing Green Hotel Assessment Committee began assessing the 637 Beijing

star-rated hotels against the Green Travel Hotel standard. By the end of 2006, 77 hotels were ranked as Gold Leaf and 57 hotels were awarded Silver Leaf status.

BOCOG and the China National Travel Administration were determined that hotels which met the Green Travel Hotel standard should also be certified as complying with the BOGOC guidelines. In February 2007, the environmental protection efforts by Olympic contracted hotels were audited. According to advice provided to UNEP, all contracted properties met the Green Travel Hotel standard.

10.5 COMMENTS AND RECOMMENDATIONS

As discussed in UNEP's 2007 Environmental Review, environmental performance was part of the selection process for Games sponsors and other partners.

This is not common practice for major sports events. For example, Official Partners of the FIFA World Cup are not assessed on the basis of their environmental performance. The use of environmental guidelines by BOCOG was therefore an important development.





The "Green" Beijing Hotel

However, the overall consideration of environmental credentials during the selection of local sponsors for the Beijing 2008 Games was weak, with no mandatory requirements for potential sponsors. Because of this, some sponsors missed an opportunity to reinforce their reputation as socially and environmentally responsibly companies. This ultimately diminished the role of sponsors in contributing to the 'Green Olympics' and was countered only by proactive environmental campaigns initiated by individual sponsors.

Recommendations for sponsors

The IOC should be encouraged to formalise the way in which Worldwide Olympic Partners integrate environmental considerations into their operations and provision of services for the Games. As observed in Beijing and at previous Games, several of these partners

are already eager to promote their environmental profile. This could be a good signal for encouraging all sponsors to follow suit.

As part of the selection criteria for national sponsors and partners for the Games, future organizing committees should be encouraged to reinforce the environmental criteria that were used for the Beijing Games and, where possible, include some mandatory or baseline environmental requirements for sponsors and other partners.

BOCOG released a comprehensive set of guidelines for an environmentally sound screening for the procurement of products and services discussed earlier in this chapter. There is however, insufficient information to assess the following:

- how ambitious the required standards were compared to international standards;
- what role they played

within the procurement or selection process (as most of them definitively were not mandatory);

- which partners did meet the requirements, and
- what was the overall impact on their products and services?

There was, unfortunately, no comprehensive monitoring process to evaluate whether partners adhered to these measures. Based on the available information, no systematic assessment is possible.

Recommendations for suppliers and contractors

Future Olympic Games Organizing Committees are encouraged to develop mandatory guidelines on the following processes:

- Suppliers - The focus of these guidelines should be more

about the product than the production process;

- Merchandisers - Compare products and services of various suppliers and ensure that licensing rights include strict environmental benchmarks;
- Caterers – Encourage the approach of BOCOG and ensure better monitoring processes, and
- Accommodation providers - The guidelines for hotels and other accommodation providers should include more quantifiable performance indicators and a comprehensive monitoring process.

Such guidelines should include incentives for companies to comply with sustainability requirements and a transparent, reliable process for assessing the environmental impact of the wide range of contractors and suppliers.





Chapter 11

NGO PERSPECTIVE

Consistent with the experience at previous Olympic Games — in particular since the environment became a pillar of the Olympic Movement — there was enthusiasm on the part of environmental non-governmental organizations to support sustainability initiatives in Beijing.

Cleaner transport was part of the NGO agenda for the Games.



© Getty Images





利生体育商厦
Lisheng Sports Business Building

天元
利生体育商厦

同一个世界 同一个梦想
One World One Dream

照相器材
Parts of camera

一品莲花

© UNEP

A wide range of stakeholders had an interest in contributing to the preparation and staging of the Beijing 2008 Olympic and Paralympic Games or were impacted in some way. These groups ranged from the Chinese public, civil society and non-governmental organizations (NGOs) to sponsors, suppliers, contractors and other diverse Games service providers in China and around the world.

As the involvement of sponsors, suppliers, hotels and other contractors is discussed in chapter 10, this chapter focuses on the role of environmental NGOs.

11.1 NGO INVOLVEMENT

According to the Beijing Organizing Committee for the Olympic Games (BOCOG), more than 30 environmental NGOs were involved in the organization of the Games. These included Chinese and international NGOs such as Global Village Beijing, Green Earth Volunteers, Greenpeace, World Wildlife Fund (WWF), Conservation International, the World Conservation Union (IUCN) and Friends of the Earth.

Serious engagement between NGOs and BOCOG only began in 2006, after UNEP organized to bring BOCOG and NGOs together at a roundtable in Lausanne, Switzerland. Many NGOs had previously approached BOCOG with ideas of how they could help realize the 'Green Olympics' vision. However, several NGOs initially found BOCOG cautious and reluctant to engage with them.

As flagged in UNEP's 2007 review, there was no clear policy within BOCOG concerning the engagement of NGOs. This led various NGOs to use their personal rather than official connections to establish working relationships with BOCOG.

Basketball superstar and UNEP environmental champion Yao Ming stands tall during the Games.

Cooperation between NGOs and BOCOG

Environmental NGOs were involved with BOCOG on numerous issues, including the following examples.

- NGOs participated in the development of some guidelines. For example, the guidelines for regulating air conditioning in hotels were developed by Global Village Beijing. The guidelines required hotels to limit the temperature of air conditioners to 26 degrees in a bid to reduce energy consumption. The guidelines were later endorsed by the government which issued a policy regulating air conditioning in public buildings to 26 degrees.
- NGOs worked with BOCOG to implement environmental education programmes and to promote public participation in the protection of wildlife. NGOs also engaged schools in greening programmes. They worked with Olympic sponsors, partners and well-known athletes on programmes designed to raise environmental awareness. For example, Greenpeace organized a series of energy saving light-bulbs promotional activities in schools with Deng Yaping, a former ping-pong world champion and Olympic gold medalist. Also, UNEP's first ever Environmental Champion, Yao Ming, a star of America's National Basketball Association and captain of China's Olympic basketball team, was a spokesman for WildAid China's shark fin campaign.
- NGOs played a role as intermediaries, promoting the environmental activities of BOCOG and government

authorities to the media. When negative international media coverage of Beijing's air quality emerged, various NGOs came out in support of the city's environmental performance, becoming vocal allies for BOCOG. Drawing on their in-depth local knowledge, NGOs expressed their support for BOCOG in areas where they believed the organizers and authorities had done a commendable job.

- Several NGOs advised BOCOG on specific issues. For example, WWF advised

BOCOG on the use of timber that had gone through the Forest Stewardship Council (FSC) certification in the construction of venues. Some local NGO representatives were requested by BOCOG to act as environmental advisors. BOCOG also requested help from Conservation International to calculate the carbon footprint of the Games. However, several NGOs were concerned their advice was not taken seriously.



NGOs used the Games to take sustainability messages to a wide audience.





UNEP Executive Director, Achim Steiner (left), meets Greenpeace China's Campaign Director, Lo Sze Ping.

11.2 NGO FEEDBACK

In general, NGOs were positive about Beijing's environmental performance. They acknowledged that BOCOC and the municipal authorities did a commendable job to improve air quality. The feeling among NGOs was that the traffic and pollution control measures, such as reducing emissions from heavy polluting industries in Beijing and nearby cities and halting some construction, were bold but highly successful.

NGOs also noted the development of Beijing's infrastructure had improved the lifestyle of its residents. The improvements had made public transport more convenient and heating system for homes more efficient. In addition, the Games led to better water treatment and, to some degree, a reduction in reliance on fossil fuels.

Another feedback from NGOs was that the Games helped to raise awareness of environmental issues amongst the general public in China. For example, the Games raised awareness of air pollution issues and the environmental

impact of plastic bags. The Games also generated mass public participation in the greening of Beijing.

Challenges for NGOs and BOCOG

Overall, NGOs had mixed feelings about their involvement in the Games. While some NGOs said they had maintained regular contact with BOCOG on specific issues, others indicated they were only consulted by BOCOG when the committee needed them to speak to the media or to an international audience in support of Beijing's environmental record.

Some NGOs also believed BOCOG did not create sufficient scope for NGO participation or take full advantage of the strong support NGOs could have offered from the early stages of Games planning. The committee only decided to engage NGOs towards the end of 2006, less than two years to the Games.

NGOs also cited problems with the flow of information and a lack of transparency. A majority of NGOs who worked

with BOCOG found it difficult to obtain information on most environmental issues. On some topics, such as carbon neutrality, renewable energy and Forest Stewardship Council certified timber, many NGOs felt BOCOG was not genuinely interested in taking their views into account, nor open to providing information on how the committee was dealing with such issues.

NGOs also felt BOCOG's Construction and Environment Department did not have sufficient profile or influence to effectively coordinate environmental issues therefore could not ensure that environmental considerations were fully entrenched in BOCOG's activities. The department had very few staff working exclusively on environmental issues – a total of 14 during the Games out of 8,000 staff – and the BOCOG Deputy Director responsible for environmental issues was himself given the responsibility of running a venue, leaving no one in charge of coordinating environmental issues during the Games.

Furthermore, the department was unable to provide accreditation for NGOs who were supportive of

BOCOG's environmental efforts, making it difficult for these NGOs to reach accredited media or observe the environmental programmes under way in venues during the Games.

NGOs also highlighted their disappointment that environmental measures taken for the Games did not have a holistic approach. Several measures were short-term with no clear indication of what would happen after the Games. These included initiatives implemented to guarantee better air quality during the Games, such as limiting car use and construction work, and the temporary or partial closure of heavy polluting factories situated in Beijing and neighbouring provinces.

NGOs felt that although some sponsors were eager to be engaged on environmental issues, BOCOG did not make a concerted effort to ensure that this happen. There was no incentive for sponsors to incorporate environmental considerations into their activities.

Some NGOs worked with Games sponsors and partners, such as Coca Cola, Samsung, China Mobile and McDonalds, to implement awareness raising projects and other activities prior to, and during, the Games but believed these programmes could have been more effective had BOCOG taken the initiative from the outset. For example, among the several sponsors providing cooling equipment or facilities for the Games, only Coca Cola responded positively to Greenpeace's call to install ozone and climate-friendly refrigeration in the venues. Some NGOs believed that if BOCOG had played a more pro-active and facilitative role earlier, more sponsors could have been actively involved in this and similar initiatives.

Most NGOs believed BOCOG could have done more on the issue of carbon neutrality. They expressed skepticism about the figures BOCOG provided on its

carbon footprint and thought the issue was generally treated in a superficial way. NGOs found it difficult to confirm the facts and methodology BOCOG used to arrive at the figures.

11.3 COMMENTS AND RECOMMENDATIONS

Consistent with the experience at previous Games – since the environment became a pillar of the Olympic Movement – there was enthusiasm on the part of NGOs to support BOCOG with its sustainability initiatives.

BOCOG missed an opportunity to fully engage NGOs and benefit from their expertise from the outset of Games preparations. BOCOG only began engaging NGOs from the end of 2006, when the construction of most Games facilities was nearing completion and many policies were already in place.

It would be useful for the Beijing Municipal Government to engage NGOs in discussions on how to carry forward and reinforce the full range of environmental measures undertaken for the Games. NGOs possess specialised knowledge and have emerged from the Games with good experience. The creation of a sustainability forum with representatives from NGOs and various sectors of the public to advise Beijing's Municipal Government could be a positive step.

Despite no evidence of a comprehensive programme to engage the general public on the extensive suite of environmental measures implemented for the Games, Beijing authorities could still take advantage of heightened public environmental awareness from the 'Green Olympics' to seek the views of citizens on the way forward for the city's environmental activities. A public survey on this issue is recommended.

The Games left an important legacy for the city of Beijing, for the rest of China and for future host cities and organizers of mass events. Documenting the successes and missed opportunities in terms of drawing

on the expertise and networks of environmental NGOs will provide the hosts of future major events with valuable information and experience in their efforts to address environmental issues.

Long the focus of NGOs, biodiversity conservation was part of the 'green' Olympics vision. Jingjing the panda was a mascot of the Games.



© Fritz Polking / Still Pictures





同一个世界 同一个梦想
Beijing 2008
One World One Dream



美
一

Large red Chinese characters, likely '奥运' (Olympic Games).

Beijing 2008

Various smaller pieces of Chinese calligraphy, including names and phrases, scattered across the banner.

Chapter 12

COMMUNICATION AND EDUCATION

Working in close cooperation with a range of partners - among them the Beijing Municipal Government, UNEP, environmental NGOs, sponsors and schools - BOCOG mobilized communities on a grand scale to promote the 'Green Olympics' vision, even engaging more than 400 million students in one programme alone.

The Beijing mascots in London spreading Olympic fever.

© Agence France Presse





To promote the 'Green Olympics' concept and raise awareness of environmental issues, BOCOG instigated various projects in the domains of communication and education. Working in close cooperation with a range of partners – among them the Beijing Municipal Government, UNEP, environmental NGOs, sponsors and schools – BOCOG mobilized communities on a grand scale and even engaged more than 400 million students in one programme alone.

BOCOG incorporated information about the 'Green Olympics' into general Games information and other publications, such as the China Environment Yearbook, and also produced a range of guidelines and other publications dedicated to environmental topics including:

- *Beijing 2008: Environmental Protection, Innovation and Improvement report;*
- *Environmental Protection Guidelines for the Olympic Projects;*
- *Environmental Protection Guidelines for the Temporary Projects;*
- *Environmental Protection Guidelines for the Beijing 2008 Hotel Services;*
- BOCOG Environmental Reports for the years 2003, 2004 and 2005/2006, and
- A series of six leaflets on environmental aspects of the Games, jointly produced with UNEP.

In addition, BOCOG showcased the three pillars of the Olympic Movement – sport, culture and

the environment – through art projects. The Construction and Environment Department of BOCOG coordinated much of the education and outreach activity.

12.1 COMMUNICATION CAMPAIGNS

BOCOG developed several initiatives to spread environmental values among the general public and generated the enthusiasm of Beijing residents who wanted to have an Olympic Games experience. Highlights of the public information and outreach activity are listed below.

The Green Community and Green Home Campaign

The project was aimed at raising environmental awareness among Beijing families and communities. It developed initiatives related to water and energy saving,

reducing pollution, waste sorting and green consumption. The campaign was launched in Beijing and, according to BOCOG, more than 886 communities and 300 families were involved.

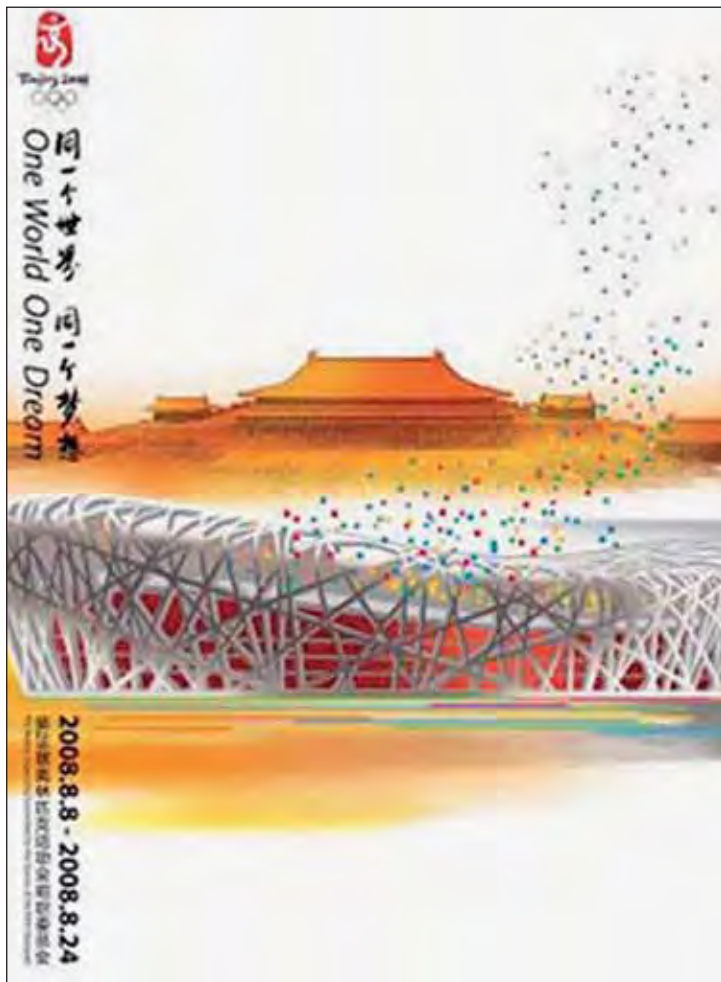
The 'One Day, No Engine Sounds' Campaign

The campaign encouraged Beijing citizens to use any means of transport other than cars. This raised awareness of air and noise pollution which are caused and can be curtailed by individual choice. 504 institutions, including 407 car clubs, joined the campaign. The Forum on China-Africa Cooperation in late 2006 was used as the campaign springboard.

Beijing Green Map Initiative

This project, developed by BOCOG and the Beijing Environment Protection Bureau,

Olympic promotional posters.



involved an initiative whereby Beijing residents participated in the labelling of the environmental and cultural facilities around their city. According to BOCOG, the project involved 8,000 people in developing China's first ever visual guide on environmental, ecological and cultural landscapes of the country's capital city.

The Fuwa Exhibition

The 'Close to the Nature Hand in Hand with Fuwa Exhibition' was a travelling display created by BOCOG and the Beijing Association for Science and Technology. The exhibition raised awareness about the four Olympic animal mascots, namely the fish, the Tibetan antelope, the flying swallow and the panda. Several environmental NGOs joined the exhibition, which enlightened viewers on each animal's habitat

and their uniqueness to their particular ecosystems.

Internal communication

BOCOG also actively engaged its staff in contributing to achieving the vision of a 'Green Olympics' by providing information sessions, updates on progress with environmental innovations and opportunities to get involved in campaigns. BOCOG reported that more than 1,000 of its staff received environmental protection training. Every year, BOCOG staff members also took part in a public Tree Planting Day and helped motivate other citizens to help in the greening of Beijing.

A proposal for a Commuter Challenge was a joint initiative of BOCOG, UNEP and the Vancouver Olympic Games Organizing Committee.

Television advertisements

The Centre for Environmental Education and Communication of Beijing, the United Nations Development Programme (UNDP), UNEP and BOCOG developed a series of television advertisements to promote public awareness on various environmental issues. The spots used famous Chinese sport personalities to communicate to the public. They were aired on several TV channels in China and on the Beijing metro prior to and during the Games.

Joint BOCOG and UNEP leaflets

UNEP and BOCOG cooperated to develop a set of six leaflets on the environment and the Games. Written in Mandarin and English, the brochures contained information on a range of environmental issues – in

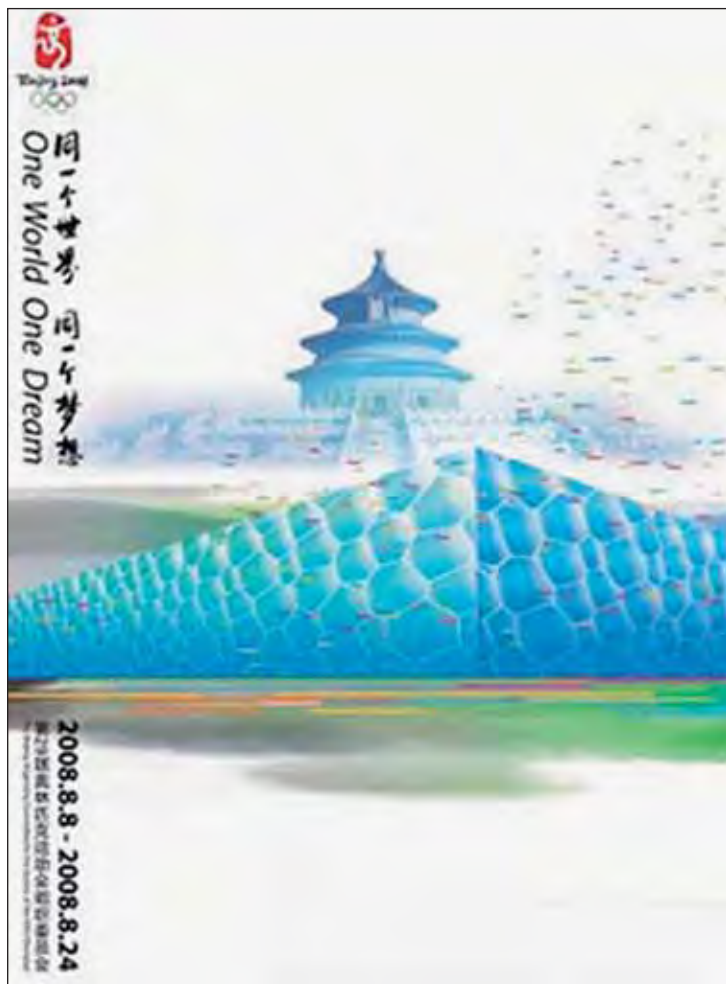
areas such as water conservation, renewable energy, air quality and green coverage – plus steps by BOCOG to address them, including during the design and construction of Games venues. The leaflets were distributed to the media and spectators during the Games.

12.2 EDUCATION

BOCOG targeted China's younger generation by organising projects in primary and secondary schools around Beijing and across the country. The major educational initiatives included:

The Beijing Primary and Secondary School Olympic Education Programme and the Green School Project

Communicating the message: collaboration was key.





Children at schools across China learnt about environmental issues through Olympic-linked programmes.

China's Ministry of Education implemented, at national level, a project that involved 400 million students. The aim was to establish Olympic Model Schools, where the Olympic values were taught, practised and promoted. The project encouraged students to adopt more sustainable lifestyles. Up to October 2006, 556 schools in China were nominated Olympic Model Schools, including 200 schools from Beijing.

In addition, a Green school project was initiated. Green schools are those that take environmentally friendly measures in their day-to-day activities and teach environmental values. The project was implemented in the city of Beijing and by October 2006 counted a total of 728 schools.

'Reserve a Barrel of Water this Summer' initiative

The project aimed to develop water saving initiatives while communicating the importance of water saving. It was implemented in primary schools around Beijing's 18 districts and counties. The driving forces behind it were the Youth League, Beijing Municipal Committee, the Young Pioneers Beijing Working Committee, Coca-Cola and BOCOG.

'Green Dreams, Colourful Olympics' Painting Competition

In 2005 and 2006 BOCOG, in partnership with the China National Youth Palace Association, organized a painting contest for students of Beijing's primary and secondary schools. In 2005, more than 2,000 students, from about 100 schools, participated in the competition. In 2006, the competition was extended to over 20 provinces, municipalities and

autonomous regions and nearly 8,000 drawings were received from students. The selected paintings were exhibited and used to decorate the Olympic Village.

The Green Olympics, Green Action Team

Members of this team held lectures and implemented promotional initiatives in different places such as in schools, factories, universities, libraries and communities. The Team was established in 2004 by BOCOG and the Beijing Environmental Protection Bureau to promote Olympic environmental values, sustainable development principles, good energy saving and water saving practices and environmental awareness in general.

12.3 COMMENTS AND RECOMMENDATIONS

In the important area of environmental education and communication, it is clear BOCOG's efforts contributed to raising awareness of the links between sport and the environment through actively engaging the public.

Local communities were encouraged by BOCOG, the Beijing municipal authorities and Games sponsors to take part in tree planting, energy saving and other Olympic-related environmental programmes. The beauty of this approach is that it gave people of all ages and backgrounds an Olympic Games experience regardless of their sporting ability or access to event tickets.

© BOCOG



BOCOG promoted its environmental messages largely to a domestic audience, with a focus on youth.

BOCOG demonstrated how hands-on environmental activities could harness the enthusiasm of citizens who wanted to contribute to the success of a major international event, and help market the event to an audience broader than sports fans.

Given the sheer scale of public participation in Beijing's environmental programmes, this is a case study of which other major international sports bodies should take note, including the Fédération Internationale de Football Association, International Rugby Board and International Cricket Council.

UNEP concludes that increased awareness of environmental issues in China, particularly among Beijing residents and businesses, is a powerful legacy of the Games. However, without

detracting from this achievement, there is room for improvement for future Games organisers.

BOCOG did not have a comprehensive plan to engage the media in its environmental performance. Given that Beijing's air quality attracted a lot of negative media attention, BOCOG could have developed a comprehensive plan to highlight the other aspects of its work on greening the Games.

A perennial communication challenge for the Games is meeting the information needs of a worldwide audience within resource constraints. BOCOG's efforts focussed on promoting its environmental achievements to a domestic audience. There is scope to extend the reach of future Games-linked environmental education and public awareness

campaigns to a global audience. UNEP anticipates exciting possibilities for greater use of social marketing tools by Olympic Games Organising Committees.

BOCOG's style of communication was appropriate, for example providing environmental information on the BOCOG website rather than relying on hard copy information materials, and arming Games volunteers with information about BOCOG's sustainability initiatives so they could answer spectators' questions spectators face-to-face. However, the website's Environment section was not kept up-to-date.

A further recommendation for future Olympic Games Organising Committees is to conduct formal research to measure public awareness and

attitudes towards sustainability initiatives for the Games, to help target environmental education campaigns and gauge the extent of behaviour change as a result.

UNEP anticipates exciting possibilities for greater use of social marketing tools by future Olympic Games Organising Committees.

BIBLIOGRAPHY

- Beijing MPS (2008). *2007 Beijing Energy Development Report*. Beijing Municipal Bureau of Statistics and Beijing Energy Conservation and Environment Protection Centre, Beijing.
- Beijing Statistical Yearbook (2006)*, China Statistics Press, Beijing.
- BOCOG (2007). *Beijing 2008, Environmental Protection, Innovation and Improvement 2001-2008*, Report by the Beijing Organizing Committee for the XXIX Olympiad (BOCOG). Beijing.
- BOCOG (2008). Beijing 2008 Environment Review – Sites and Venues (Powerpoint Presentation). (Unpublished).
- BOCOG (2007). New Beijing, Great Olympics: Report to UNEP-Environment protection work for Beijing Olympic Projects. Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG). 2008 Project Construction Headquarters Office of the Beijing Municipal Government, Beijing. (Powerpoint Presentation). (Unpublished).
- BOCOG. Beijing Olympic Venues. Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG), Beijing. (Catalogue).
- BOCOG. Guide to Environmental Protection for Beijing Olympic Torch Relay (Excerpts). Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG), Beijing. (Brochure).
- BOCOG. Guidelines of Olympic Project Green Construction (Abstract). Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG), Beijing. (Brochure).
- BOCOG. Report on the elimination of ODS in Beijing. Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG). Construction and Environment Department, Beijing. (Powerpoint Presentation). (Unpublished).
- Chinese Ministry of Science and Technology (2008). Carbon footprint and offsets of the Beijing 2008 Olympic Games (Powerpoint Presentation on selected results). Released at the International forum on Climate Change and Science and Technology on April 25, 2008.
- Chinese State Council (2008). *White Paper: China's Policies and Actions for Addressing Climate Change*. Beijing.
- Chou, C., C. Tsai, C. Shiu, S. Liu and T. Zhu, Measurement of NO_y during the Campaign of Air Quality in Beijing (CAREBeijing-2006): implications for the ozone production efficiency of NO_x, *Journal of Geophysical Research*, 114, doi:10.1029/2008JD010446, 2009.
- Gozun, E. Ambient Air Quality Standards in Asia: Is there a trend towards stricter standards? Presented at *Better Air Quality (BAQ) Workshop 2006*. Yogyakarta, Indonesia, 13-15 December.
- IOC, BOCOG (2006). IOC/BOCOG venue and infrastructure construction schedule. Competition venues. Report 11. International Olympic Committee (IOC), Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG), Beijing. (Unpublished).
- LOCOG (2007): *London 2012: Towards a one planet 2012*. Sustainability Plan update. London Olympic Games Organising Committee (LOCOG). London.
- McGill University (1999). *Report on Urban Household Water Use Pilot Survey in Beijing and Tianjin*. Montreal.
- National Bureau of Tourism (2006). Green Hotels. (Promotional document). Beijing.
- Organising Committee for the 2006 FIFA World Cup (2006): *Green Goal Legacy Report*. Frankfurt.
- Probe International (2008). Beijing's Water Crisis: 1949–2008 Olympics. Montreal. Available at: <http://www.probeinternational.org/beijing-water-crisis/beijings-water-crisis-1949-2008-olympics>
- Shijie, C. (2007). The Symposium on Beijing Olympic environmental work examined by UNEP. Beijing Municipal Bureau of Industrial Development, Beijing. TEXT (Unpublished).
- Streets, D., J. Fu, C. Jang, J. Hao, K. He, X. Tang, Y. Zhang, Z. Wang, Z. Li, Q. Zhang, L. Wang, B. Wang, C. Yua, Air quality during the 2008 Beijing Olympic Games, *Atmospheric Environment* 41, 480–492, 2007.
- Streets, D., Z. Qiang, K. Pickering, N. Krotkov, A. Prados, G. Carmichael, K. He and J. Hao, Integration of satellite, air quality, and emissions data to improve regional air quality management: Preliminary application to the 2008 Beijing Olympics, *2008 Regional Air Quality Management Conference*, China Ministry of Environmental Protection and U.S. Environmental Protection Agency, Beijing, China, November 6-7.
- Streets, D.G., T.C. Bond, G.R. Carmichael, S.D. Fernandes, Q. Fu, D. He, Z. Klimont, S.M. Nelson, N.Y. Tsai, M.Q. Wang, J.-H. Woo, and K.F. Yarber, An inventory of gaseous and primary aerosol emissions in Asia in the year 2000, *Journal of Geophysical Research*, 108 (D21), 8809, 2003.

UNEP (2007). *Beijing 2008 Olympic Games: An Environmental Review*. United Nations Environment Programme (UNEP). Nairobi.

U.S. Green Building Council (2008): Final Review of Beijing Olympics Village. Leadership in Energy and Environmental Design (LEED) for Neighborhood Development Rating System.

Wang, L., J. Hao, K. He, S. Wang, J. Li, Q. Zhang, D. Streets, J. Fu, C. Jang, H. Takekawa, S. Chatani, A Modeling study of coarse particulate matter pollution in Beijing: Regional source contributions and control Implications for the 2008 summer Olympics. *Journal of the Air and Waste Management Association*, 58: 1057-3289, 2008.

Wang, Z., An Ensemble Multi-model air quality forecast System in Beijing (EMS-Beijing) presented at *The 8th NIMR-IAP Joint Research Workshop*, Oak-Valley Korea, November 5-6, 2008.

WHO (2000). *Air Quality Guidelines for Europe*, World Health Organization Regional Publications, European Series, No. 91, ISBN 92 890 1358 3.

WHO (2005). *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment*. World Health Organization.

Witte, J., M. Schoeberl, A. Douglas, J. Joiner, J. Gleason, N. Krotkov, J. Gille, P. Bhartia, and K. Pickering, Air quality measurements from satellites during the 2008 Beijing Olympics, AGU Annual Meeting, San Fransisco, December, 15-19, 2008.

WMO (2008). Wang, J., X., Zhang, T. Keenan, and Y. Duan. Air quality management and weather prediction during the Beijing Olympics, *Bulletin of the World Meteorological Organization (WMO)*.

WWF International (2005). *Asia-Pacific 2005: The ecological footprint and natural wealth*. Switzerland: World Wildlife Fund (WWF International).

WWF International (2006). *Living Planet Report 2006*. Switzerland: World Wildlife Fund (WWF International).

Zhang, G., D. Streets, G. Carmichael, K. He, H. Huo, A. Kannari, Z. Klimont, I. Park, S. Reddy, D. Chen, L. Duan, Y. Lei, L. Wang, and Z. Yao, ASIAN EMISSIONS IN 2006 FOR THE NASA INTEX-B MISSION, *Atmospheric Chemistry and Physics*, submitted, December, 2008.

Zhang, A. (2008): China after the Olympics: Lessons learned after Beijing. Greenpeace China. Beijing. Available at: <http://www.greenpeace.org/china/en/news/green>.

INTERNET SOURCES

Agence France-Presse
www.afp.com

Beijing Environment Protection Bureau
www.bjepb.gov.cn

Beijing Organizing Committee for the Games of the XXIX Olympiad (BOCOG)
<http://en.beijing2008.cn>

Beijing Municipal Government
www.bjghw.gov.cn
www.bjyl.gov.cn/english

Beijing 2008 Paralympic Games
<http://en.beijing2008.cn/paralympic>

Chinagate.com.cn. 2007. Tap Water in Beijing Drinkable Even Without Being Boiled.
Available at: http://en.chinagate.cn/environment/2007-07/02/content_8468440.htm

Fox Sports
www.foxsports.com.au

Global Forum for Sports and Environment (G-ForSE)
www.g-forse.com

International Herald Tribune
www.ihf.com/articles

International Olympic Committee (IOC)
www.olympic.org

LA Times
www.latimes.com

Li, T. (2008): Are "carbon neutral" Olympics possible?
<http://www.chinadialogue.net/article/show/single/en/2403>

State Environment Protection Administration (SEPA) English
<http://english.sepa.gov.cn>

The Guardian
www.guardian.co.uk

The New York Times
www.nytimes.com

United Nations Environment Programme (UNEP)
www.unep.org

Xinhua English
<http://www.chinaview.cn>
<http://www.xinhua.org/english>

INDEX

A

Agenda 21 20,105
Agriculture 14, 72, 73, 104
Air pollution index (API), 26, 27, 37
Air quality 15, 24-27, 46, 53, 65, 96, 97,121,129
Algae 76
Asuwei landfill marsh 54

B

Beijing Coke & Chemical Plant 28
Beijing Environment Protection Bureau 29, 130
Beijing Environmental Monitoring Center 16, 27, 42, 45,29
Beijing Municipal Government 53, 77, 90, 98, 123, 128
Biomass 104
Bird Nest Stadium 82, 93
Blue Sky Days 13, 26, 37
BOCOG 16, 18, 24, 29, 37, 53, 96, 112, 121
Brominated flame retardants (BFR) 113
Buses 14, 29, 44-45, 52, 105

C

Capital Iron and Steel Company 28
Carbon dioxide (CO₂) 54, 67, 113
Carbon footprint 67, 105-107, 113, 121
Carbon monoxide (CO) 26, 42
Carbon offset 104
Catering 114
China Mobile 113, 122
Chinese Meteorological Agency (CMA) 33
Clean fuels 14, 26, 42, 46, 52
Climate change 36, 104-105
Climate neutrality 102-107
Coal 13, 26, 27, 50-55, 90, 98
Coal-fired boilers 29, 30
Coca Cola 83, 112, 122, 130
Community participation 65
Conservation International 121
Construction 14, 26, 45, 60, 74, 82, 90-97
Contractors 106, 112-115

D

Desulphurization 28
Dust 14-15, 26, 29, 35, 52, 76, 83, 97, 104, 112, 122

E

Economy 52, 53, 99
Ecosystem 15, 60, 64, 77, 129
Education 16, 126-130
Energy efficiency 27, 52, 53, 55, 90, 97, 103, 104, 113, 114

F

Forest 64-66, 73, 76, 94, 97, 104, 121
Forest Stewardship Council 121, 122
Forestation 15,28,60,65
Fourth Ring Road 15, 26, 60
Fuel 14, 27-29, 34-36, 42-46, 52-53, 97,122
Furnaces 52
Fuwa exhibition 129

G

Gas 17,28,33,43,52,54,84
General Electric 113
Geothermal heating 14, 52, 54
Global Village Beijing 121
Green belt 15, 60, 63-65, 95
Green coverage 15, 59-60, 63-67, 76,129
Green economy 10
Green Lighting Project 54
'Green Olympics' 13, 16, 42, 51, 60, 97,111-115,121-123,128-129,
Greenhouse gases 97-98,104-106,113
Greenpeace 54, 66, 98,112-114,121-122
Guanting Reservoir 14, 73

H

Haier 113
Hazardous waste 14, 82-83
Health 18, 26-27, 36, 75-77
Heating 14, 17, 26-27, 30, 52-54, 90, 93, 98,122
Hong Kong 19
Hotels 54,83,112,114-115,121,
Hydrofluorocarbons (HFC) 113

I

Industrial pollution 14, 53
International Olympic Committee (IOC) 13, 20, 76, 96-98,106,112-114,
Industrial areas 26, 76, 82

J

Journalists 18-19

L

Lillehammer 13, 20
London 20,126
Low sulphur coal 27
LOW-E double glazing 53

- M**
 Mascots 16,126,129
 Media 18, 26, 53, 76, 95, 97,104-105,121-122,129-131
 Merchandise 114-115
 Ming Tomb Réservoir 73
 Miyun Réservoir 14, 64, 72-74, 95, 97
 Mobile phones 113
 Montreal Protocol 29
- N**
 Natural gas 13-14, 27, 29-30, 36, 43, 52, 90,
 Nitrogen dioxide (NO₂) 26, 29-34, 42, 46
 Noise 17, 43-44, 90, 96,128
 Non-governmental organizations (NGOs) 13, 16, 77, 99,121-123,126,128
- O**
 Offsetting 104
 Olympic (bid commitments) 13-14, 16, 44, 77, 82-83, 90, 97,104-106
 Olympic Games and the environment (history of) 13
 Olympic Park 44
 Olympic Venues 15, 53-54, 60, 66, 76, 82-83, 90, 93-96,106,113
 Olympic Village 20, 44, 53, 76-77, 90, 93-96,113,130
 Organizing committee 13,16-18,115, 121,129,132-133
 Ozone 15, 26, 29,32-34,36,113,122,132
 Ozone depleting substances (ODS) 15,26,29,95
- P**
 Paralympic Games 18,32,43,59,70,72,74,82,88,90,97,104-105,112-113,121,
 Particulate matter 26,30,42,65,
 Photovoltaic 54,90,93,97
 Polyvinyl chlorides (PVCs) 113
 Population growth 26, 72, 82, 134
 Power generation 28, 72, 93, 106, 134
 Primary Industries 52, 134
 Protected areas 14, 26, 56, 64-66
 Public transport 14, 18, 28, 41, 98, 106, 122
- Q**
 Qingdao 18, 28, 74, 76
- R**
 Radioactive waste 14, 83
 Railways 44, 60, 64
 Rainfall 30, 33, 73
 Rainwater-collection 135
 Recyclable waste 82, 134
 Refrigeration 28, 112, 122
 Renewable energy 52, 54, 90, 98, 104, 122, 128
 Reservoirs 14, 72, 74, 77
 Roads 13, 41, 60, 64, 76
- S**
 Samsung 113, 122
 Sand storms 30
 Sewage 14, 17, 53, 72, 75, 90, 94
 Shark fin campaign 121, 134
 Shijingshan district 15, 26, 52
 Silt 14, 134
 Stakeholders 84, 107, 121
 Standard Ambient Air Quality Standards 26
 Sulphur dioxide (SO₂) 26, 34, 46, 55
 Suppliers 107, 111-115, 121
 Sustainable development 16, 130
- T**
 Taxis 14, 42-44, 52
 Torch relay 19, 105, 132
 Trains 47, 84, 134
 Transport 14-18, 26-30, 41-47, 55, 98, 105, 122, 128
 Travel 104, 114, 129
- U**
 UNEP 29, 42, 47, 66, 82, 90, 97, 105, 114, 121, 126, 129, 131
- V**
 Vehicle Environmental Labeling System 129, 134
 Vehicle registrations 134
 Venues 15-20, 29, 52-55, 60, 64, 66, 76, 90, 93-97, 103, 112, 122
 Veolia 54
- W**
 Waste management 73, 81-84, 90, 96, 114
 Waste treatment 17, 81-84, 104
 Water 13-18, 53-60, 70-76, 90-95, 98, 106, 113, 130
 Water Cube 90, 96
 Water saving 14, 76, 90, 94, 97, 113, 130
 Water supply 70, 72, 77, 98
 Wetlands 17, 60, 64, 66
 World Health Organization (WHO) 26, 27, 37, 122, 128, 131, 133
 Worldwide Partners 111

UNEP promotes
environmentally sound practices
globally and in its own activities.

This publication is printed using 60% sugarcane fibre.
Recycled content is 15% pre-consumer waste
with 25% FSC certified mixed source fibre,
the inks are vegetable based. Our distribution policy
aims to reduce UNEP's carbon footprint.

The Phoenix is the king of birds and symbolizes humankind's constant striving spirit.
It has deep significance in Chinese culture because it represents hope.

www.unep.org

United Nations Environment Programme
P.O. Box 30552 Nairobi 00100, Kenya
tel: +254 20 762 1234
fax: +254 20 762 3927
e-mail: unepubb@unep.org



ISBN: 978-92-807-2888-0
Job Number: DCP/1017/NA