

- Case Study - Green Olympics



Sustainable development goals (SDGs)

Goal 7: Affordable and clean energy

Goal 11: Sustainable cities and communities

Goal 13: Climate action



Green technology

Relevant concept/
issues



Relevant sector

Construction, energy, transportation, green materials, 3D printing, apparel and other industries

Olympics was an important principle for the Beijing 2022 Winter Olympics, which set environmental requirements in terms of venue facilities, technical support and energy use. There were a number of environmentally friendly elements included in the Winter Olympics, such as the green Olympic torch, green buildings, green power, green transportation, etc.

1. Green Olympic torch

At the Beijing 2008 Olympics, the flaming main torch consumed roughly 5,000 cubic meters of natural gas in an hour, and emitted large amounts of carbon dioxide. The Bird's Nest even set up a gas station to supply the main torch with gas throughout the day and night.



Fig. 1. Green Olympic torch.
Image retrieved from http://news.sohu.com/a/522086428_673345

The Beijing 2022 Winter Olympics used hydrogen as fuel for torches. Hydrogen was used to light the main torch, as well as a large number of hydrogen fuel cell vehicles during the event. Hydrogen is considered to be the cleanest and most environmentally friendly fuel given that its combustions only produce energy and water, which is an absolute zero-emission fuel. Hydrogen is categorized according to raw materials used: “gray hydrogen” is made from coal, “blue hydrogen” is made from natural gas, and “green hydrogen” is derived from water electrolysis by using renewable energy. As the name suggests, green hydrogen is the most environmentally friendly.

2. Green Olympic venues

All new venues at the Beijing Winter Olympic Games adopted high-level green design and construction technology and there was a commitment to “energy, land, water, material efficiency to protect the environment” during the construction. All new venues were recognized as three-star green buildings. The original permanent locker rooms in the National Aquatics Center no longer satisfied the needs of the Olympics. Given that building a number of new locker rooms would be costly and take up operational space after the Olympics, the National Aquatics Center assembled used containers for the athletes’ changing rooms at a much lower cost. After the Olympics, those containers could be completely removed from the venues so more operational space could be restored. Following the removal of the containers they were used to fulfill public service functions, such as the spaces for customer service, catering, merchandise.

3. Green power

Green power refers to the electricity produced from a zero-emission or near-zero-emission process. Green power was used in all 26 venues at the Beijing Winter Olympics. It was the first Olympics in history to use 100% green power. Green power was mainly generated by clean energy, including solar, wind and biomass. Currently, the main green powers used in China are solar photovoltaic and wind.

4. Green transportation

The bullet train for the Beijing Winter Olympics consisted of green, low-carbon carriages with lightweight technology, biodegradable materials, graphene air purification devices and gray water reuse systems. In terms of aerodynamics, the front end of the eagle-shaped nose was chosen from over 40 designs; it enabled 7.9% lower wind resistance and 10% more energy-efficiency than previous generations, and saves 1.8 million kilowatt hours of electricity per year.

The bullet train for the Olympics can adapt to temperatures as low as minus 40 degrees celsius. It has integrated advance technologies, including low-temperature sealing technology, anti-icing and anti-snow technology, anti-strike technology, condensate water disposal technology and heat insulation technology. The total weight of the train is about 20 tons less than the previous generation.

The train carriages were made of biodegradable materials that are 75% recyclable and 50% biodegradable. The subway, a branch line of the Olympic bullet train, has smart air-conditioners that are able to adjust the volume of fresh air in real time according to the number of passengers on board. Regenerative braking is prioritized over driving. When it comes to the braking condition, the system will switch from electric motor-operated mode to generator-operated mode, which transmits the electricity back to overhead lines for the purposes of energy conservation.



Fig. 2. The bullet train for the Beijing Winter Olympics.
Image retrieved from http://news.sohu.com/a/522086428_673345

The hydrogen shuttle buses served the core area of Yanqing cluster and are equipped with fuel cell engines called, “Hydrogen Teng.” The engines are 100% made in China including the raw materials and parts. Each hydrogen shuttle bus that runs 100 kilometers can reduce 70 kilograms of carbon dioxide emissions compared to previous buses. This is equivalent to the total amount of carbon dioxide absorbed by 14 trees in a day. These shuttle buses produce zero emission and zero pollution.

5. The Green Olympic village

Yanqing Olympic Village has green and low-carbon buildings that monitor energy-consumed equipment in guest rooms, gyms and public areas in real time. Based on the flow and behavior patterns of people, event information and meteorological parameters, the village has a system that predicts the energy consumption loading of buildings, optimizes the working mode, and responds to energy demands flexibly and efficiently.

6. Green ice making

Beijing Winter Olympics used carbon dioxide refrigerant for ice making. Currently it is the most environmentally friendly refrigerant, given it is less harmful to the ozone layer than traditional refrigerant. It generates a large amount of recyclable and reusable heat waste, and is 30% more efficient than traditional ice-making methods. The refrigeration alone saved about 2 million kilowatt-hours of electricity per year, which is equivalent to reducing emissions by planting 1.2 million trees. The whole refrigeration system has near-zero emission.

7. Green materials

China's self-developed cadmium telluride power glass (CdTe) was fully applied in projects for the National Speed Skating Oval and Zhangjiakou venues at the 2022 Beijing Olympics. CdTe is a new type of green building material that can generate electricity.

8. Green venues and facilities

The 2022 Beijing Winter Olympics utilized the venues and facilities built for the 2008 Beijing Olympics. This included the National Stadium “Bird's Nest” for the opening and closing ceremonies; the National Aquatics Center “Water Cube” was transformed into the “Ice Cube”; The National Indoor Stadium and Wukesong Sports Center that were used as “hockey arena”; a temporary “field hockey rink” in 2008 was transformed into a “speed skating arena”; the 2022 Olympic Village and the main media center were built on the land that reserved for 2008 Olympics In addition, both “Hockey Arena” and “Speed Skating Oval” used photovoltaic panels to build green roofs. These renovations have reduced carbon emissions from the source.

9. Solid waste as the material for the 3D printed snowflakes

The snowflakes that decorated the Olympics themed flower bed were 3D-printed out of solid waste. This was a high-tech product that was developed by the Carbon Asset Company exclusively for the purpose of a zero-carbon event. In order to simulate the uneven granules on the surface of snowflakes, designers = modified and tested the modeling many times. Using solid waste as the material for 3D printing, carbon emissions were effectively reduced. This technology can be applied broadly in the future. It will be helping China achieve carbon peak and move towards carbon neutrality.



Fig. 3. Snowflake decorations in the Olympics
Image retrieved from http://news.sohu.com/a/522086428_673345

10. Outfits for the waste removal teams

The jacket fabric was fabricated from RPET material, which has good waterproof and antifouling properties and good air permeability. The detachable warm inner lining of the cold proof jacket was made from 83% recycled materials. The light, soft, inner lining has as good warmth retention as a good down jacket. Moreover, it only absorbs water equivalent to 1% of its own weight, which means even in wet environments – such as when waste removal crews sweat or work in the rain or snow – the thermal lining retains warmth. The label on the jacket says: “I’m made from 28 bottles”. These delicate design details enabled the waste removal personnel at venues in the front line of the Olympics to be the ambassadors of sustainability, helping more people to become aware of, and be part of, the recycling process.



Fig. 4. Jacket made from RPET materials.
Image retrieved from http://news.sohu.com/a/522086428_673345

11. The “Low Carbon Winter Olympics” WeChat mini-program

The Beijing Winter Olympics Organizing Committee released a mini-app called “Low Carbon Winter Olympics” on WeChat in an effort to encourage the public to actively participate in a low-carbon lifestyle and contribute to the low-carbon Winter Olympics. The mini-app recorded users' low-carbon behaviors in their daily lives. Users could obtain carbon points, and “low-carbon Olympics” honorary medals by uploading information about their low-carbon behaviors (sending relevant screenshots via WeChat) and by participating in Winter Olympics trivia games. They can exchange carbon points for corresponding awards while practicing low-carbon behaviors, such as green travel, garbage classification, or clear-your-plate. The program was in Chinese and English, so users throughout the globe could participate. It encouraged users to record the days of blue sky, and organized a “Low Carbon Campus Competition” to encourage teachers, students and parents to participate in quizzes and improve their awareness of low-carbon actions.



Fig. 5. Low Carbon Winter Olympics.
Image retrieved from <https://www.doc88.com/p-13373981128131.html>

12. Biodegradable tableware

Corn, potatoes, crop straw and other renewable resources were used as the raw materials for tableware for the Beijing Winter Olympics. Through processes of raw material testing, PLA production and processing, and lunch box production, corn and other materials were processed and made into biodegradable disposable lunch boxes.



Fig. 6. Biodegradable tableware.
Image retrieved from https://m.sohu.com/a/516763470_479771

13. 3D Printed carbon fiber speed skates

The full name of “3D Printed Carbon Fiber Speed Skates” was: “Research and Development and Demonstration Application on Individualized Precise Carbon Fiber Composite Material Speed Skates”. This research combined the development of high-performance carbon fiber composite materials, the establishment of a database about speed skaters' foot shape and sole, and the development of 3D scanning and printing system to customize and fast manufacturing of speed skates.



Fig. 7. 3D Printed Carbon Fiber Speed Skates.
Image retrieved from https://m.sohu.com/a/516763470_479771

Reference:

生态中国网. 2022 北京冬奥会如何做到绿色环保 ? [How did the 2022 Beijing become a green Winter Olympics?] www.eco.gov.cn

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冬奥会场馆 : 绿色、科技、智慧、可持续 [Winter Olympics venues: green, technological, smart and sustainable] <https://www.doc88.com/p-13373981128131.html>

2022 北京冬奥会进入倒计时 , 来看看背后有哪些化工新材料技术助力 ! [What do you need to know about the new chemical materials for the upcoming 2022 Beijing Winter Olympic Games?] https://m.sohu.com/a/516763470_479771

Appendix 1:

Green actions by previous Olympic games

Year	City	Green Actions
1984	Los Angeles Olympics	In order to reduce the impact of environmental pollution on the event, the Los Angeles municipal government had taken a series of measures, including scheduling the marathon in the early morning when the pollution was light; using electric vehicles; and arranging vehicles to carry oxygen production equipment to blow oxygen on the road in order to prevent athletes from being deprived of oxygen.
1988	Seoul Olympics	The 1988 Seoul Olympics made a breakthrough in changing energy infrastructures, by controlling coal-fired pollution, improving the water quality of the Han River and temporarily shutting down some industrial companies. Seoul used to be a coal-fired city, but it reduced the amount of direct coal burning by two thirds throughout the preparation and hosting of the Olympics.
1996	Atlanta Olympics	The organizing committee proposed plans on waste disposal, energy consumption and air pollution prevention. The 21-acre Centennial Olympic Park built an energy-efficient and clean-fueled transportation system, as well as an air quality monitoring and forecasting system. The park encouraged the use of public transportation and reduced motor vehicle mobility. During the Olympics, Atlanta saw up to 2 million less vehicles on the roads in a single day. A not-for-profit organization raised \$4.5 million to plant 330,000 trees in the city for the purposes of improving air quality.
2000	Sydney Olympics	This was the first green Summer Olympics that achieved great outcomes in venue selection, wildlife protection, use of clean energy and eco-friendly building materials, as well as solid waste classification and recycling. The picturesque Sydney Olympic Park at Homebush Bay was built on a disused landfill. The Sydney Olympic Village could accommodate 15,000 residents, which was the largest solar-powered community in the world. The design of stadiums factored in artificial energy and mostly used natural lighting. Rainwater was collected through canopies into four large tanks for watering the field. Recycled water was used to flush toilets. Furthermore, various water-saving devices were installed across the venues.
2004	Athens Olympics	When preparing for the Olympics, based on the principles of respecting the natural landscape and using natural resources to good effect, the Athens Olympics Organizing Committee carried out landscaping planning at event venues, non-event venues and across greater Athens. These measures resulted in good natural ventilation, interpenetration between parks and urban green spaces, as well as natural airflow circulation. The Committee also planted 290,000 trees in Athens and around the Olympic venues in 2003 alone. It conserved water resources by adopting advanced technologies for wastewater recycling and irrigation. In order to reduce and prevent waste, the Committee implemented an integrated sustainable waste management program that maximized the use of recycled items. In order to ease pressure on the power supply system, the Committee promoted clean energy, such as solar power. The public transportation system in Athens, especially the new light rail and suburban railroads, used trams to increase transportation capacity without increasing environmental pollution.