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*Always Moving Forward: Small Steps Towards a Better Future*



# Always Moving Forward

Small Steps Towards a Greener Future

Mark Messer  
University of Calgary

# National Speed Skating Oval Beijing, China

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# Venue for 2022 Speed Skating Winter Olympics

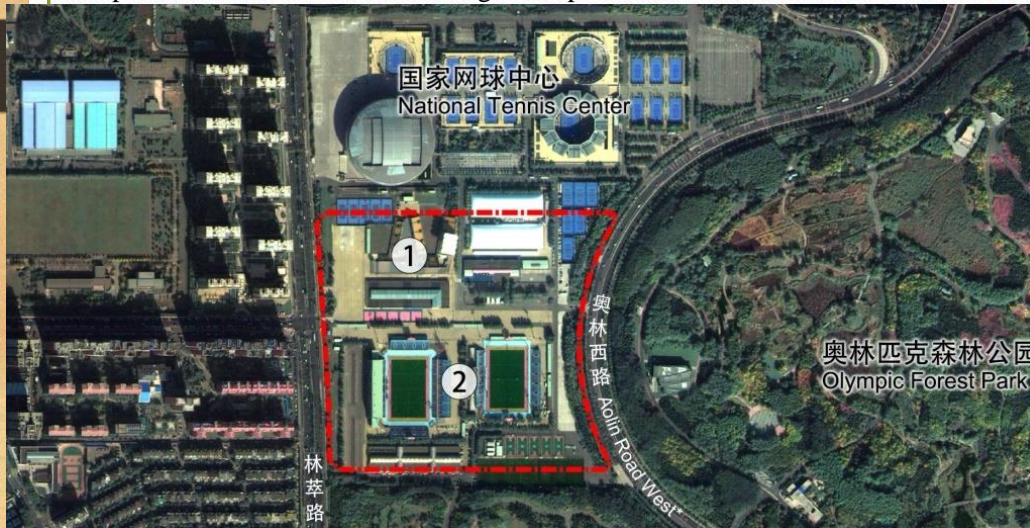
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- Opened October 8, 2021
- Games held February 5-19, 2022
- 13 Olympic Records
- 1 World Record
- Capability of covering the entire event floor with ice
- Normal operation is year-round ice on 400m oval, and 2 international rinks
- 12,000 seats but none were used for the Games



# Sustainable Venue

The National Speed Skating Oval is located on the site of the venue for Hockey and Archery during the 2008 Beijing Olympic Games, preserving the original greenery and green belts on the east and west sides of the venue, using the original ecological environment to maintain the original living environment and ensuring the original characteristics of animals and plants. The NSSO in Beijing fully implemented the principle of ecological priority at the early stage of site selection and design to ensure that the biodiversity and ecosystem functions in the area were not affected. It aimed to reduce the adverse impact on the ecological environment of the area during construction and to make full use of the functional space of existing resources. At the same time, the environmental impact assessment was carried out in strict accordance with the requirements of environmental protection. The application and implementation of energy-saving technologies and environmental protection measures were fully implemented to minimize the ecological impact.



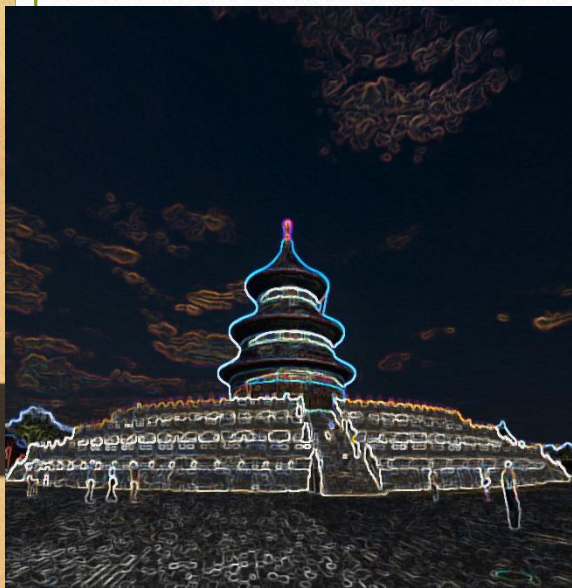
Hockey and Archery during the 2008 Beijing Olympic Games



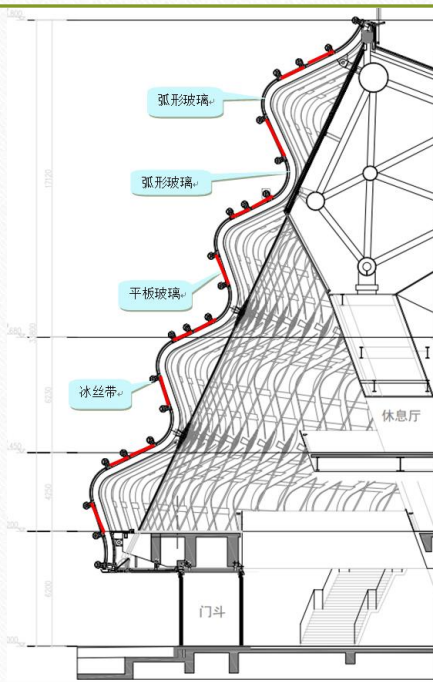
National Speed Skating Oval



# Energy saving and use



Curtain wall concept: ice pile, Temple of Heaven



Curtain wall design



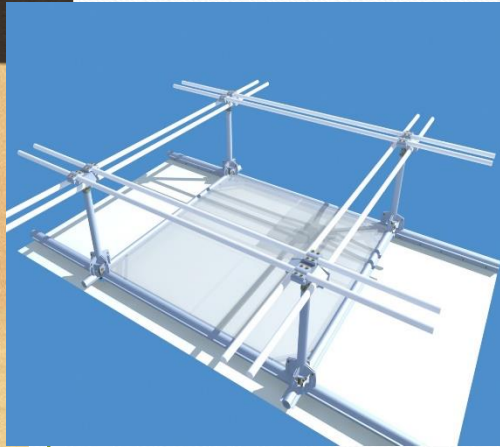
Curtain wall

The curtain wall system of the venue is curved in the shape of the Temple of Heaven, and the double super white and silver low-e semi-tempered laminated insulating glass with a heat transfer coefficient level 6.

# Energy saving and use

## Architecture and Structure

High reflection low radiation and low transmission Low-e membrane ceiling is used to reduce the radiation heat exchange between the ceiling and the ice surface, and the emissivity of the membrane is about 0.3.



installation diagram



Reduce building ice making load  
**40%**



# Energy saving and use

## Heating, ventilation and air conditioning systems

- The air-conditioning system adopts high-efficiency centrifugal inverter chillers, which is 15% and 52.7% higher than the requirements of the Energy Conservation Design Standards for Public Buildings, respectively.
- Reasonable use of frequency conversion technology, air conditioning water system load side are variable flow operation, air conditioning hot and cold water system is lower than the energy-saving standard specification limit of 20%.

GREE				离心式冷水机组			
产品型号	CYBS20P1BK1B	名义工况	用户工况				
制冷剂/充注量	R134a/900 kg	制冷量	2813	2813	kW		
额定电压	380V 3~	额定功率	414.3	476.9	kW		
额定频率	50 Hz	性能系数	6.79	5.90			
净重	9390 kg	IPLV	9.44				
外形尺寸(宽×深×高)		冷冻水进/出水温度	-7	-5	℃		
	455×201×230 cm	冷却水进/出水温度	30/-	32/-	℃		
生产日期	2020年06月	蒸发器额定水量	484	303	m³/h		
出厂编号	0681254000002	冷凝器额定水量	605	567	m³/h		
珠海格力电器股份有限公司							
生产许可证编号: XK06-015-00223							





# Energy saving and use

## Ice-making and heat recovery

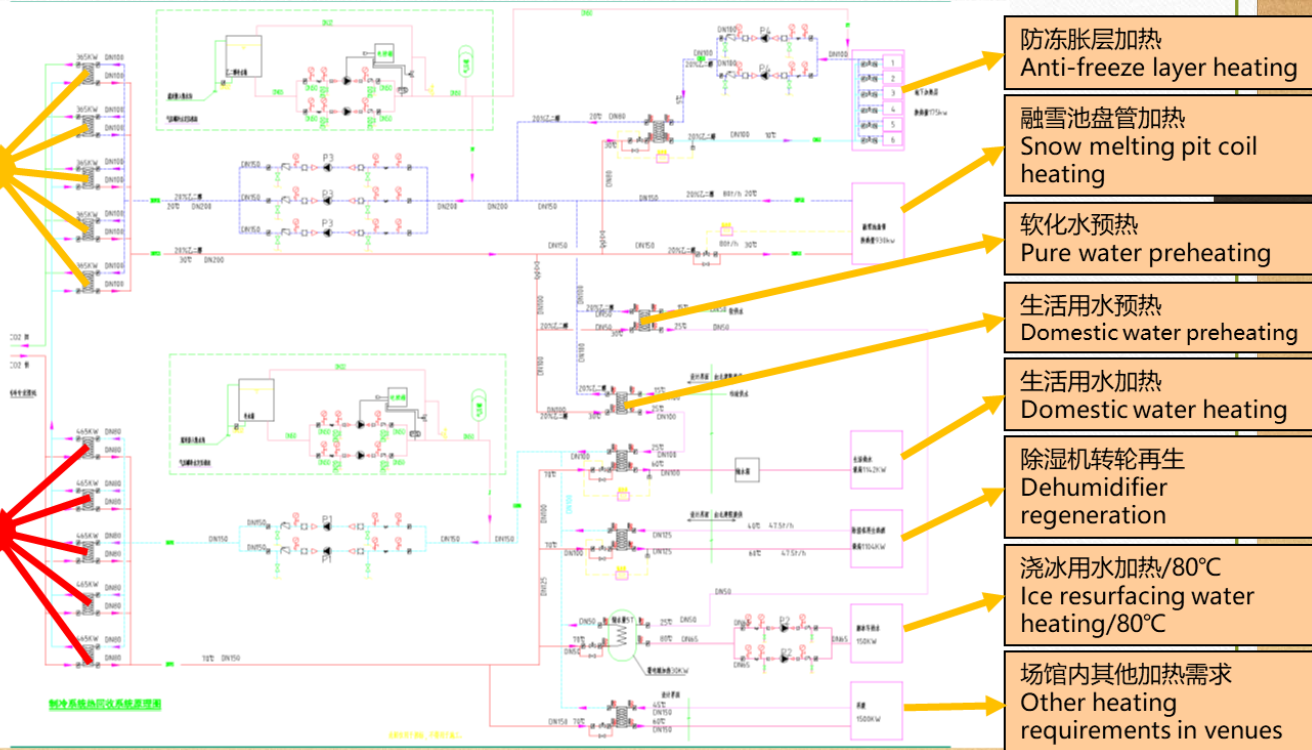
The carbon dioxide transcritical direct cooling ice system applies the integrated design concept of combined cooling and heating, which reduces the waste heat discharged to the environment by recycling the heat, effectively protects the environment around the building and saves the operation cost.

Condensation heat recovery system

中温级热回收器  
Medium temperature heat recovery

高温级热回收器  
High temperature heat recovery

2 million kilowatts of electricity  
Annual electricity savings



# Energy saving and use

## Integrated Energy Use

Efficient use of solar energy, air energy and other clean energy

Solar PV  
**300kW**

Power generation capacity

Solar PV  
**1.5%**

Percentage of electricity provided by renewable energy



**Solar PV**

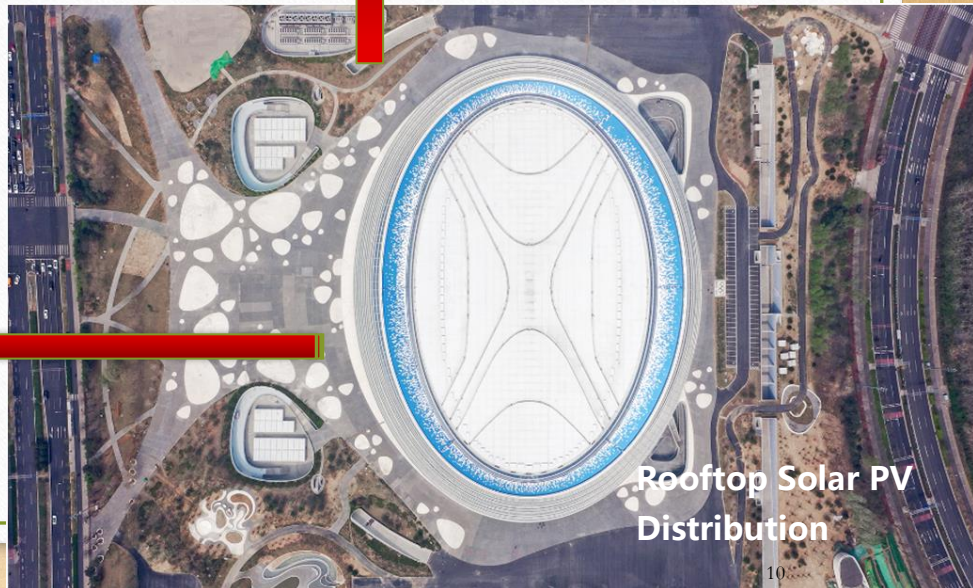
Cooling/heat supply

**500~600kW**

Reduce carbon emissions

**160 tons**

**Air source heat pumps**



**Rooftop Solar PV  
Distribution**



# Environmental

## Ecological porous fiber cotton

Under the principle of "ecological priority, runoff control and sustainable development", the venue combines the construction concept of "sponge city" and sets up efficient rainwater collection modules in the greenery on the west and east sides, choosing ecological porous fiber wool, which integrates purification-buffering-infiltration-emission functions.

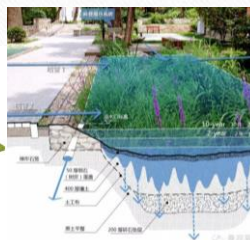
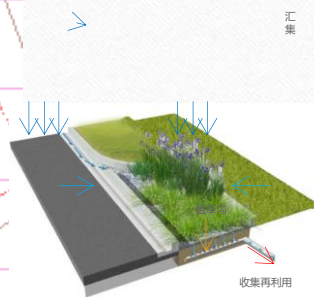
One-time rainwater storage volume

**350m<sup>3</sup>**

Landscape

**85%**

Total annual runoff control rate



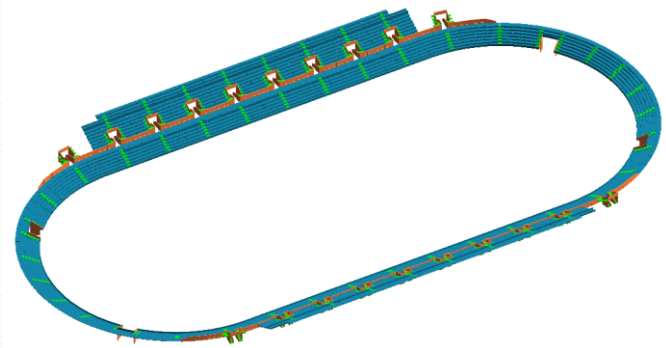
# Material saving and utilization

## Construction waste utilization



Construction site

The recycled aggregate concrete produced by using construction waste is used for part of the precast bleacher slabs, which realizes the self-enclosed regenerative use of aggregate.



clean



Screening



produce





# Material saving and utilization

## Construction waste utilization



The waste pile head is utilized and is used in 2 ways.

- 1) for piled concrete aggregate, used for backfilling in ramp footings.
- 2) Used for backfilling in the location of temporary housing.





# Material saving and utilization

## Large span double curved saddle steel truss roofing cable net

The main steel structure of the National Speed Skating Oval is a saddle-shaped ring beam cable network system with diagonal tension on the outside, and the span of its cable network reaches  $198\text{m} \times 124\text{m}$ , using only 1/4 of the amount of steel used in traditional steel structures.





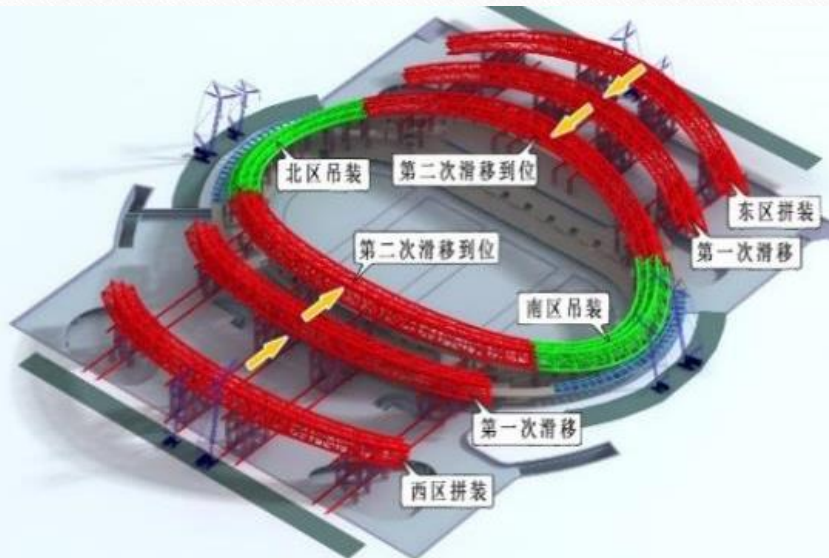
# Material saving and utilization

## Large span double curved saddle steel truss roofing cable net

The adoption of high- and low-level variable rail secondary sliding installation technology saved 2,800 tons of sliding tire frame and achieved the economical use of material resources through the turnover of materials.



Domestic high vanadium closed ropes for construction



# Eco-friendly ice making method

ODP  
0

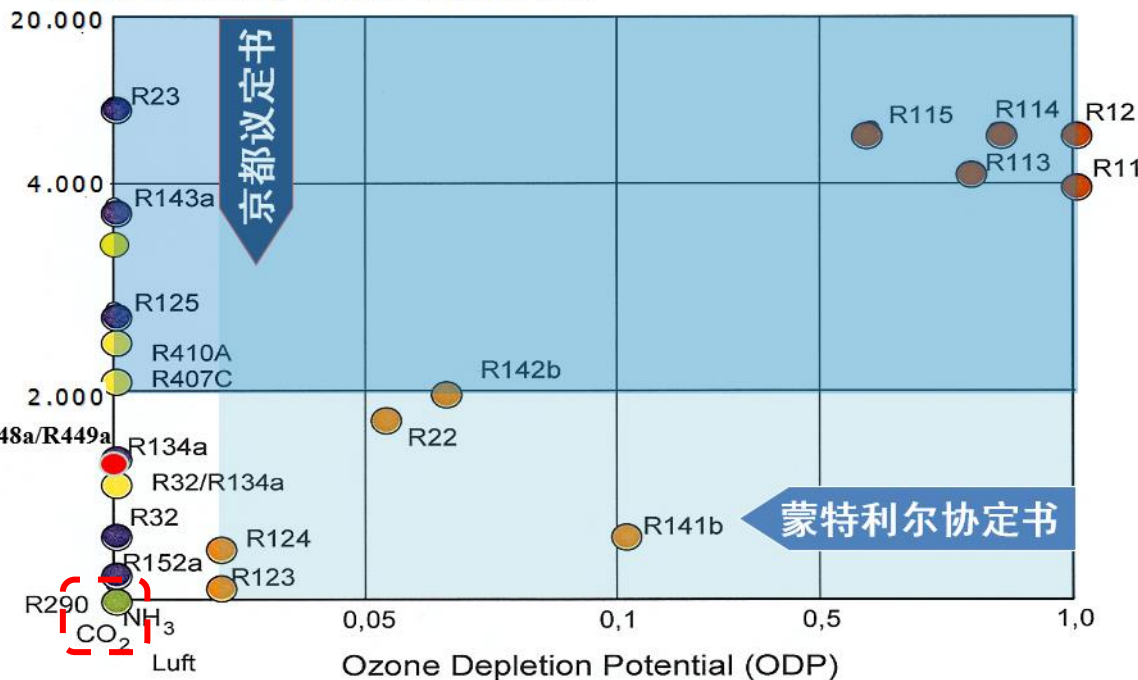
Ozone depletion  
potential

GWP  
1

Greenhouse effect  
potential

For the first time in the international arena, the CO<sub>2</sub> transcritical direct-cooling ice system was used in the Winter Olympic speed skating venue, replacing the traditional Freon refrigerant, reducing the damage to the ozone layer and the greenhouse effect, and embodying the concept of "Green Olympics". Carbon emission reduction of 25,000 tons of CO<sub>2</sub> reduces the annual CO<sub>2</sub> emissions of nearly 3,900 cars, or the carbon reduction achieved by planting more than 1.2 million trees. Also provides precise temperature control and rapid recovery for Olympic quality ice conditions.

Global Warming Potential (GWP)<sub>100a</sub>



Reduce carbon  
emissions

**2500 tons CO<sub>2</sub>**

Reduce cars

**3900**

Annual carbon dioxide emissions

Plant

1.2 million trees

Reduce carbon emissions



# Small steps towards a greener future

