

**ALLEN WEI**

**CHINA**

**CHIEF ENGINEER AT AIRHOUSE**

*Assembly and Benefits from Direct Expansion Ice-Making  
System*



**Assembly Direct Ice-Making**

# **Airhouse Direct Expansion System Introduction**

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The background is a dark space scene with a grid pattern. A large, curved horizon of the Earth is visible at the bottom. In the center, there is a glowing blue dotted world map. The text "About us" is overlaid on the map.

# About us



# Developing Winter Sports from the North to the South of China

Temperate monsoon climate

Subtropical monsoon climate





# Airhouse introduction

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## Problems Identified

High energy consumption, **10000 kWh** of electricity per day

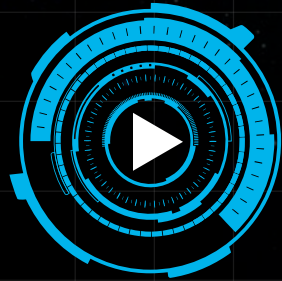
**Complicated** operation and maintenance

**Uneven** ice temperature = poor ice quality

Prohibit the use of **ammonia** refrigerant

## Problems Solved

**Direct expansion ice-making system**

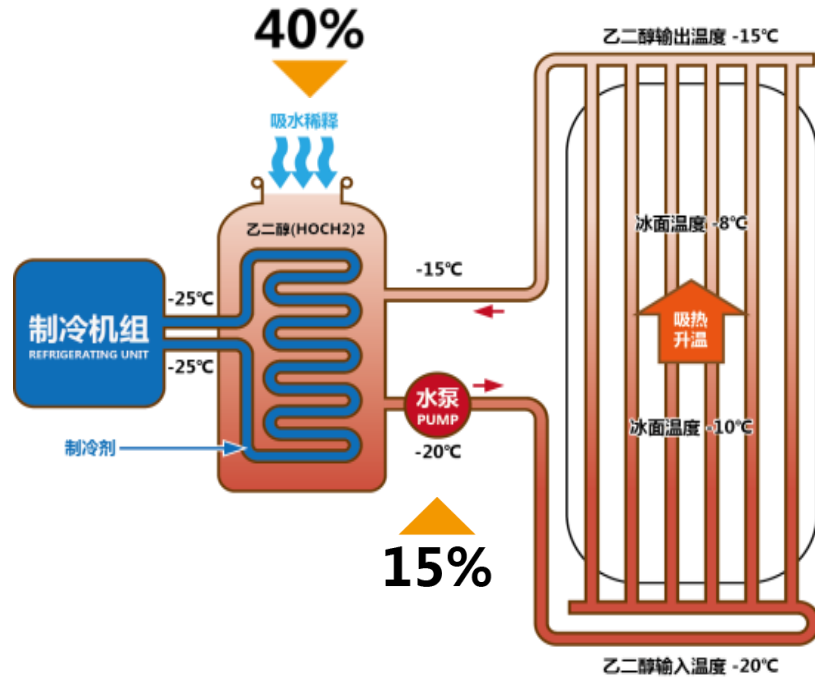


# Indirect expansion VS Direct expansion



Indirect expansion

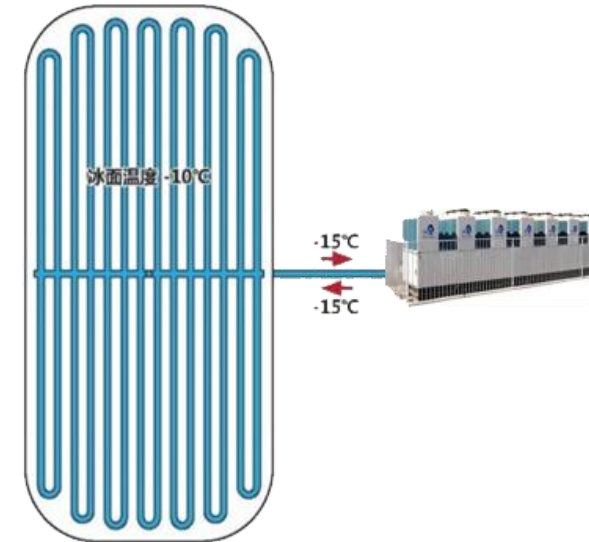
Poor Ice Quality  
, Huge Energy Consumption



The cold energy generated by the refrigeration compressor is firstly conveyed to the exchange tank, the ethylene glycol in the tank is cooled by cold exchange, and then the low-temperature ethylene glycol is conveyed to the pipeline of the site by a high-power water pump to realize ice-making. The secondary refrigerant is an anti-freezing aqueous, 40% of the cold energy is lost during the exchange process, and 15% of the cold energy is lost through the water pump. So 55% of the cold energy is lost by indirect expansion.

Direct expansion

Great Ice Quality  
, Low Energy Consumption



The refrigeration compressor directly delivers the refrigerant to the pipeline of the site, and the refrigerant absorbs heat and evaporates in the pipeline to realize ice-making, which completely gets rid of the large energy loss caused by indirect exchange. And make sure that the ice temperature is consistent at any point of the ice rink. Because the direct-cooled ice-making system realizes the physical characteristics of one pressure = one temperature in a closed pipeline.





**Annual power  
consumption**

0 0 0 0 0 0 0 0 KWh







**Annual power  
consumption**

**0 4 3 4 5 0 0 kWh**





**To encourage 300 million people  
in winter sports!**

**Announced by Xi Jinping**

**1000 Olympic size ice rink!**

**《2022 Ice and Snow Development Plan》**

**1000 Non-standard size ice rink!**

**《Hundreds of Cities with Thousands of Ice》**





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# ASHRAE member

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Airhouse has been a resident member of ASHRAE since 2015, and has given a speech on direct expansion system at TC10.3 meeting, which has been widely praised. The professional team of Airhouse includes refrigeration engineers studying in the United States and mechanical engineers studying in Germany, who constantly pay attention to the global refrigeration trends and constantly develop new technologies in line with the development of times.



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# Airhouse introduction

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## Bird's Nest Torch Workshop



## Winter Olympics Training Base



## Winter Olympics Torch Starting Point



## Beijing 2008 Olympics

Airhouse design & construct the main torch secrecy workshop at the top of the Bird's Nest has preserved the last secret of the Olympics.

## Beijing 2022 Winter Olympics

Airhouse design & construct six direct expansion ice rinks as the Winter Olympics headquarters to provide training support for Winter Olympics athletes and ultimately achieving excellent results.

## Established in 1993

Airhouse holds 3 invention patents and 9 utility model patents for ice rinks, and has developed relevant standards for direct expansion ice rinks with the request of the Chinese government.





# Skating Rink Cases

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Direct expansion system only





# Airhouse Ice Rink PART 01

**Assembly + Direct expansion =  
Free ice making**



# Making ice Outdoor Summer



**Realize true  
full seasonality of ice sports**



# Making ice Outdoor Summer



Outdoor temperature: **32°C**

Outdoor humidity: **55%**

Daily Electricity cost: **302 KWh**

中国唯一CO2跨临界直冷制冰系统案例

2019.10.02  
北京冬奥组委

坐标：中国北京石景山

北京



# Characteristics of ice plate

## Flexible ice making area

The area of the ice rink can be combined at will, from the curling track to the speed skating oval.

## Bear high pressure

The pressure in the aluminum alloy tube plate is 12 Mpa, and the carbon dioxide refrigerant is used safely.

## Sufficient load

Load: 600kg/m<sup>2</sup>  
Plate thickness: 150mm  
(including insulation layer and refrigeration pipe)



## Good quality ice

The speed of ice making determines the whiteness of the ice surface. Quick-freezing provides a natural and beautiful milky white.

## Rapid ice-making

When the ambient temperature of the assembled aviation aluminum ice plate is 32 degrees, the ice thickness can reach 12 cm after 14 hours of operation.

## High thermal conductivity

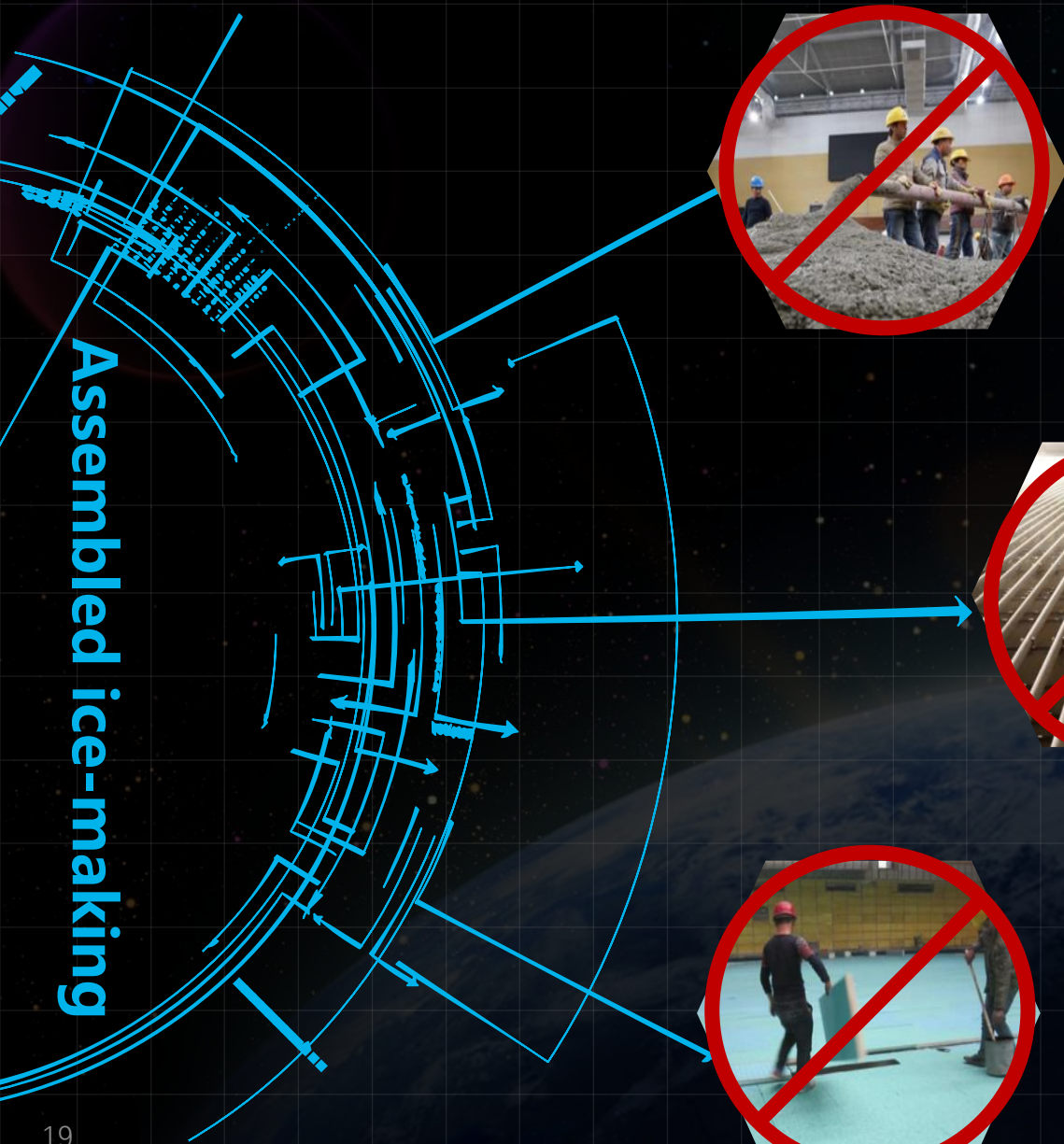
Thermal conductivity: 160w/m. K, 92 times of concrete 1.74w/m. K.





# Replace the traditional civil engineering

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Assembled ice-making

## No concrete construction

The Olympic standard skating rink is laid with an ice-making board with a length of 6 meters, a width of 800 mm and a height of 150 mm, which replaces the concrete technology and greatly reduces the depth of the required foundation trench.

## No piping construction

By adopting the assembly technology, the ice-making plate contains a pipeline and is convenient to connect, It only takes 14 days to assemble an Olympic standard ice rink.

## No Insulation construction

The assembly type ice making plate is provided with foamed polyurethane, and the direct cooling type ice making technology does not need frost-preventing layer, the temperature under the plate is above 0 °C.



# Airhouse Ice Rink PART 02

**Provide high-quality ice surfaces  
with ultimate energy efficiency**



# Ultimate Energy Efficiency

## The First year (2020.4-2021.4)

电能(KWh)	458500.0
Electricity Cost (KWh)	
日期	2021-04-12
Date	
运行时间	8776h
Operating Time	

## The Third year (2020.4-2023.4)

电能 (KWh)	1412266.7
Electricity Cost (KWh)	
日期	2023-04-12
Date	
运行时间	26280h
Operating Time	



Ice Rink of Beijing Capital University of Physical Education and Sports has been operating continuously for four years, with an annual energy consumption of less than 500,000 kWh and an average annual energy consumption of 470,000 kWh.



# Data Comparison

Comparison of common ice-making units (Olympic standard ice rink)

Ice-making unit	R507,R404a/glycol indirect expansion	R507,R404a/R744 indirect expansion	R744 direct expansion	R134a direct expansion
Annual power consumption	3.5 million KWh	2.6 million KWh	500,000 KWh	500,000 KWh
Total power installed	800-1200KW	600-800KW	350KW	250KW
Cooling capacity	800-1400KW	800-1000KW	550KW	520KW
Refrigerant	R507,R404a	R507,R404a	R744	R134a
Secondary refrigerant	glycol	R744	none	none
Ice-making time	more than 96 hours	48-72 hours	20 hours	20 hours
Foundation trench	600mm	600mm	150-500mm	150-500mm
Ice quality	The ice surface is both soft and hard, and the temperature difference of the ice surface is more than 2 °C	High ice temperature in summer, even ice surface temperature	even ice surface temperature	even ice surface temperature
Machine room size	150-200m²	150-200m²	40m²/no indoor machine room required	40m²/no indoor machine room required
Pipe structure	polyethylene pipe	steel pipe/stainless steel pipe	stainless steel pipe/Aluminum alloy ice plate	steel pipe/Aluminum alloy ice plate



# True transcritical system

## No need of the maintaining machine

Airhouse carbon dioxide supercritical system bears 12mpa of pressure for the whole system, which meets the high pressure operation of carbon dioxide, and does not need to add additional energy consumption after shutdown. To ensure the safety of ice rink operation and the time after shutdown.

## R744 Supercritical System

## No need for frost-preventing protection

Airhouse ice-making plate is made of alloy aluminum material with high thermal conductivity. The evaporation temperature of the plate surface is close to the ice surface temperature, and the insulation layer is thickened to avoid the bottom plate of the ice rink being frozen. The ice rink does not need to add an additional frost-preventing layer.



# Build an high-quality ice rink



- The ice temperature is the same in the whole field, and the athletes' good results is a high-quality ice rink.
- Energy saving and environmental protection, saving money for the operators is a high-quality ice rink.
- The construction & maintenance is simple, and sustainable development is a high-quality ice rink.

Only direct expansion ice-making technology can achieve high-quality ice rinks. Refrigerant is directly transported to the site to make ice. One pressure = one temperature. Athletes and ice makers do not need to worry about the quality of ice.

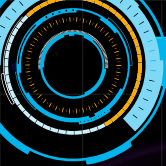




# Airhouse Ice Rink PART 03

## Supporting the Green Deals





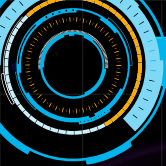
# Green & efficient Start by saving energy

Airhouse—one skating rink that consumes no more than 500,000 kilowatt-hours of electricity per year

## Comparison of traditional ice-making technology with Airhouse direct expansion

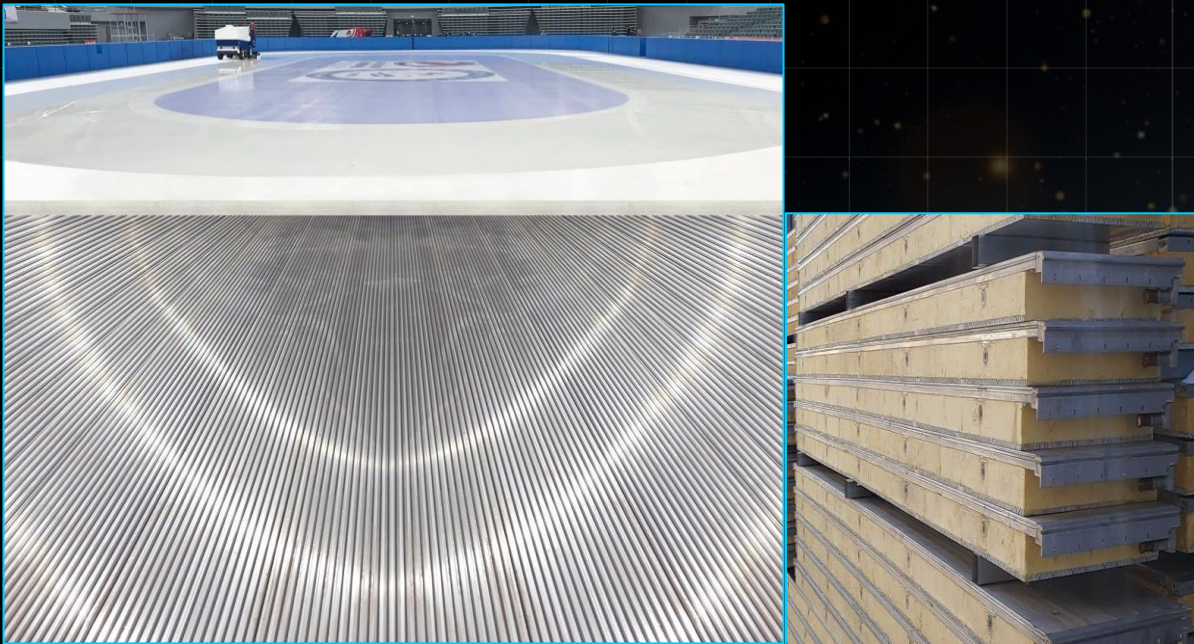






# Continuous & flexible End by assembly

Airhouse-Everything can be assembled



## The meaning of assembly

The permanent Olympic standard skating rink at least constructed in a three-month period can be paved in only 14 days by assembly, and can be disassembled and combined into a new rink in other areas where demand for the rink. The complex design and cumbersome construction of the ice rink will be manufactured in the factory by Airhouse assembly technology, and the construction site of the assembly ice rink can become simple, unified and standardized.





# Current situation of the skating rink

Heat is rejected to the atmosphere through condenser



Typical ice-making machine room



Past Olympic ice-making machine room

The ice-making unit releases a large amount of heat energy while producing cold energy, but the heat energy is not fully utilized. The ice-making unit of the skating rink faces two major problems:

1. Heat demand is huge during winter, the ice-making unit of the ice rink is affected by the low temperature condensation environment and operates at a small load, which can not guarantee a stable heat source throughout the year.
2. The R507/ethylene glycol system is usually used for the ice rink. The system has low condensation temperature and the recovered heat is very little. It can only be used in the ice rink to prevent freezing the ground or melt the snow pool for the resurfacer.



# Combined cooling and heating

## Unique advantages of Airhouse patented technology integrated ice-making machine:

### Ecological protection

Using natural working substance carbon dioxide as refrigerant

### Safety and reliable

The direct cooling ice making machine system has the longest running time in the world, and the unit has been running for 7 years with zero maintenance so far.

### Space saving

Smallest ice making unit in the ice rink industry

Heat energy



Cold energy

### Economy

Using the high efficiency of carbon dioxide total heat recovery, the annual power consumption of ice rink + swimming pool does not exceed 500000 degrees (KW · H) without adding any additional equipment.

### Easy to use

Provide owners with electric refrigerator service, with the simplest user interface and the highest level of automation remote control system in the skating rink industry

### No machine room

No need to be equipped with indoor machine room

### Scalable

Multiple ice making units may be combined together for a larger ice making area



# Combined cooling and heating

## Ice rink refrigeration

The cold energy generated by Airhouse integrated unit provide  $-2^{\circ}\text{C} \sim -9^{\circ}\text{C}$  ice temperature, reach different demand of Olympic standard ice rink (60m  $\times$  30m)



Cooling Capacity

Continuous supply heat and cool



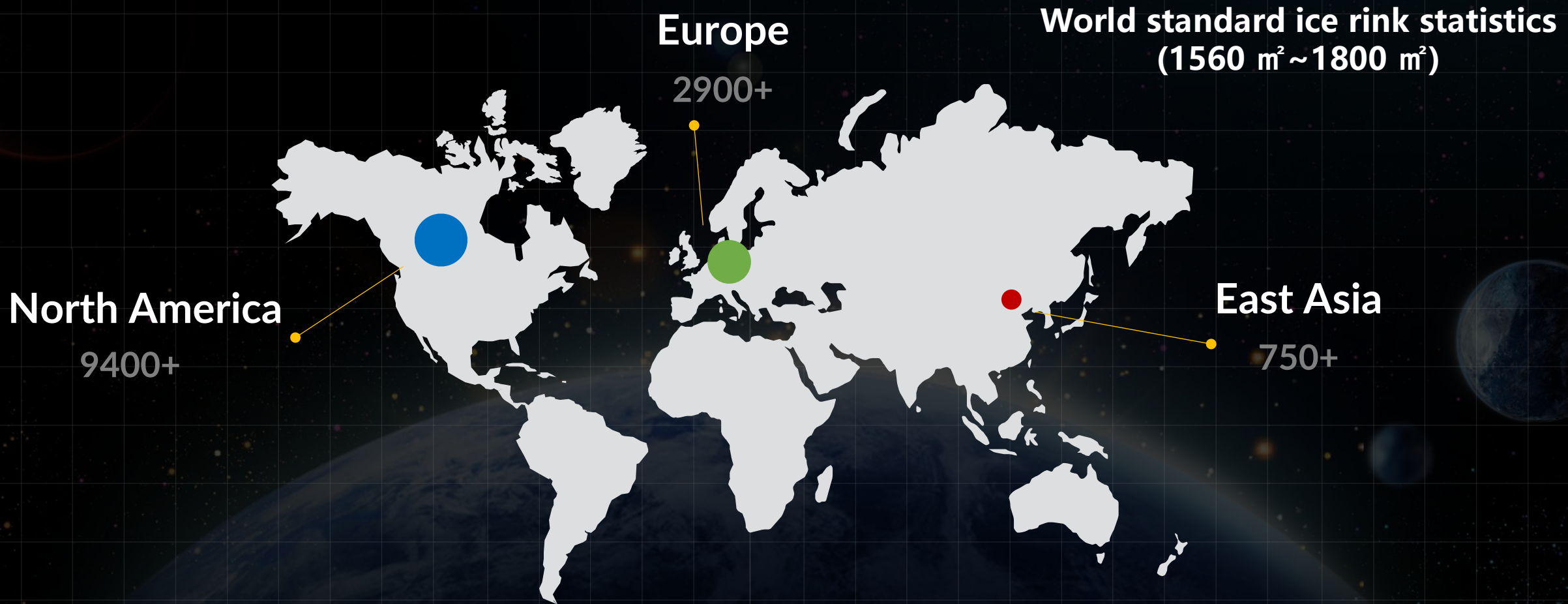
Heating Capacity

## Swimming pool heating

Airhouse integrated unit produces cold energy and recovers waste heat, and provide  $26^{\circ}\text{C} \sim 28^{\circ}\text{C}$  constant temperature hot water for international standard swimming pool (50m  $\times$  25m  $\times$  2m)



# Market Conversion



**Facing the huge market of nearly 20,000 ice rinks worldwide,  
We hope to achieve deep strategic cooperation with everyone present here.**



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# Double Win Cooperation Share the Future Together



Website: [www.airhouse.net.cn](http://www.airhouse.net.cn)  
Email: [allenwrap@163.com](mailto:allenwrap@163.com)



Tele: +008613501054600