



Kawasaki centrifugal chiller using water as a refrigerant

MIZTURBO™

Sep 26th 2017

Kawasaki Heavy Industries, Ltd.

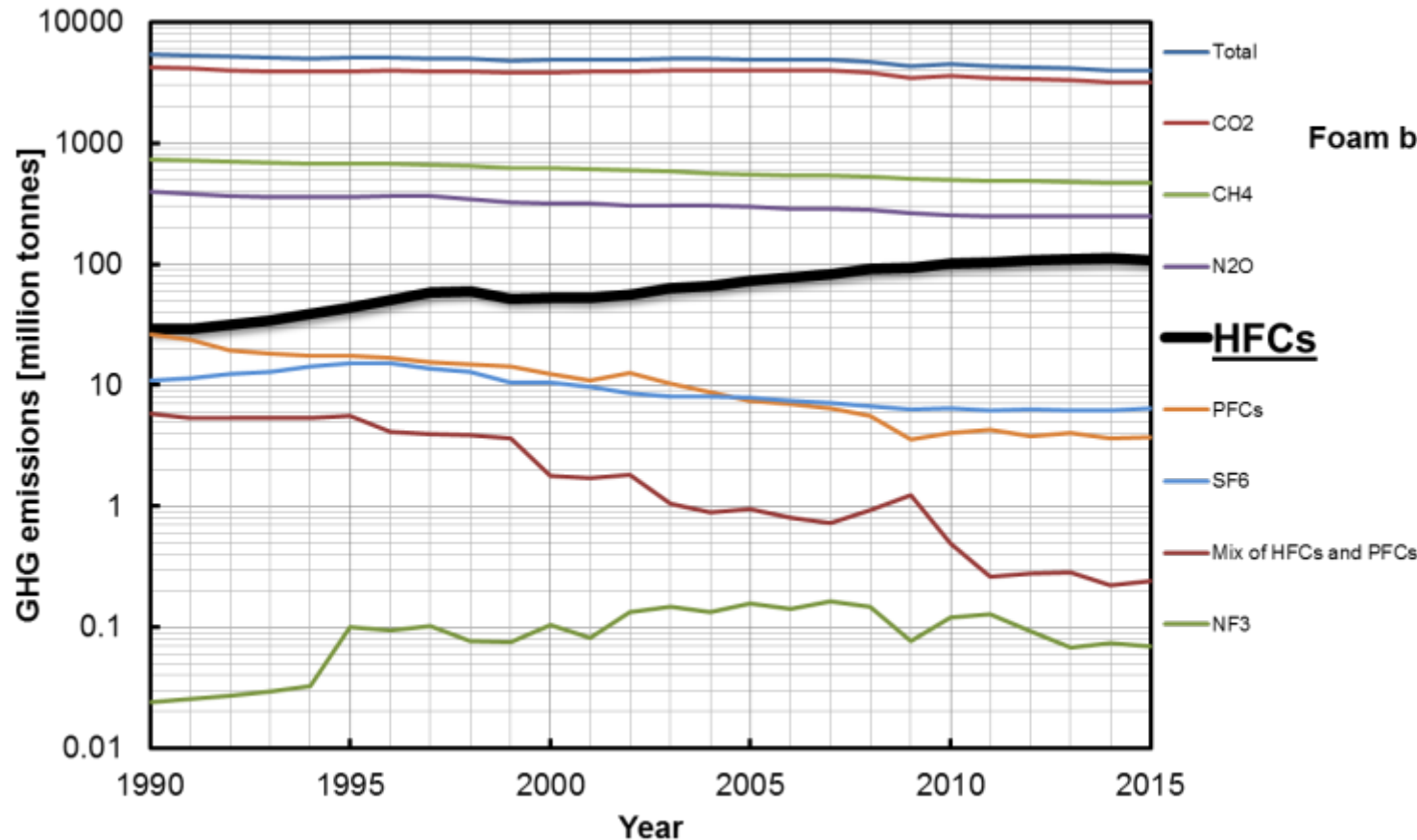
Machinery Division

Hayato Sakamoto

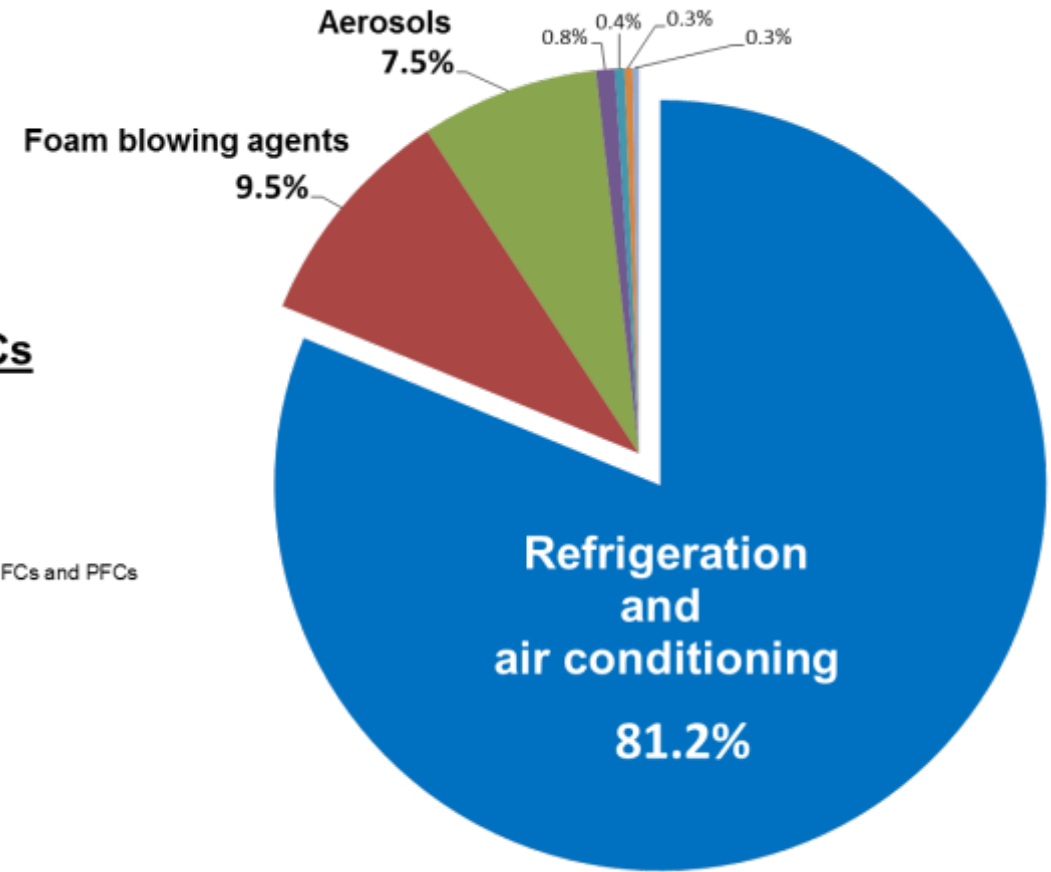
1. Introduction of MiZTURBO

2. Study of CO₂ emissions in Europe

GHG emissions in Europe



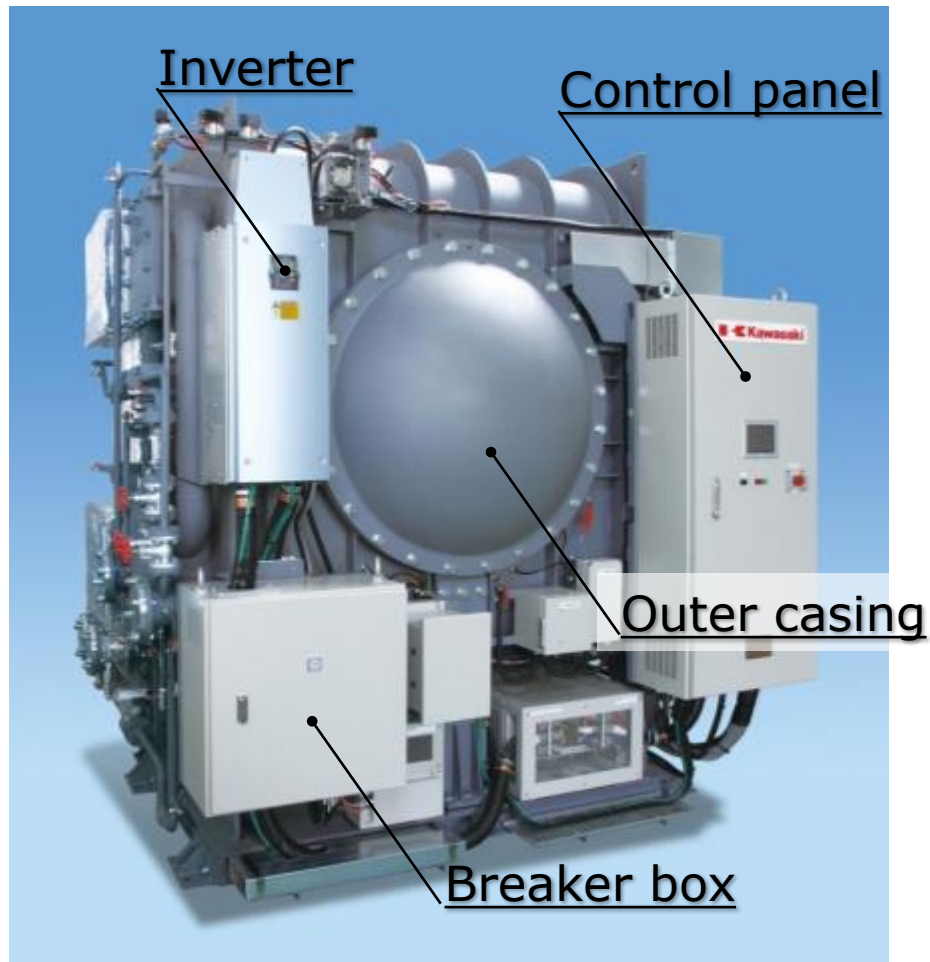
GHG emissions 1990 to 2015 in CO2 equivalents (Mt)



Share of source categories in 2015

- **HFCs emission reduction in refrigeration and air conditioning**
- **MIZTURBO™ is a solution to reduce HFCs emissions**

MiZTURBO™



Cooling capacity		100USRt (352kW)
Power consumption		69kW
Refrigerant		R718(water)
Chilled Water temperature	Inlet	12degC
	Outlet	7degC
Cooling Water temperature	Inlet	30degC
	Outlet	35degC
Motor drive		Inverter
Power supply		3Φ, 400/440V (50/60Hz)
Size		2.5m x 2.5m x 2.6m
Weight		8.0 ton
Intended application		Air conditioning

* MiZTURBO can supply the chilled water at higher temperature up to 20degC, and be applied to other applications such as process cooling

Compressor, Motor, Evaporator and Condenser are in the outer casing.

Features

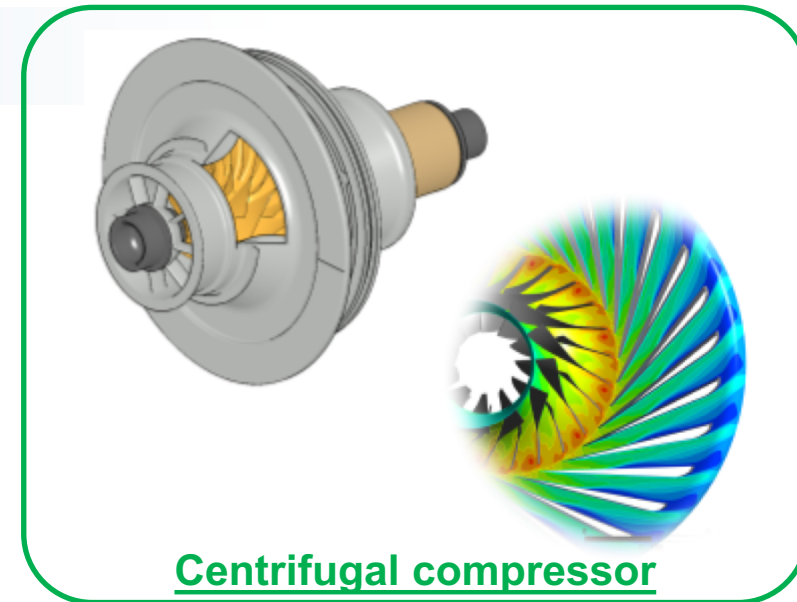
Water refrigerant

→ **Zero emission of HFC**

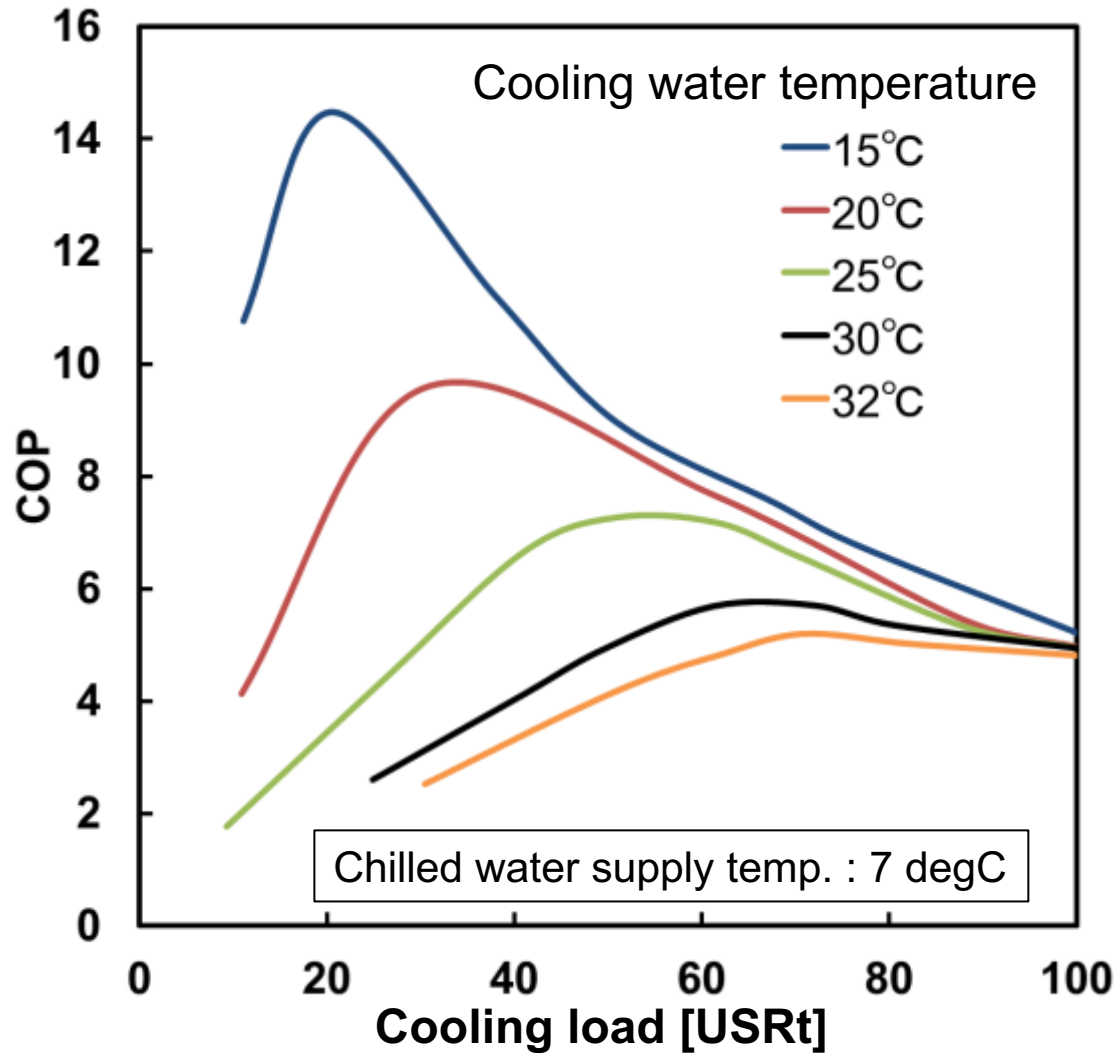
High efficient performance

- Development of the high efficient compressor under low pressure and high pressure ratio

→ **Low power consumption**



Performance - 7degC supply -



■ COP(capacity[kW]/input power[kW])

- **5.10** at 100%
- Higher at a partial load

■ Operatinal range

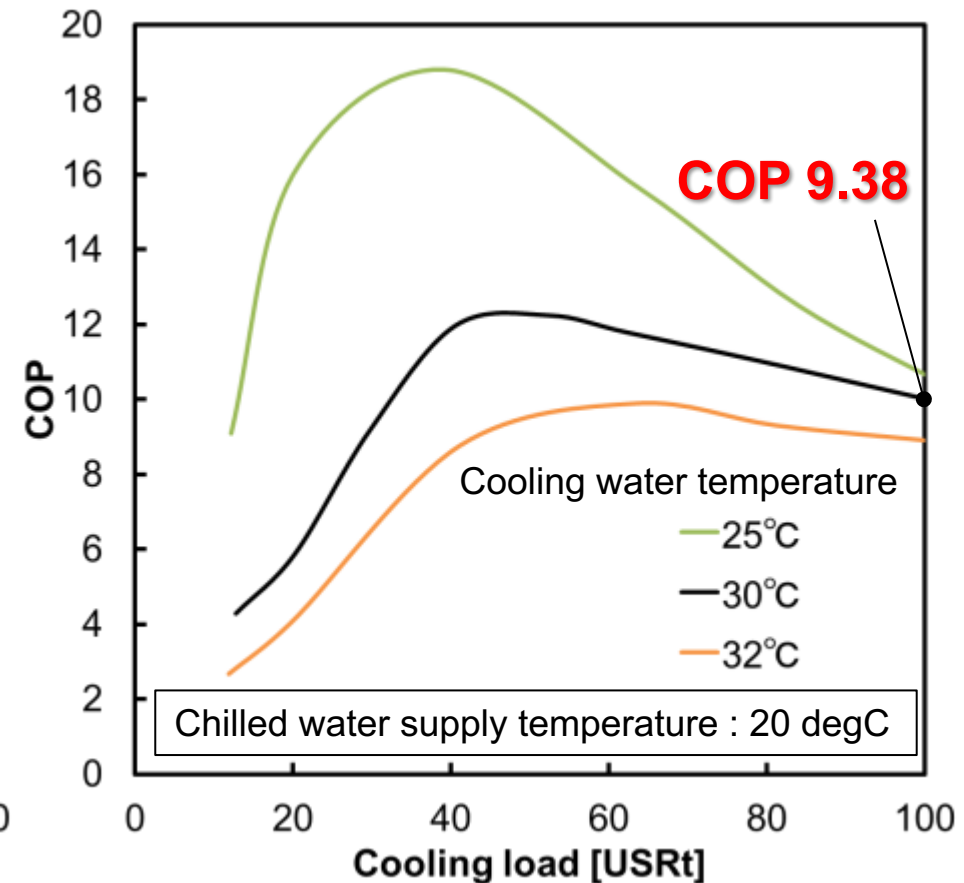
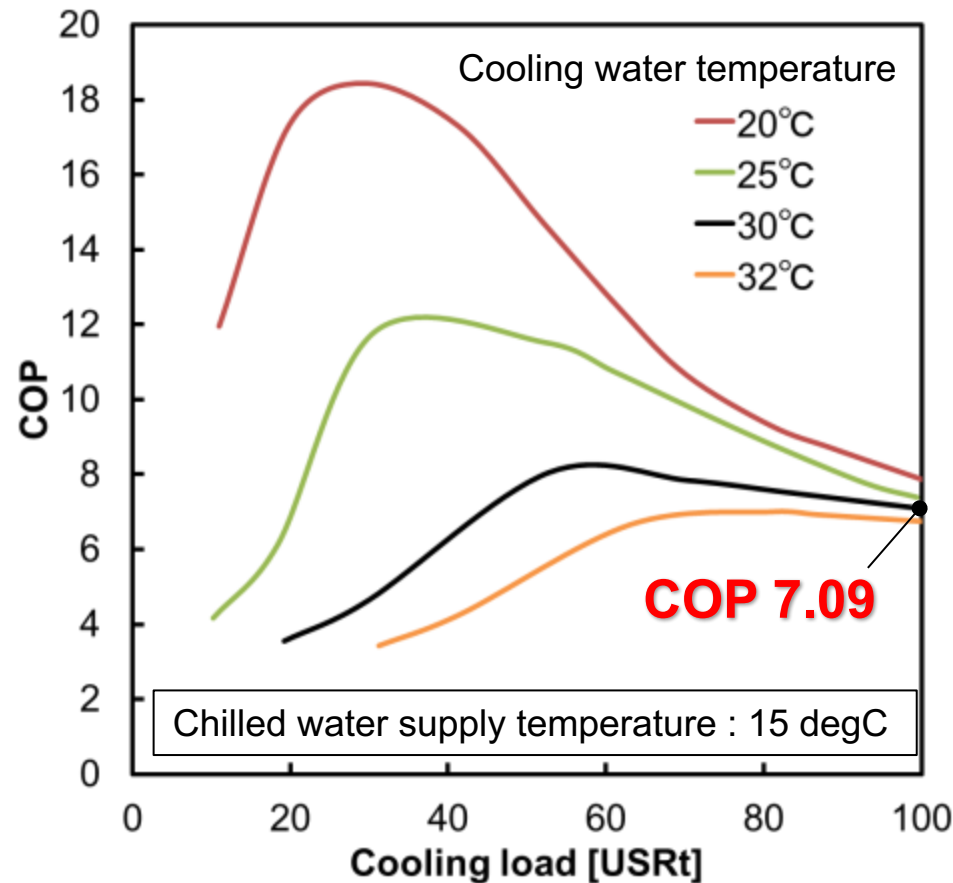
- 10%~100% at less than 25degC of cooling water temperature

■ IPLV(Integrated Part Load Value)

- **8.0** (AHRI 551/591)
- **7.4** (JIS B 8621)

Comparable performance to the other centrifugal chillers

Performance - 15degC & 20degC supply -



- **MiZTURBO shows higher COP for 15-20 degC supply.**
Possible application : Air conditioning for data center
Air conditioning system combined with desiccant
Process cooling etc.

Features

Water refrigerant

➔ **Zero emission of HFC**

High efficient performance

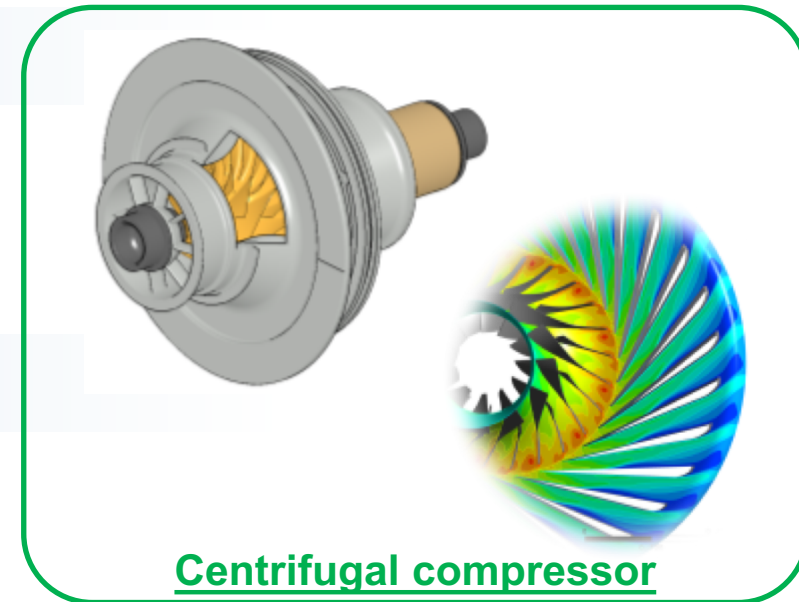
- Development of the high efficient compressor under low pressure and high pressure ratio

➔ **Low power consumption**

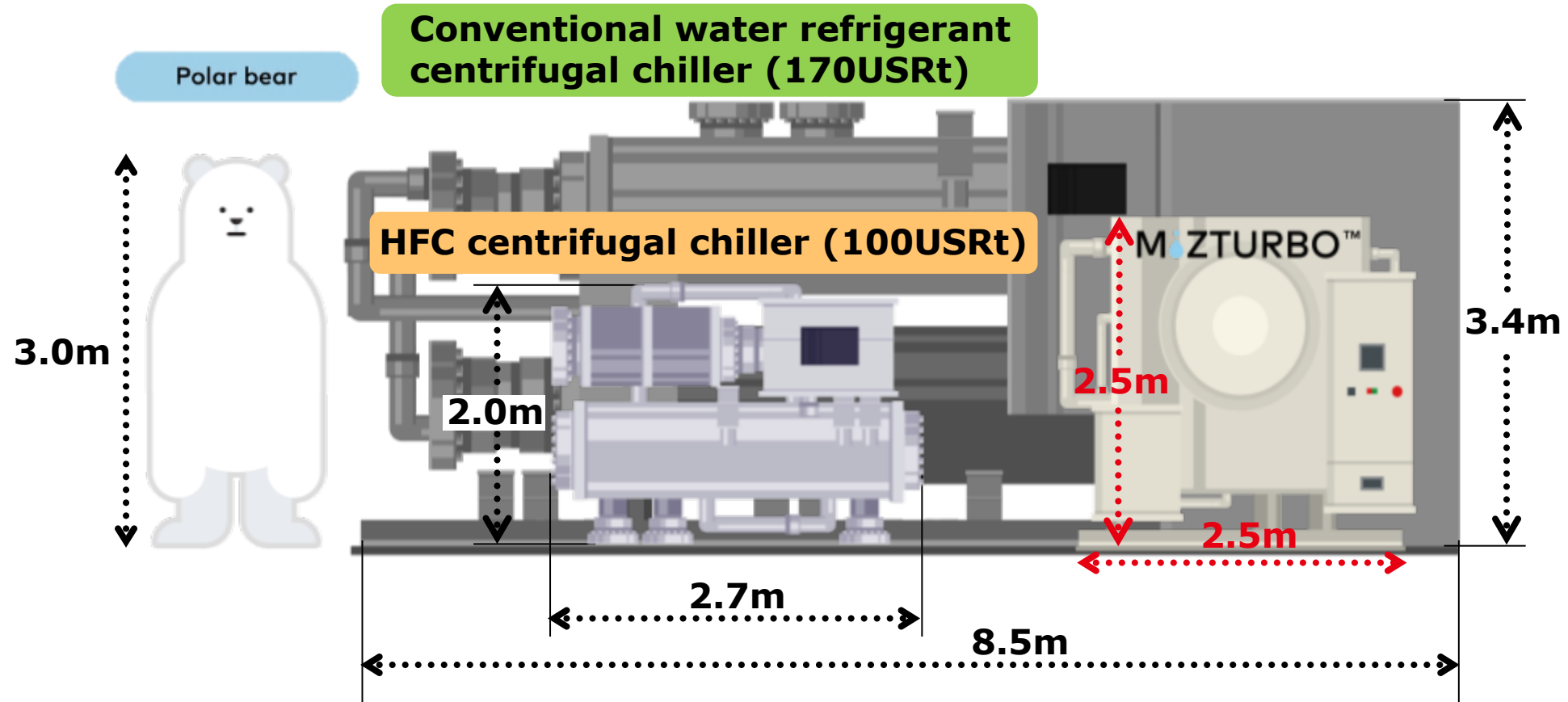
Compact

- Development of the core components
- Optimization of their layout

➔ **Alternative to existing chillers**



Compact



- Conventional water refrigerant centrifugal chiller is extremely large because of high specific volume.
- MiZTURBO is as compact as the existing chillers by optimum arrangement of components.

Features

Water refrigerant

➔ **Zero emission of HFC**

High efficient performance

- Development of the high efficient compressor under low pressure and high pressure ratio

➔ **Low power consumption**

Compact

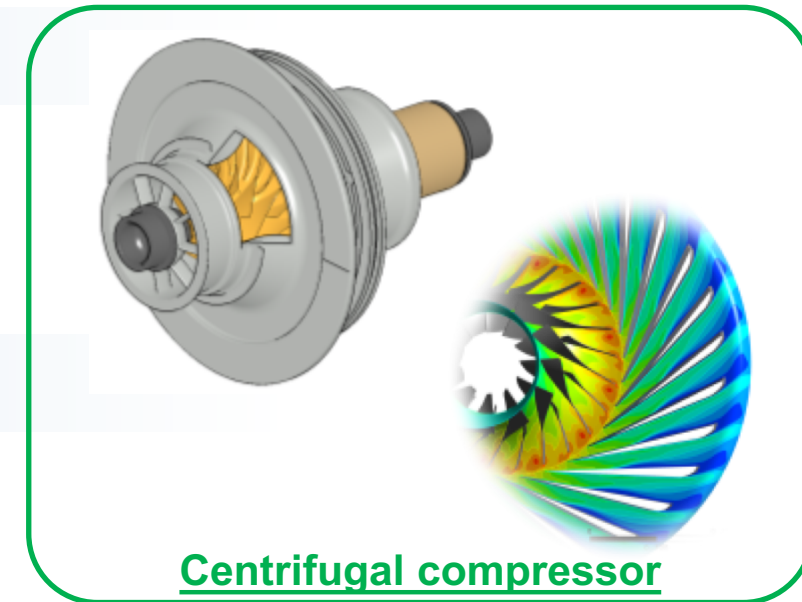
- Development of the core components
- Optimization of their layout

➔ **Alternative to existing chillers**

Oil-free

- The compressor is driven by the high speed motor

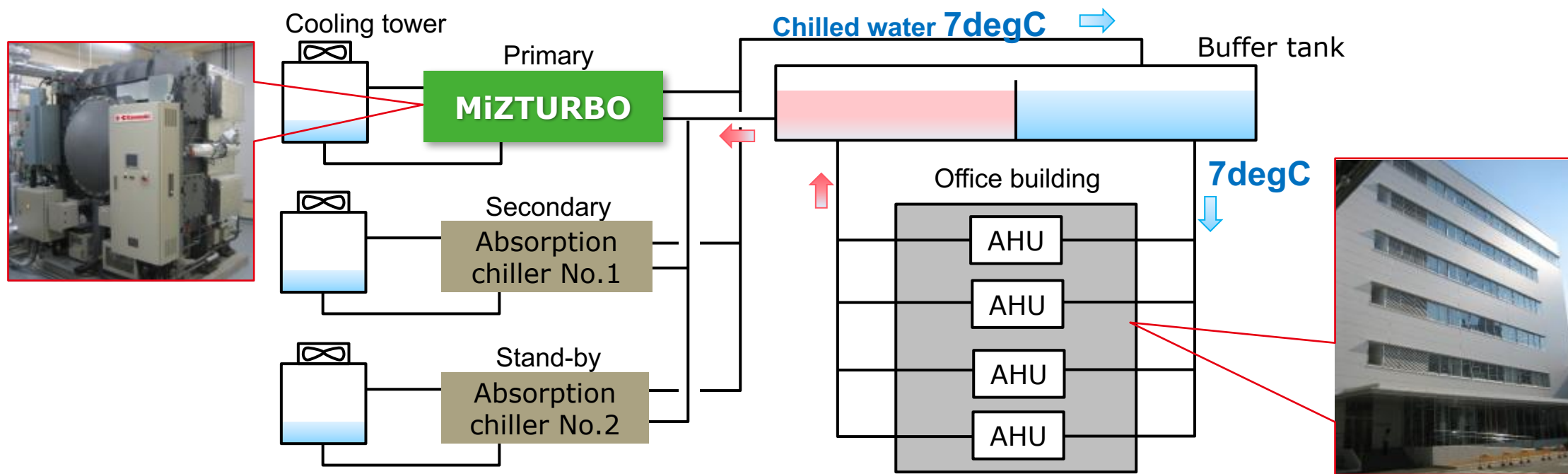
➔ **Auxiliary system for oil is not necessary**



Actual operation in Japan

MiZTURBO has been used for an air conditioning in Kawasaki's Kobe works in Japan since 2013

- Floor Area : 5,000m²
- Primary chiller : MiZTURBO 100USRt 1unit
- Secondary chiller : Absorption chiller 120USRt 1unit



Total operation time is 5,700 hours.

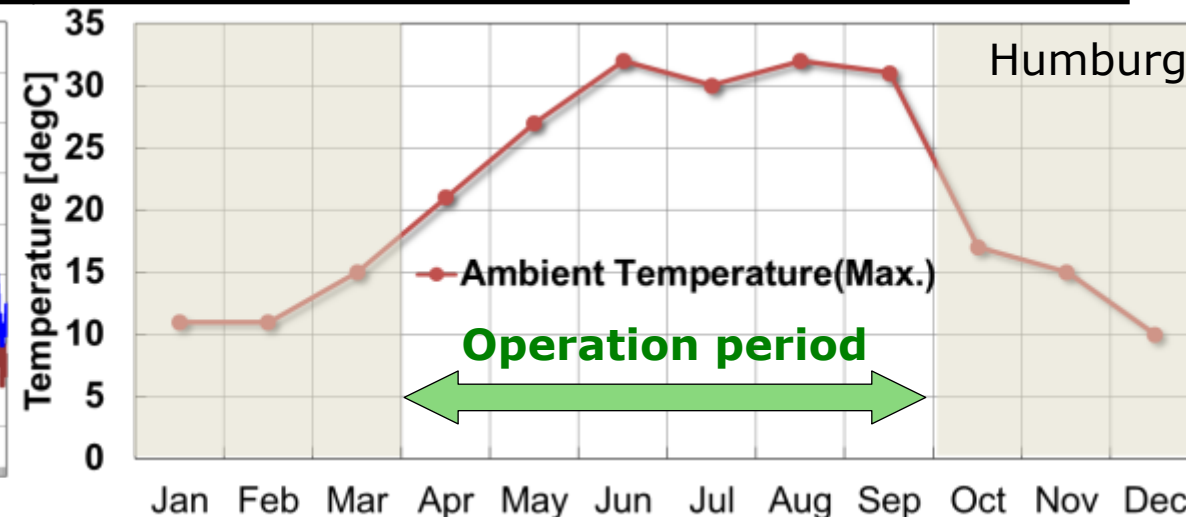
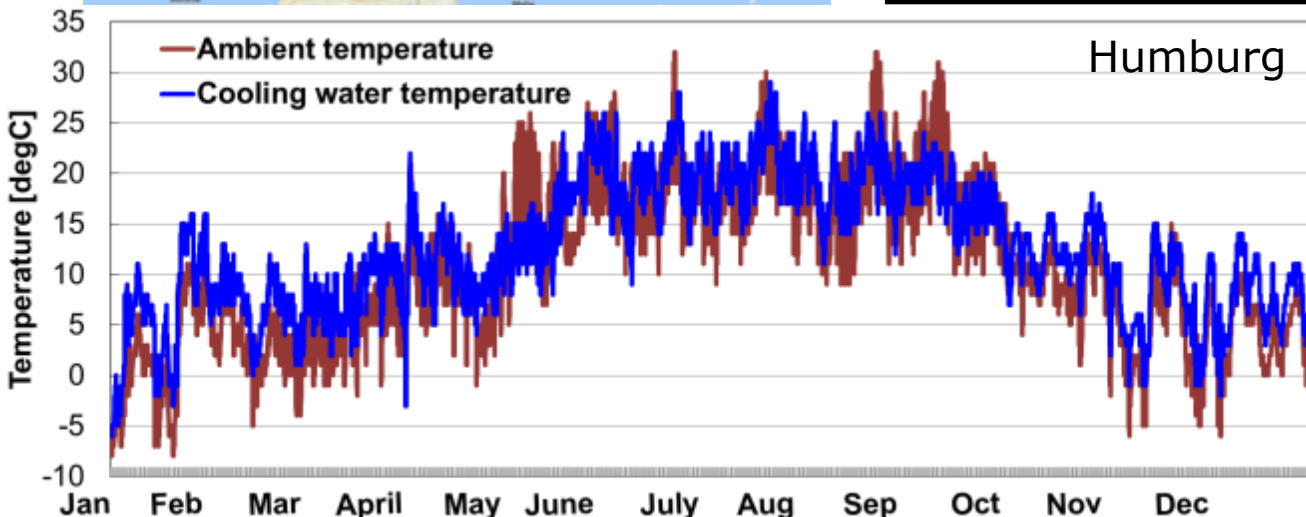
1. Introduction of MiZTURBO

2. Study of CO₂ emissions in Europe

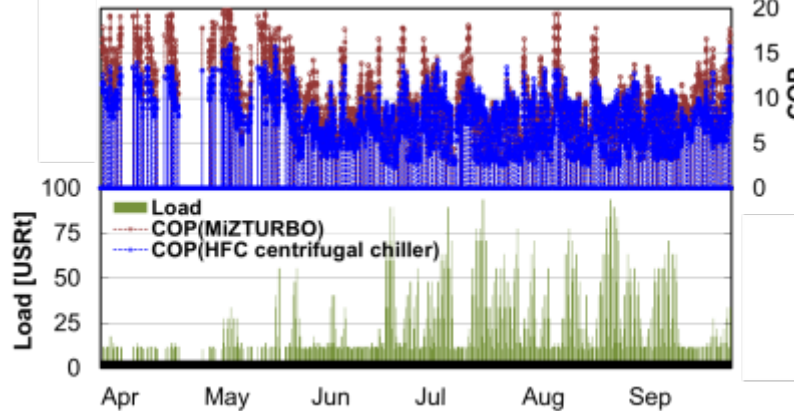
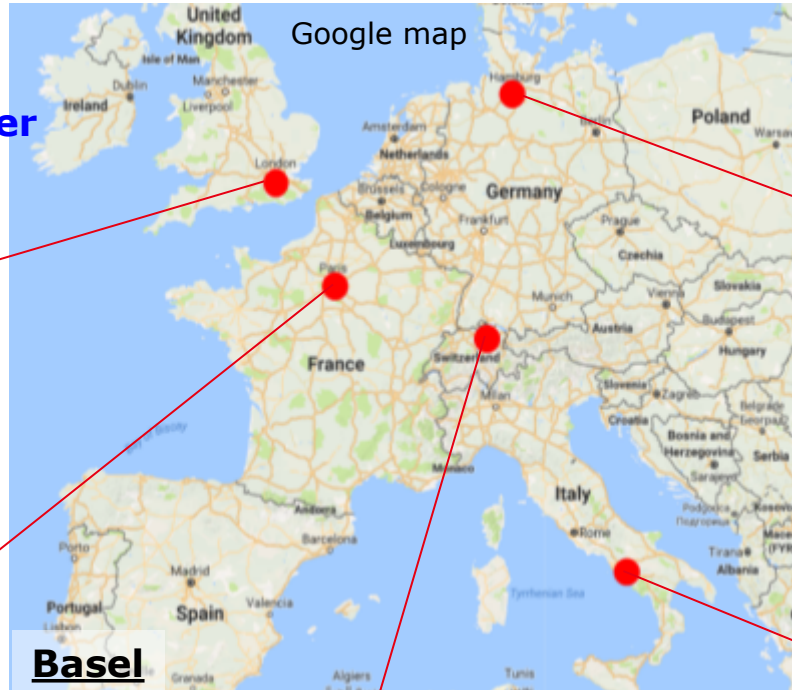
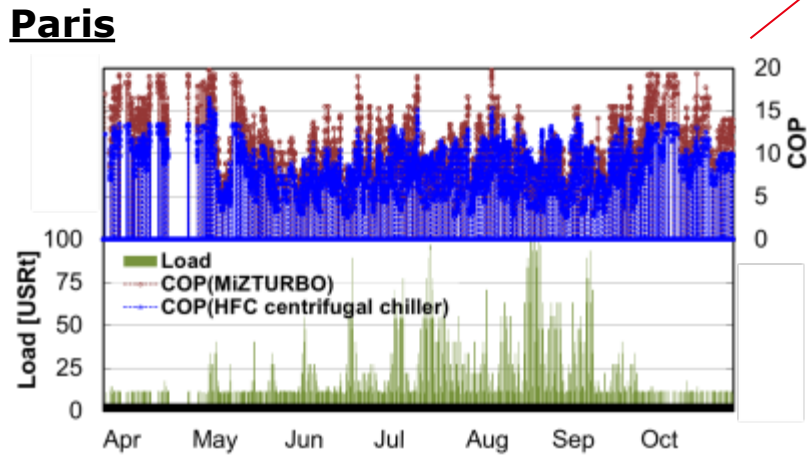
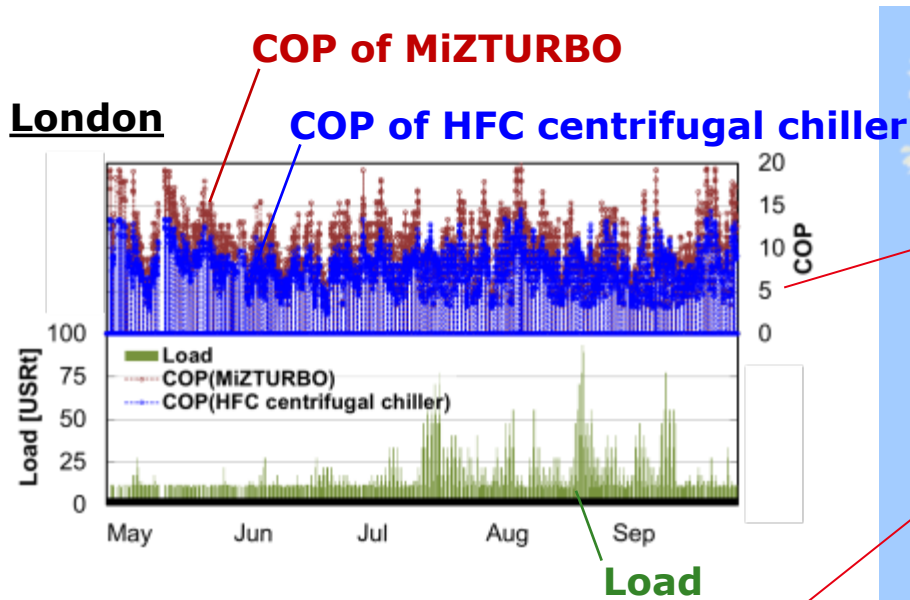
Calculation conditions



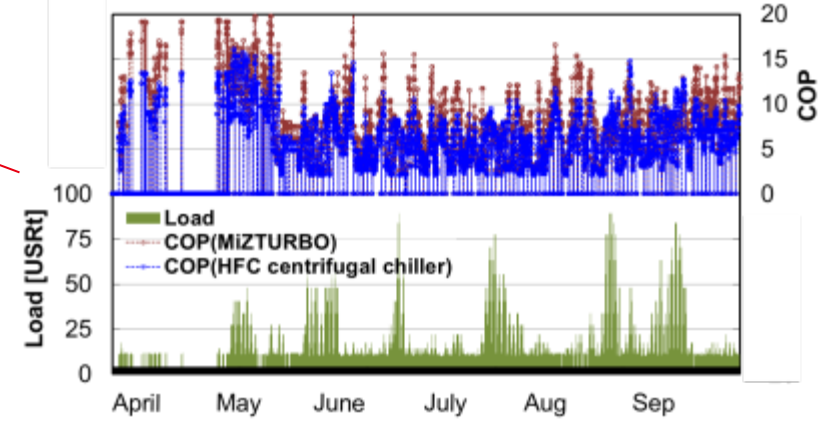
Location	Hamburg, London, Paris, Basel, Napoli
Weather history	Jan 1 st 2016 – Dec 31 st 2016
Collected data from weather history (every 1 hour)	Ambient temperature Dew point temperature (Cooling water temp. = Dew point + 5degC)
Operation period	The month when maximum ambient temperature > 20degC
operation time	6:00AM – 9:00PM
Operation year	15 years



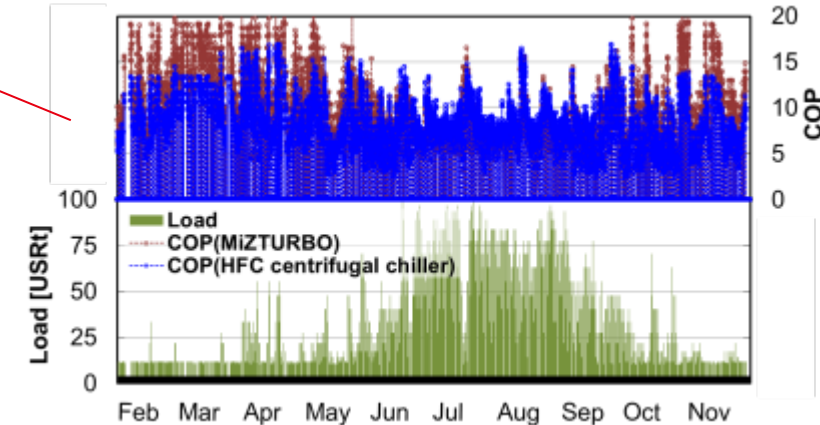
Results - Load and COP -



Hamburg



Napoli

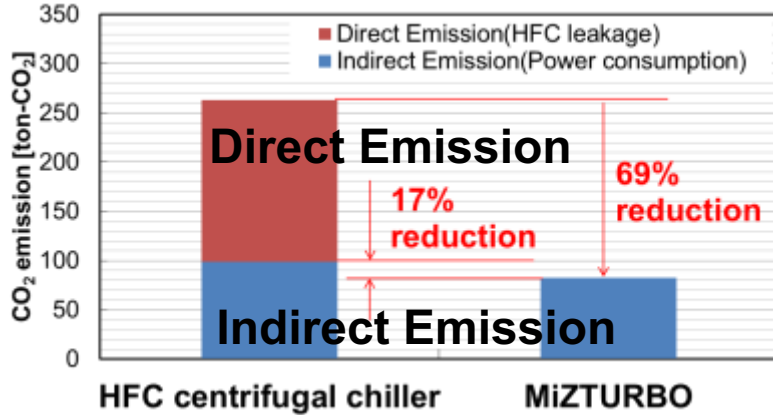


Results - Comparison of CO₂ emissions -

HFC leakage rate during operation : 2%/year
 HFC leakage rate on disposal : 20%

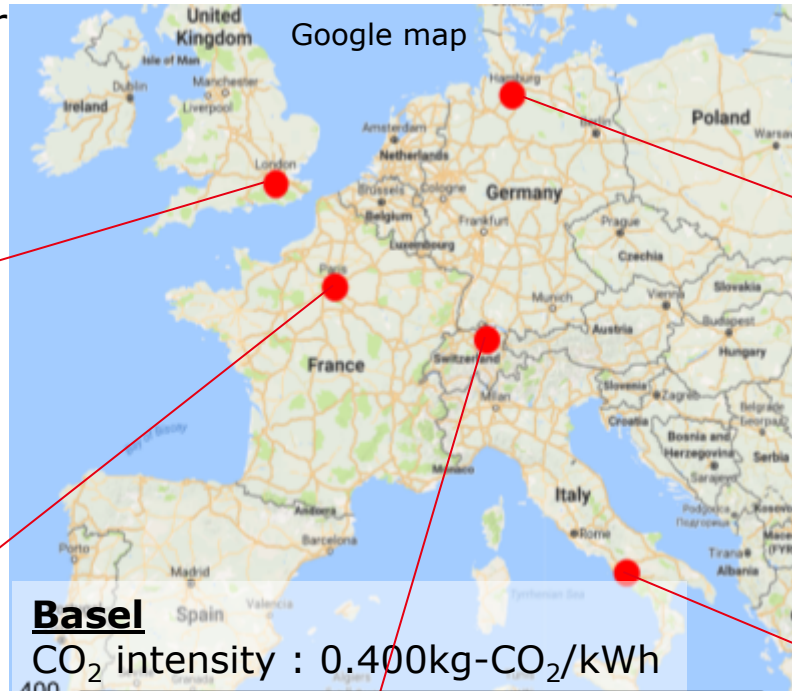
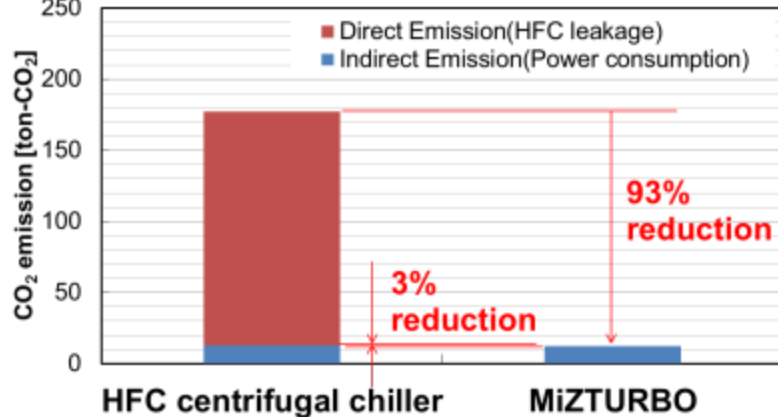
London

CO₂ intensity : 0.388kg-CO₂/kWh



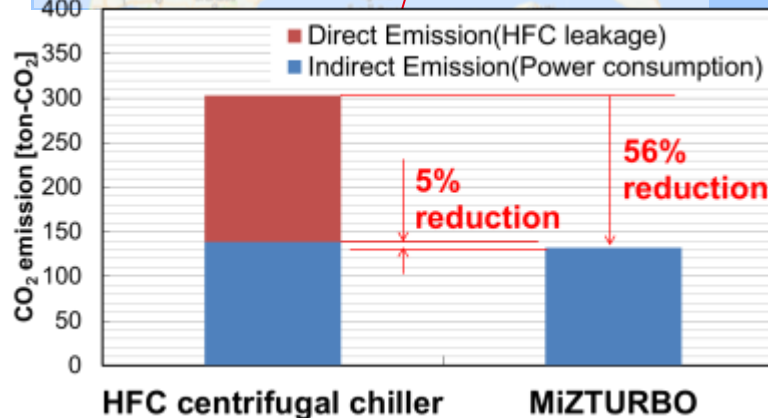
Paris

CO₂ intensity : 0.035kg-CO₂/kWh



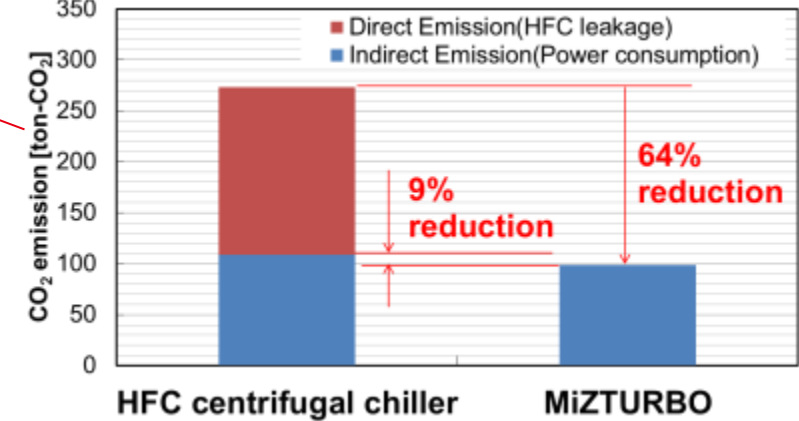
Basel

CO₂ intensity : 0.400kg-CO₂/kWh



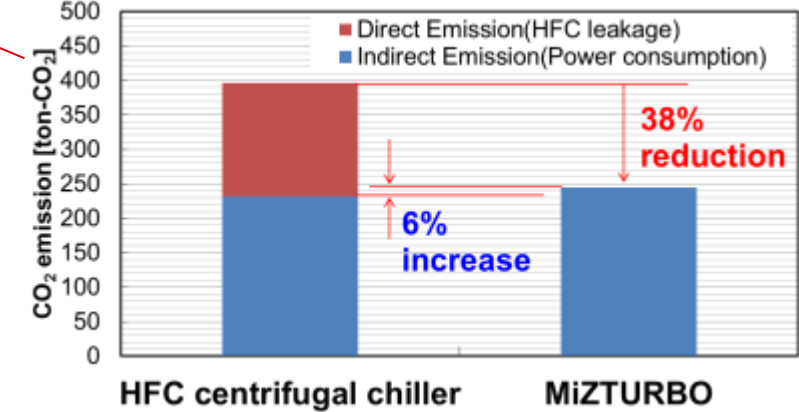
Hamburg

CO₂ intensity : 0.443kg-CO₂/kWh



Napoli

CO₂ intensity : 0.278kg-CO₂/kWh



CO₂ emission would be reduced by MiZTURBO

Summary

■ Introduction of MiZTURBO

- Features : water(R718) refrigerant, High efficient, compact and oil-free
- 5,700 hours operation in Japan

■ CO₂ emission in Europe

CO₂ emission would be reduced in Europe by MiZTURBO

■ Availability in Europe

The followings are the items to be solved.

- Compliant with the standards, regulations, CE marking etc.
 - Under Investigation
- Cooperation with customers and governments to create a path of introduction
 - Pilot plant, subsidy etc. to increase the acknowledge and accelerate the uptake of MiZTURBO

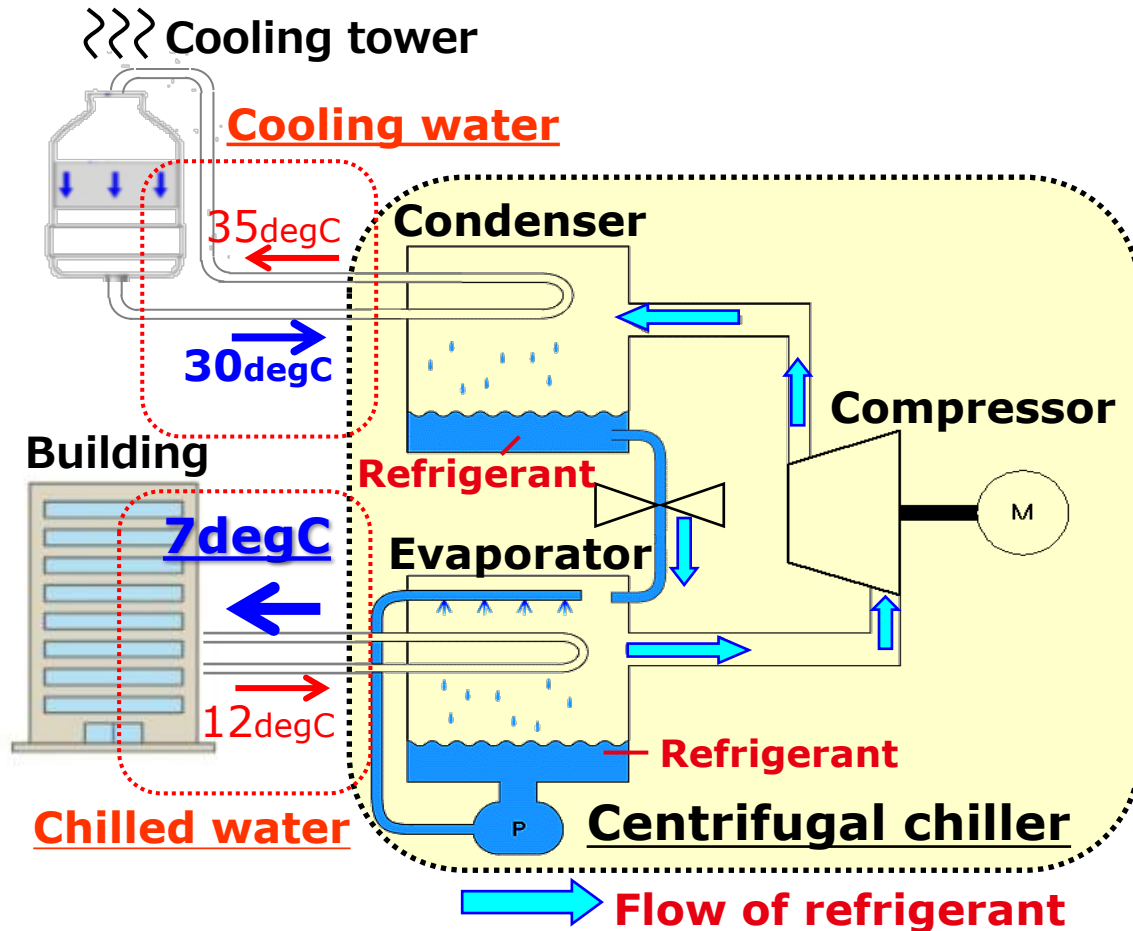


ATMO
sphere

Thank you very much!



Principle of Centrifugal chiller



Evaporator

- ① Refrigerant is heated by returned chilled water and evaporates.
- ② Returned chilled water is chilled by evaporative latent heat of the refrigerant.

Refrigerant : Liquid -> Vapor

Condenser

- ① Compressed vapor of the refrigerant is cooled by cooling water and condenses.
- ② Cooling water is heated by latent heat of the refrigerant.

Refrigerant : Vapor -> Liquid

	Common chiller	MiZTURBO
Refrigerant	HFC	Water

Comparison of performance curve

