APCBC presentation in ICEBO

ESL-IC-14-09-25

(Asia Pacific Conference on Building Commissioning)

Sept. 2014, Beijing, China

Commissioning Process and Operational Improvements in the District Heating and Cooling Plant

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TARGETS

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(1) To achieve the top-class energy efficiency among the DHC plants in Japan

(2) To evaluate the energy saving effects of commissioning and operational improvements

OUTLINE

- ABOUT THE DHC PLANT
- EXAMPLES OF COMMISSIONING AND OPERATIONAL IMPROVEMENTS
- RESULTS AND CONCLUSION

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DHC plant in Nishi-Umeda district of Osaka, Japan

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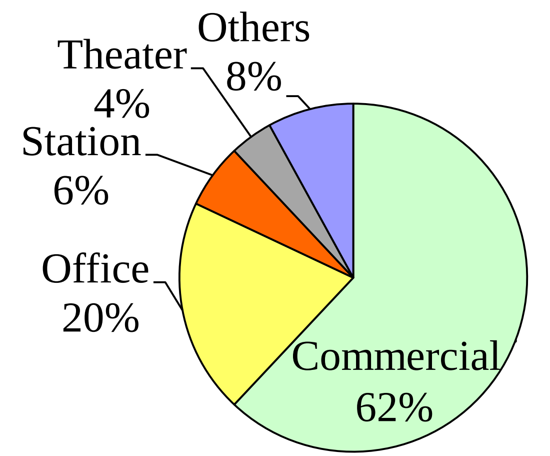
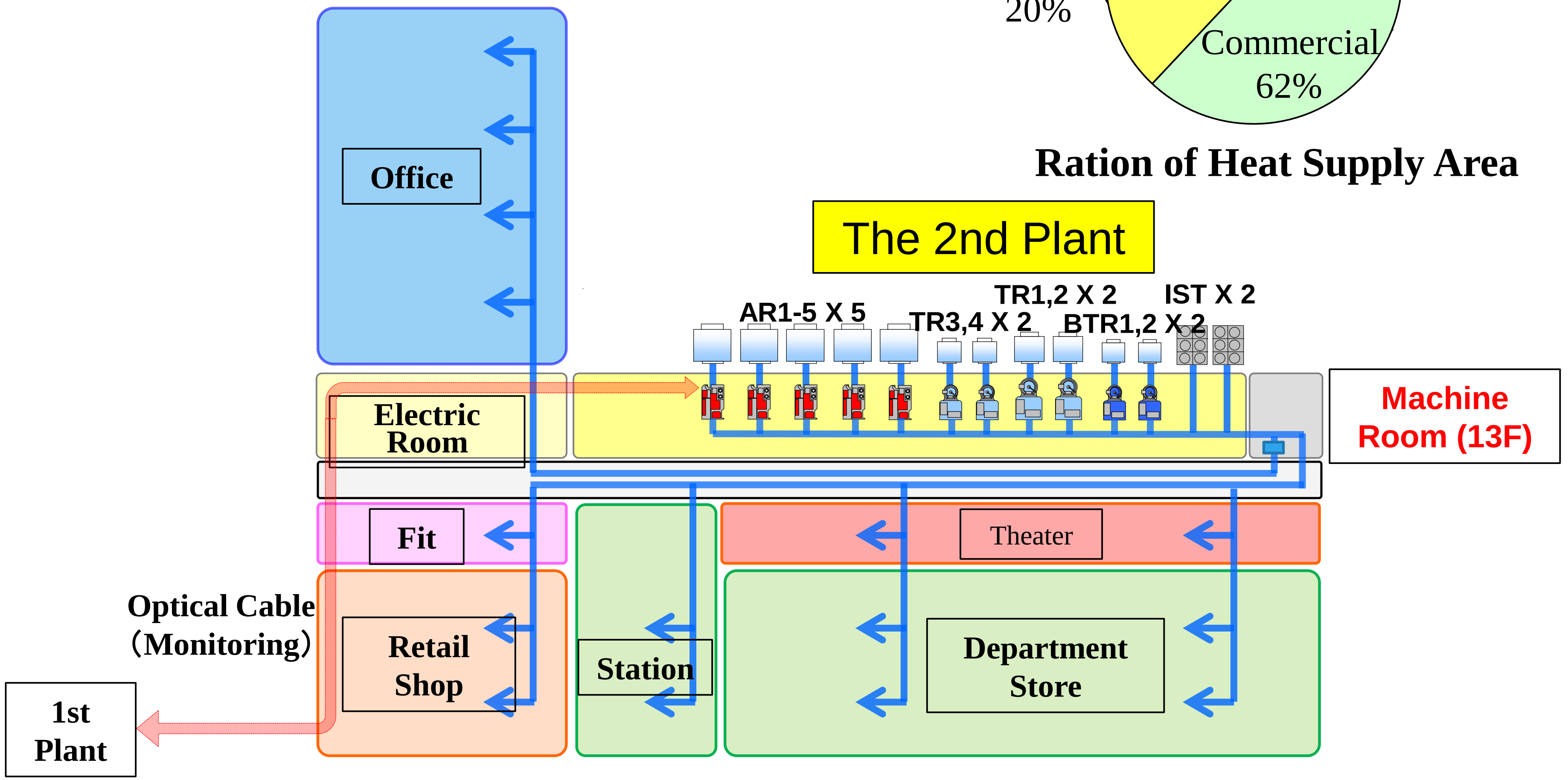
Total Supply Area ：approx.200,000㎡

The plant supplies both chilled and hot water to commercial facilities, offices, theaters, and the train station, etc.



Ration of Heat Supply Area



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Heat supply Schematic Diagram

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Capacity of cold heat generators：36,871 kW（10,500RT）
Capacity of hot heat generators ：15,430 kW

Symbol	heat generator	Capacity	Number
AR1～5	Gas-fired Absorption Water Chiller Boiler (= Absorption Chiller)	Cooling Capacity : 3,516kW (1,000RT) Heating Capacity : 2,900kW	5
TR1,2	Centrifugal Chiller (Constant Speed)	Cooling Capacity : 3,516kW (1,000RT)	2
TR3,4	Inverter Centrifugal Chiller	Cooling Capacity : 1,758kW (500RT)	2
BTR1,2	Centrifugal Chiller for Ice Storage	Cooling Capacity : 1,571kW (447RT) Ice Making Capacity : 1297kW (369RT)	2
IST1,2	Ice Storage Tank	Capacity of Thermal Storage :11,603kWh (3,300RTh)	2
BO1,2	Hot Water Boiler	Heating Capacity : 465kW	2

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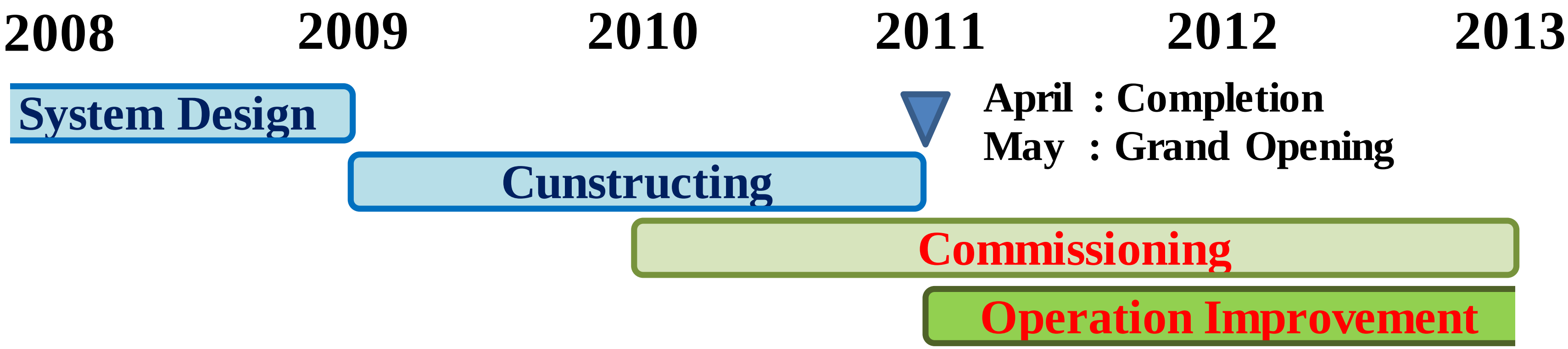
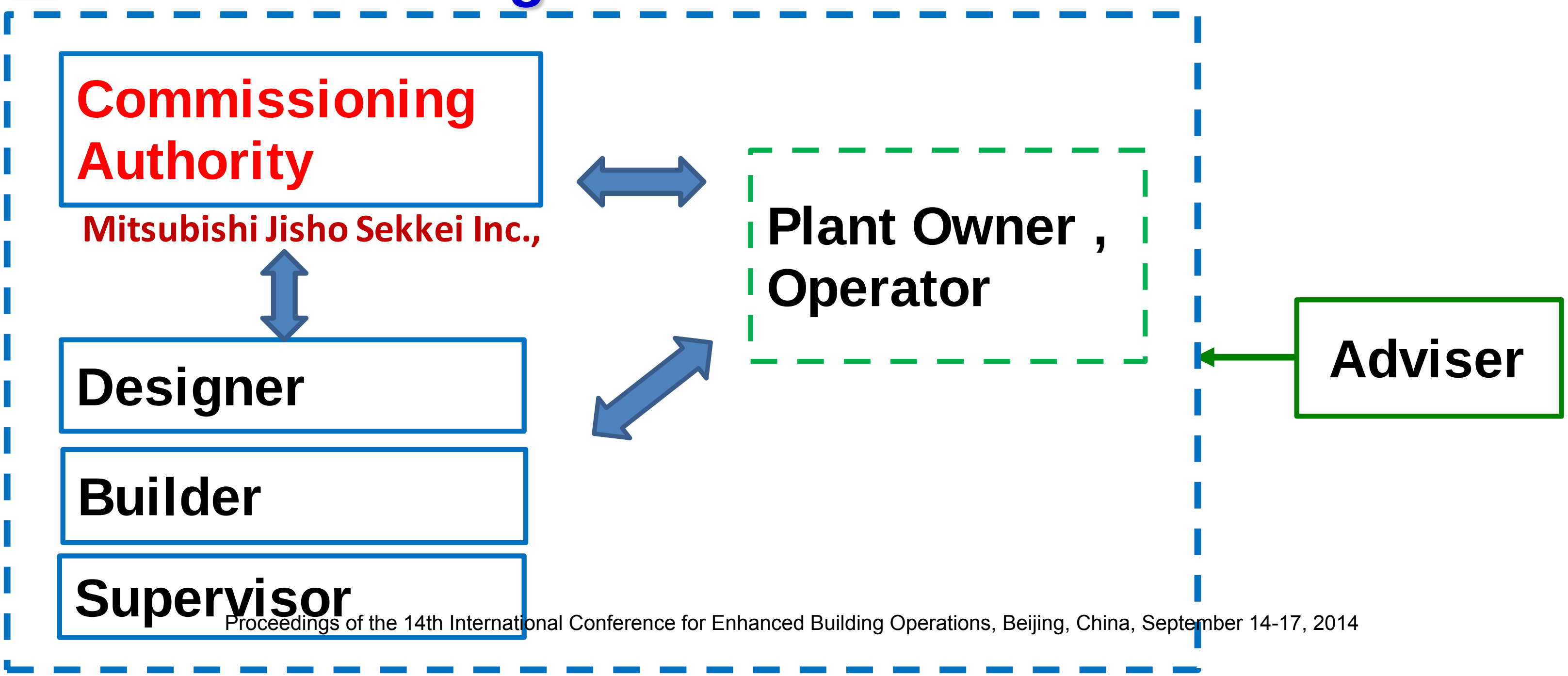
■Commissioning Schedule



■ Commissioning Team



POLICY

- **Verification of the designed performance of the systems and the equipment through the commissioning process**

- **Operational improvements in efficiency, based on the result of the commissioning**

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Examples of commissioning and operational improvements

1. **Search for the most suitable operation method in consideration of efficiency and running cost**
2. **Commissioning and optimizing the number of operating inverter centrifugal chillers and the start/stop timing**
3. **Commissioning and optimizing the flow control on the cooling water**

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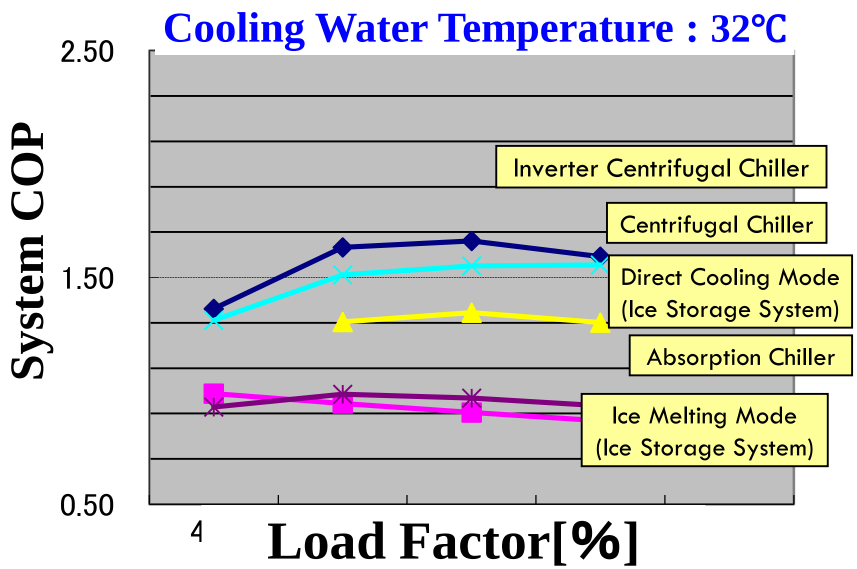
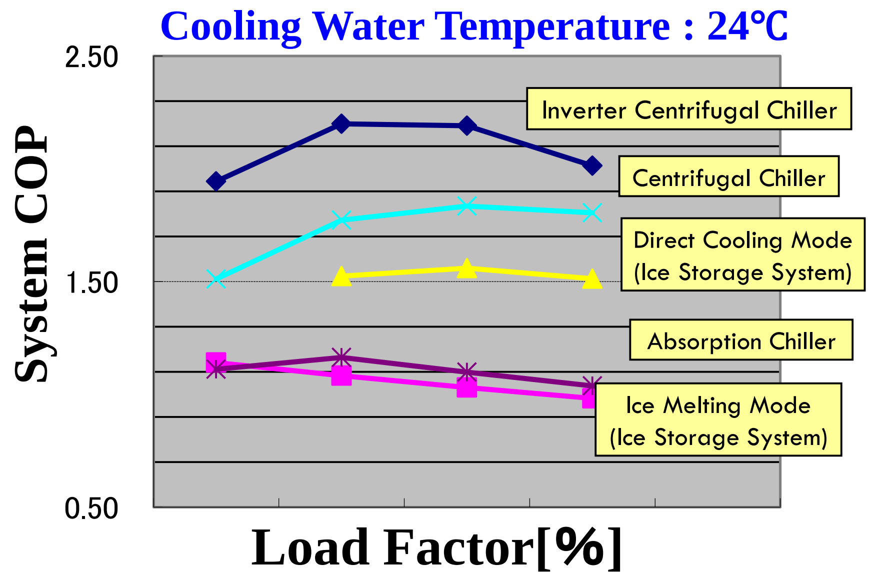
Search for the most suitable operation method in consideration of efficiency and running cost





Relations of load factor/cooling water temperature and system COP

- **Regardless of cooling water temperature, theinverter centrifugal chiller is more efficient than other heat generators.**
- **As cooling water temperature decreases, the inverter centrifugal chiller increases its efficiency, compared to the absorption chiller.**

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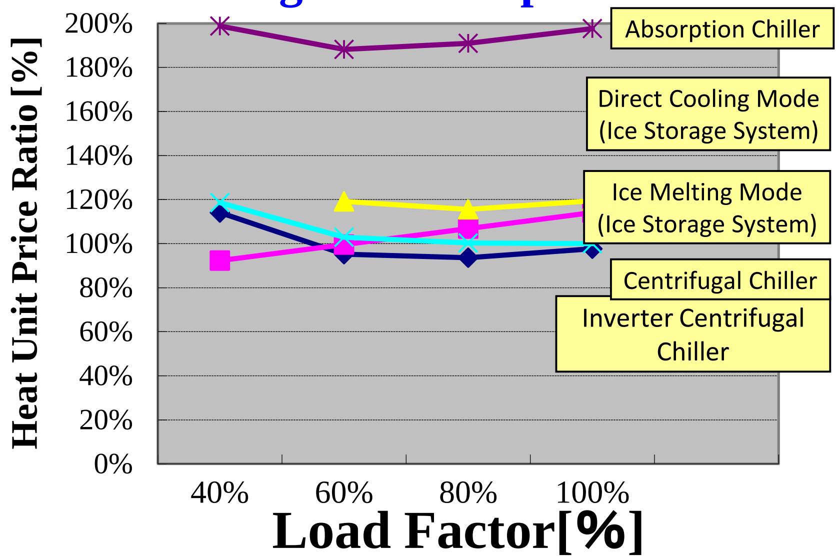
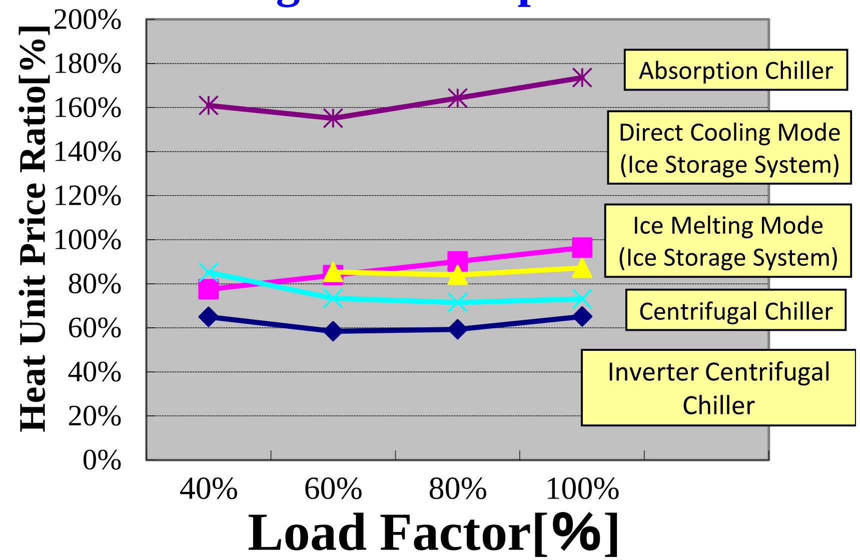
Search for the most suitable operation method in consideration of efficiency and running cost

cooling water temperature : 32℃



cooling water temperature : 24℃



Relations of load factor/cooling water temperature and running cost

◆**Heat Unit Price Ratio : 100% = Heat unit price of centrifugal chiller with cooling water temperature at 32℃ and Load factor 100%)**

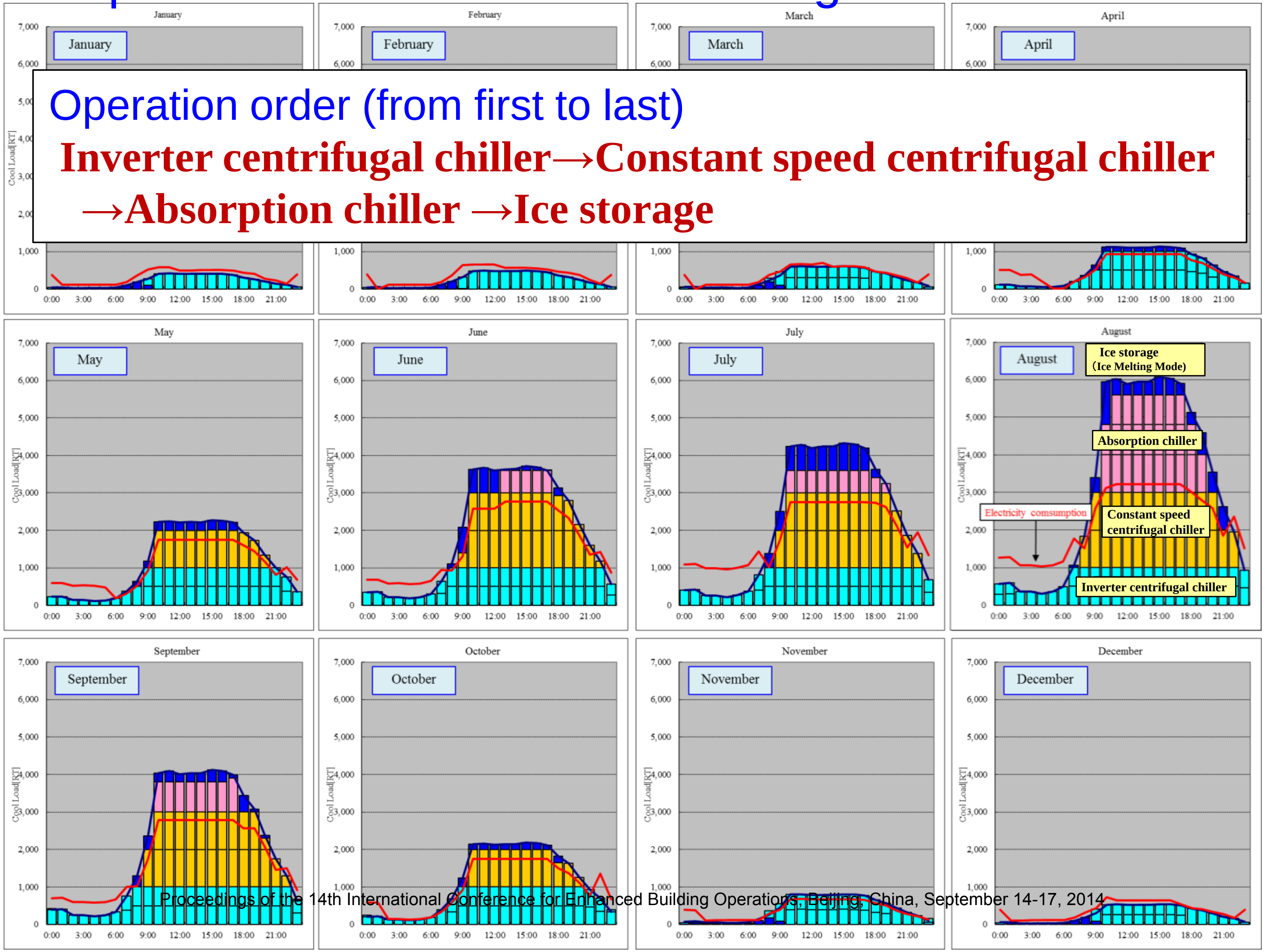
- **In terms of running costs (heart unit price), the electric system (centrifugal chiller) is more advantageous than the gas system (absorption chiller)**
- **In case of low load period in summer, the ice storage system is more advantageous than others in running costs**

Search for the most suitable operation method in consideration of efficiency and running cost

Operation order of the cold heat generators

Operation order (from first to last)

Inverter centrifugal chiller→Constant speed centrifugal chiller →Absorption chiller →Ice storage



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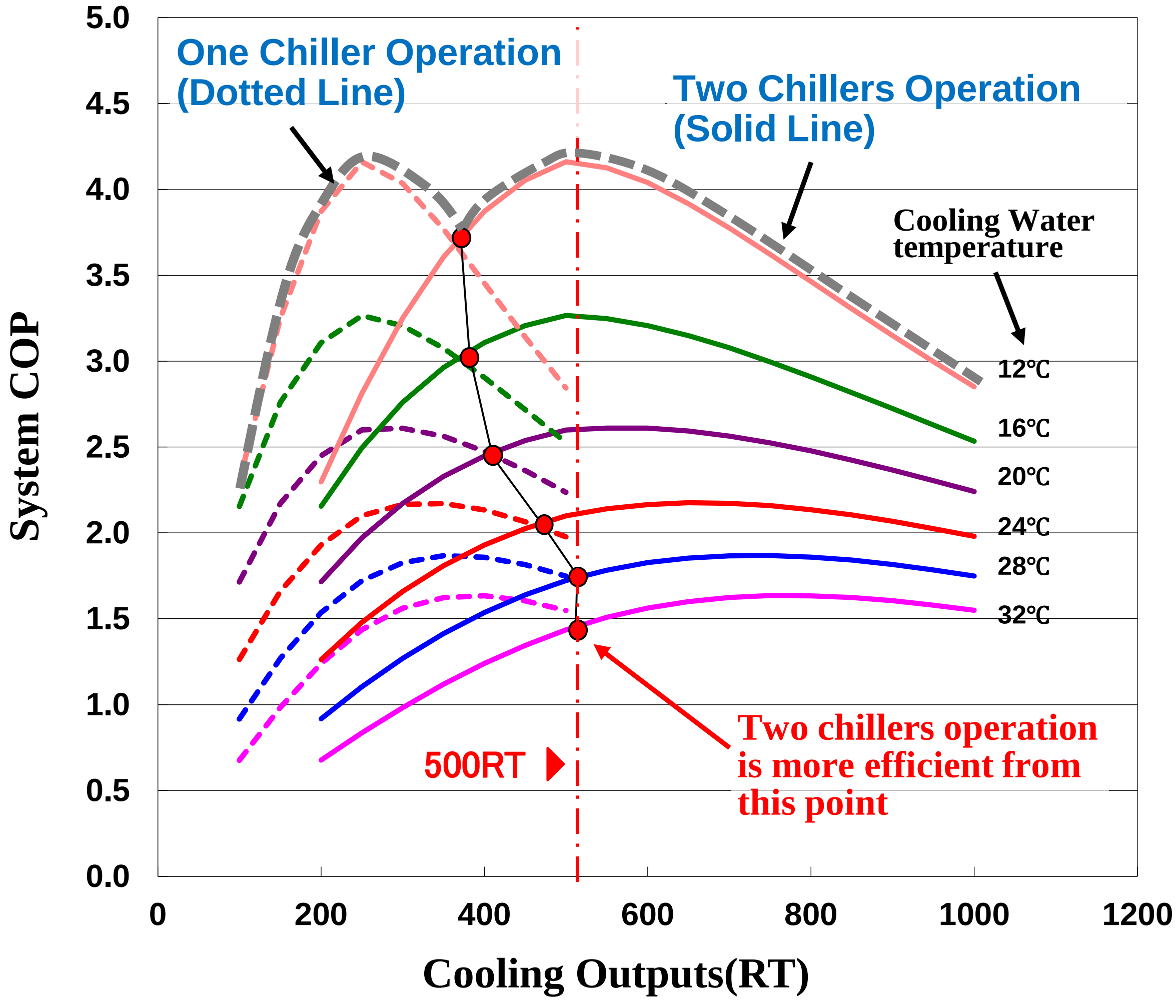
Commissioning and optimizing the number of operating inverter centrifugal chillers and the start/stop timing

Efficient operation by controlling number of operated chillers (simulation)



As the cooling water temperature decreases, the system COP improves by adding the second chiller earlier.

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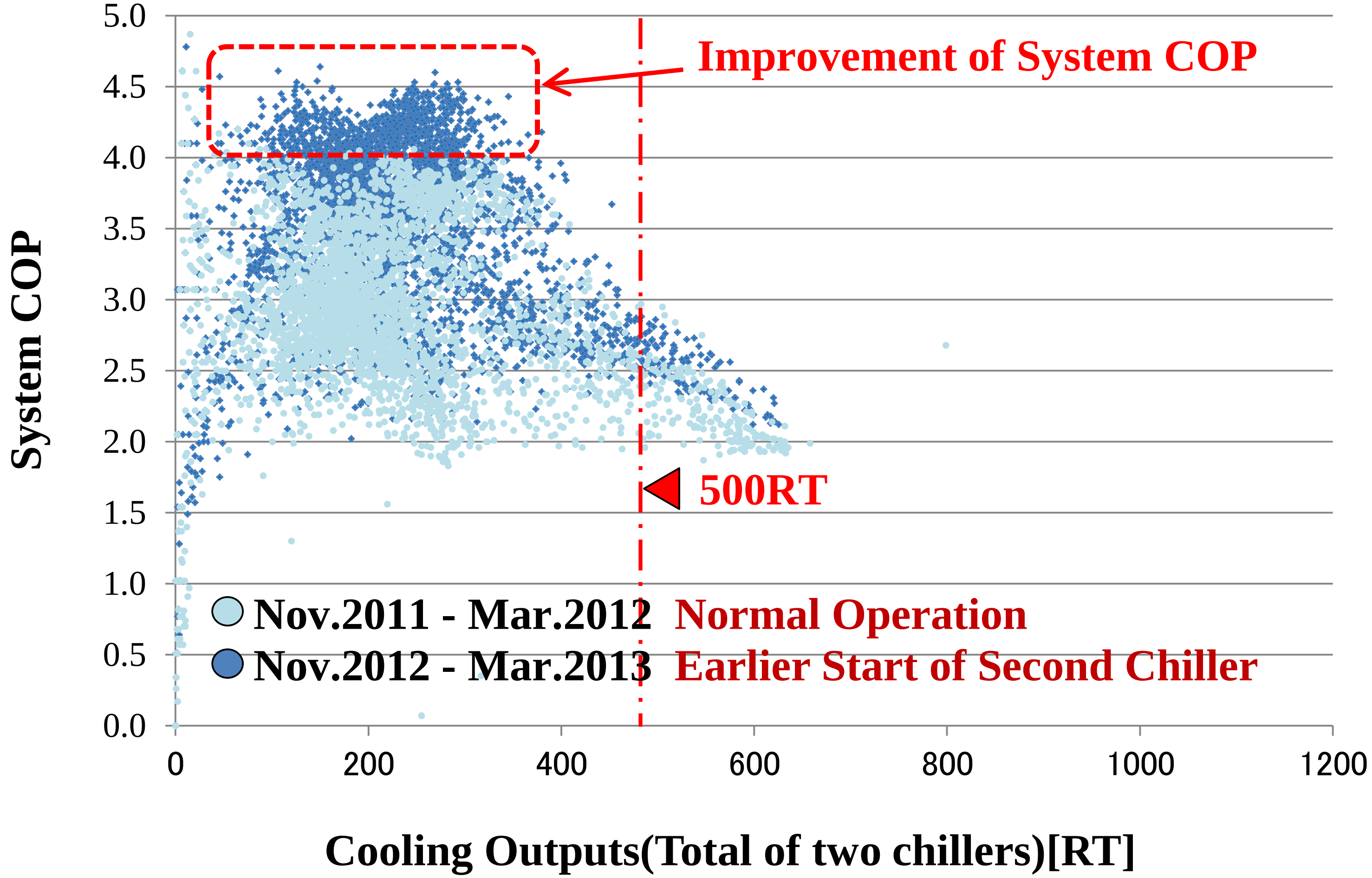
Commissioning and optimizing the number of operating inverter centrifugal chillers and the start/stop timing

Efficient operation by controlling number of operated chillers (measured data)



System COP improved with the 2nd inverter centrifugal chiller starting earlier

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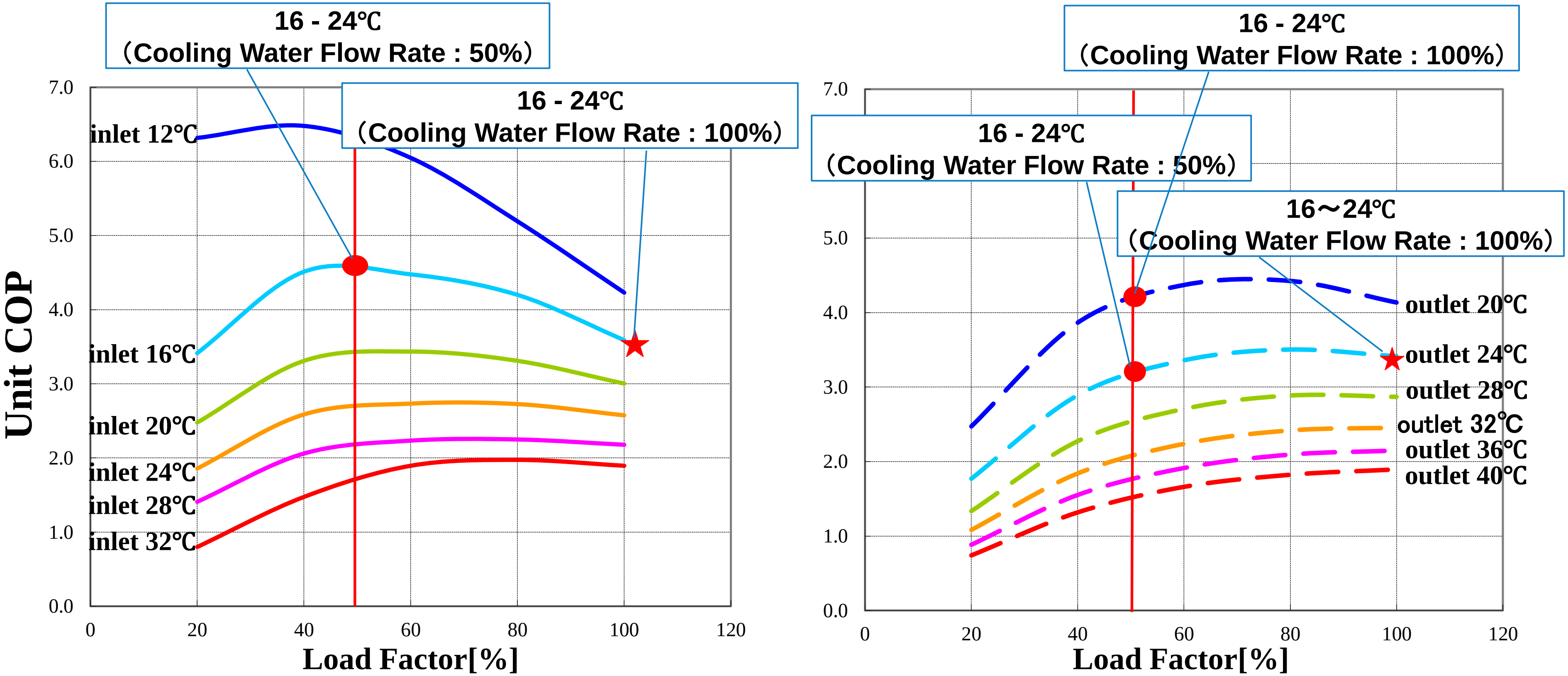
Commissioning and optimizing the flow control on the cooling water

Unit COP based on cooling water inlet/outlet temperature



Based on inlet temperature of cooling water | **Based on outlet temperature of cooling water**

Changes in the unit COP of the inverter centrifugal chiller

The unit COP data published from manufacturers are based on the inlet temperature and the constant flow system

➡ **In case of the variable cooling water flow system, The unit COP is affected more by the outlet water temperature than by the inlet water temperature**

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Commissioning and optimizing the flow control on the cooling water

Energy simulation

In case of the variable cooling water flow system, the cooling water outlet temperature should be a parameter of control

Comparison between the variable cooling water flow system and the constant system by simulation

Based on the simulation, except for the mid summer (July and August), the constant cooling water flow system is more energy saving than the variable system in this plant

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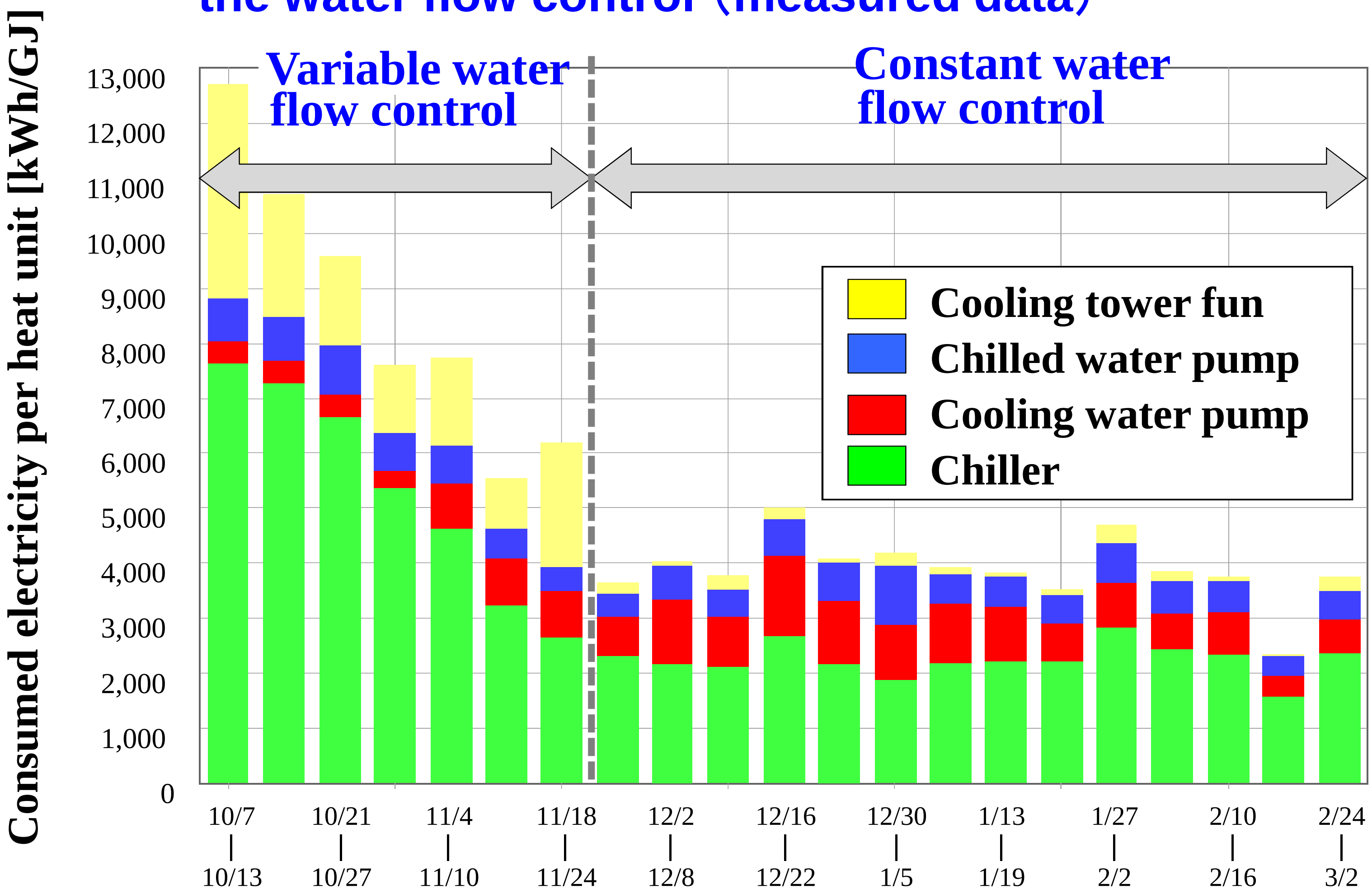
Commissioning and optimizing the flow control on the cooling water

Change in energy consumption by changing the water flow control（measured data）



The constant cooling water flow control has been applied for the inverter centrifugal chillers from the second year

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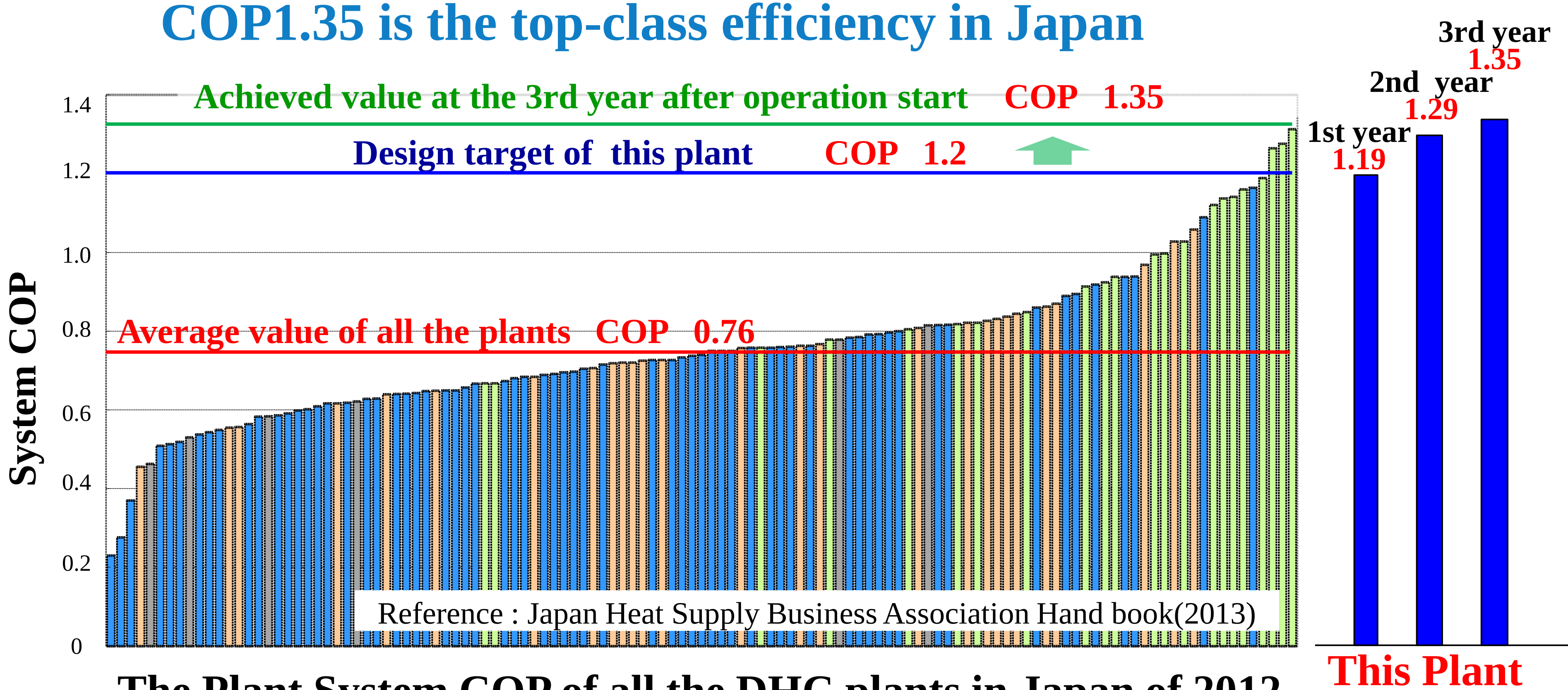
Annual average plant system COP of 1.35 has been achieved at the 3rd year after operation start

COP1.35 is the top-class efficiency in Japan



The Plant System COP of all the DHC plants in Japan of 2012

Definition of the plant System COP

$$\text{Plant System COP} = \frac{Q}{G_p + E \times e_p}$$

Q : Total heat supply (chilled water and hot water)[KJ]
Gp : Gas-fired Absorption Water Chiller Boiler [KJ]
E : Total electricity consumption of the plant[kWh]
ep : Conversion factor to primary energy[9,760kJ/kWh]

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CONCLUSION

(1) Top-class energy efficiency of DHC plants in Japan have been achieved by applying the commissioning process

(2) In order to achieve assured energy savings, the commissioning process and operational improvements based on its results are very important

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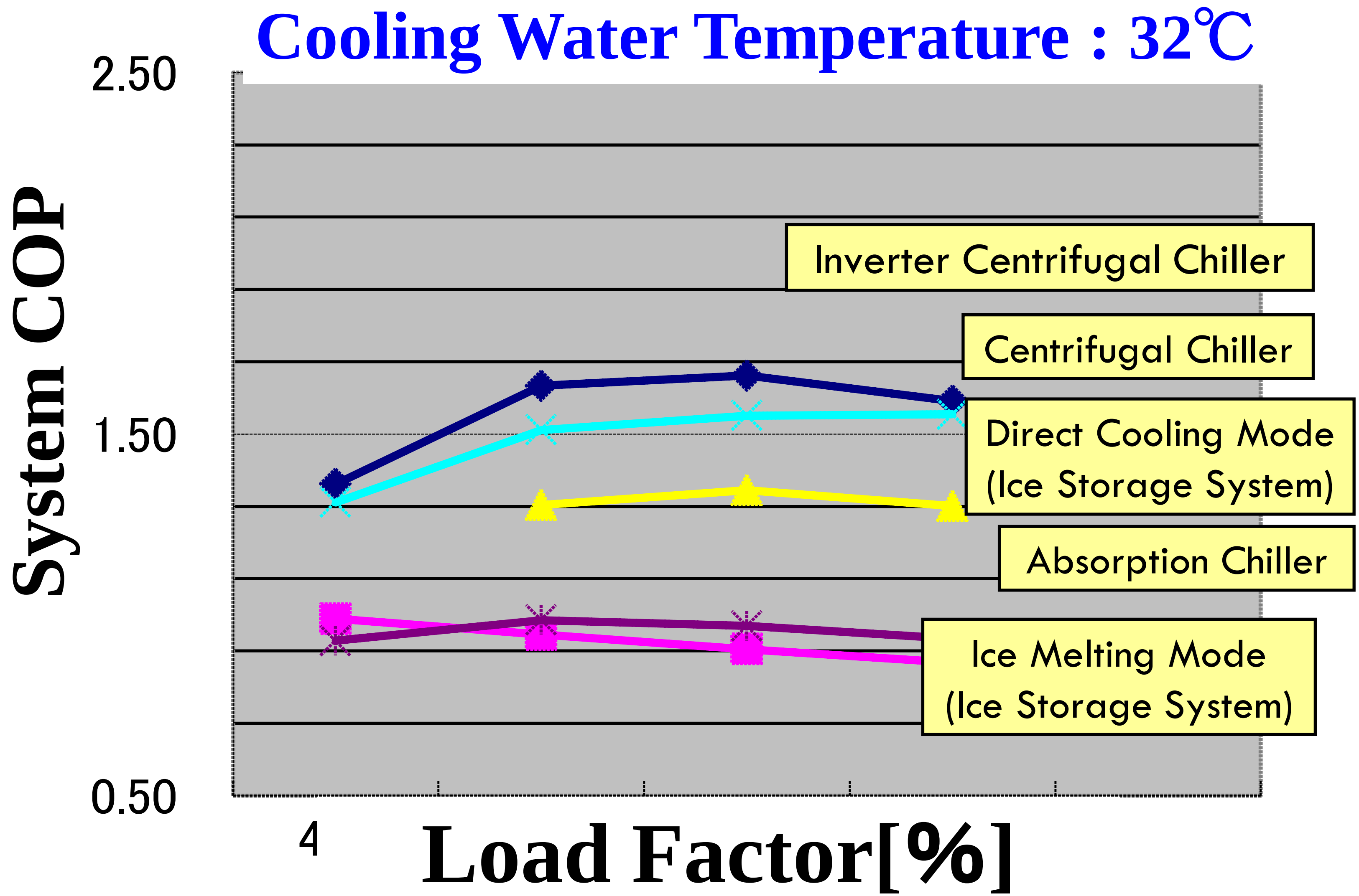
Search for the most suitable operation method in consideration of efficiency and running cost



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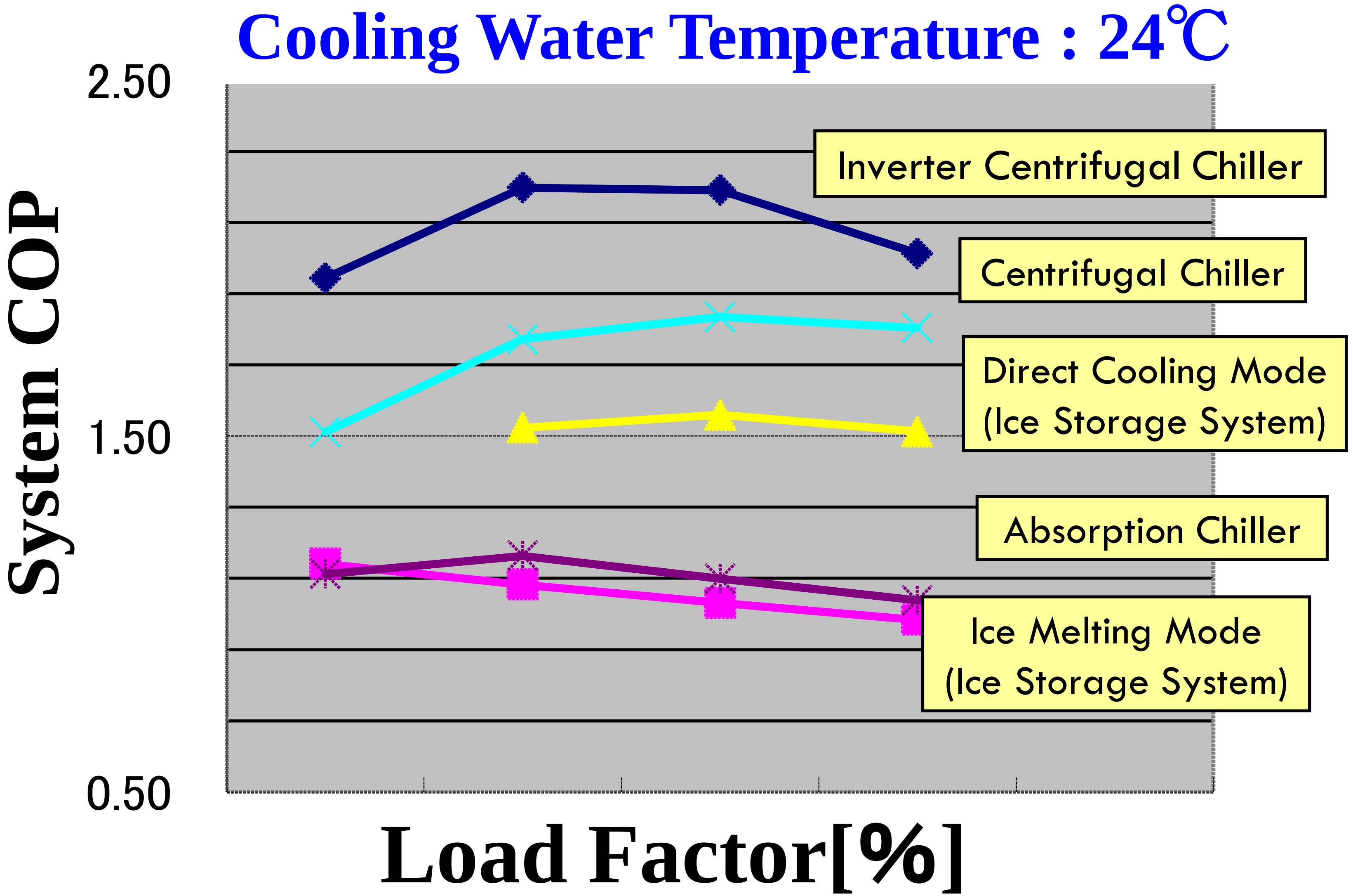

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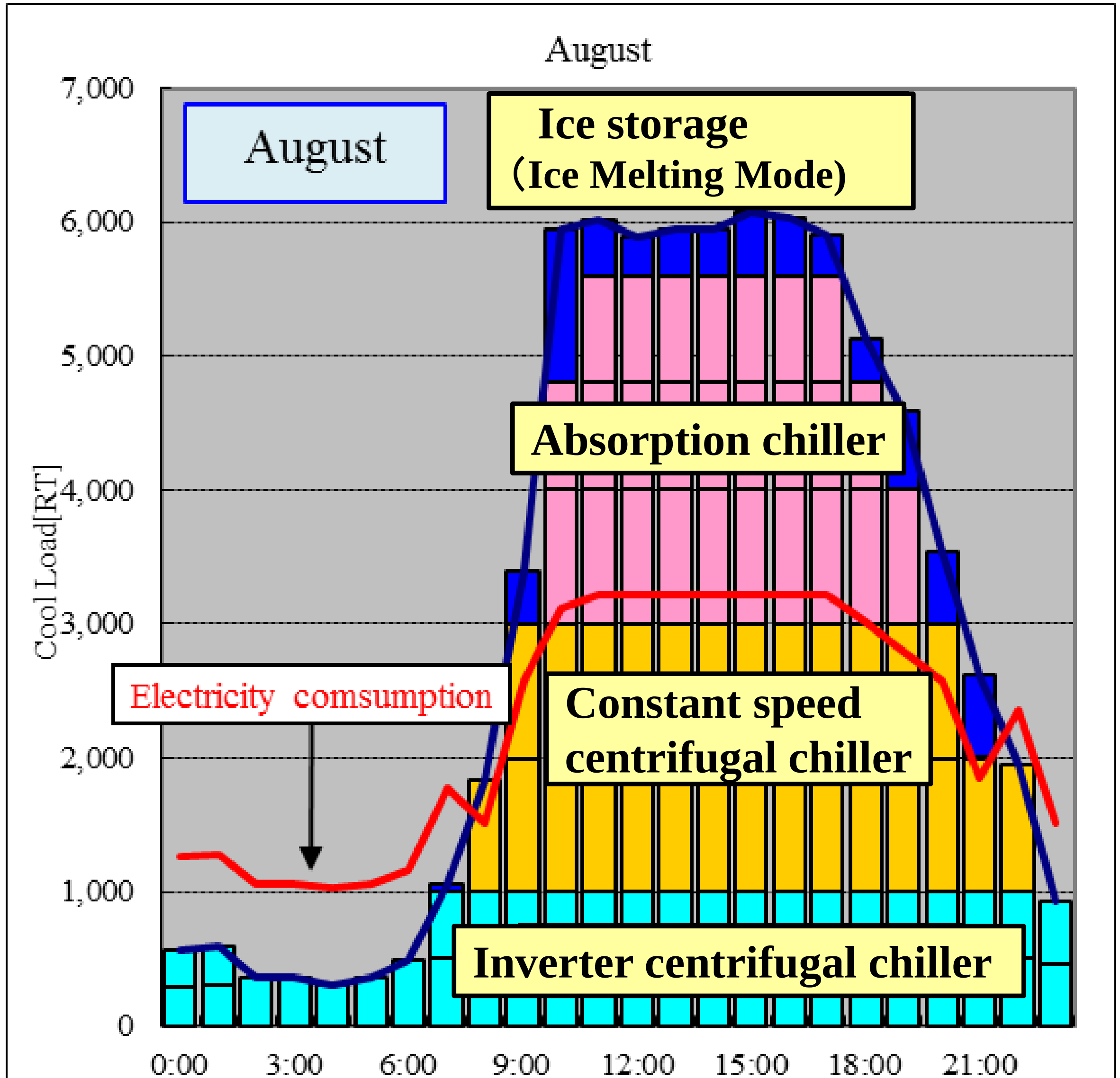
Search for the most suitable operation method in consideration of efficiency and running cost

Operation order (from first to last)

- Ice storage
- ↑ Absorption chiller
- ↑ Constant speed centrifugal chiller
- ↑ Inverter centrifugal chiller



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