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9 & 10 February, 2016 – Tokyo

Energy efficiency of brine-ice thermal storage system using a new type of CO_2 refrigeration unit

9 February, 2016
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株式会社ヤマト
Yamato
CLEAN & AMENITY SYSTEM

Company profile YAMATO Co. Ltd.

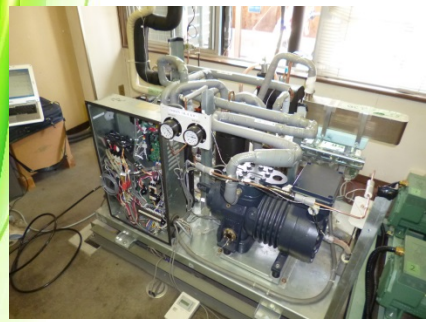
1. Founding ：1945
2. Capital stock ：5 billion yen
3. Employee ：698（April, 2015）
4. Main business

・Design and installation for air-conditioning and refrigeration facilities
・Development of environmental technology such as thermal storage and so on
・Operation management and maintenance of facilities

Headquarter（Maebashi, Gunma）

Background of case study

- Using CO_2 refrigeration unit for brine-ice thermal storage equipment (CO_2 Ultra Eco-Ice : CO_2UEI)


Company A


Company B


Company C


Panasonic

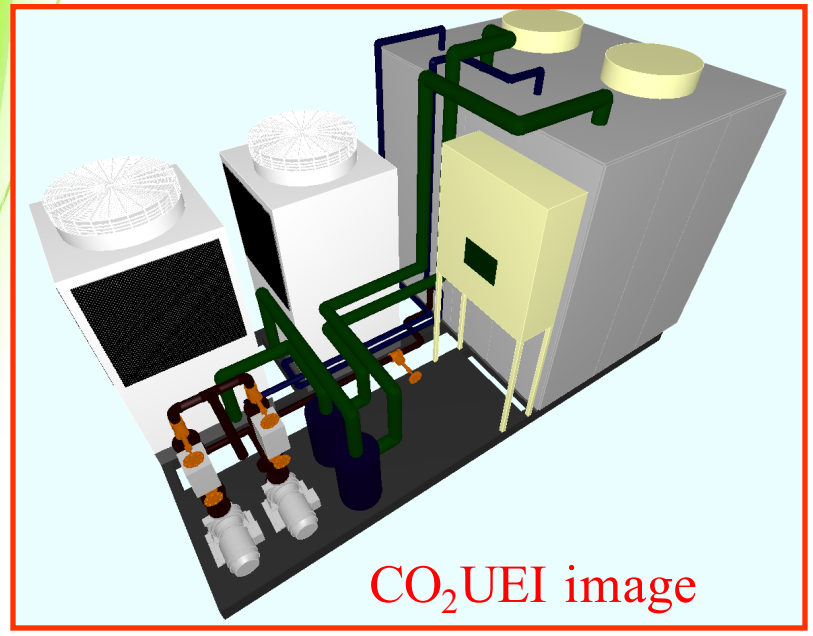
<Problems>
- Amount of appropriate CO_2 refrigerant
- Circulation of oil
- Adjustability of Electric Expansion valve for CO_2 refrigeration unit

Resolved

- Demonstrating CO_2UEI energy efficiency, economic efficiency, ice generation performance and cooling performance and so on

⇒Report case study for energy efficiency and economic efficiency based on CO_2UEI demonstrations

CO_2 Ultra Eco-Ice（CO_2UEI）system

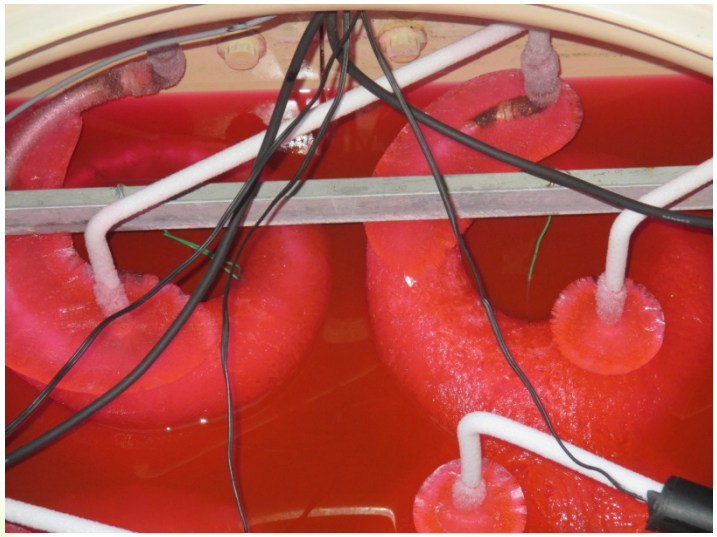


CO_2 Ultra Eco-Ice(CO_2UEI) system

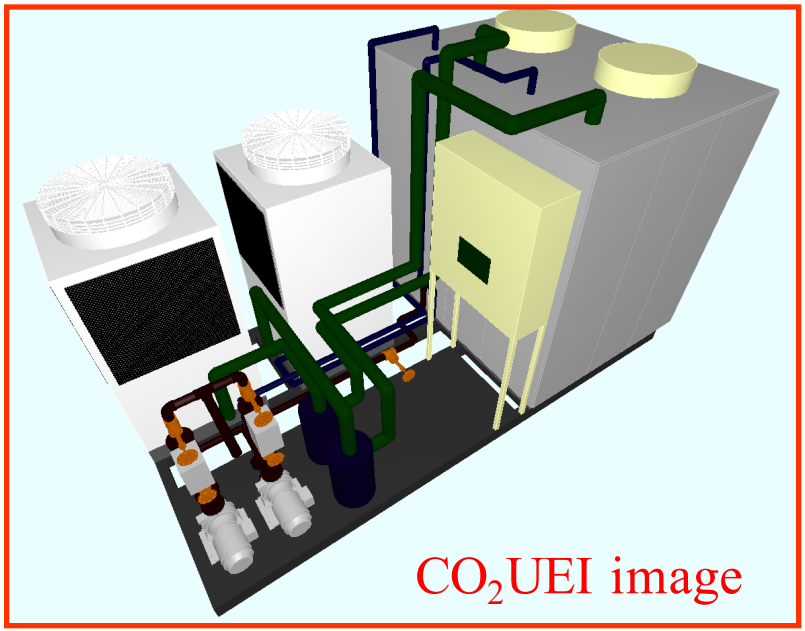
CO_2 Ultra Eco-Ice（CO_2UEI）

CO_2 refrigeration and storage tank

Brine-ice storage generator for CO_2



Brine-ice generation



Merits of using thermal storage

1. Energy efficiency
   Continuous operation of refrigerators during nighttime at lower temperature
   Accumulating cooling energy for daytime loads

2. Reducing daytime electric power demand（Peak cut）
   Using cooling energy accumulated during nighttime for daytime loads
   Reducing refrigeration capacity during daytime

3. Reducing Refrigerator cost（depending on the design of storage）
   Reducing necessary refrigeration capacity during daytime

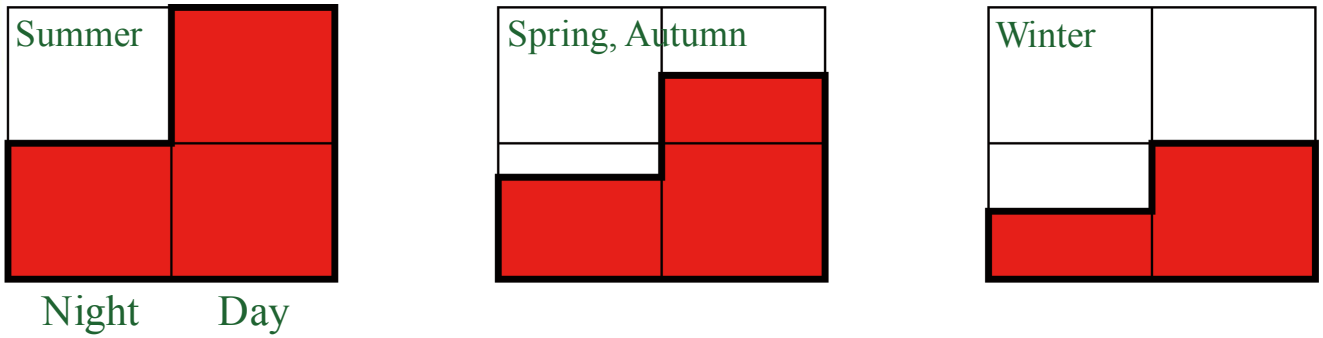
4. Amount of piping construction for CO_2 refrigerant and the reliability
   Piping construction is only between CO_2 refrigeration and storage tank

5. Safety ensured by thermal storage equipment
   Thermal storage equipment is installed outside
   Leaked refrigerant have no influence on the inside of building

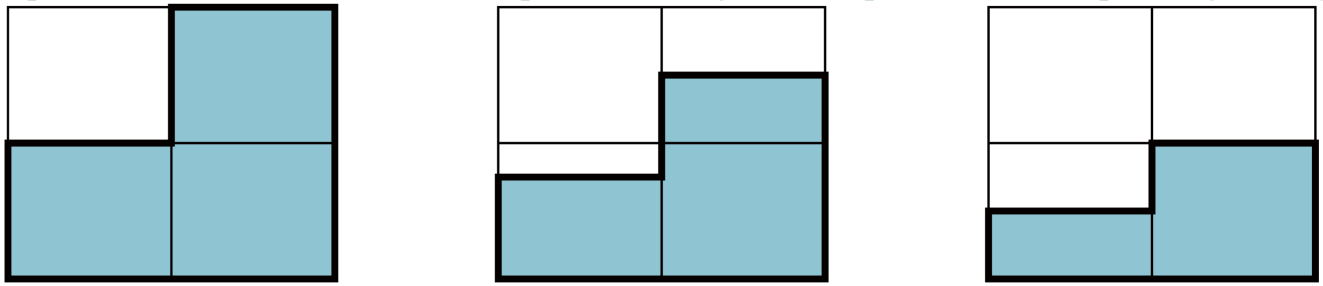
6. Equipment troubles correspondence
   Backup by plural refrigerators for storage
   Maintained cooling performance by accumulated cooling energy

Merits of using thermal storage

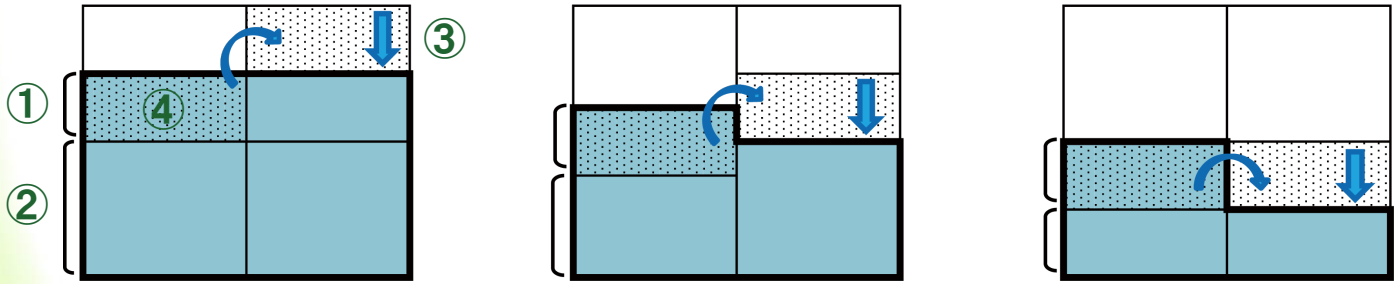
▪Assumed heat load



▪Operational conditions of direct expansion refrigerator（Operations corresponding to only heat load）



▪Operational conditions of thermal storage refrigerator



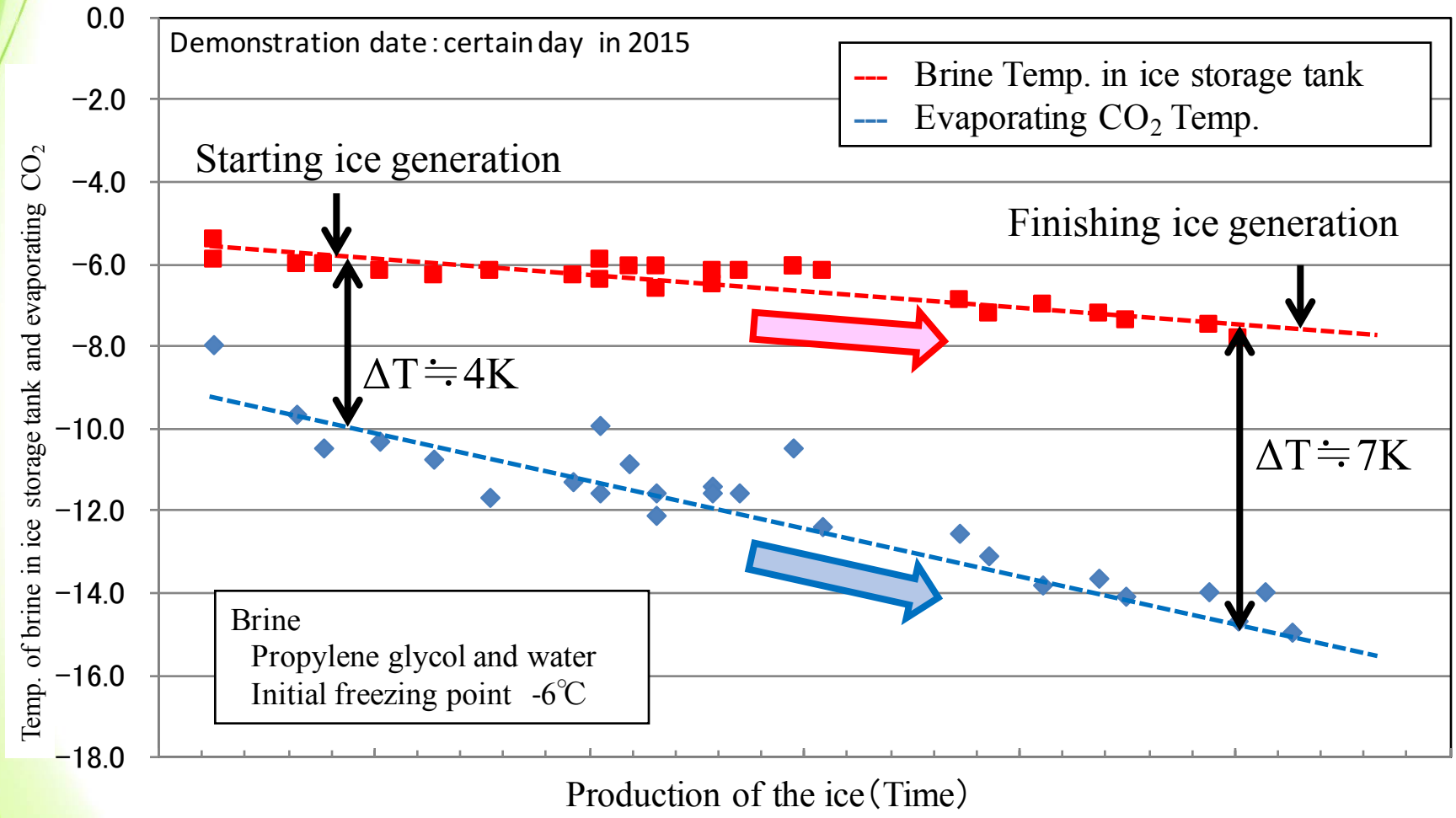
①Thermal storage refrigerators
②Refrigerators for daytime and nighttime
③Reducing power demand and refrigerator capacity
④Storage（High COP）

CO_2UEI demonstration for energy and economic efficiency

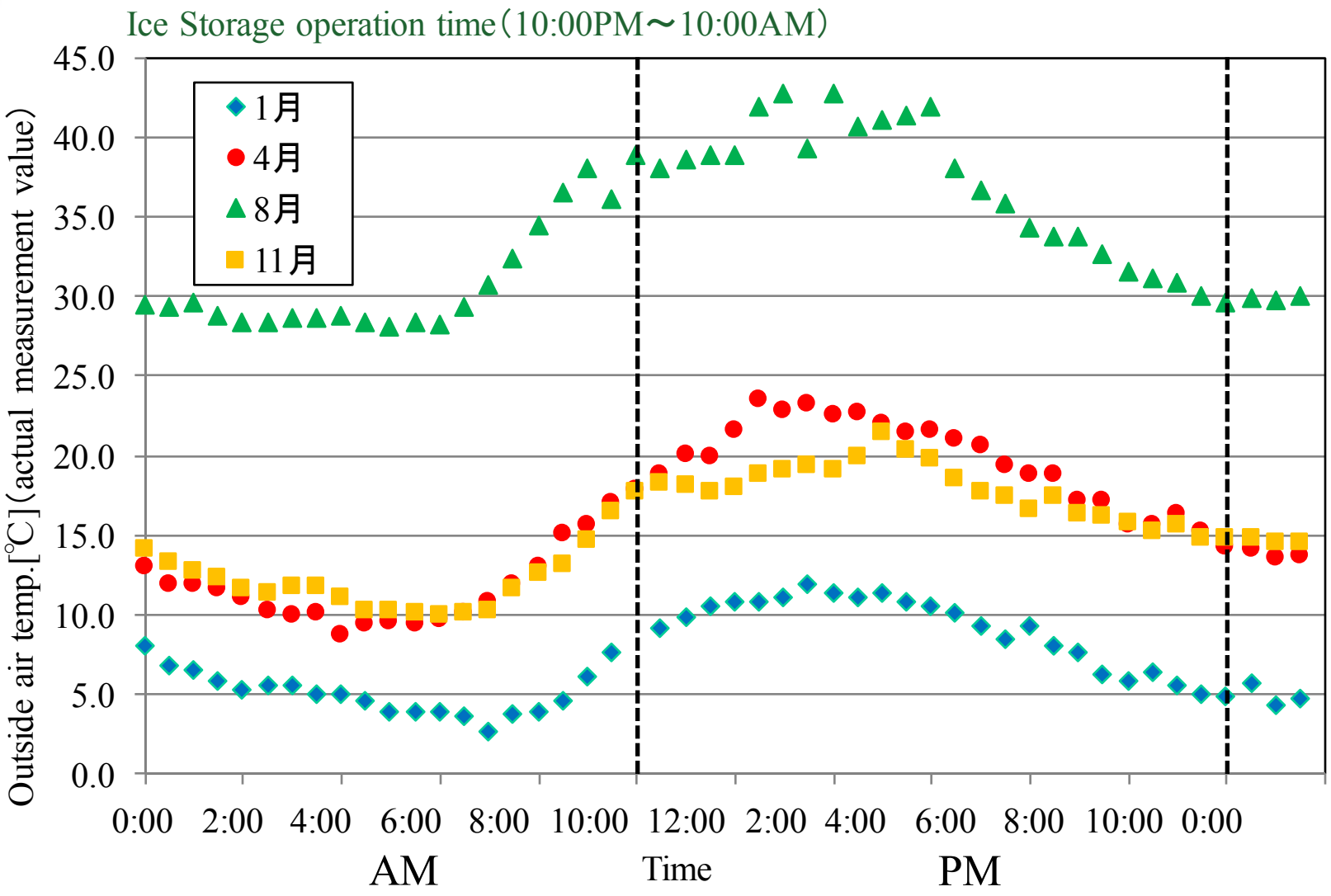
Ice storage operation

- Increasing propylene glycol conc. and decreasing brine freezing point by ice generation
- Decreasing heat transfer performance between brine and refrigerant and CO_2 Temp. by ice generation

⇒Brine and CO_2 temp. curves are almost constant throughout the year



Outside air Temp.（actual measurement value）



（Data:365 days per 30minutes in certain year）

Energy and economic efficiency of CO_2UEI

1.Energy efficiency
(Brine-ice storage refrigerator during nighttime vs DX refrigerator during daytime)

<Conditions>
・DX refrigeration（non storage） operation
Air temp. : 10:00am～10:00pm actual measurement value throughout the year
Evaporation Temp.（Te）: assuming Ave. Te -10℃

・Brine-ice storage operation
Air temp. : 10:00pm～10:00am actual measurement value throughout the year
Evaporation Temp.（Te）: using Te of UEI demonstration（Te -10～-15℃）

<COP a year of DX and brine-ice storage refrigerator>
・DX refrigerator :2.55
・Brine-ice storage refrigerator :2.78 ⇒Energy efficiency : △9.0[%] (△kWh)

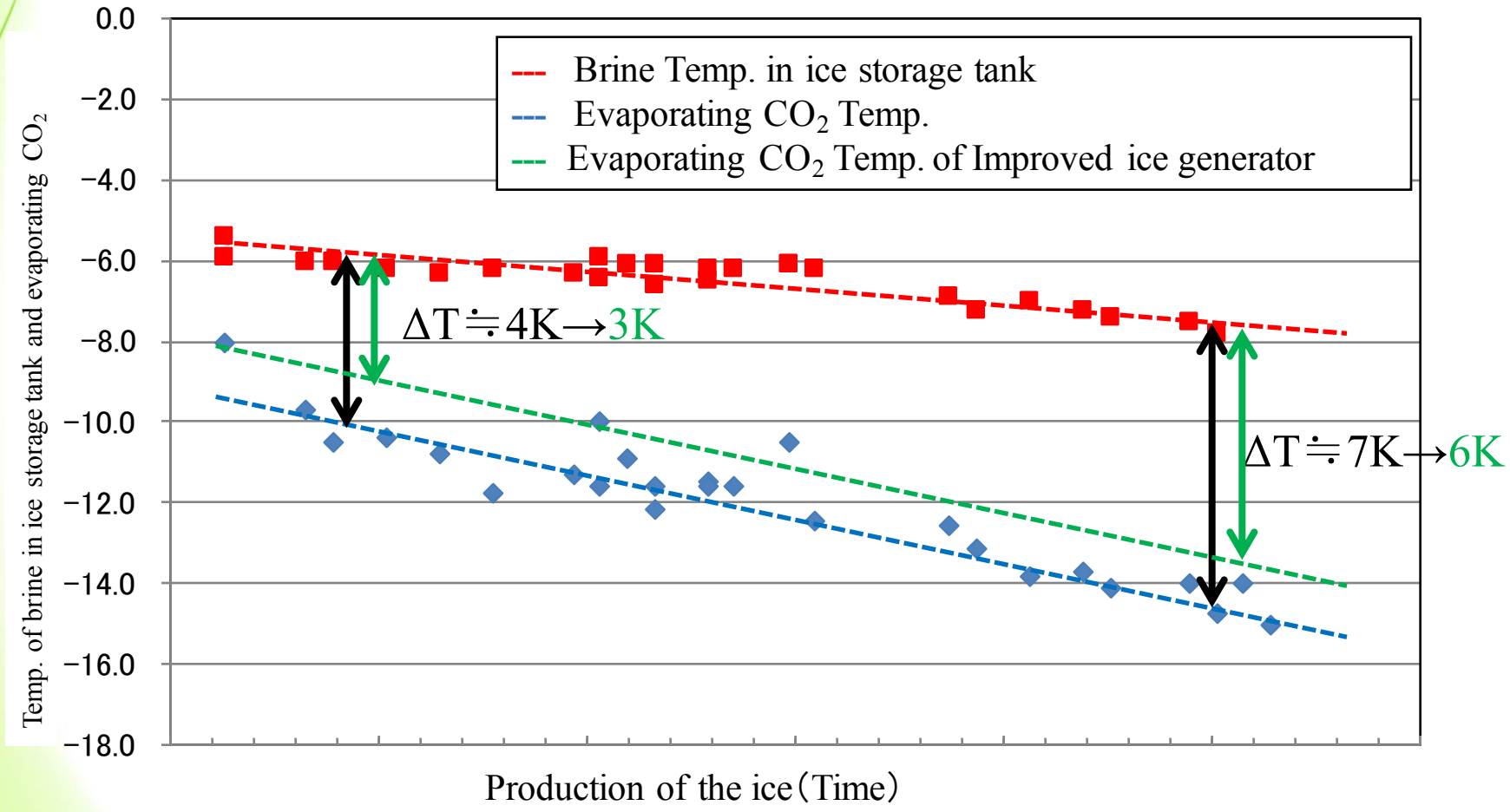
2. Electric power consumption down
Effect of increasing of COP etc. : △30[%] (△kW)

3. Refrigeration capacity down(kW)
Effect of increasing of COP and leveling of refrigerator operation : △35[%] (△kW)

Further development of CO_2UEI

Self-developed brine-ice storage generator for CO_2 refrigerant

August, 2015 Production of brine-ice storage generator for CO_2 (prototype)
2016 Improvement of brine-ice storage generator for CO_2
Target of energy efficiency ＞△10%



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Thank you very much!