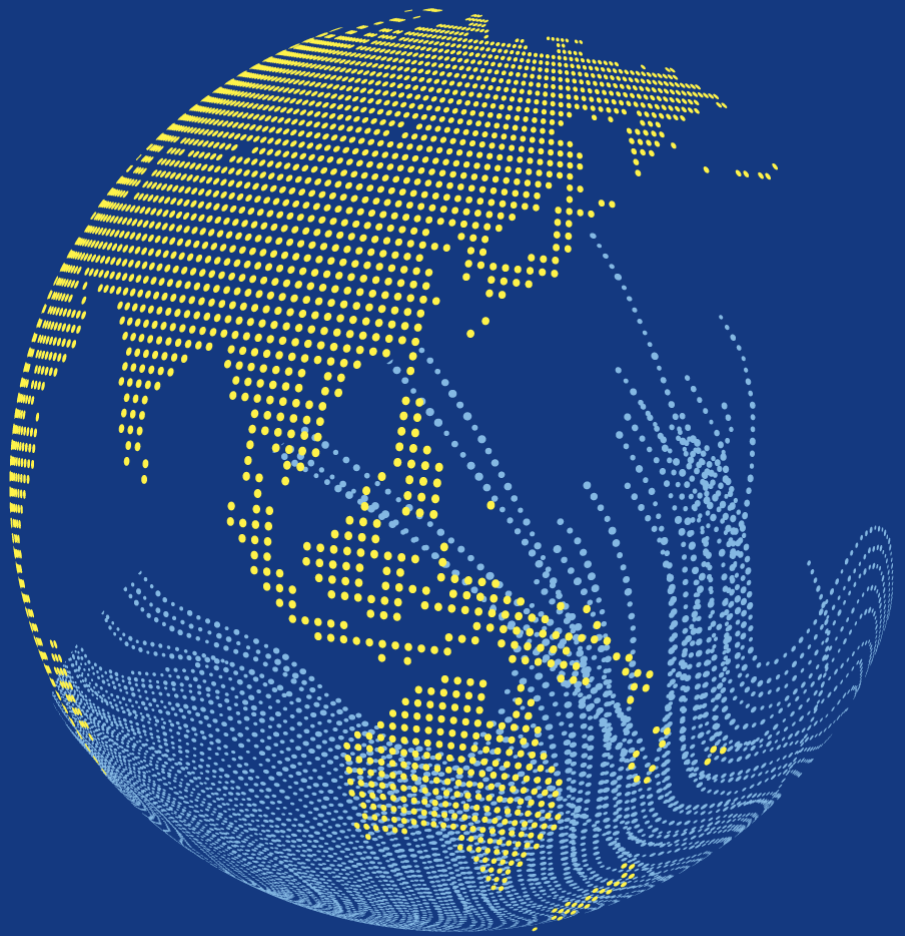
ATMOsphere JAPAN

Business Case for Natural Refrigerants



12/02/2019

TOKYO

Technical initiatives for further spread of CO_2 refrigeration system

— Water cooling condensing unit with heat reclaim,
TC CO2 Rack System for Large warehouse & solution for store renovation —

Panasonic Appliances Company
Cold Chain Business Division
General Manager Manabu Onishi

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Agenda

1) Background & Achievement

2) Technical Strategy for CO_2 system

3) Technical development for encouraging further spread of CO_2 system

4) Issues & Action Plan

Background & Achievement of CO2 system

Our CO2 system was promoted by government support and its high evaluation

2005 Participated in METI (NEDO) project

⇩ Basic research period

2009 Started Field Test in supermarkets

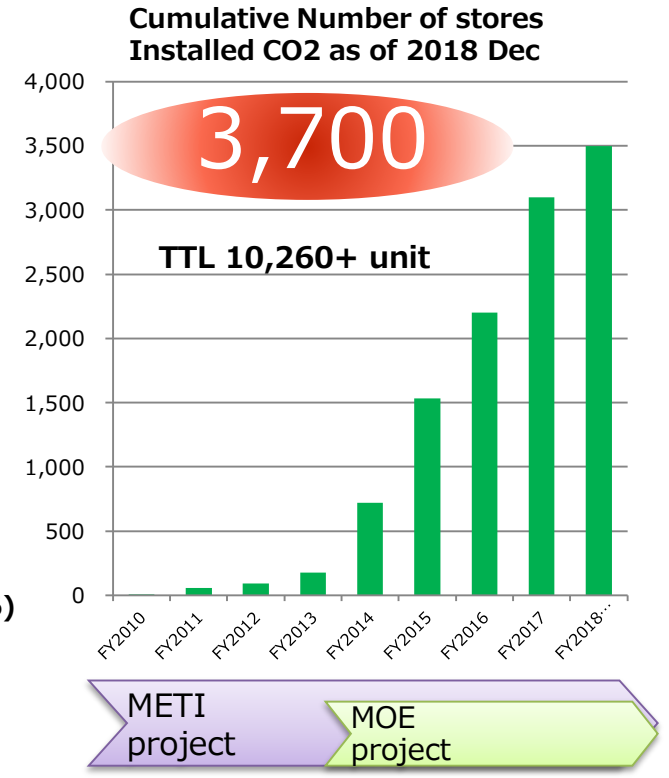
2010 Launched CO2 condensing unit
- ★Grand Prize for Ozone Layer Protection & Global Warming Prevention (2010)
- ★Energy Conservation Grand Prize (2013)

2014 MOE project "Energy efficient refrigeration and Air-conditioning Equipment based on Natural Refrigerant Good Practices" accelerated further spread
- ★Electrical Science and Engineering Promotion Award (2014)
- ★Chairman Prize of ECCJ (2014)

2015 Launched Pressure Adjust Control type CO2 condensing unit & side flow type 10HP condensing unit
- ★Grand Prize for Ozone Layer protection & Global Warming Prevention (2015)
- ★MOE Mister Prize for Global Warming Prevention Activity (2016)

2016 Started exporting 2 HP condensing unit to Europe (2018 : 10HP)

2018 Launched 30HP Cascade system



CO_2 system installation (Overseas)

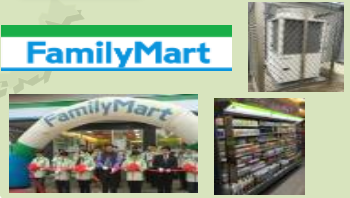
Europe

EU : +250 PJs

China/Asia

13 stores installed

1 store installed (2016 Jan)



1 store installed (2017 May)

13 stores installed (2015 May)

Already installed in China, Taiwan, Indoensia & Malaysia

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CO_2 system installation (Europe)

OCU-CR1000VF8（10HP）

OCU-CR200VF5（2HP）

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EU : +250 PJs

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CO_2 system installation (China)

2018 July : PAPRSDL CO_2 RACK system @CSF Market (Beijing)

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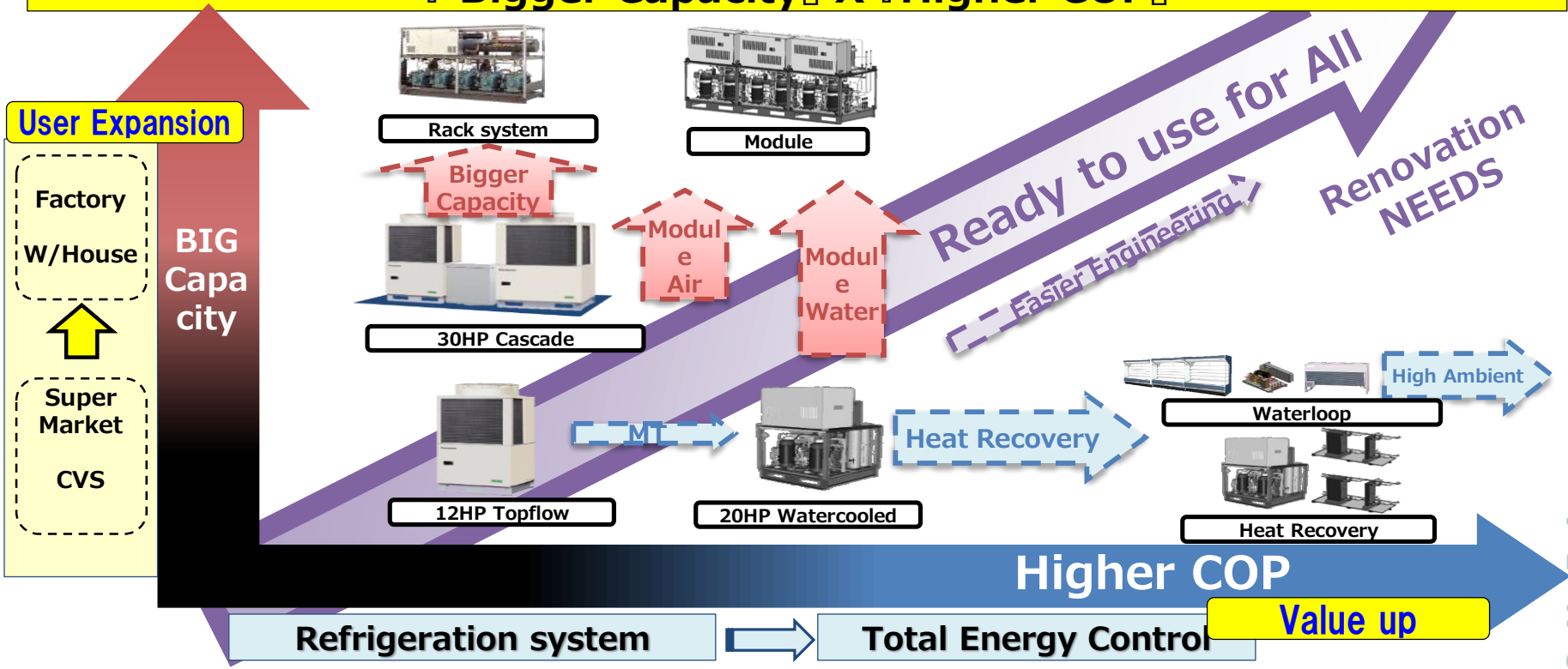
CO2 Refrigeration System Development

『 Bigger Capacity』X『Higher COP』



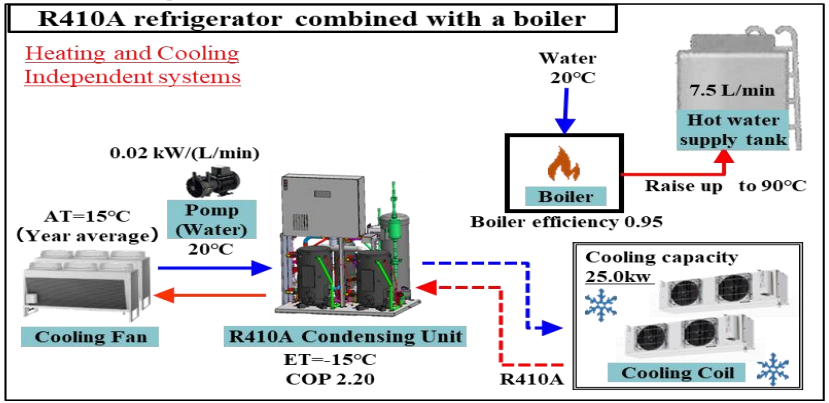
Technology development for encouraging further spread of CO_2 system

1. Further energy saving (better Customer Value)
- Total energy saving by heat reclaim

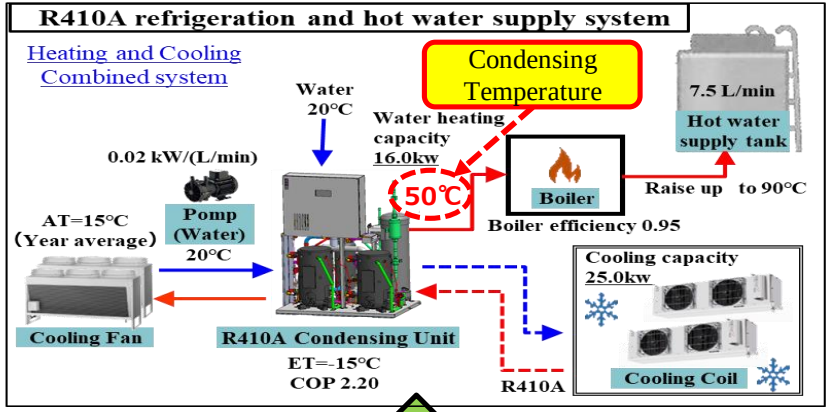
1. Capacity Maximization (for various customers)
- Large-scale project such as logistics warehouse etc
- Wider line-ups to fulfill customer's requirement

3. Solution for store renovation (Further spread)
- Reduction of man-hours for installation

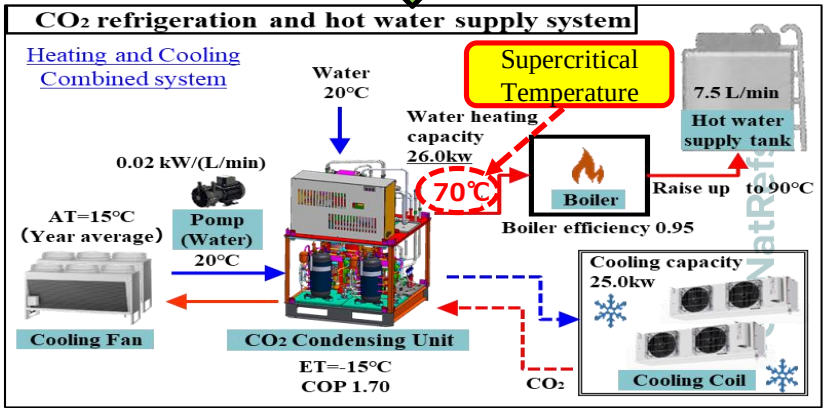
CO2 water-cooled system with heat reclaim



Difference in
Configuration



Difference in
Refrigerant



- **Energy saving**
  Input energy ⇒ Boiler, Cooling fan, Pump, Condensing unit
- **Environmental impact**
  CO_2 emission ⇒ Direct impact (Refrigerant leakage)
  Indirect impact (Electric power, Heavy oil)

【Estimation condition】

Electric power CO_2 emission factor : 0.5 kg-CO_2/kWh
Heavy oil CO_2 emission factor : 2.7 kg-CO_2/L
Refrigerant leak rate : 16 %

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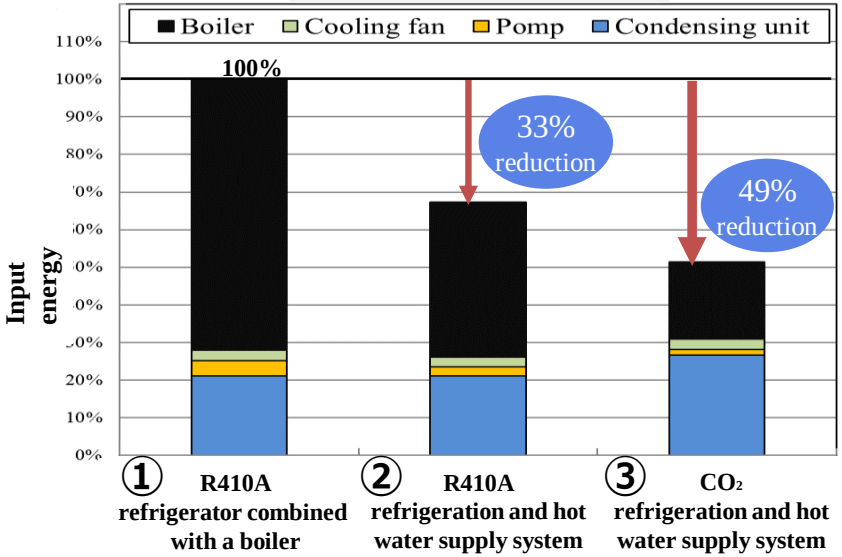
CO2 water-cooled system with heat reclaim

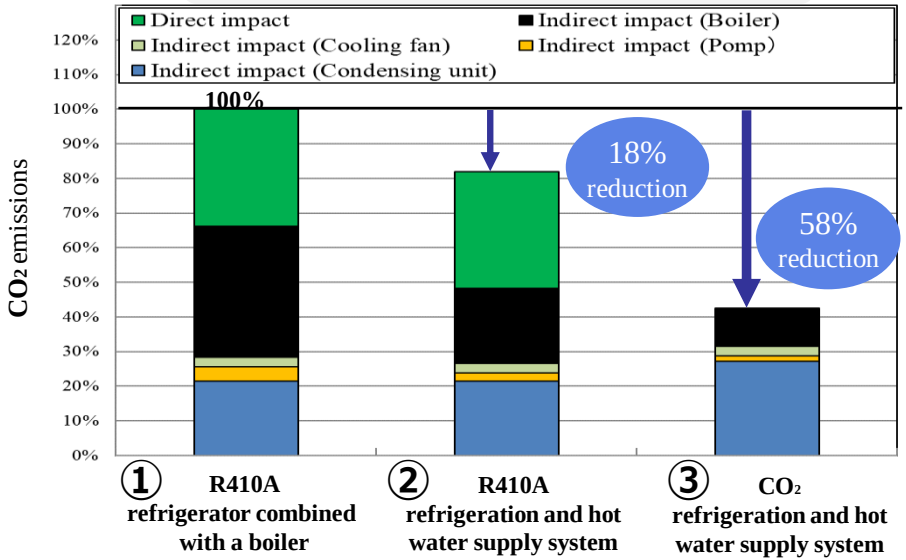
Energy saving



② Boiler input reduction

③ Increased condensing unit input but significant boiler input reduction

Environmental impact



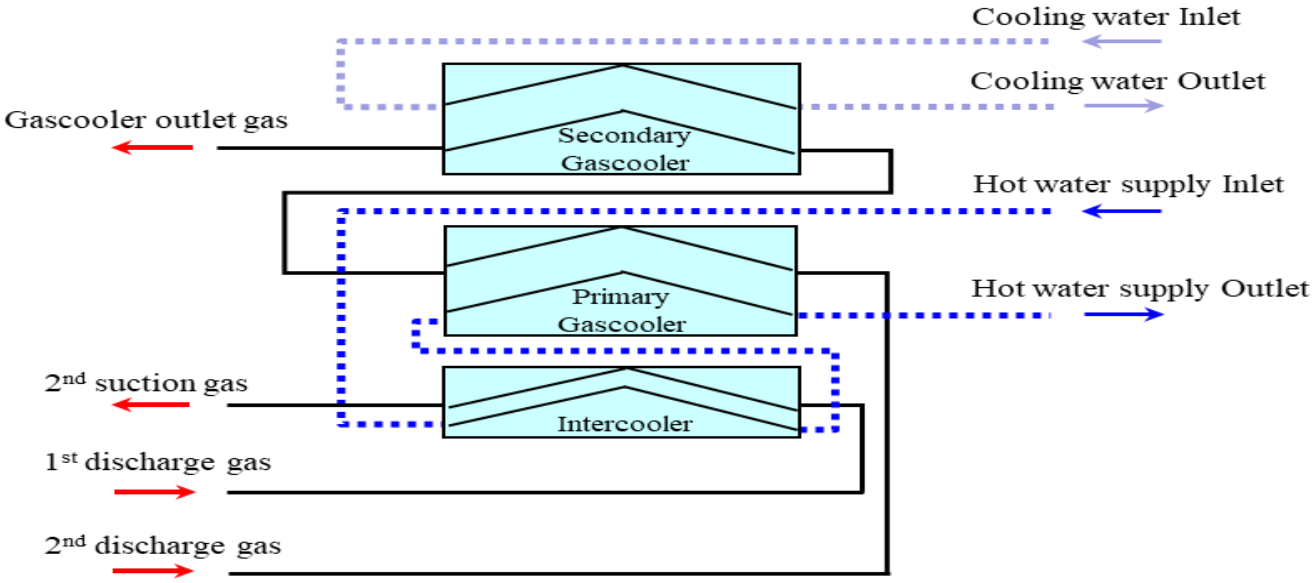
② Boiler input reduction

③ Since the GWP of the CO_2 is 1/2090 of the R410A , it is negligibly small

Both of energy saving and environmental impact are significantly reduced

CO2 water-cooled system with heat reclaim

Configuration of heat exchangers



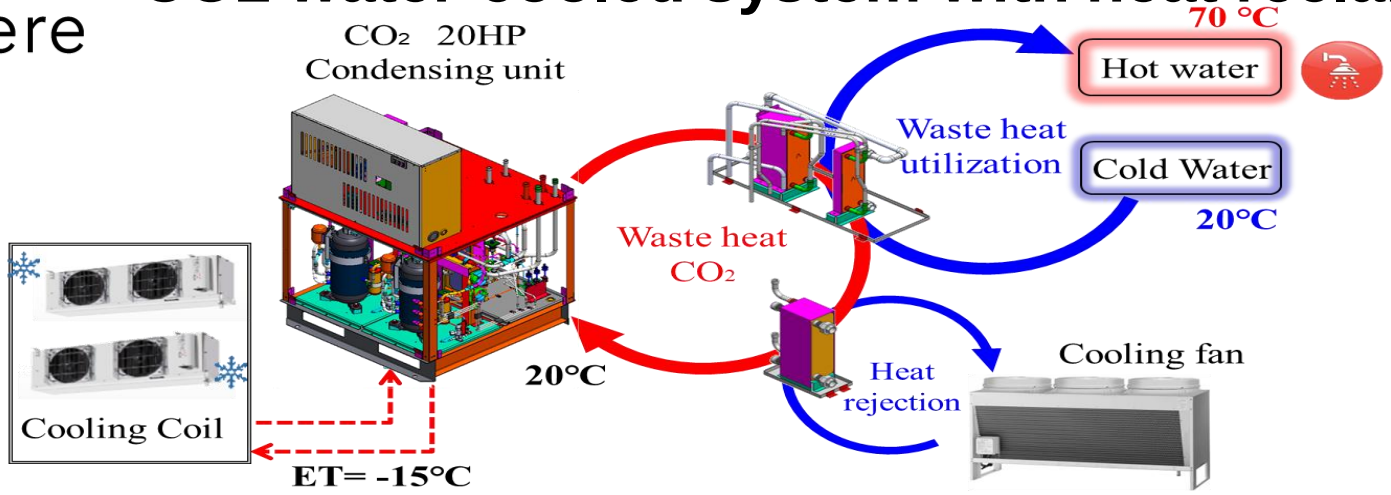
Problems for supplying high temperature hot water

Since the amount of water is reduced, insufficient cooling performance

⇒ Enhance the effect of “Split cycle” by flowing water the intercooler first

⇒ Cooling performance was secured by providing cooling water to the secondary gas cooler and exhausting heat

CO2 water-cooled system with heat reclaim



Cooling side		Heating side	
High pressure [MPa]	10.1	Hot water supply inlet [°C]	20.5
Low pressure [MPa]	2.19	Hot water supply outlet [°C]	70.4
2nd discharge gas [°C]	93.7	Water heating capacity [kW]	29.4
Gascooler outlet gas [°C]	20.9	Hot water supply amount [L/min]	8.5
Cooling capacity [kW]	28.2	Cooling water inlet [°C]	20.7
Condensing Unit input [kW]	16.2	Cooling water outlet [°C]	25.7
COP [-]	1.74	Rejected heat [kW]	15.0

Even when supplying hot water, sufficient cooling performance was secured

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Technology development for encouraging further spread of CO_2 system

1. Further energy saving (better Customer Value)
   ・Total energy saving by heat reclaim

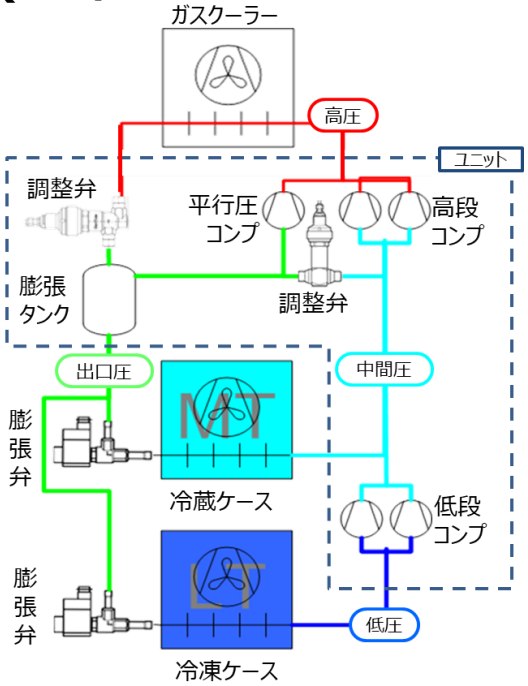
1. Capacity Maximization (for various customers)
   ・Large-scale project such as logistics warehouse etc
   ・Wider line-ups to fulfill customer's requirement

3. Solution for store renovation (Further spread)
   ・Reduction of man-hours for installation

TC CO_2 Rack system

- **Installation in China**

  TC CO2 Rack system (booster) (MT/LT)



Produced in PAPRSDL

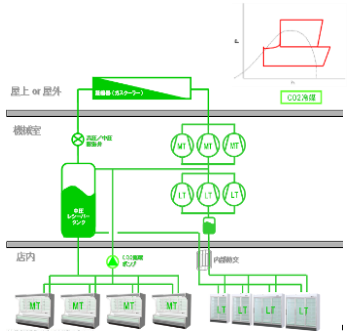
TC CO_2 Rack system

■Specification comparison

TC CO_2 Rack System (Booster) [Large unit]

System Type : Indoor（Gas cooler: Outdoor）Centralized Large system
（= RACK System, “Rack”）
Compression type : Booster（2 stage compression by multiple compressors

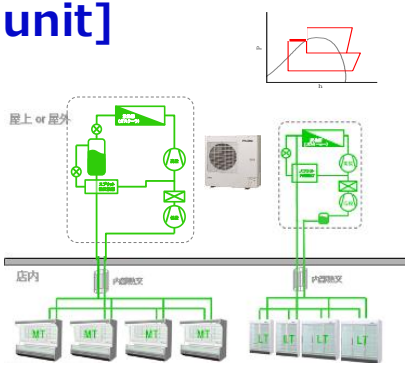
<Feature>・Centralized 2 system for MT+LT
・For large facility (Not for small one)
・Large amount of refrigerant
・Iron or Stainless piping



TC CO_2 Outdoor Condensing Unit [Small/Medium unit]

System Type : Outdoor（Package unit）Distributed small/Medium system
（= Outdoor Condensing Unit, “OCU”）
Compression type : 2 stage compression rotary
(single compressor for 2 stage compression)

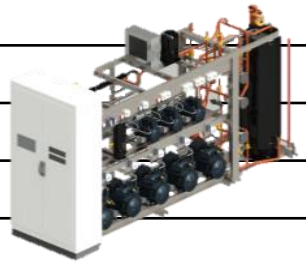
<Feature>・Flexible installation for both MT/LT system
・For Small & Mid facility
(Need large number of units for large facility)
・Small amount of refrigerant
・Compact design due to outdoor package unit, Easy to install



TC CO_2 Rack system

■ CO_2 Rack for large warehouse

Power Source	3 phase 50/60HZ – 200V	
AT (as rated condition)	+32℃	
ET range	-45℃ ～ -20℃	
AT range	-15℃～+43℃	
Rated Output	**≒ 50HP**	**≒ 80HP**
Regal Ref. ton	**15.1 tons**	**18.9 tons**
Comp. Q'ty (MT/LT)	4 (2/2)	4 (2/2)
Cooling Capacity Et=－32℃	**41.7 kw**	**63 kw**
Cooling Capacity Et=－40℃	29.1 kw	43.2 kw



≒ OCU-HS 20HP × 2 units
or OCU-CR 10HP × 5 units

≒ OCU-HS 40HP × 2 units
or OCU-CR 15HP × 6 units

Launching 50HP & 80HP for LT application

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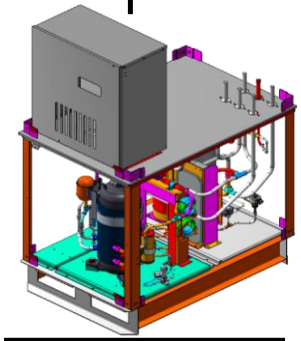
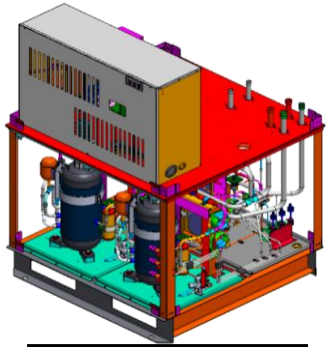
CO2 unit modularization

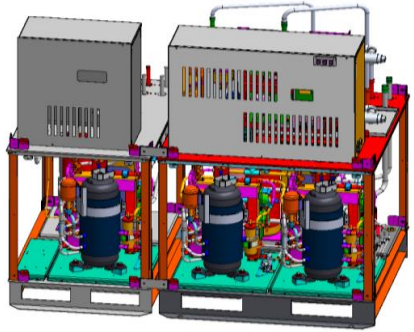


10HP Module

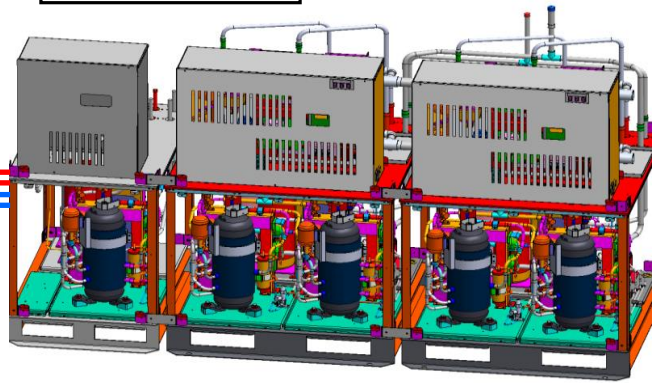


20HP Module

30HP Indoor



50HP Indoor



MT

LT

①Realizing various combination of larger output power system by utilizing standardized CO2 unit

②Flexible and variable combination by multiple connection

③NO NEED to submit report to authority if output power is below 100HP because of other manufacturers

Technology development for encouraging further spread of CO_2 system

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   ・Total energy saving by heat reclaim

1. Capacity Maximization (for various customers)
   ・Large-scale project such as logistics warehouse etc
   ・Wider line-ups to fulfill customer's requirement

3. Solution for store renovation （Further spread)
   ・Reduction of man-hours for installation

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Example of Store renovation

FUJI CO., LTD

Full Store Renovation without store close

■Store Information

Grand Fuji Matsuyama

■Address	:Miyanishi1-2-1, Matsuyama
■Store Open	:2017/3/1(Renovation)
■Floor Space	:28,433㎡
■Open Hour	:9:00～23:00

■CO2 Condensing unit :
20HP×9、15HP×4、10HP×1

■Showcase : 122

■Energy saving : approx. 52%(vs previous R22 system)

■CO2 Emission reduction :approx. 375 ton(2017 result)

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Example of Store renovation

FUJI CO., LTD

Full Store Renovation without store close

■Construction Method

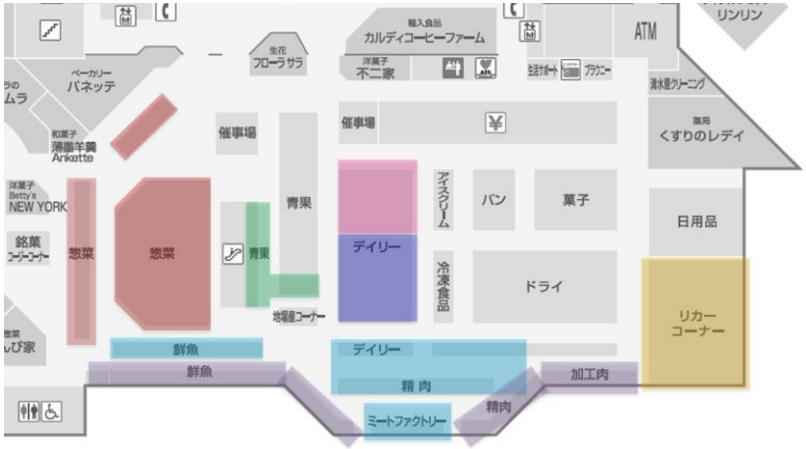
Daily progress method

Duration: 2 months
Showcase renovation: Partial renovation with temporal enclose in store from a month ago

■The most important point
Explain well to the customer
about schedule & installation method

■Necessary point to run Daily progress method
- Prior construction
- Confirm other condition provided by store

<Temporal enclose Image>



Example of Store renovation

Analysis and issue（system by system renovation without store close)

（１）Prior construction（Secure installation space of CO2 unit and install new piping）
- CO2 unit Installation
- Install new Power Distribution Board（Main cable connection is construction work）
- Electrical & refrigerant piping construction between CO2 unit and showcase

（２）Showcase replace

Store close（PM10:00）→ Store product Removal → Showcase change（old to new）
→ complete electrical & piping connection（N+1day AM5:00）

（３）Commissioning

①HFC unit

②CO_2 unit

※120min longer than HFC ⇒ Item TO BE improved（Consider to shorten each installation process）

Issues & Action Plan

Product Development

・Capacity Maximization ： Introduce even larger capacity line-up
・Energy Saving ： Total Thermal Utilization by heat reclaim and optimum control

CO2 Family Formation

・Solution for Store Renovation : Collaborative Development of Tools for efficient installation
・Installation Training ： Continue efforts for training & Set up Certification rules
・Combination with other Show-case OEMs : Develop the Controller to enable the operation

Further Cost Reduction

・Accelerate the Value Engineering at every aspects (Material, Parts, Installation & System)

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Business Case for Natural Refrigerants

Thank you for listening.