NEDO

MINISTERIO
DE ECONOMÍA, INDUSTRIA
Y COMPETITIVIDAD

CDTI Centro para el Desarrollo Tecnológico Industrial

Development of high temperature Heat Pumps using a low GWP refrigerant

2018.2.13
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MAYEKAWA Mfg. Co., Ltd.

MAYEKAWA MYCOM

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MAYEKAWA's Proposal with [Natural Five]

[Natural Five] are natural refrigerants utilized for refrigerators & Heat Pumps to achieve both **[Energy Saving]** and **[No Use of Fluorocarbons]** .

Mayekawa has developed wide range of application with **[Natural Five]**.

Air

Air Cycle refrigerator
"PascalAir"

NH_3

NH_3/CO_2 Indirect Cooling System
"NewTon"

CO_2

CO_2 Heat pump
"unimo"

H_2O

Adsorption Refrigerator
"AdRef-Noa"

HC

Air-conditioning/Water-supply
Heat Pump

MAYEKAWA's Proposal with [Natural Five]

[Natural Five] are natural refrigerants utilized for refrigerators & Heat Pumps to achieve both **[Energy Saving]** and **[No Use of Fluorocarbons]** .

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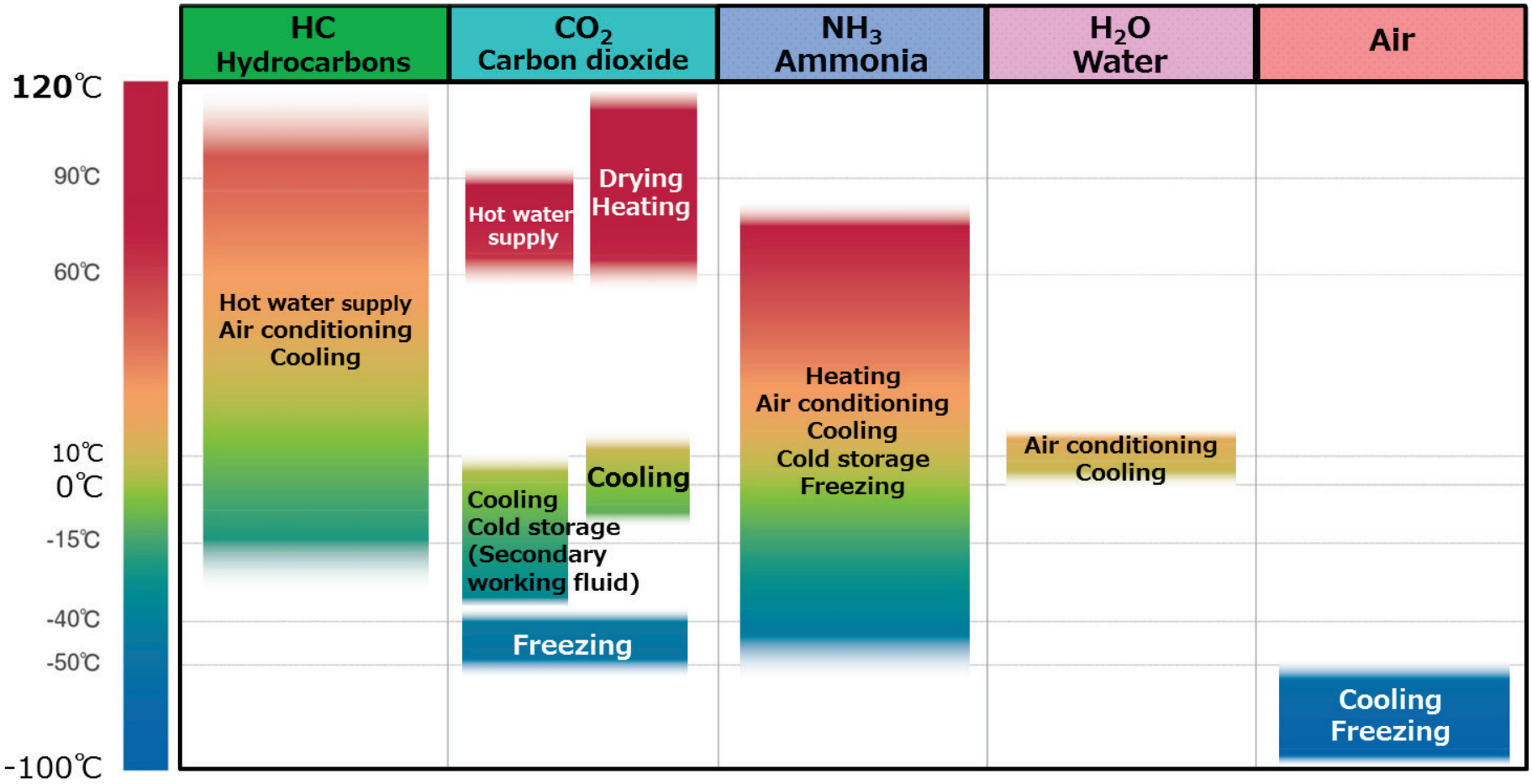

MAYEKAWA's Refrigerators and Heat Pumps using Natural Refrigerants

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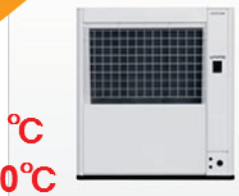
Steam Expander

HC

H_2O

+180℃



Air +120 ℃
Water +90℃

NH_3 Heat pump

HC Heat Pump

+150℃

CO_2 Heat Pump "unimo"

+50℃

CO_2

H_2O

NewTon

NH_3

NH_3/CO_2
"NewTon"

+5℃

Adsorption Chillers

CHRIS

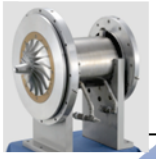
CO_2 Heat Pump
Desiccant Dehumidifier

REABEL

MAYEKAWA SIERRA-W

-50℃

Turbo
Comp.&Exp.



NH_3-CO_2 Cascade

NH_3 –Ethane Cascade

Refrigerator

He
Compressors

-95℃

-120℃

Air Cycle
"Pascal Air"

Air

He

-208℃

Brayton refrigerator

Ne

-271℃

-269℃

Helium Refrigerator, Helium Compressor

NH_3/CO_2 Indirect Cooling System *"NewTon"*

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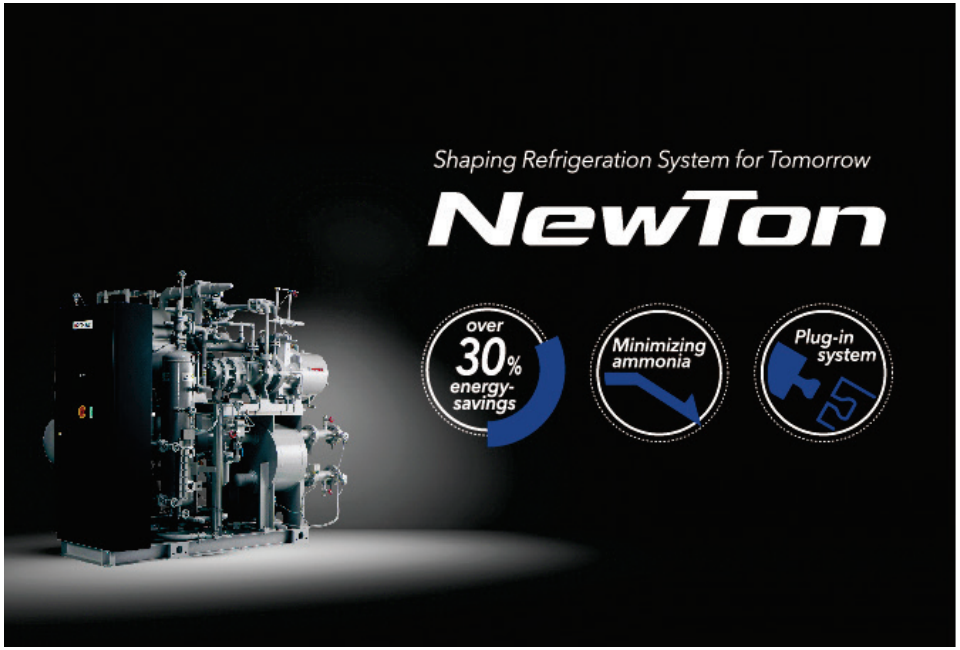
NewTon



Compound Screw Compressor for *NewTon*-R,F

Single-stage Screw Compressor for *NewTon*-C

Energy Saving

- IPM Motor-driven Semi-Hermetic Screw Compressor
- Matrix Converter for IPM Motor
- New Screw Profile for NH_3
- *Shell&Plate Heat Exchanger*

Safety

- "Indirect Cooling" method minimizing NH_3 circulation area
- Minimum NH_3 Charge:21kg(R-3000)
- *Bellows valves*

Compact

- Downsizing:24% less in weight
- Packaging for shorter installation

Support

- Remote Monitoring for Predictive Maintenance
- Maintenance Support 24hr/365day

"NewTon" Products Line-up

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Application		Type (Capacity)	Liquid CO_2 supply
Cold Warehouse	Frozen	Reabel (37.6kW) R-3000 (94.7kW) R-6000 (189.4kW) R-8000 (270.0kW)	CO_2 supply: -32℃ (in-house temp. : -25℃)
	Chilled	Sierra (24.1kW) C (237.0kW)	CO_2 supply: -5℃ (in-house temp. : -2℃)
Freezer		F-300 (70.0kW) F-600 (140.0kW) F-800 (170.0kW)	CO_2 supply: -42℃ (inside freezer : -35℃)
Ice Rink		S (185.0kW)	CO_2 supply: -11℃

NewTon R-3000, *NewTon* F-300

NewTon C, *NewTon* S

【Energy saving】
▲16～41%
【Installation】
as of 2017
1,495sets

"NewTon" Installation

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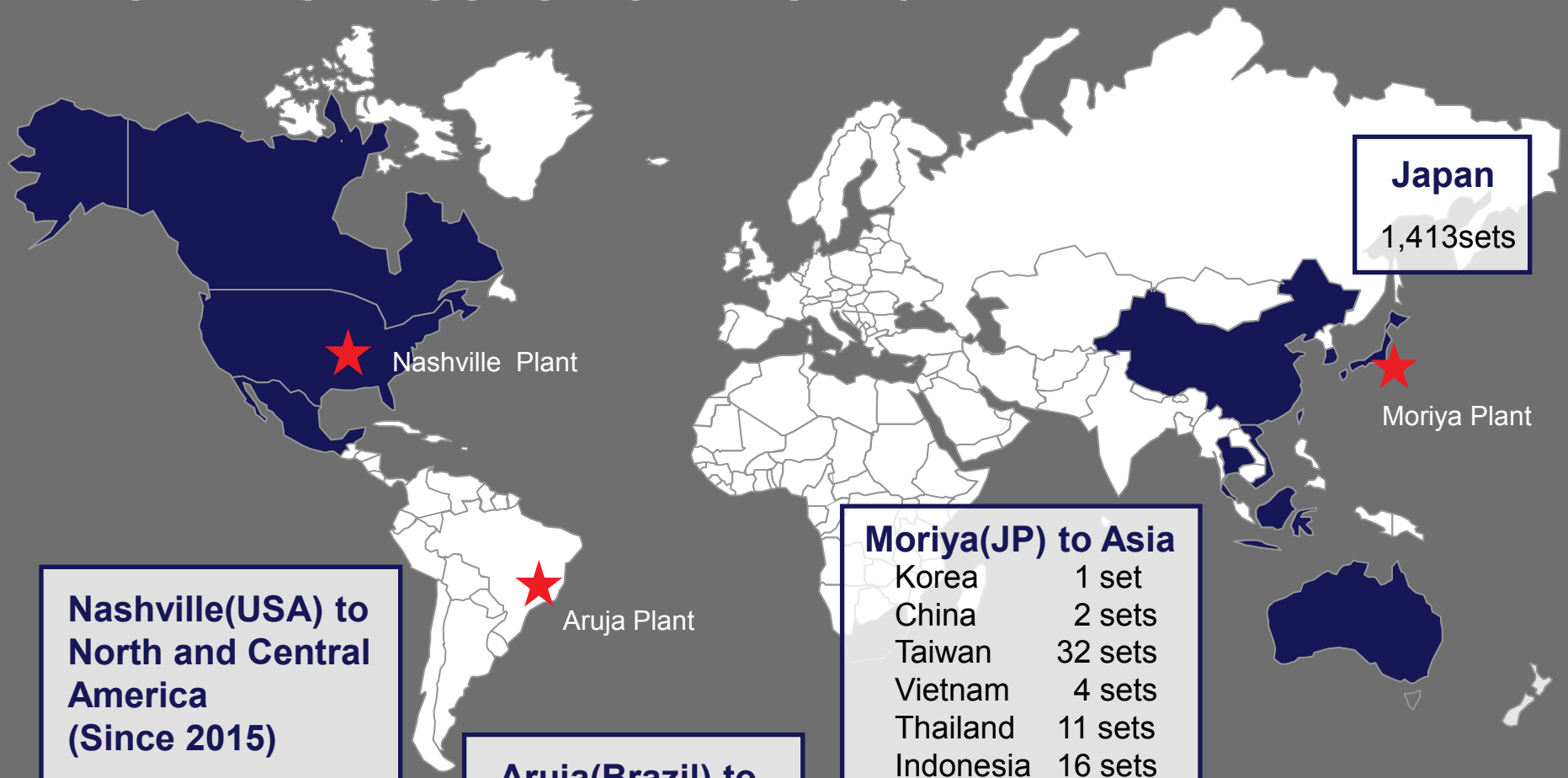
NewTon

NewTon to the World



Japan
1,413sets

Nashville(USA) to North and Central America (Since 2015)

Canada	4sets
USA	2sets
Mexico	1set

Aruja(Brazil) to South America (Near future)

Moriya(JP) to Asia

Korea	1 set
China	2 sets
Taiwan	32 sets
Vietnam	4 sets
Thailand	11 sets
Indonesia	16 sets
Australia	4 sets
Philippines	1 set
Myanmar	4 sets

CO_2 Heat Pump "unimo"

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unimo Products Line-up

Food Plant, Manufacturing Plant
Hotel, Hospital, Spa, etc.

unimo AW	unimo WW	unimo AWW	"Eco Sirocco"
Air-source "Eco Cute"	Water-source "Eco Cute"	Air-source/Water-source "Eco Cute"	Water-source CO_2 Heat Pump supplying Hot Air
			
Supply of Hot water 65℃~90℃	Supply of Hot water 65℃~90℃ And Cold water -9℃~35℃	Supply of Hot water 65℃~90℃ or Supply of Hot water 65℃~90℃ And Cold water -9℃~35℃	Supply of Hot air 80℃~120℃ and Cold water -9℃~35℃

Heat Pump (HP)･･･developing

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~Supply Temperature & Heat Capacity~

Heat Capacity [kW]

Supply Temperature [℃]

200℃ generation HP

Supply of Hot oil:
(heating medium)
160℃～200℃
Heat capacity：500kW
Compressor ：Turbo
One-way heating

150℃ generation HP

Supply of Hot oil:
(heating medium)
120℃～150℃
Heat capacity:260kW
Compressor ：Screw
Circulation heating

Circulation HP

Supply of Hot water:
65℃～90℃
Heat capacity：35kW
Compressor ：Scroll
Circulation heating

Circulation Heat Pump

Picture of test facility

Feature

- Low GWP refrigerants(GWP:1～4)
- Circulation heating(ΔT＝5～10℃)

Specifications (Design)

Item		Design value
Refrigerant		**HFO-1234ze(E) or HC-based**
Compressor		Scroll
Lubricating oil		PAG or PAO
Design pressure		3.5 MPaG
Heat capacity	90℃	35.0 kW ※1
	65℃	29.5 kW ※2
COP_h		3.0 ※1
Heat source temp.		40℃
Hot water temp.		**85℃ ⇒ 90℃**

※1 Heat source inlet temp.40℃,Hot water inlet temp.85℃
※2 Heat source inlet temp.25℃,Hot water inlet temp.60℃

Food Plant, Manufacturing Plant
Hospital etc.

150°C generation Heat Pump

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Research project sponsored by NEDO.

Feature

- Low GWP refrigerants(GWP:3)
- Circulation heating(ΔT＝5～20℃)

Specifications (Design)

Item	Design value
Refrigerant	**n-Pentane**
Compressor	Screw
Lubricating oil	PAG
Design pressure	2.0 MPaG
Heat capacity	260 kW
COP_h (Tc=160℃,Te=80℃)	3.0
Heat source temp.	90℃
Hot oil temp.	**130 ⇒ 150℃**

Picture of test facility

Food, Beverage, Pharmaceutical, Chemical industries etc.

200°C generation Heat Pump

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Feature

- Low GWP refrigerants(GWP:15)
- Magnetic bearing(No lubricating oil)

Picture of test facility

Specifications（Design）

Item	Design value
Refrigerant	**n-Butane**
Compressor	**Turbo**
Lubricating oil	**Not used**
Design pressure	6.0MPaG
Heat capacity	500kW
COP_h (hot oil 100℃/200℃)	3.5
Heat source temp.	80℃
Hot oil temp.	**100℃ ⇒ 200℃**

Food, Beverage, Pharmaceutical, Chemical industries etc.

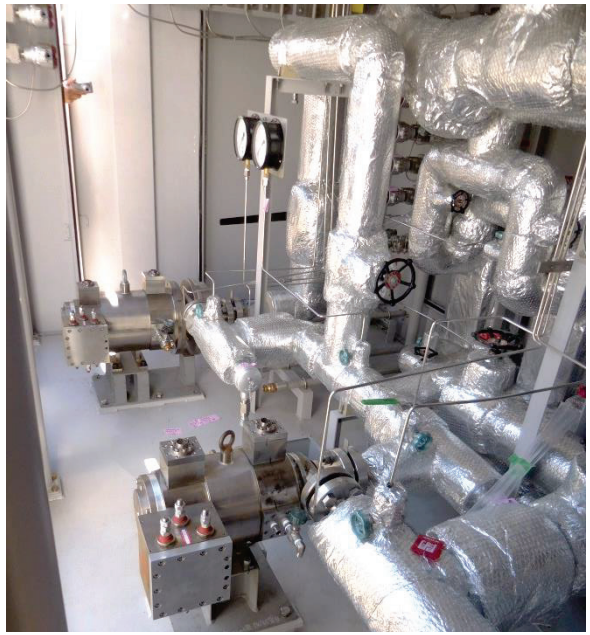
200°C generation Heat Pump

Research project sponsored by METI※ & NEDO.
10-year plan from 2013 to 2022.

※ METI:Ministry of Economy, Trade and Industry (Government of JAPAN)

- First 5 years : Hot oil temp. 80℃ ⇒ 160℃
- Last 5 years : Hot oil temp. 100℃ ⇒ 200℃

Developing heat pump to provide heat 160℃.(FY2017)



Mayekawa's challenges

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High temperature Heat Pumps using a low GWP refrigerant

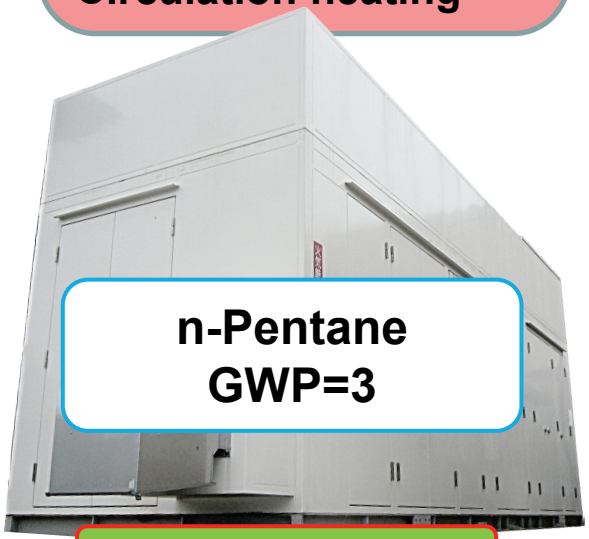
Circulation HP

Supply of Hot water:
65℃～90℃
Heat capacity：35kW
Compressor ：Scroll
Circulation heating

HC-based：GWP=4
HFO-1234ze(E)：GWP<1

150℃ generation HP

Supply of Hot oil:
(heating medium)
120℃～150℃
Heat capacity: 260kW
Compressor ：Screw
Circulation heating



n-Pentane
GWP=3

Sponsored by NEDO

200℃ generation HP

Supply of Hot oil:
(heating medium)
160℃～200℃
Heat capacity： 500kW
Compressor ：Turbo
One-way heating

n-Butane
GWP=15

Sponsored by METI & NEDO

※ GWP values based on the IPCC's 5th report or Ministry of the Environment report.

Thank you
for your attention

MAYEKAWA

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Web Site of MAYEKAWA

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http://www.mayekawa.eu/