

Minami-Osaka Sales Office of The Kansai Electric Power Company

Middle-size ZEB Office with Optimal Control
for Multi-split Type Air-conditioning System

The Kansai Electric Power Co., Inc.

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27. May. 2019



Outline of the Building

2

Street address	Sakai city, Osaka pref. Japan
Building use	Office
Site area	3,245 m ²
Building area	1,029 m ²
Total floor area	7,338 m ²
Construction	Steel frame
Number of Levels	8F
Completion	Aug. 2014
Air-conditioning	Multi-split Type Air-conditioning System



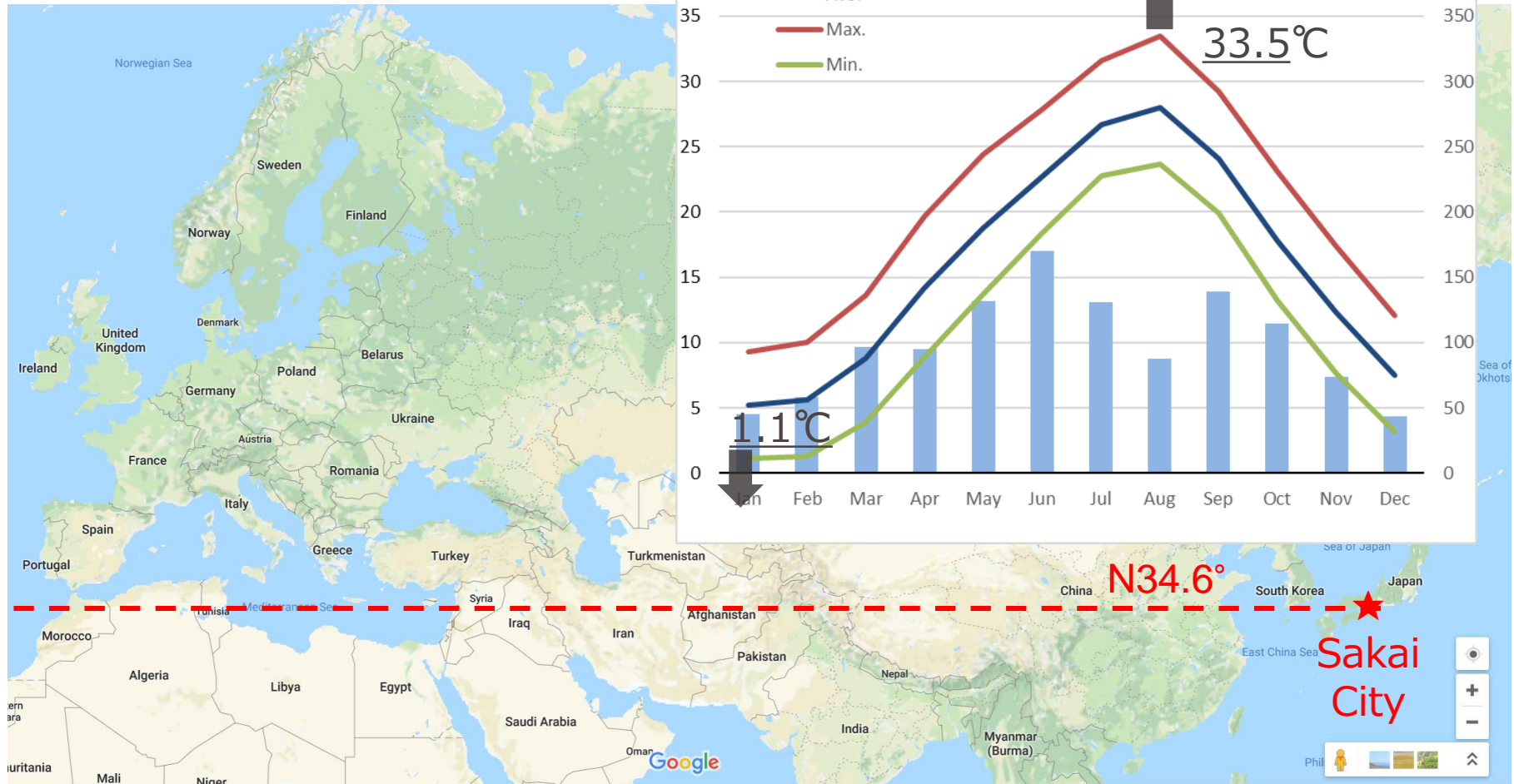
Location of Minami-Osaka Sales Office

3



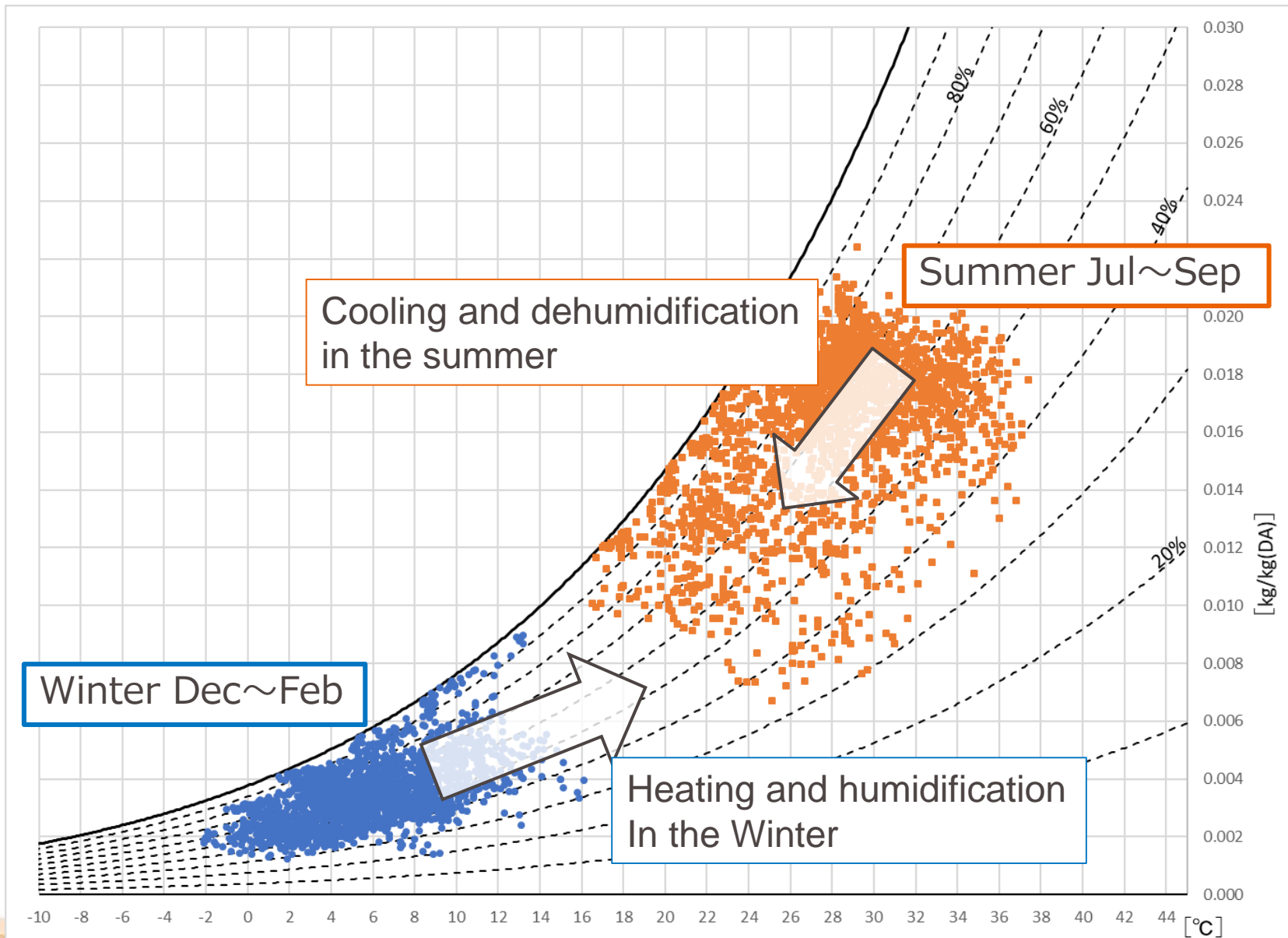
Weather conditions of Sakai city

4



Condition of outside air (Osaka 2018)

5



Standard floor plan (2F)

6

A non-air conditioned room such as a toilet and warehouse is located on the west side to shield the afternoon sunshine.

Roof insulation Polystyrene 50 mm

Outer wall insulation blowing urethane 50 mm
(Normally polystyrene 25 mm)

NW

SW

Meeting room

Office room

15m × 43m

No pillar

About 650m² (5.5m²/person)

NE

Solar radiation shielding by vertical louvers, eaves

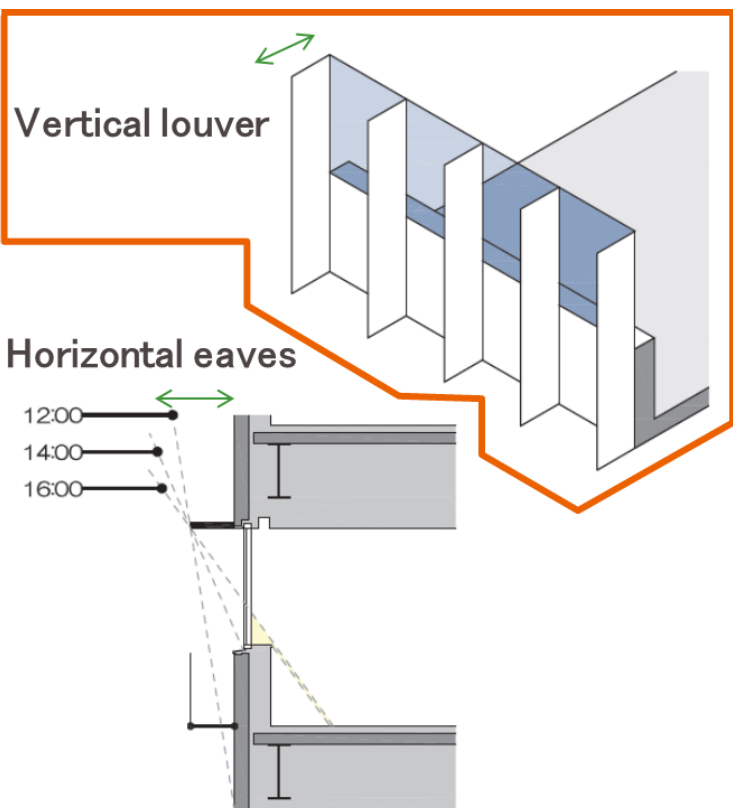
N

43.2m

Floor area about 1,020m²

SE

Adopt the Low-E double glazing



		Horizontal eaves					
		None		300mm		600mm	
Sensible heat load (W/m ²)		None		300mm		600mm	
Vertical louver	None	9:00	123	9:00	123	9:00	123
		12:00	147	12:00	139	12:00	139
		14:00	183	14:00	170	14:00	158
		16:00	190	16:00	182	16:00	173
		+67		+59		+50	
	300mm	9:00	123	9:00	123	9:00	123
		12:00	144	12:00	139	12:00	139
		14:00	179	14:00	168	14:00	156
		16:00	179	16:00	172	16:00	166
		+56		+49		+43	
	600mm	9:00	123	9:00	123	9:00	123
		12:00	142	12:00	139	12:00	139
		14:00	175	14:00	165	14:00	155
		16:00	167	16:00	163	16:00	159
		+52		+42		+36	

	Insulation	Glass	Eaves	Thermal load coefficient Case 1 = 100
Case 1	Wall 25mm Roof 50mm	Float 8mm	Absence	100
Case 2	Wall 25mm Roof 50mm	Pair 6mm	Absence	93.1
Case 3	Wall 50mm Roof 50mm	Pair 6mm	Absence	92.7
Case 4	Wall 50mm Roof 50mm	Low-E	Absence	83.5
Case 5	Wall 50mm Roof 50mm	Low-E	presence	80

Present situation

- ✓ Middle-size office in Japan, multi-split type air-conditioning system (EHP) is often used in general.
 - ✂In Japan, multi-split type air conditioning system driven by motor is called EHP.

Problems

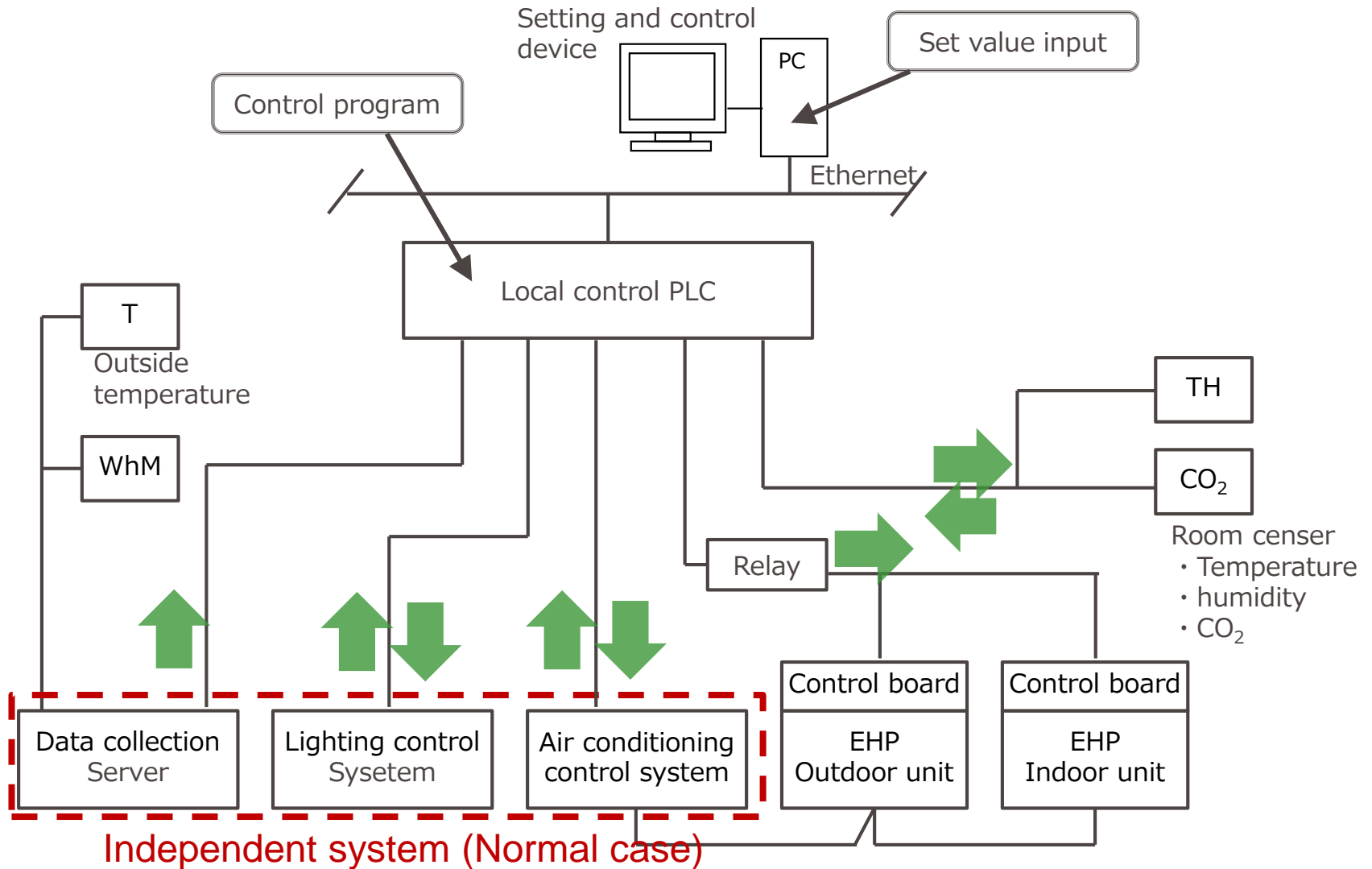
- ✓ There is no special operator in the middle-size office building.
- ✓ The control of EHP is left to only the manufacturer.

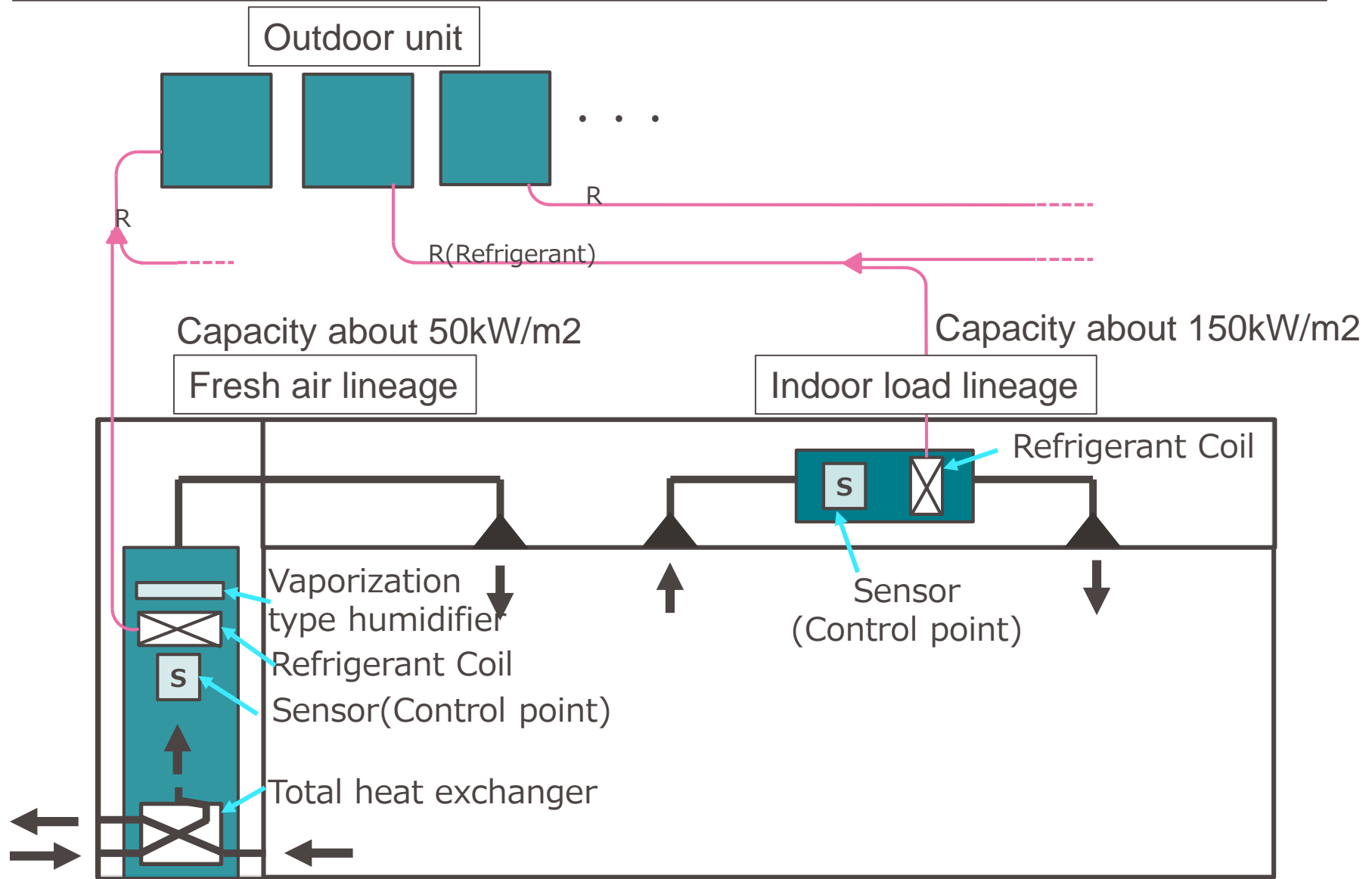
This time

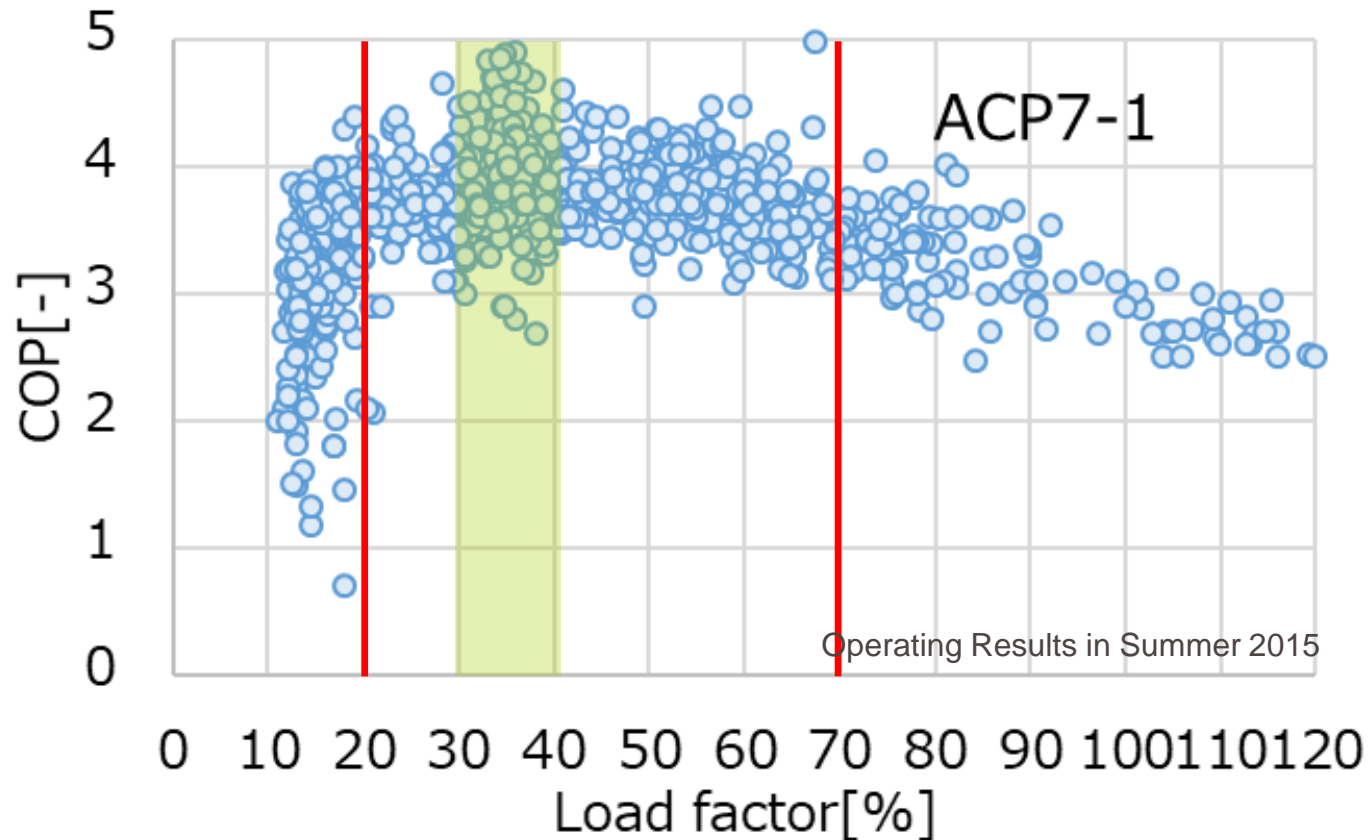
We developed a system to **send operation commands from the outside to the EHP**

- ✓ **High Efficiency Operation Control of EHP**
- ✓ **Optimum operation control of EHP's fresh air unit**
(Temperature and humidity control)
- ✓ Optimum operation control of EHP to take in fresh air
(CO2 concentration control)

Installed these control systems etc.,
aimed for ZEB at middle-size office building.

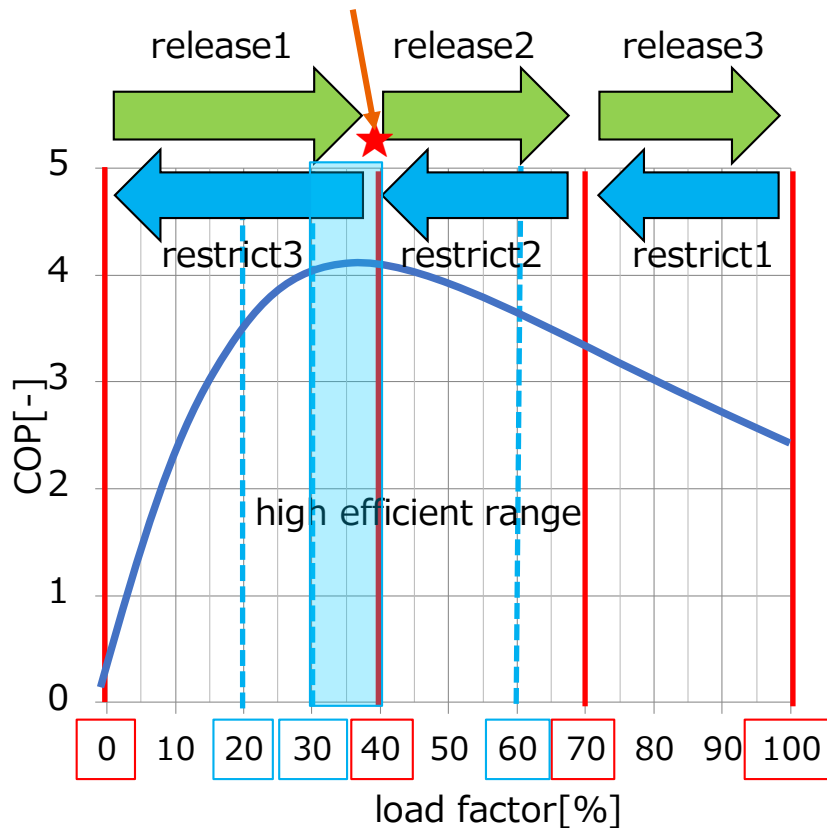






- ✓ High efficiency (Load factor is 30 ~ 40%)
- ✓ Efficiency is greatly reduced (Load factor is 20% or less)
- ✓ Efficiency is gradually reduced (Load factor is 40% or more)

START(40%)



■ release1~3

When the difference between the room temperature and the set temperature becomes 1°C or more, the capacity restriction of the outdoor unit is released step by step.

■ restrict1

When the load factor becomes 60% or less, the capacity of the outdoor unit is restricted from 100% to 70%.

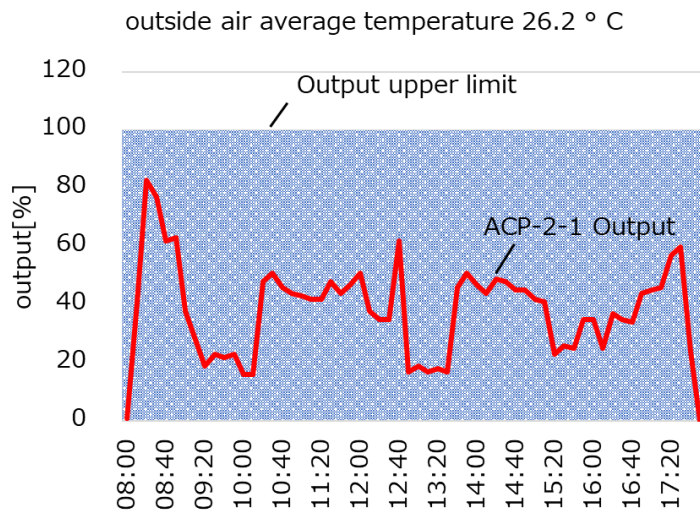
■ restrict2

When the load factor becomes 30% or less, the capacity of the outdoor unit is restricted from 70% to 40%.

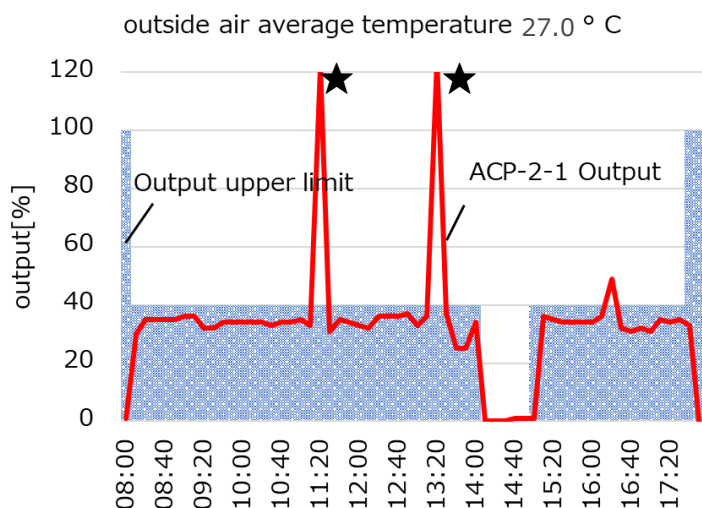
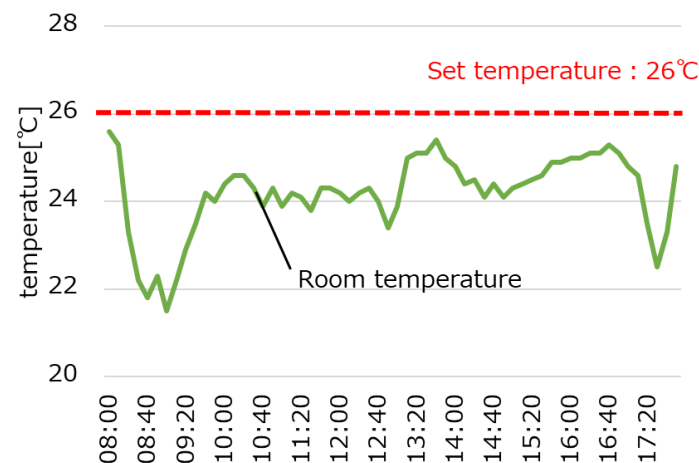
■ restrict3

When the load factor becomes 20% or less and the indoor temperature satisfies the set temperature, the capacity of the outdoor unit is restricted from 40% to 0%.

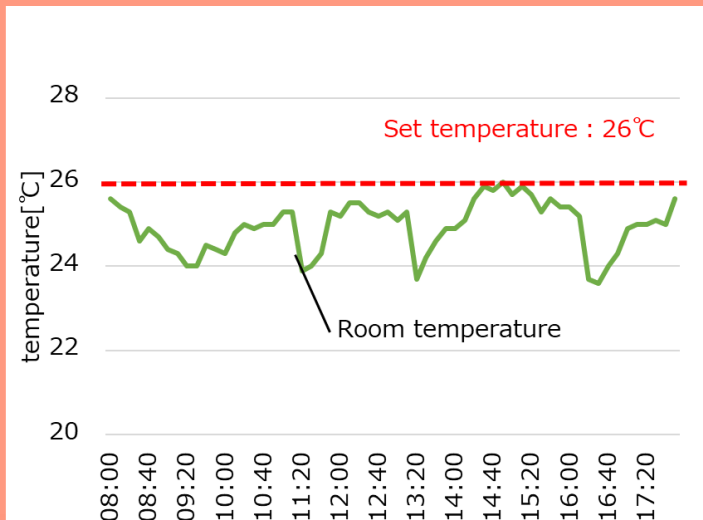
Outdoor unit output



Room temperature



★ : Oil return operation

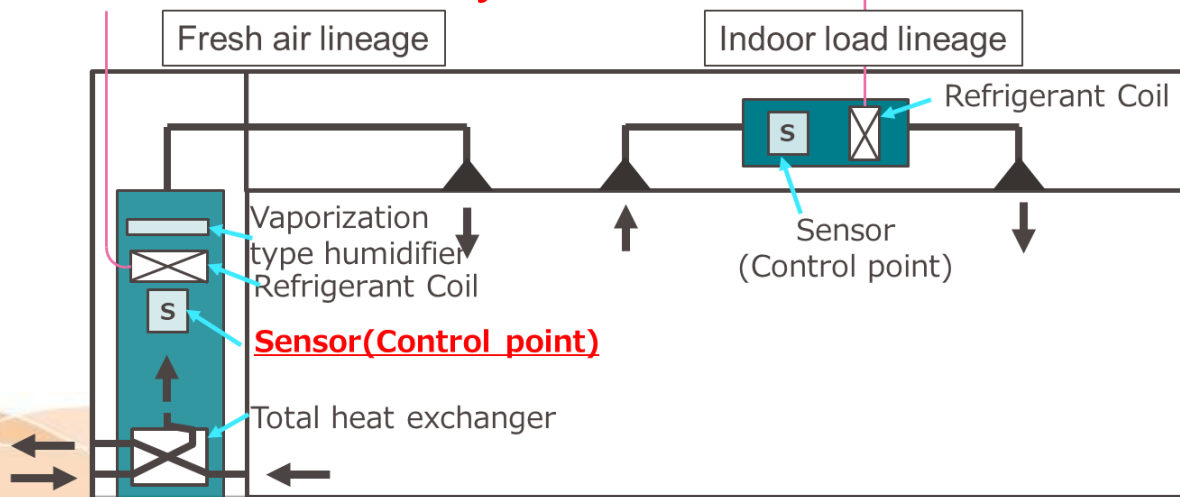


There is a difference between the set temperature and the actual room temperature because it measures by the different sensor installed in the different position.

- ✓ During cooling, when the **air temperature just before the refrigerant coil exceeds the set temperature, compressor runs.** (Reverse during heating)
- ✓ **It has fixed temperature setting** [Cooling 21 °C, Heating 25 °C]
- ✓ The **control of output is left to the manufacturer.**
- ✓ It becomes **excessive air conditioning** by the situation of the room.

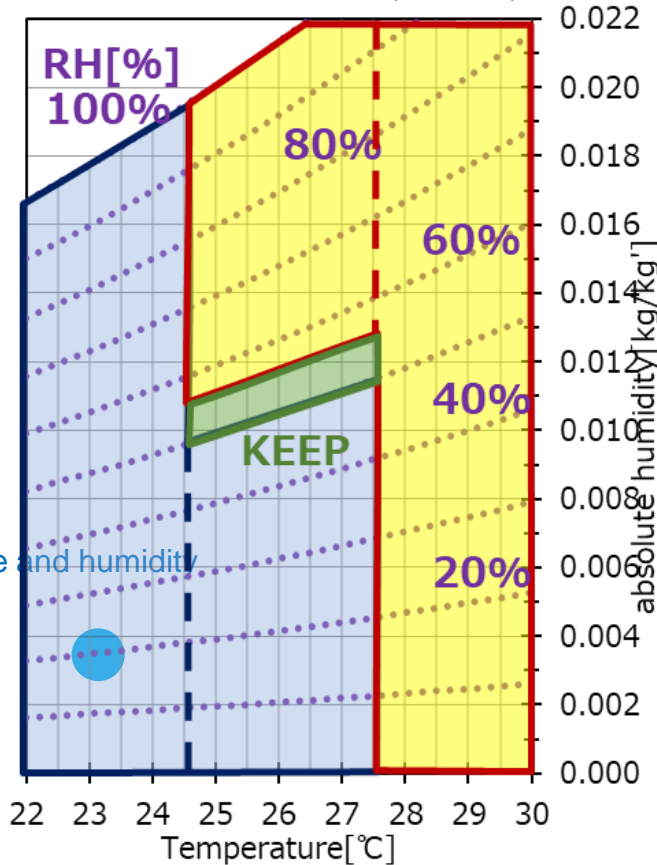


Set the upper output limit of the outdoor unit of fresh air unit according to the temperature and humidity of the room.



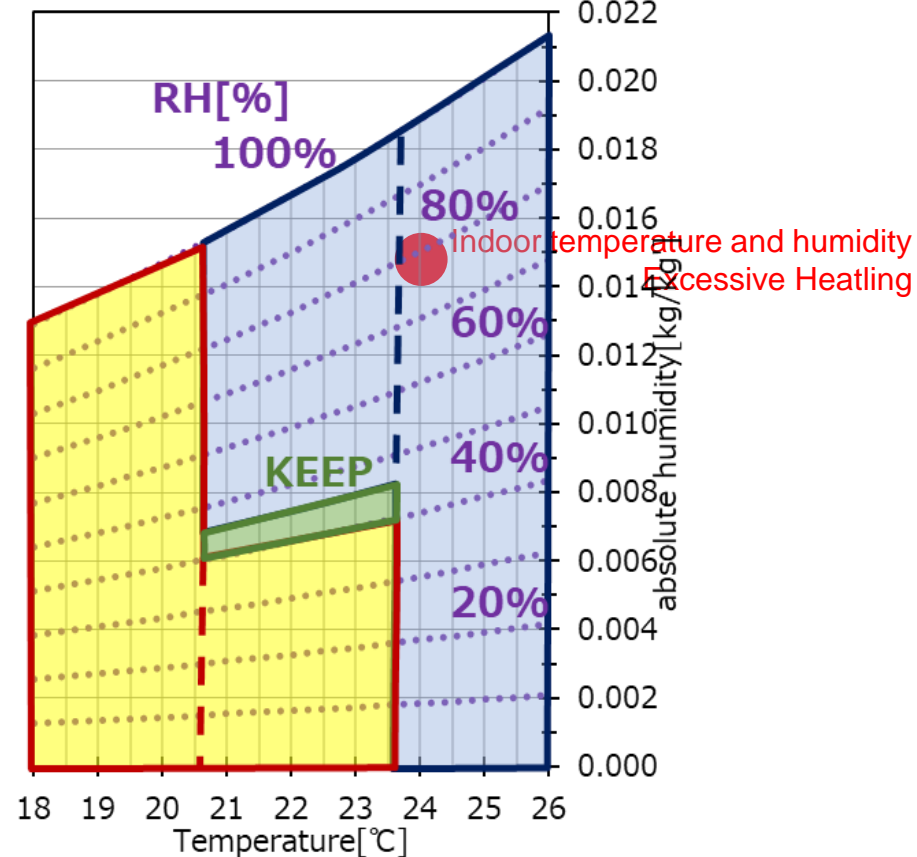
Cooling

Cooling setting 24.5°C~27.5°C 50%~55%RH
(variable)



Heating

Heating setting 20.5°C~23.5°C 40%~45%RH
(Variable)



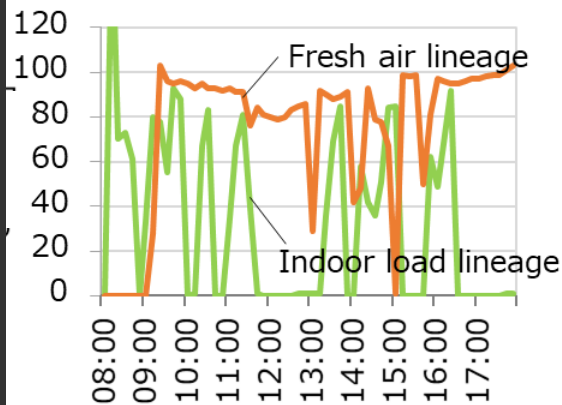
From the difference between room and setting temperature and humidity, set the upper output limit of the outdoor unit of fresh air unit.

The output of the outdoor unit is four stages of 0% -40% -70% -100%

Control disabled

Feb 13, 2015 Control invalid

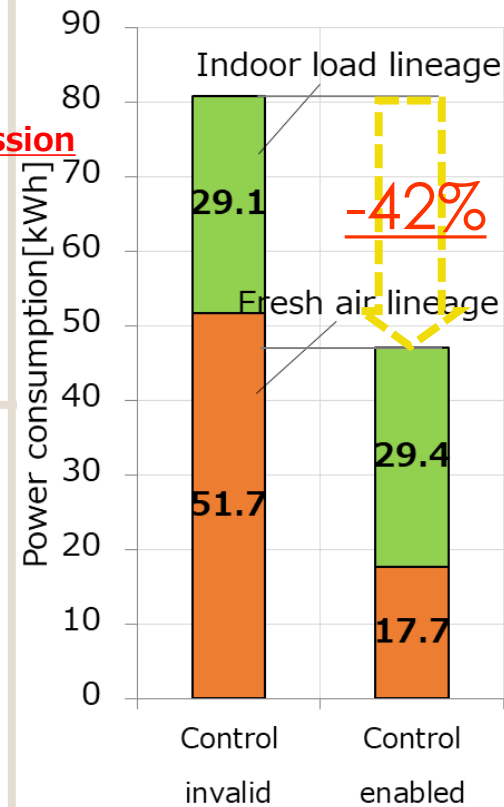
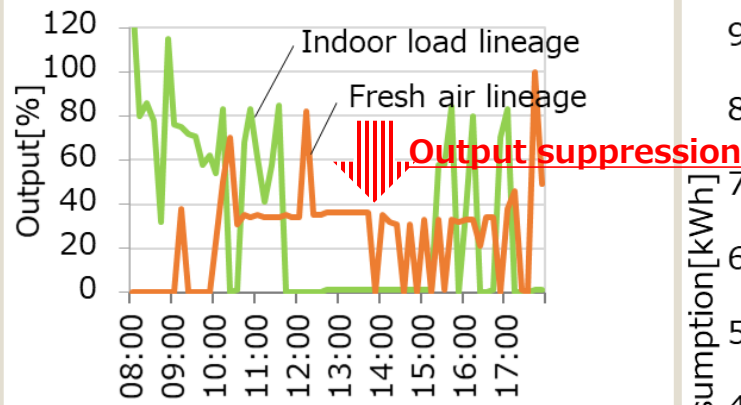
Outside temperature average : 4.1°C



Control enabled

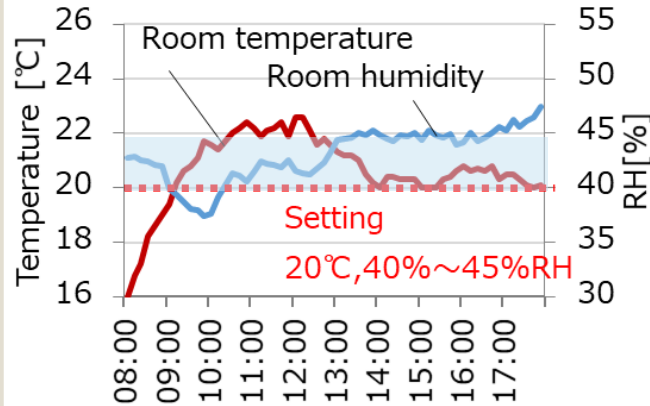
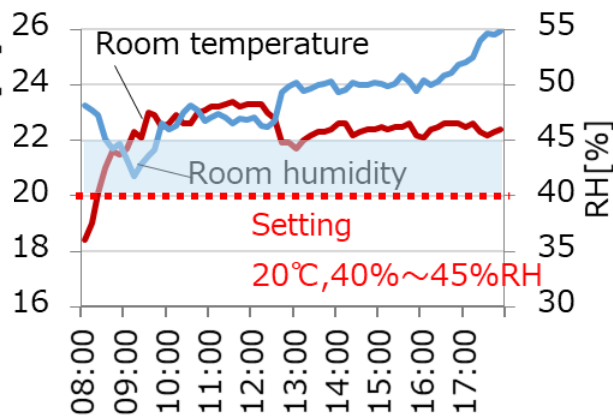
Feb 10, 2015 Control enabled

Outside temperature average : 4.8°C



Output

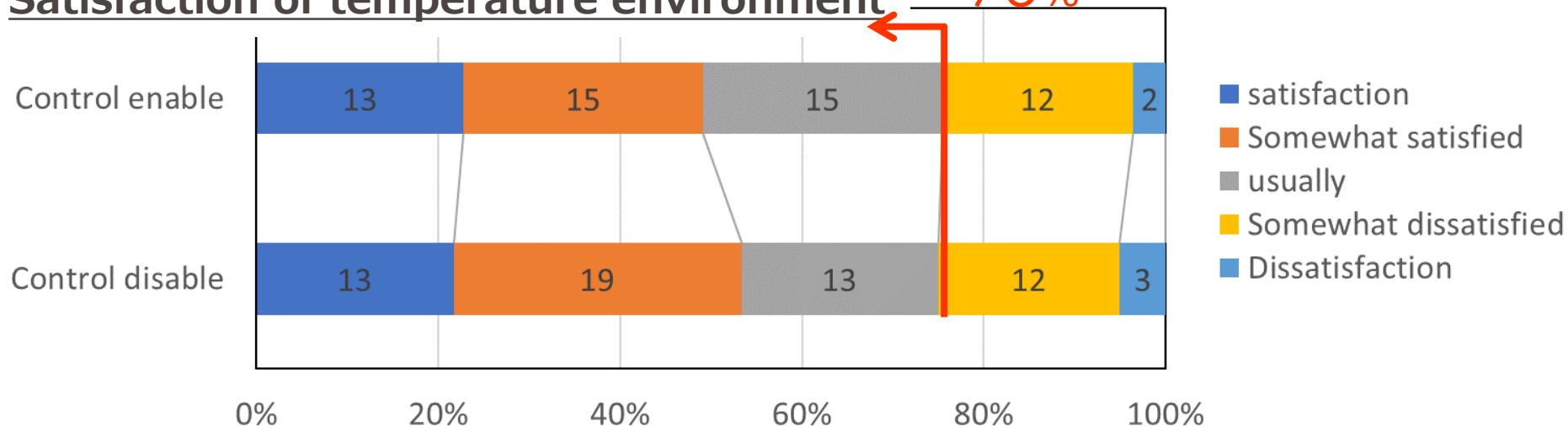
Temperature and humidity



[Control disable : N=60、Control enable : N=57]

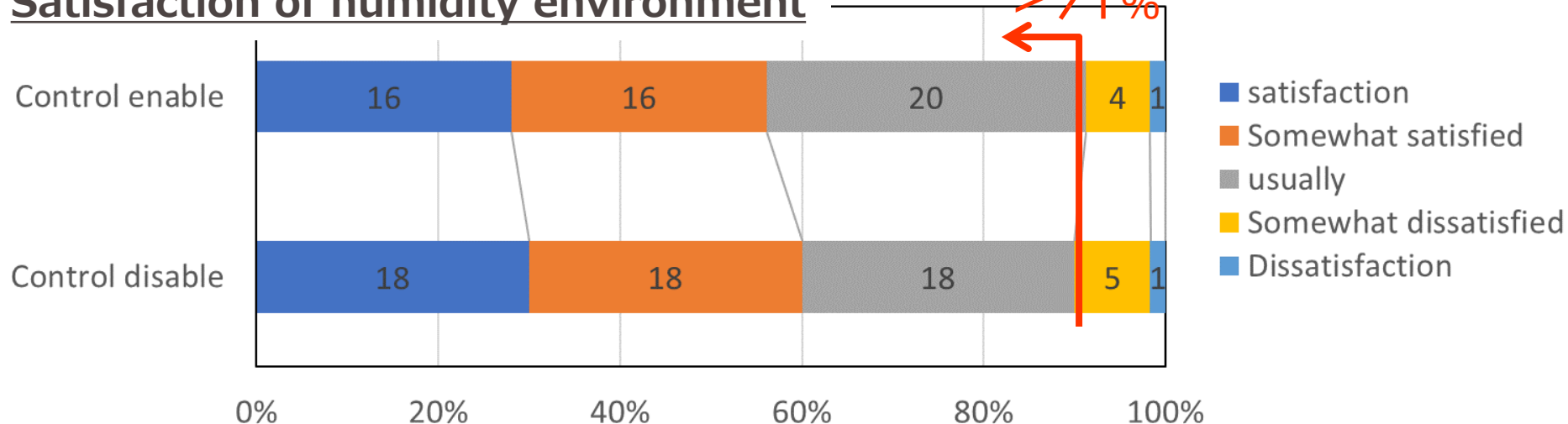
Satisfaction of temperature environment

>75%



Satisfaction of humidity environment

>91%

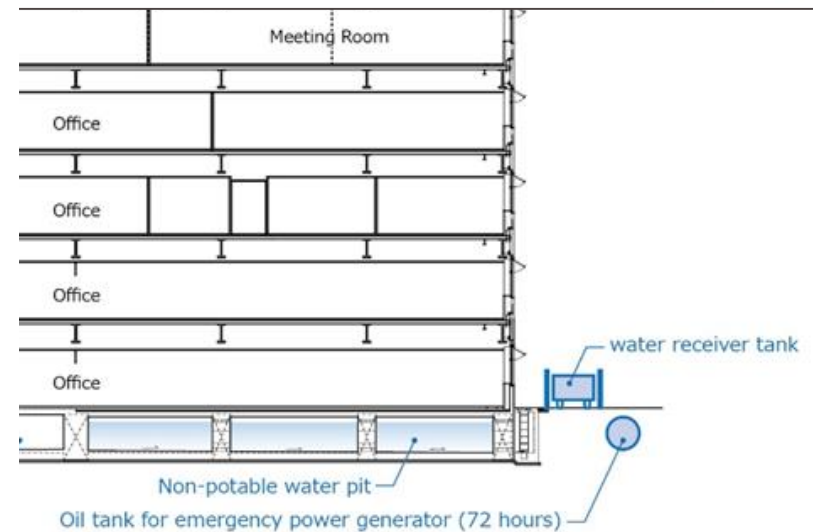
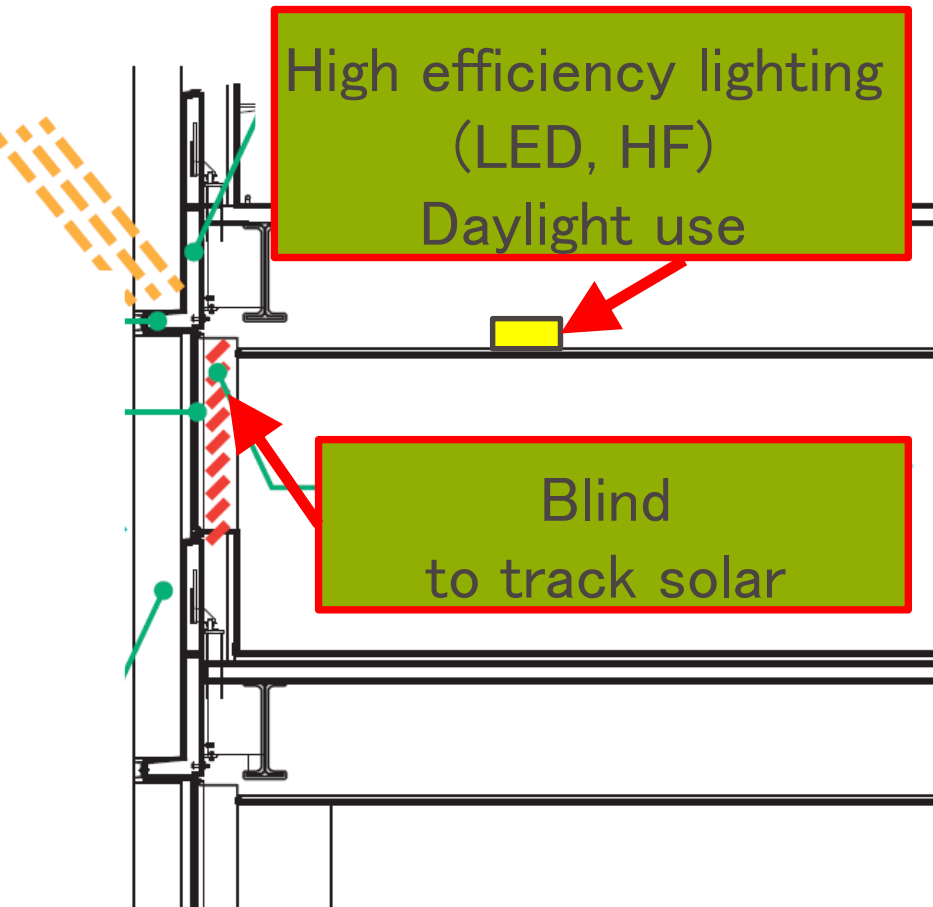
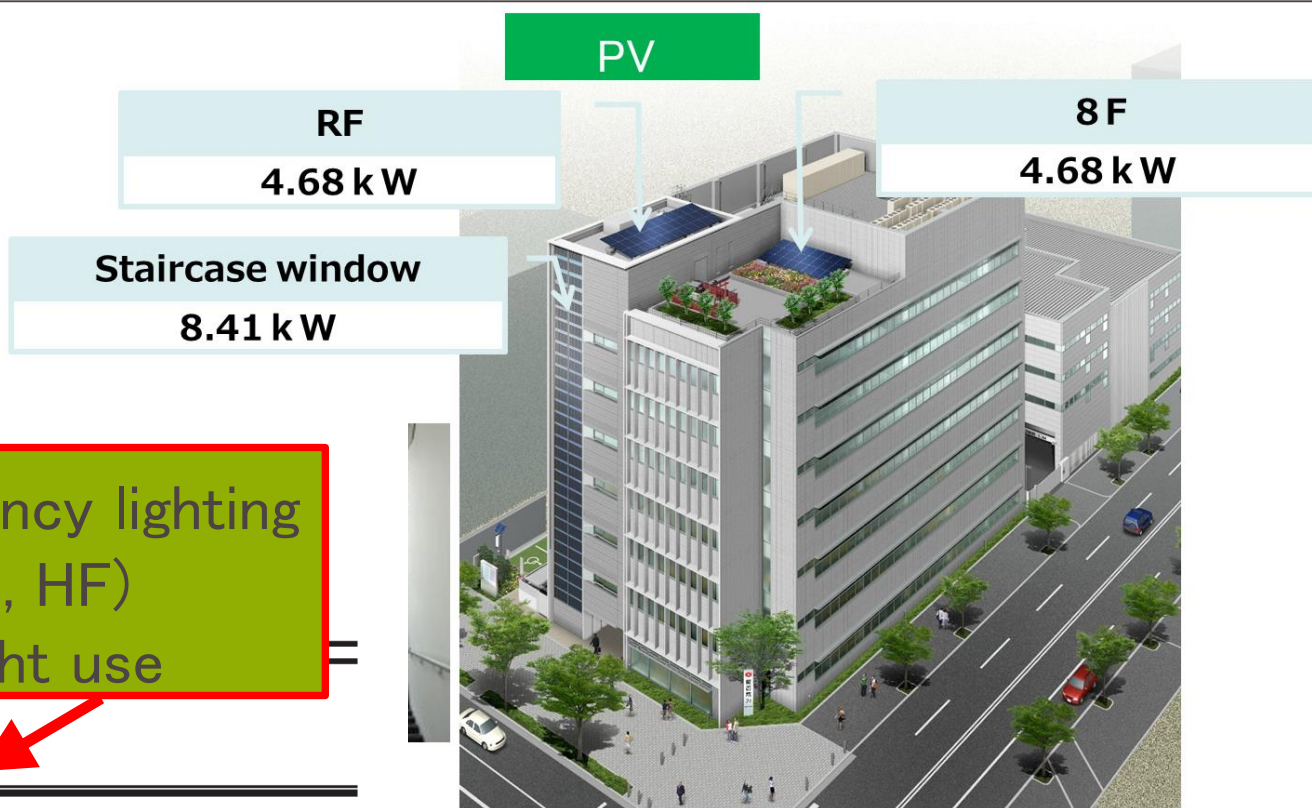


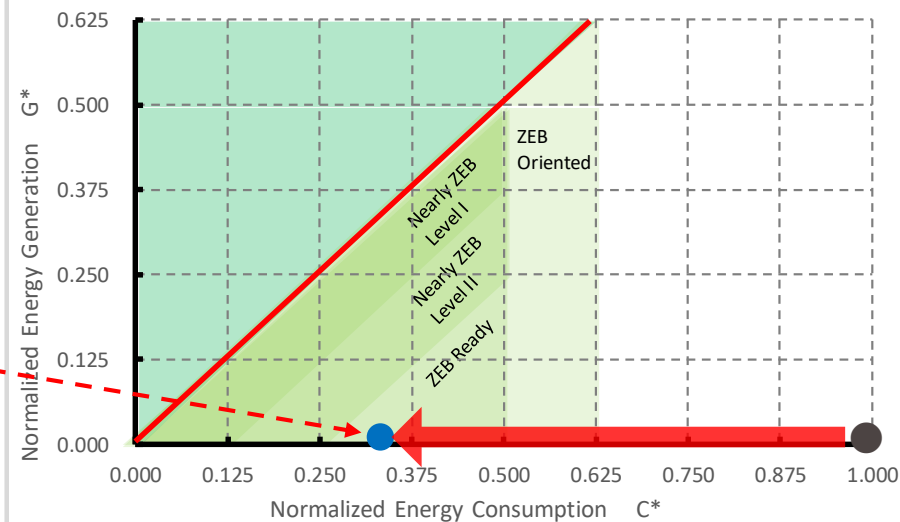
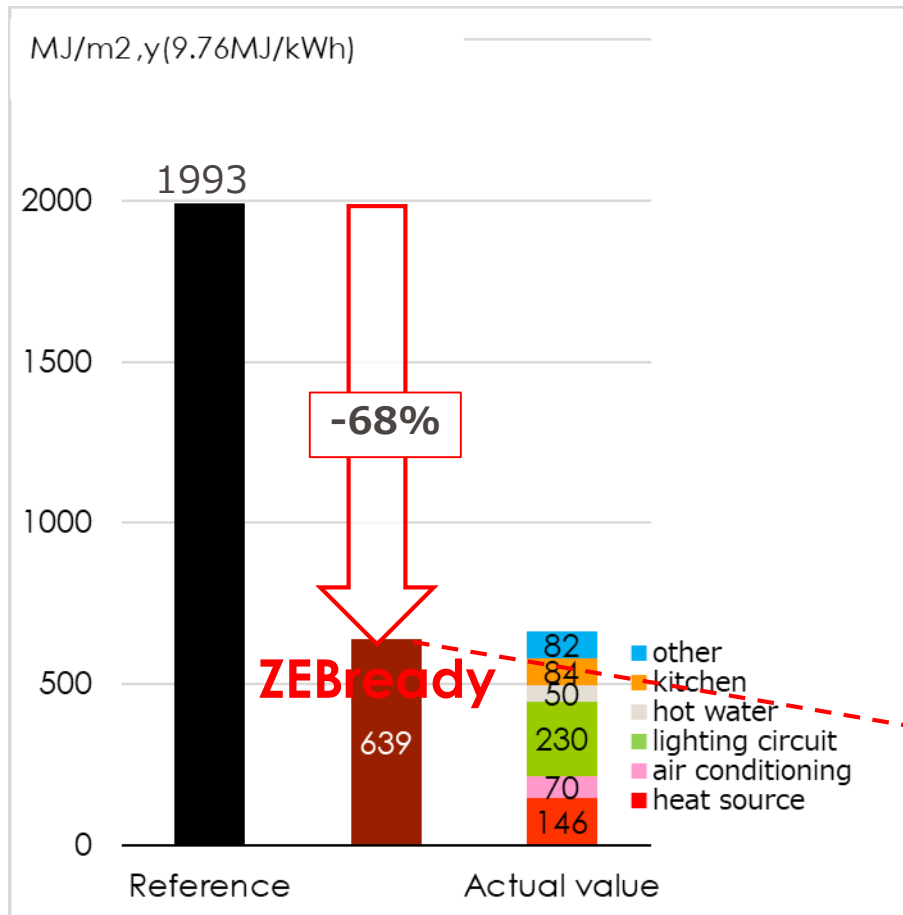
No big difference between disable / enable of control

Other method

Environmental symbiosis method

- reduction of air conditioning load (Eaves, low-rise building)
- use of natural energy (solar photovoltaic system)
- high efficient system (air conditioner, lighting)





Achieved ZEBready at a middle-sized office

9 関西電力南大阪営業所 Minami-Osaka sales office of the Kansai electric power company
個別空調量制御を備えた中相塔FERオフィス

設計・施工が容易でコスト面に優れ、運転効率が高い電気式空気熱源ヒートポンプ方式ビル用マルチ
Multi-split type air-conditioning systems (EHP) are widely installed in small office buildings, given that they are economic in design and offer effective performance attributes

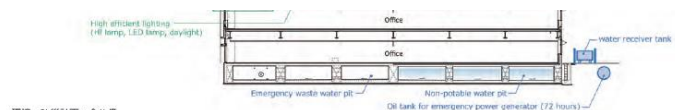
国内のZEB先進事例の概要

Overview of Best Practices in Japan



- No. 1 雲南市役所新庁舎
- No. 2 清水建設本社ビル
- No. 3 大成建設ZEB実証棟
- No. 4 KTビル
- No. 5 竹中工務店東関東支店
- No. 6 大林組技術研究所本館「テクノステーション」
- No. 7 東京大学 21 KOMCEE
- No. 8 ダイキン・テクノロジー・イノベーションセンター
- No. 9 関西電力南大阪営業所
- No. 10 東京ガス立川ビル
- No. 11 三建設工業つくばみらい技術センター
- No. 12 ダイダン九州支社「エネフィス九州」
- No. 13 新日本空調工学センター「実証Labo」
- No. 14 新菱冷熱工業本社ビル

- No. 1 Unnan City Hall
- No. 2 Shimizu Corporation Headquarters
- No. 3 ZEB Demonstration Building, TAISEI Corporation
- No. 4 KT Building
- No. 5 Takenaka Corporation Higashi Kanto Branch Office
- No. 6 OBAYASHI Technical Research Institute Main Building, "Techno-Station"
- No. 7 21 KOMCEE, The University of Tokyo
- No. 8 DAIKIN Technology & Innovation Center
- No. 9 Minami-Osaka sales office of the Kansai electric power company
- No. 10 Tokyo Gas Tachikawa Building
- No. 11 Sanken Setsubi Kogyo Tsukubamirai Technology Center
- No. 12 DAI-DAN Kyushu Branch Office "Enefice Kyushu"
- No. 13 The SNK Engineering Center - "Demonstration Labo"
- No. 14 SHINRYO Headquarters Building

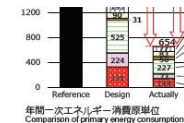


環境・防災計画の全体像
Overall picture of environmental plan and disaster prevention

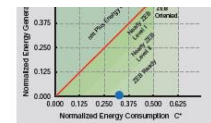
20



連続デマンド制御のイメージ
Conceptual diagram of continuous demand control method



Comparison of primary energy consumption



21

http://www.shasej.org/recommendation/ZEB%20in%20Japan_2017_SHASE100th.pdf

Thank you for your attention



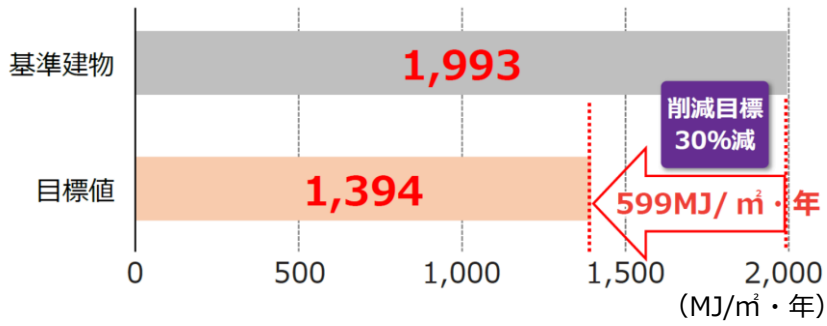
その他資料 in Japanese

3.合理的な環境負荷低減手法の導入計画とBESTツールを用いた検証・評価

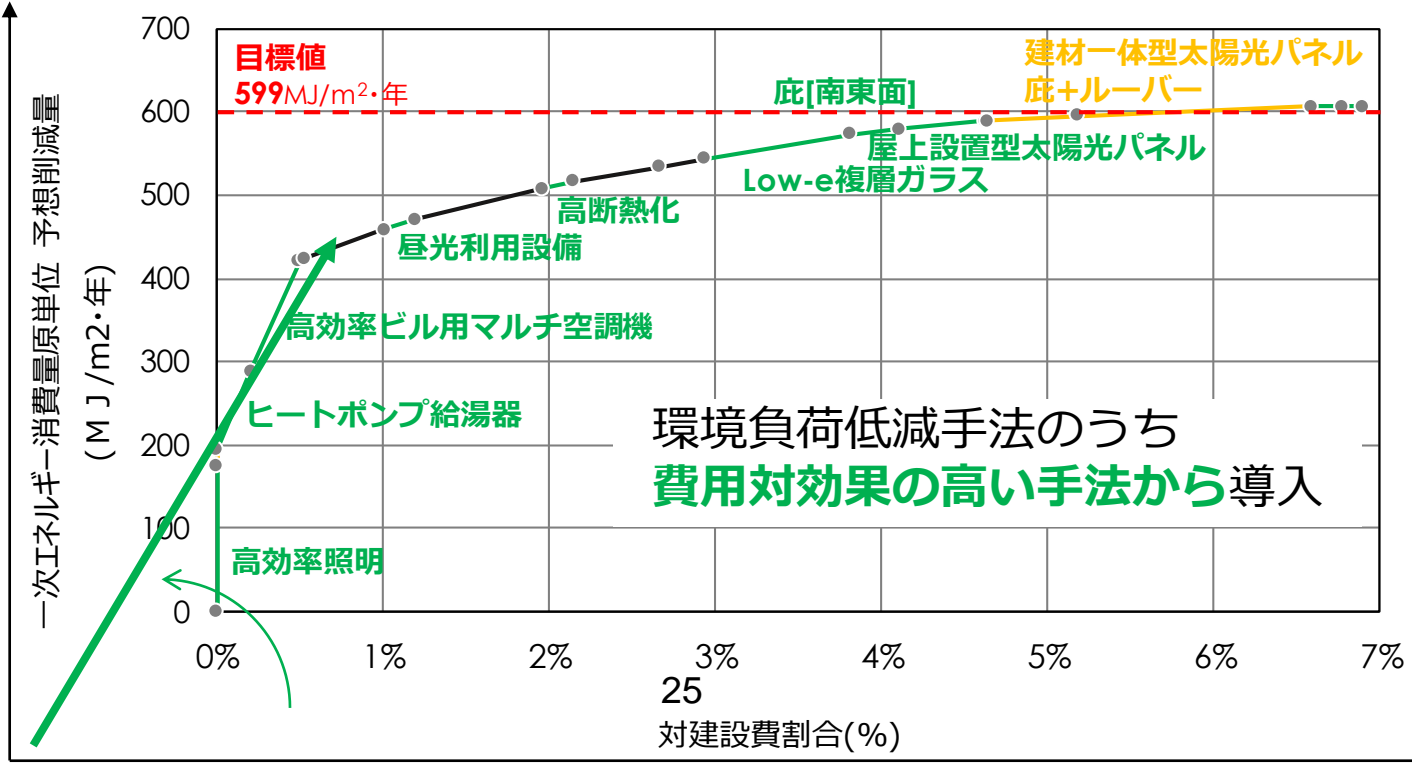
合理的な環境負荷低減手法の導入計画

中小ビルでは、コスト影響が大きく
省エネ技術の導入が難しい

今ある手法の組み合わせにより
最適なものを選択することで、
低コストで省エネルギーオフィスビルを実現

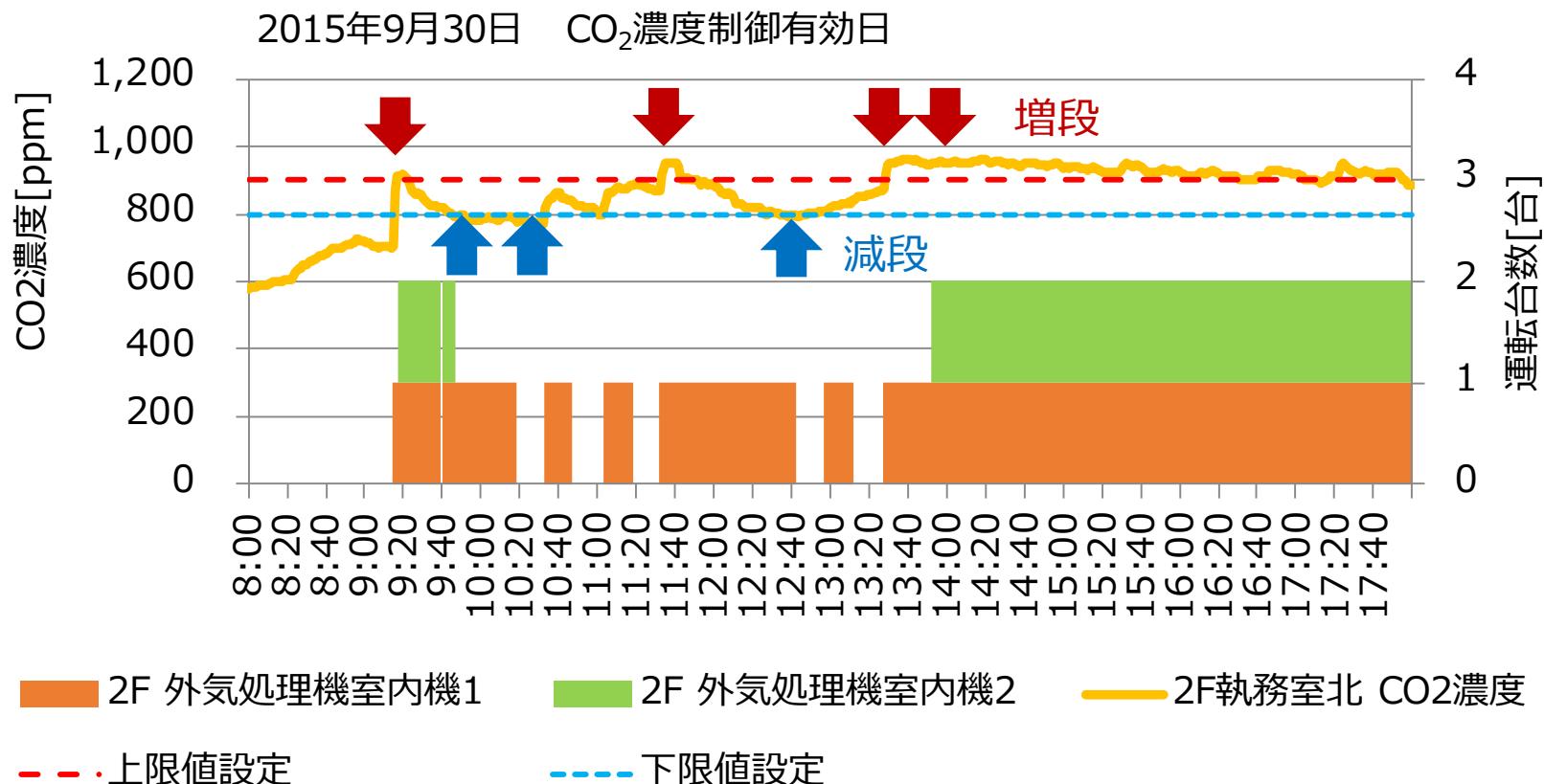


効果



費用

外気処理機の運転時間 -43%

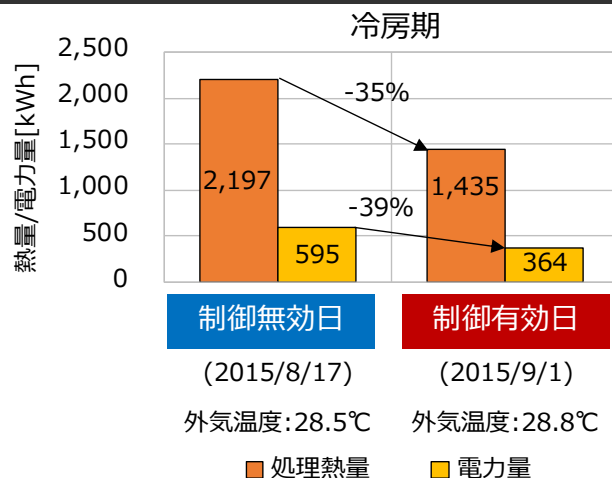


ビル用マルチ空調機の高度な制御手法の開発

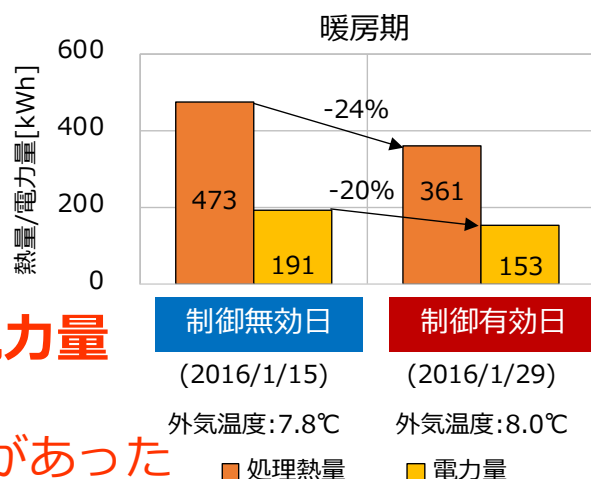
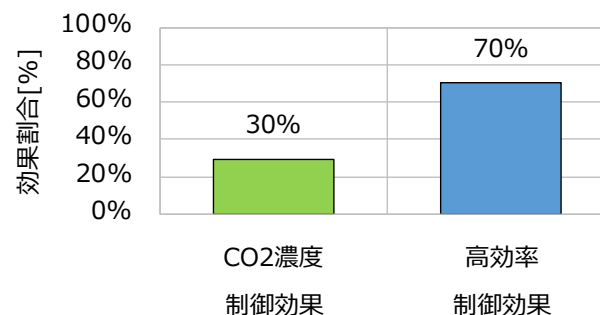
② 温湿度制御：有効

③ CO₂濃度制御 ① 高効率運転制御：有効と無効を比較

熱量 / 電力量

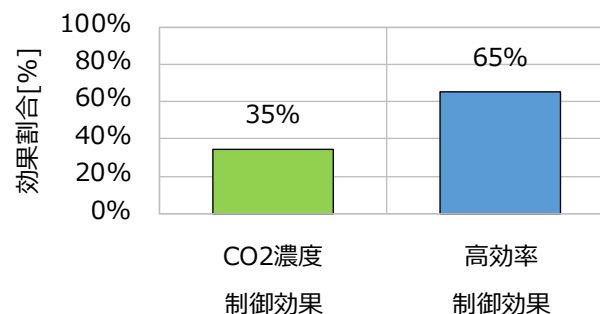


電力量削減効果(冷房)



CO₂が約30% 高効率が約70%

電力量削減効果(暖房)



熱量・電力量
ともに
削減効果があった

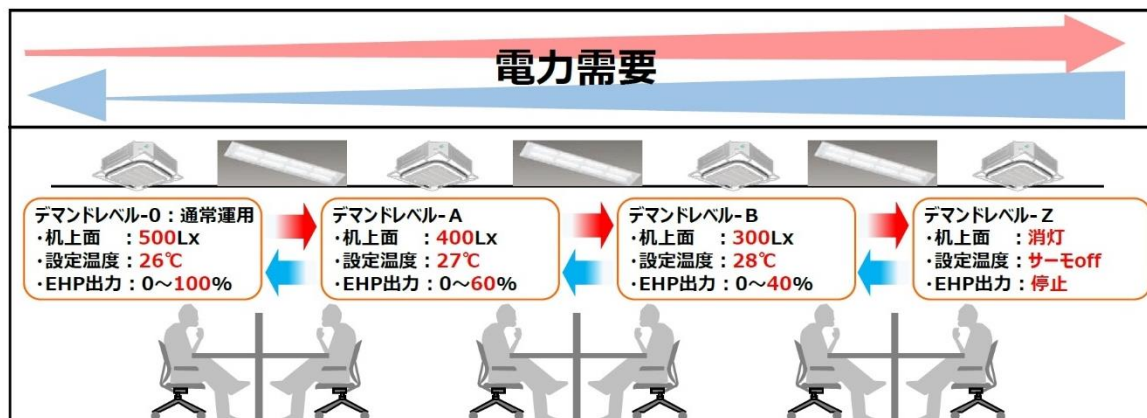
冷房期

暖房期

※最大デマンドとは
30分間の平均電力消費のうち、過去1年間で最大の値

開発の背景

- ・電気料金の基本料金となる最大デマンドの抑制は、ユーザーからの**要望が大きい**。
- ・従来のデマンド制御は、**機器のON-OFF**により行っていた為、**室内環境の急変**を伴う。



室内環境に配慮しながら、**段階的**にデマンドを抑制する**連続デマンド制御**を開発した。

室外機出力

100% → → → 0%

設定温度

26℃ → → → 27.5℃

照度

500lx → → → 300lx

図-4.18 連続デマンド制御の概要図

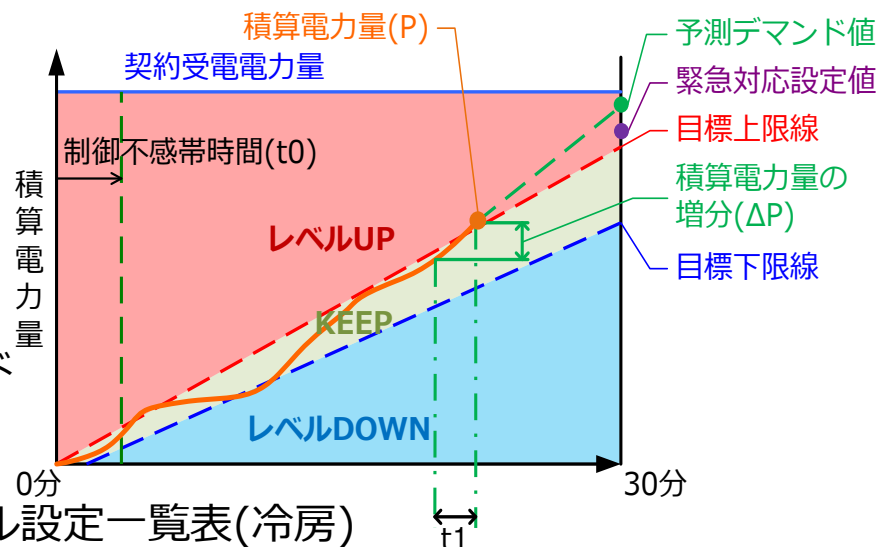


表-4.3 デマンドレベル設定一覧表(冷房)

■空調機器設定

空調範囲	制御対象	レベル0	レベル1	レベル2	レベル3	レベル4	レベル5	レベル6	レベル7	レベル8	レベル9	レベル10
執務室	室外機	100%	100%	70%	70%	70%	70%	40%	40%	40%	40%	OFF
	室内機(半分)、小部屋	26.0℃	26.0℃	26.0℃	26.5℃	26.5℃	27.0℃	27.0℃	27.0℃	27.5℃	27.5℃	27.5℃
	室内機(半分)	26.0℃	26.5℃	26.5℃	26.5℃	27.0℃	27.0℃	27.0℃	27.5℃	27.5℃	27.5℃	27.5℃
外気処理機	室外機	100%	70%	70%	70%	70%	40%	40%	40%	40%	OFF	OFF
	室内機(*2)	-	-	-	-	-	-	-	-	-	OFF	OFF
外気処理機(2Fのみ)	室外機	100%	70%	70%	70%	70%	40%	40%	40%	40%	40%	40%
	室内機(*2)	-	-	-	-	-	-	-	-	-	-	-
食堂	室内機	26.0℃	26.0℃	27.0℃	27.0℃	27.0℃	27.0℃	27.0℃	27.0℃	27.5	27.5	27.5℃
	室外機	100%	100%	70%	70%	40%	40%	40%	40%	40%	40%	OFF
	室内機(半分)	26.0℃	26.0℃	26.5℃	26.5℃	27.0℃	27.0℃	27.5℃	27.5℃	27.5℃	27.5℃	27.5℃
	室内機(半分)	26.0℃	26.5℃	26.5℃	27.0℃	27.0℃	27.5℃	27.5℃	27.5℃	27.5℃	27.5℃	27.5℃

※ 暖房期は、レベル10で室内機をすべて停止にする。冷房期は送風運転とする。

■照明機器設定

照明範囲	レベル0	レベル1	レベル2	レベル3	レベル4	レベル5	レベル6	レベル7	レベル8	レベル9	レベル10
執務室 壁際/ロッカー	500Lx	460Lx	420Lx	380Lx	340Lx	300Lx	300Lx	300Lx	300Lx	300Lx	300Lx
執務室 営業所員座席	500Lx	480Lx	460Lx	440Lx	420Lx	400Lx	380Lx	360Lx	340Lx	320Lx	300Lx
会議室	500Lx	480Lx	460Lx	440Lx	420Lx	400Lx	380Lx	360Lx	340Lx	320Lx	300Lx
廊下・ELVホール	ON	1/3間引き	1/3間引き	1/3間引き	2/3間引き	2/3間引き	2/3間引き	2/3間引き	2/3間引き	2/3間引き	2/3間引き
自販機・湯沸し	ON	ON	ON	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF

- ・人のいない範囲を積極的に。
- ・各レベルにおける電力変動は均一に。