アジア蒸暑地域における
グリーンビル評価基準の地域性検討

首都大学東京
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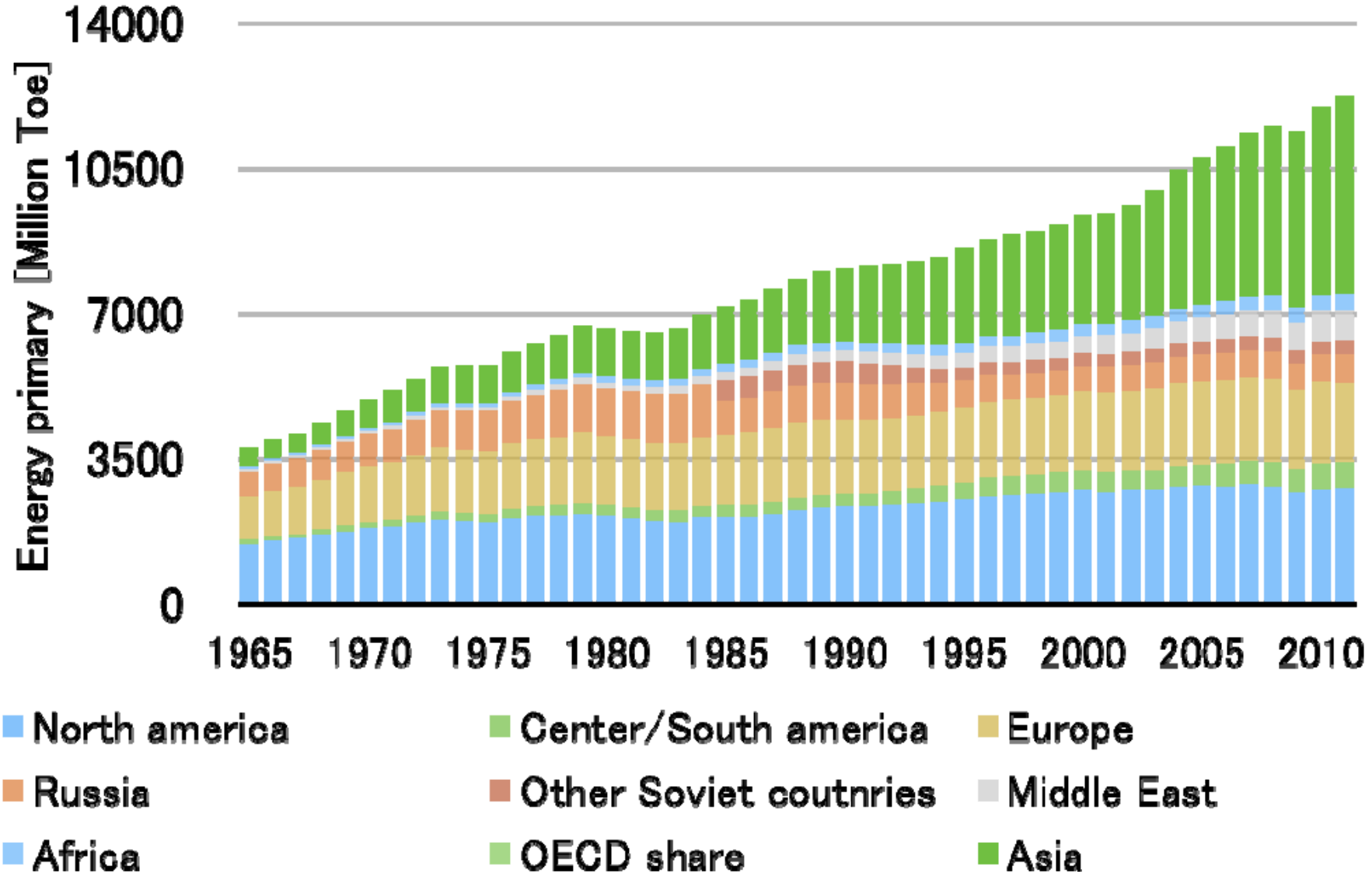
なぜ東南アジアの研究をするのか？

- 日本の建設市場は縮小
- 中国の次として人口経済の発展可能性を有する
- 気候風土文化が比較的日本に類似している(?)
- インフラレベルの都市開発は進んでおり，次のステップとして建築に焦点が移っている
- 欧米主導の開発となっており，大幅な改善余地がある

導入1
蒸暑地域における都市建築

World Wide Green Building Certification


14000
10500
7000
3500
0
Energy primary [Million Toe]
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
North america
Center/South america
Europe
Russia
Other Soviet coutnries
Middle East
Africa
OECD share
Asia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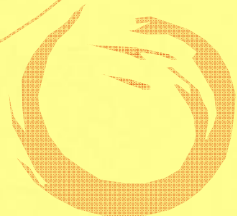
Reason lack of on-site investigation

- Current Green Building doesn’t require after built performance
- Building steak holder doesn’t want to responsible for actual performance
- Investment recovery term is quite short
- Movement of personal information protection

Energy for Building

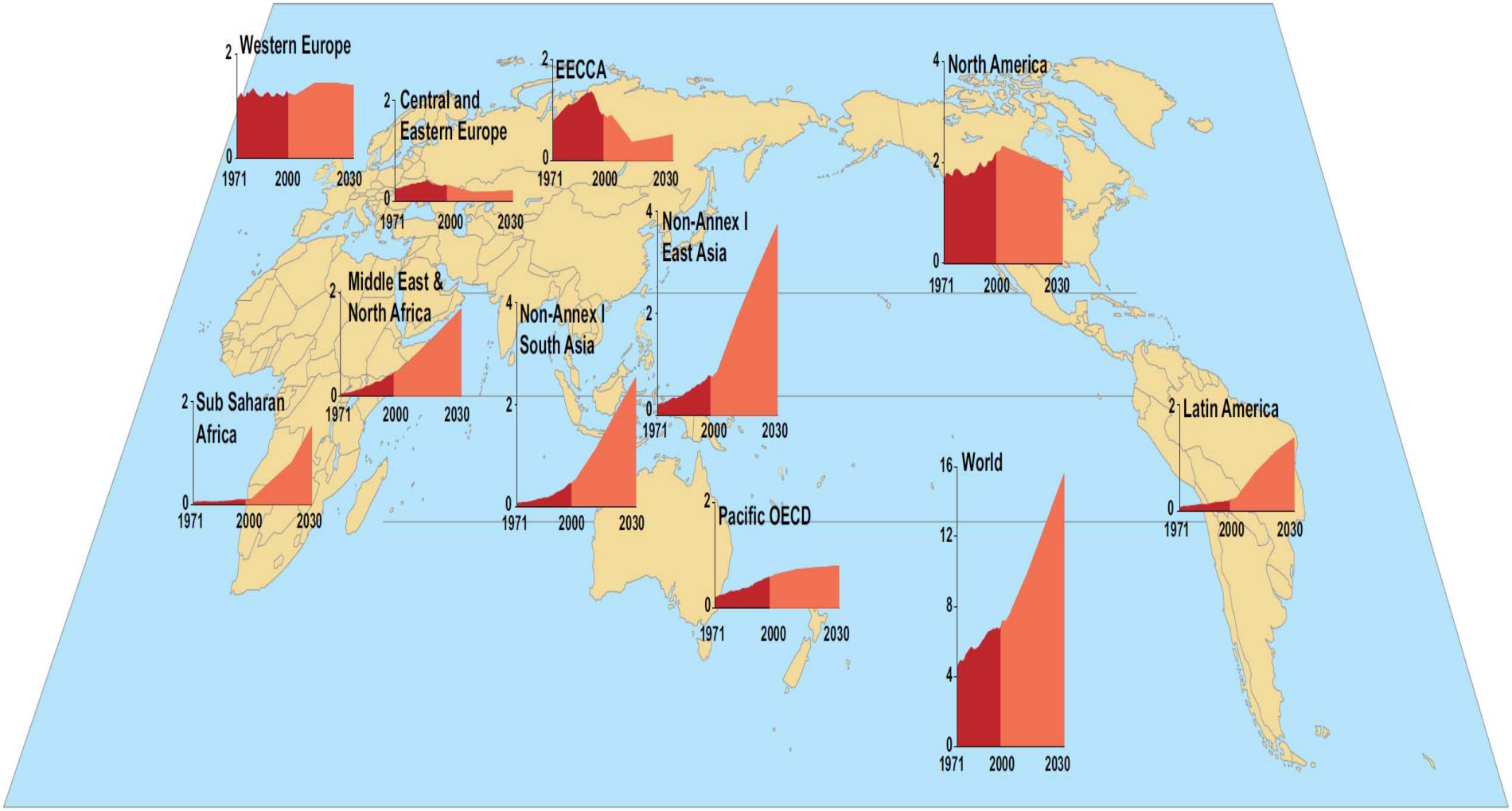
- Air conditioning is one of the most factor for building energy consumption
- IEQ should be discussed at the same time for human well-being and productivity
- Importance of Asia is increasing in terms of global sustainability
- Green building movement in Asia is spreading but design methodology follow Western and actual performance is not verified

導入2
ポテンシャル



住宅・商業ビルのCO2排出量予測

（シナリオA1B：高度な経済成長路線の維持）

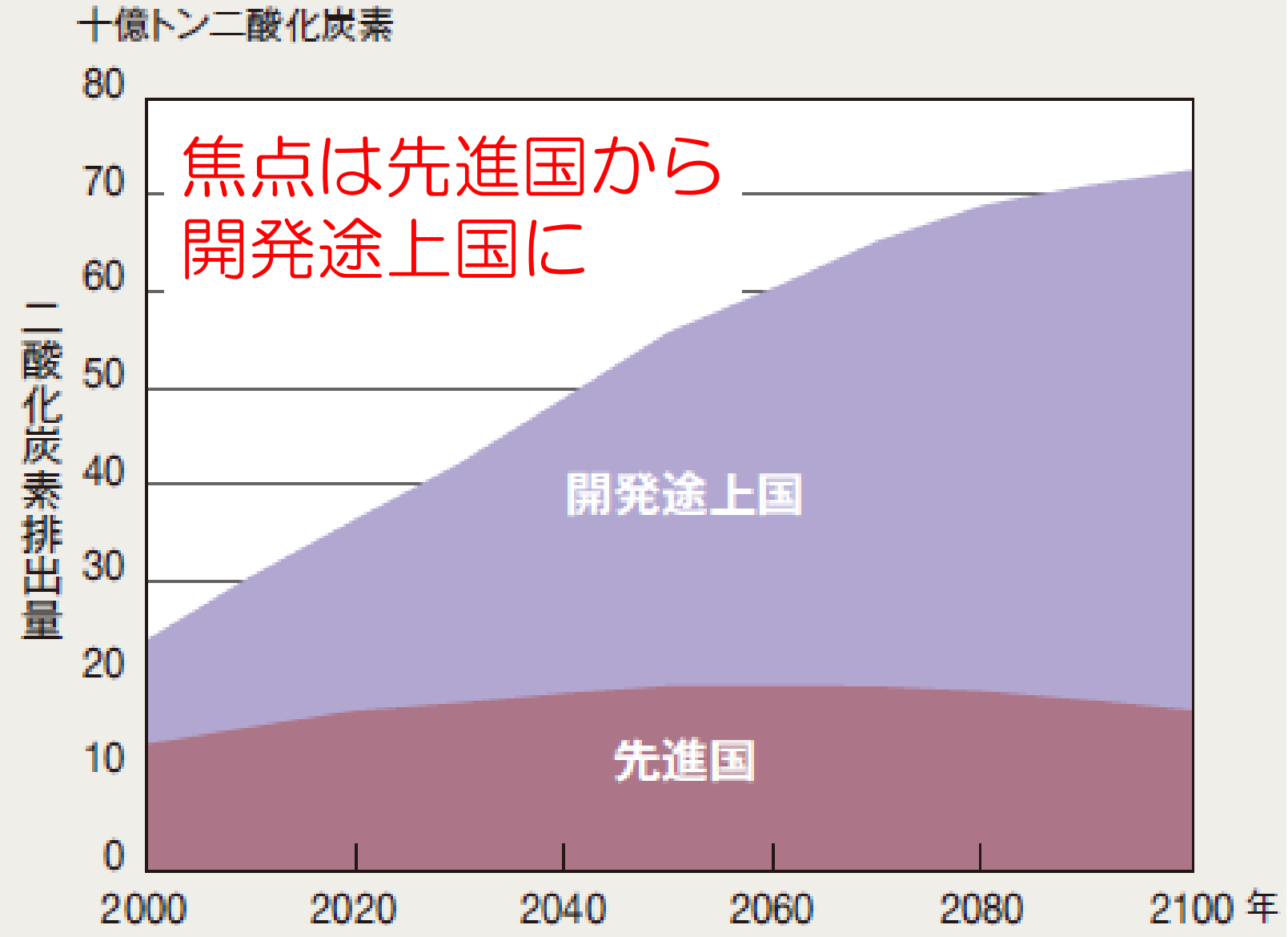


出展　IPCC 4th Assessment Report

Climate Change 2007: Mitigation of Climate Change Figure 6.2

Organization for Economic Co-operation and Development
countries of Eastern Europe, the Caucasus and Central Asia

先進国と発展途上国の排出量予測

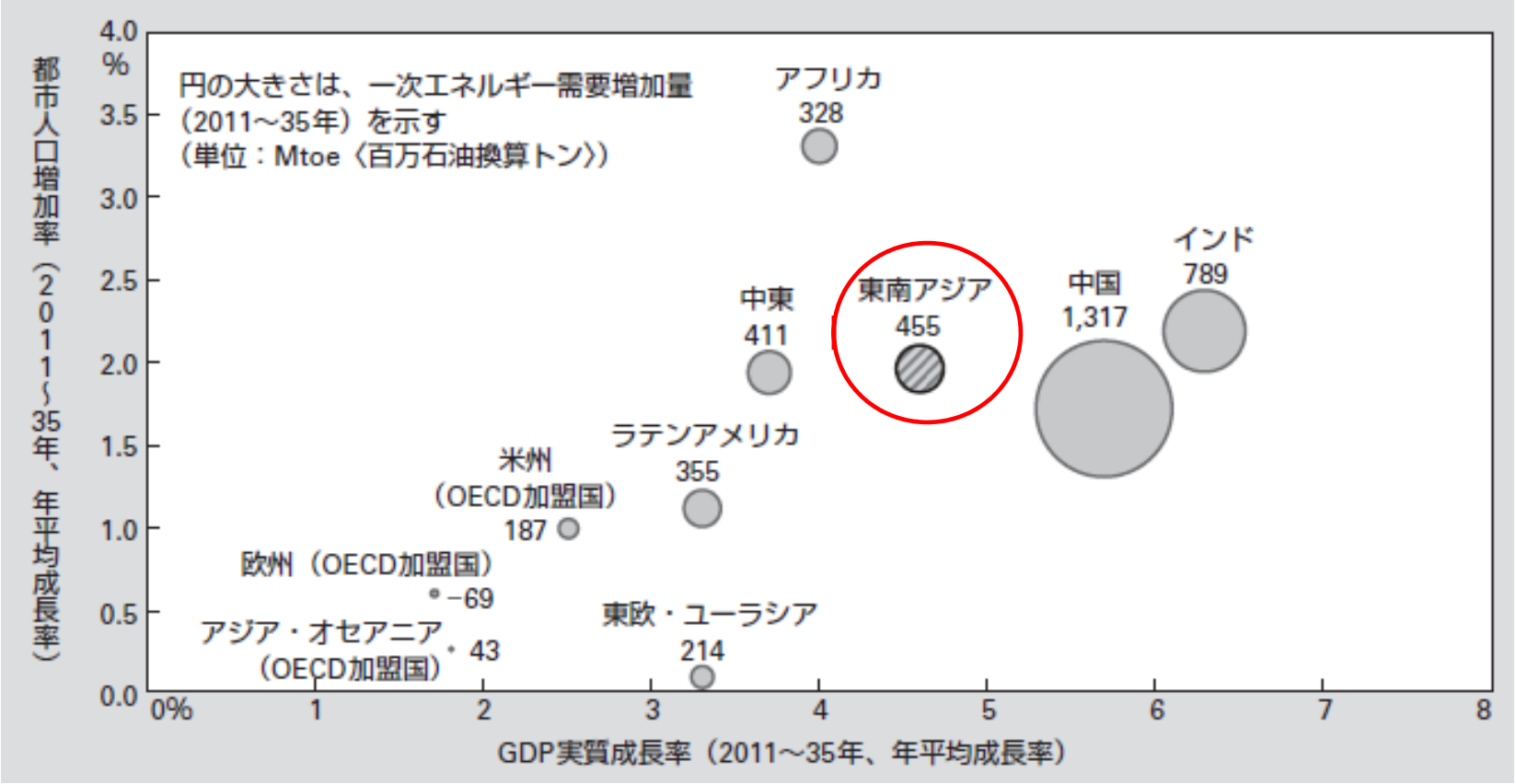


出典）環境省

Energy supply situations & basic policies of ASEAN

Energy situations in ASEAN countries

- it is expected that the demand for primary energy will increase by 2030s because of GDP growth and urbanization



出典：IEA(国際エネルギー機関) World Energy Outlook 2013

アジアにおけるプロジェクト紹介

首都大学東京・研究室の活動

アジア高度人材育成プログラム

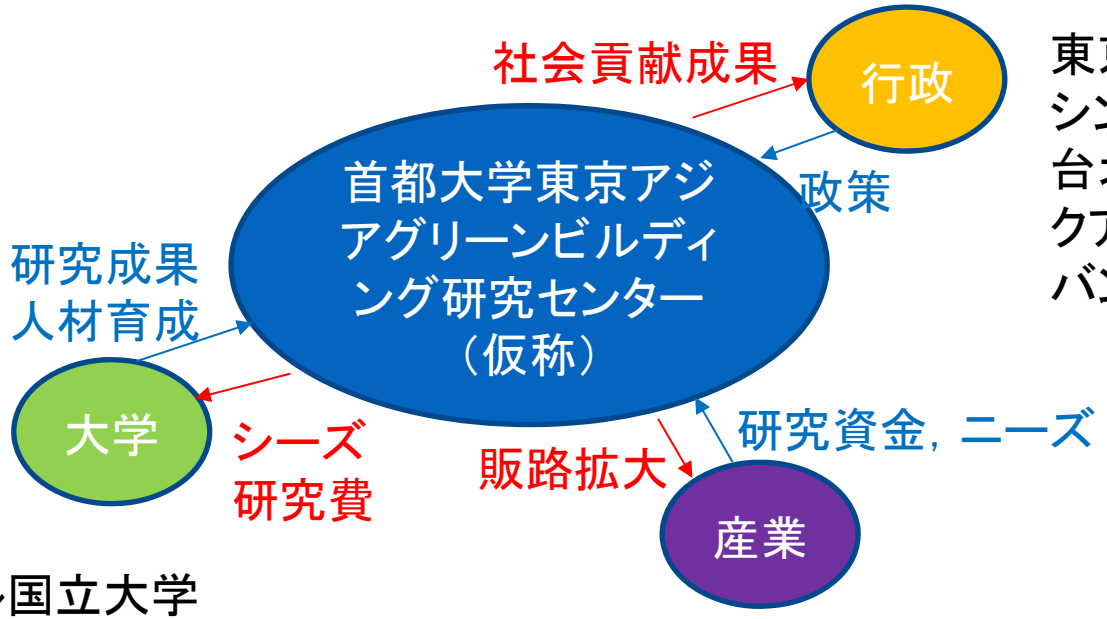
- 2013年度～2017年度
- 建築学域研究予算4300万円／年度
- アジア地域の博士後期課程学生を受け入れ
- 留学生の渡航・生活費・学費は全額都費拠出
- 指導教員が自分の責任で現地でスカウト
- 3年間での修了のみが条件

産学公連携プラットフォーム事業

- アジア高度研究のうちの環境分野特化プロジェクト
- 2017年度～2019年度
- 研究室予算3000万円／年度
- アジア各都市の実態データ収集
- 既存評価手法の改善提案
- 日本企業，東京都およびアジア各都市行政との連携
- 研究センターの設立

5．プラットフォームのイメージ

アジアグリーンビルディング研究センター



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バンコク都

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ダイキン工業
東京電力ホールディングス

研究室メンバー　2016年10月

- 准教授　　一ノ瀬雅之
- 助教(環境系)　熊倉永子
- 特任助教　　佐々木留美子
- D3　Ngyuen Dong Giang (Vietnam)
  Syfaii Imam Nedyomukti (Indonesia)
  Sattayakorn Sutida (Thailand)
- M2　池谷風雅，木下碧子，千種晃平，徳田恵理子
- M1　倉田佐帆，長谷川順也
- B4　肖一(PRC)，白井美帆，深和佑太
- 研究生　劉暢(PRC)

Collaborator in Asia

National Univ. of Singapore

National Cheng Kung Univ.

Univ. Technology Malaysia

Kasetsart Univ.

Chulalongkorn Univ.

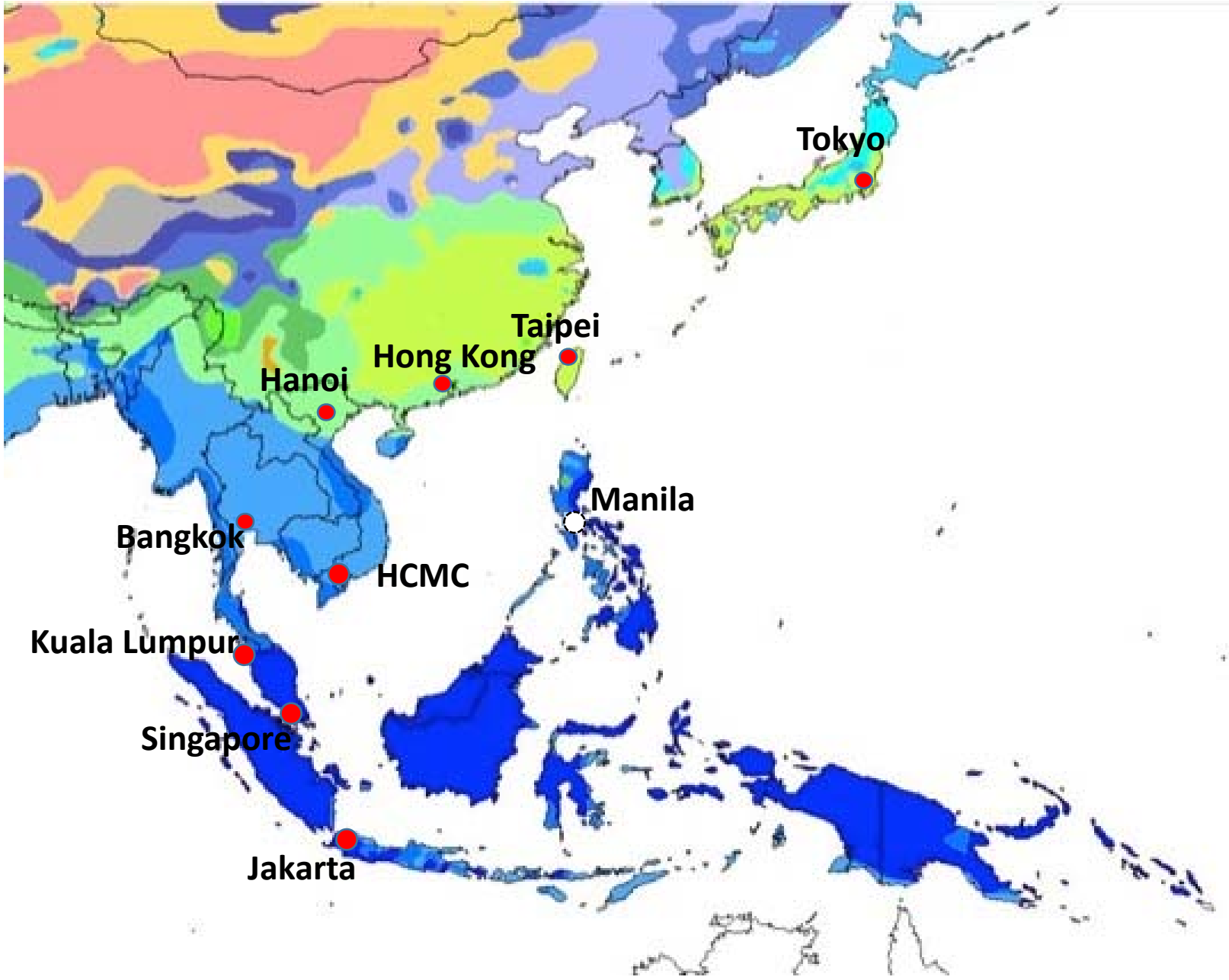
Binus Univ.

Hanoi Architectural Univ.

NUSとの調印式　2015年3月27日

アジアにおける課題

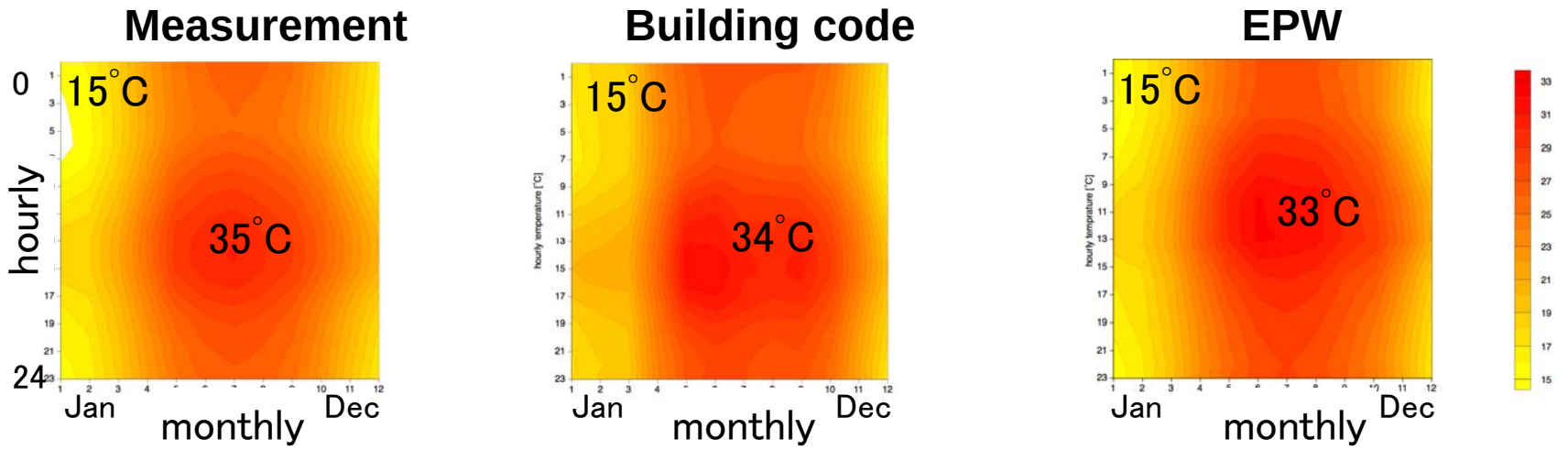
Investigation Cities in Asia

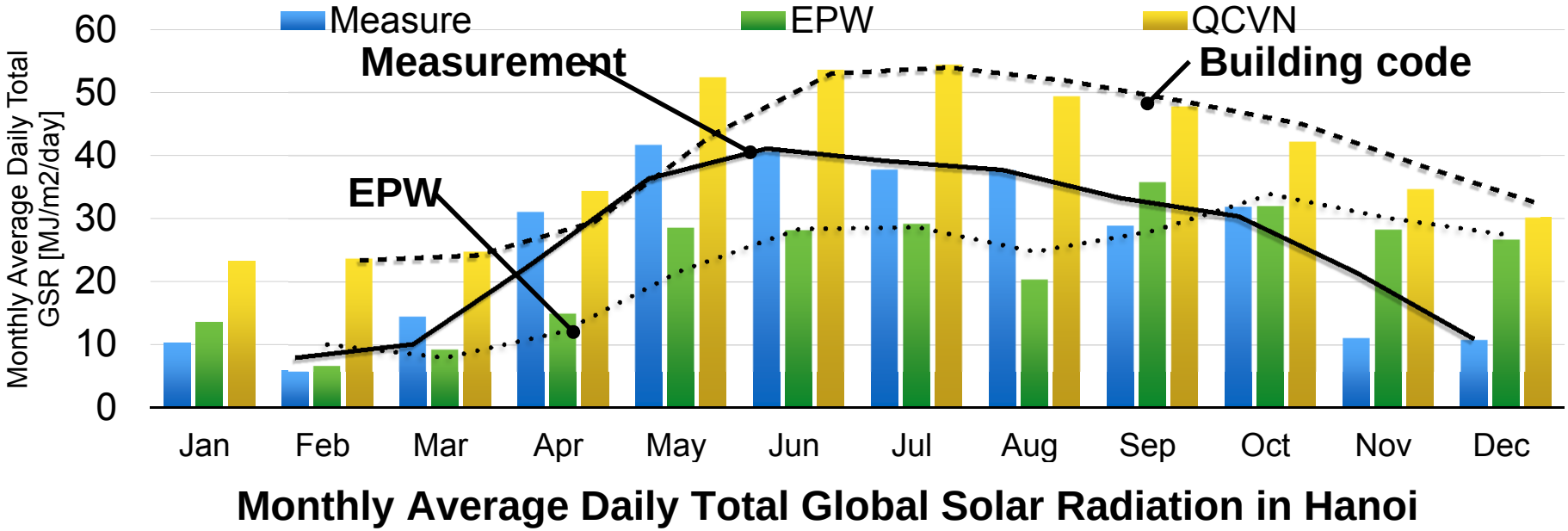


アジアにおける課題

- 気象データの妥当性
- 建築外皮性能の評価法
- 空調空間の熱環境実態
- 大規模建築のエネルギー消費実態
- グリーンビル評価基準

実測・ベトナム基準・ＥＰＷの気象データ比較





OTTV:Overall Thermal Transfer Value

The current *OTTVi* formulation (DEDE, 2007)

$$OTTV_i = (U_w)(1-WWR)(TD_{eq}) + (U_f)(WWR)(\Delta T) + (WWR)(SHGC)(SC)(ESR)$$

Heat gain through the opaque wall via a conduction process

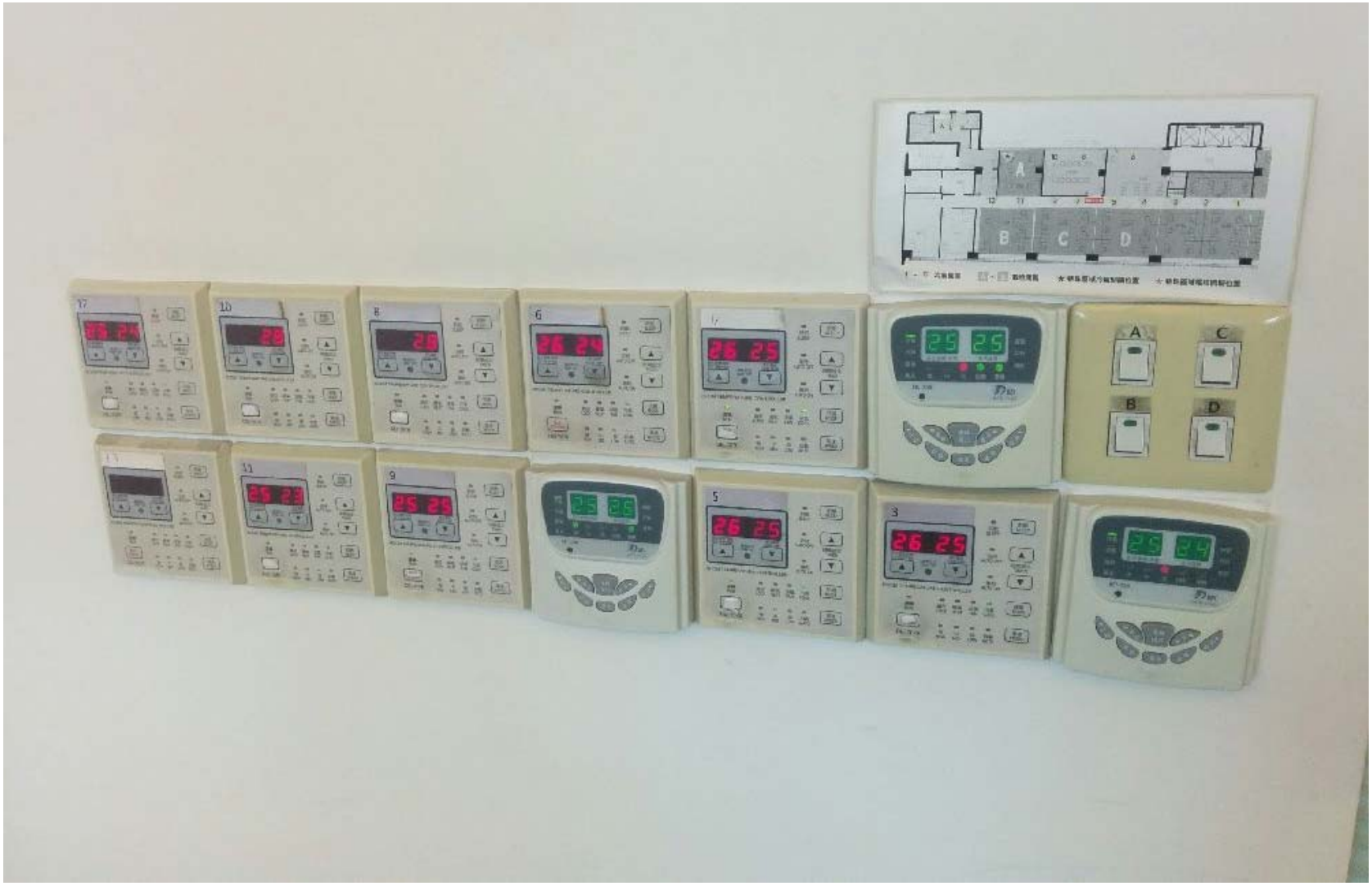
Heat gain through the window by conduction

The solar transmission through the window.

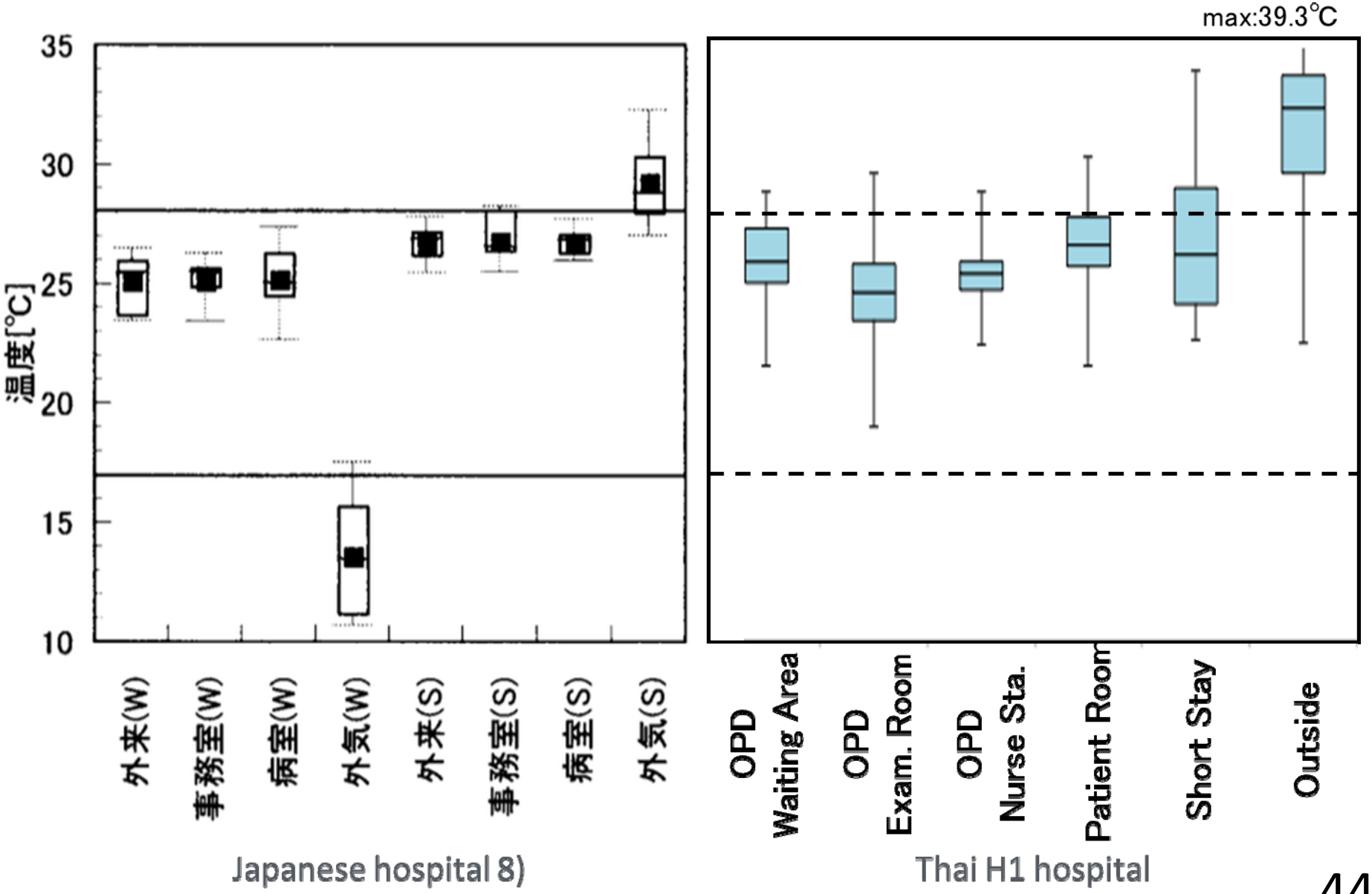
OTTVi = Overall Thermal Transfer Values (W/m^2)
Uw = The overall coefficient of heat transfer for the opaque wall ($W/(m^2.\ ^oC)$)
WWR = The ratio of window to the total wall
TDeq = The equivalent temperature across the opaque wall (^oC)
Uf = The overall coefficient of heat transfer for the transparent and glass wall (W/(m
ΔT = The temperature difference between indoors and outdoors (^oC)
SHGC = The solar heat gain coefficient of the glazing
SC = The shading coefficient of the external shading device
ESR = The effective solar radiation on the window. (W/m^2)

	Singapore	Malaysia	Thailand	Philippines	Jamaica	Hong Kong
Latitude (city)	1° 20' N Singapore	3° 7' N Kuala Lumpur	13° 41' N Bangkok	14° 35' N Manila	17° 56' N Kingston	22° 18' N Hong Kong
Year adopted	1979	1989	1992	1993	1992	1995
Status	Mandatory	Voluntary	Mandatory	Voluntary	Mandatory	Mandatory
OTTV limits for walls (W/m^2)	45	45	45	48	55.1 - 67.7	Tower: 35 Podium: 80
OTTV limits for roof (W/m^2)	45 (max. U-value if no skylights)	25 (max. U-value if no skylights)	25 (max. U-value if no skylights)	Max. U-value if no skylights	20	(average for walls and roof)
TD_{eq} for walls (K)	10 - 15	19.1 α	9 - 18	12.65 α (office) 5.4 α (hotel)	varies with α	1.4 - 7.5
TD_{eq} for roof (K)	16 - 24	16 - 24	12 - 32	---	varies with α	7.9 - 18.6
DT for walls (K)	5	neglected	5	3.35 (office) 1.10 (hotel)	varies by location	neglected
DT for roof (K)	5	neglected	5	---	varies by location	neglected
Average SF for walls (W/m^2)	130	194	160	161 (office) 142 (hotel) 151 (store)	372	160
Average SF for roof (W/m^2)	320	488	370	---	435	264
Consider exterior shading?	Yes	Yes	Yes	No	Yes	Yes
Daylighting credits?	No	Yes (10% or 20%)	N/A	Yes (10%)	Yes (7.5% or 30%)	No

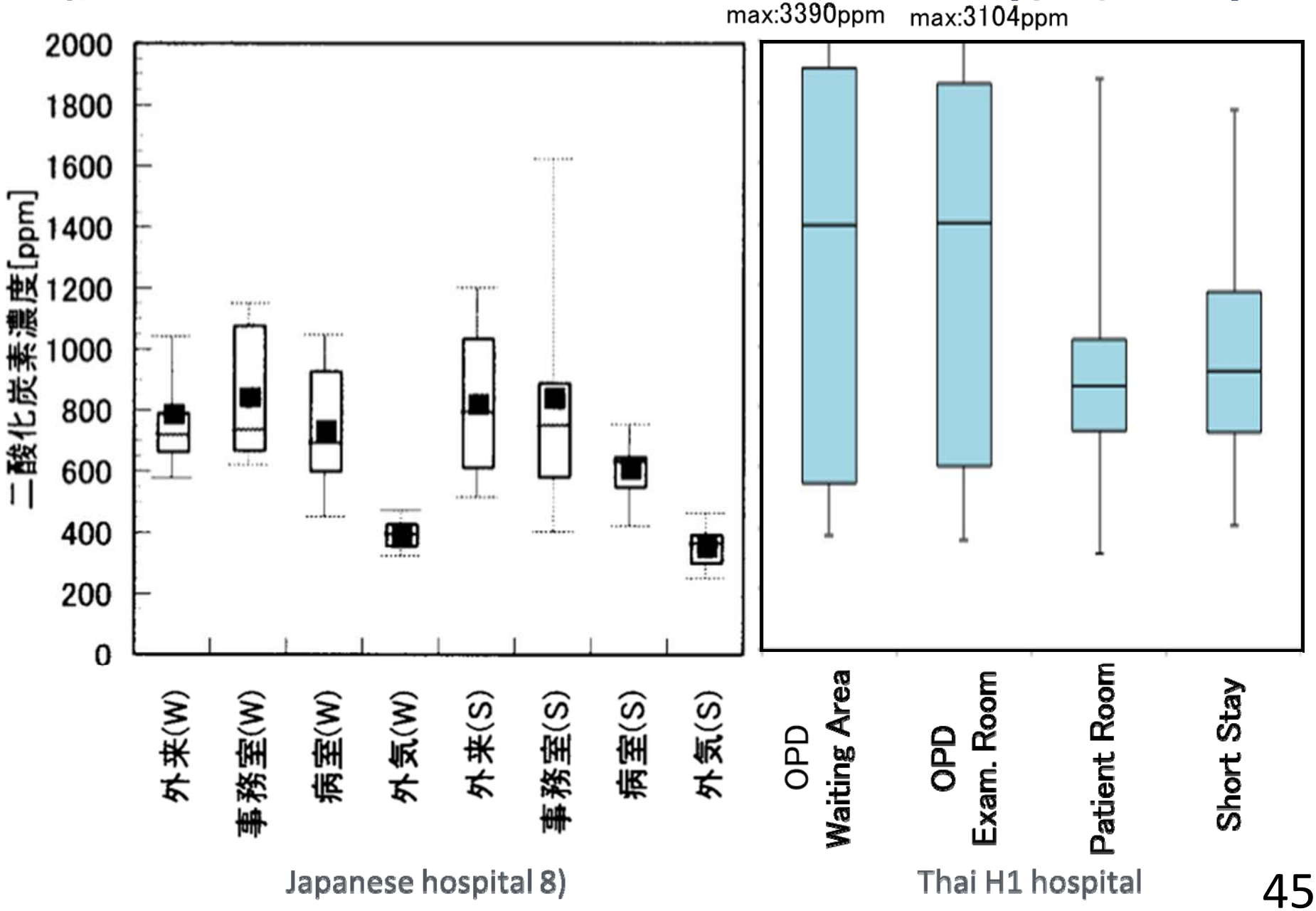
著しく低い設定温度・運用管理なし



病院における温度出現頻度（稼働時）



病院におけるCO2濃度出現頻度（稼働時）



ベトナムにおける
グリーンビルディング認証の来歴

Source: Ministry of Construction, IFC, Solidiance, 2013

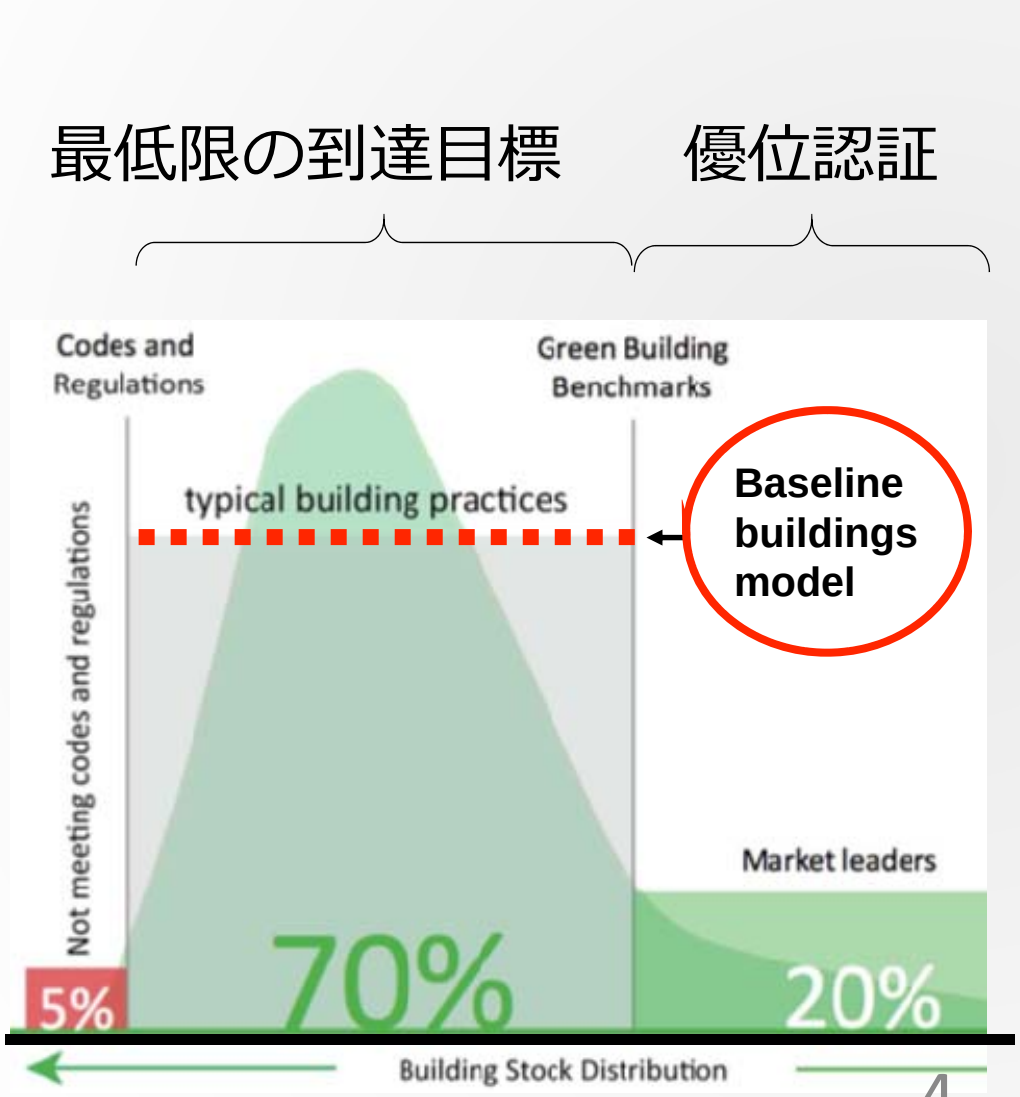
Year	Government **Code & Standard**	GB rating system **Domestic**	GB rating system **International**
2005	**QCVN** - Energy Efficiency **Building Code** (v.1)		
2007		VGBC was established	**LEED** in Vietnam
2010	**Law** on Energy Efficiency and Conservation	**LOTUS Green rating system** (pilot)	
2011	**Green building council Vietnam** was established (Ministry of Construction)		
2013	**QCVN** - Energy Efficiency **Building Code** (v.2)	**LOTUS Green rating system** (v1.1)	
2014			**EDGE**

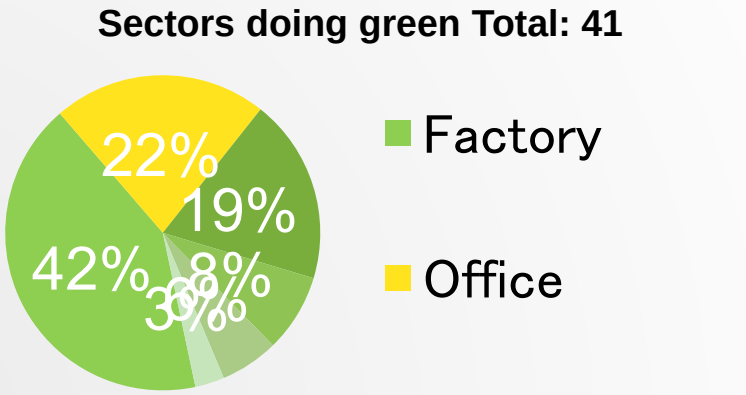
QCVN (09:2013)

LOTUS (2013)

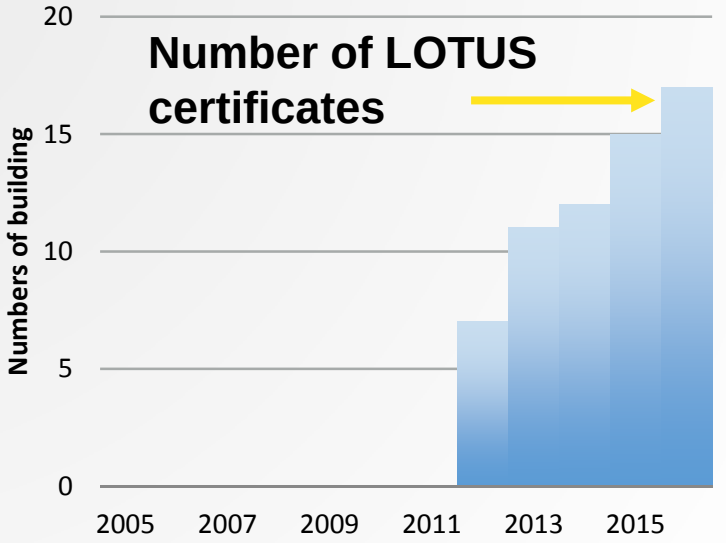
LEED

VNグリーンビルディング認証の概要



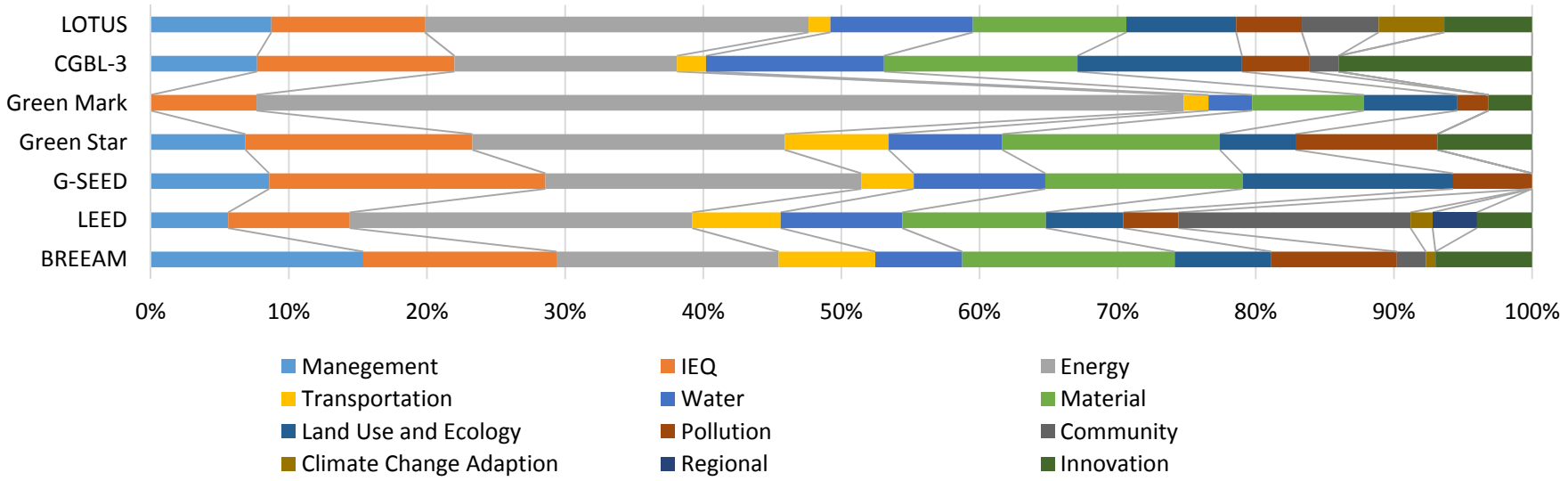


Office building adoption has been limited with certified green buildings



一部拡大（認証数）

Country	India		China	Australia	Malaysia
Green Building System / Code	Energy Conservation Building Code (ECBC)	Green Rating for Integrated Habitat Assessment (GRIHA)	Chinese Green Building Evaluation Label	green star	Green Building Index(GBI)
Symbol mark					
Number of application (Until XXXXyear)	?	575 (2015)		–	712(2016)
Number of certification(Until XXXXyear)	?	74 (2015)	More than 50 (Until 2010)	–	340(2016)



各指標における項目に対する点数の割合

Glocalization

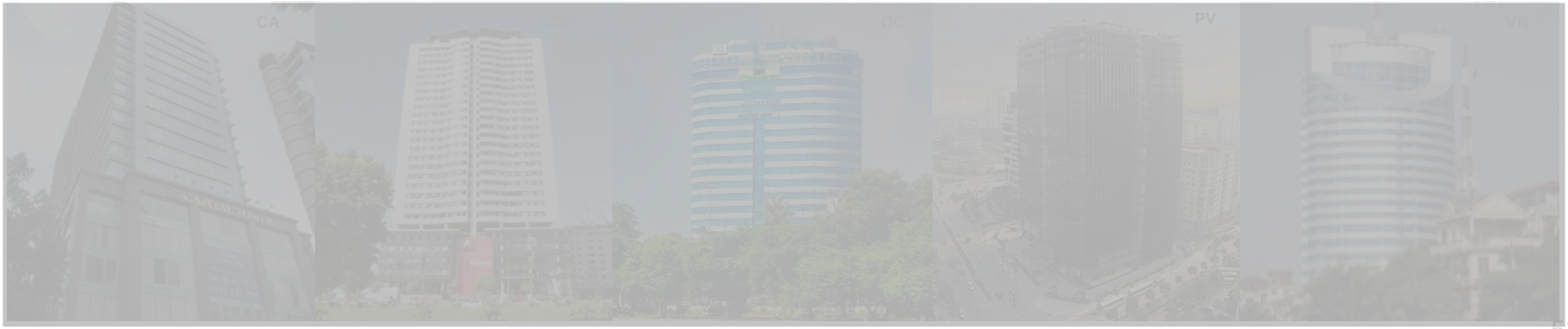
ASHRAE 90.1

BEAM

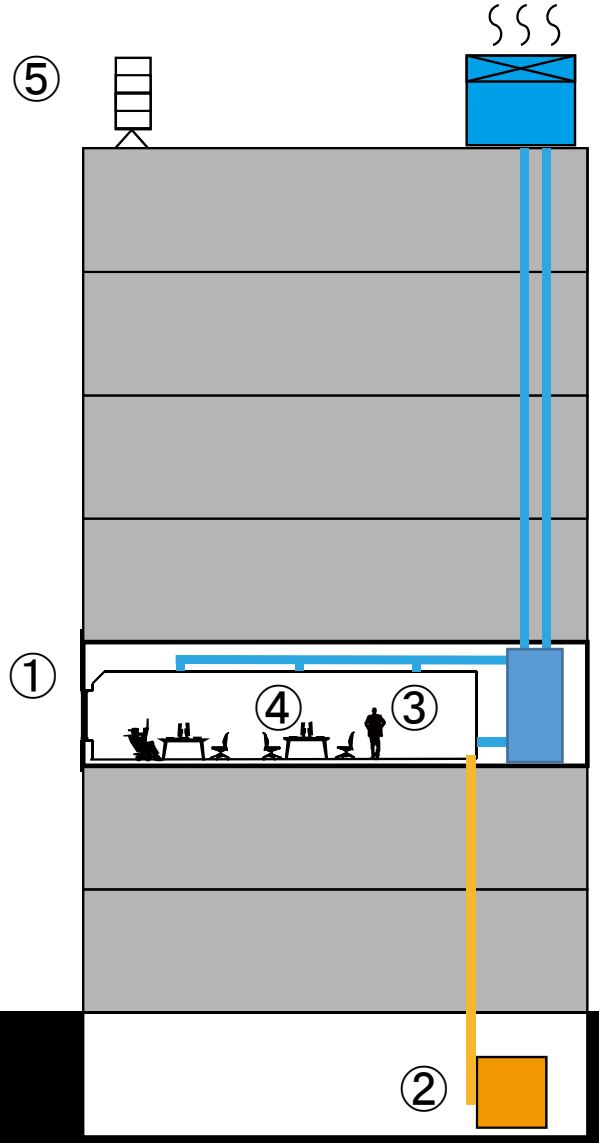
オフィスビル調査概要

評価対象オフィスビル

Building	CA	CE	OC	PV	VN
Total stories	23	27	19	25	27
Total area [m2]	28,000	22,500	34,640	61,400	40,000
Typical office [m2]	981−1265	834	980	2090	1520
Net floor area	879	644	919	1684	873 (1237)
Celling height [m]	2.65	2.65	2.65	2.7	2.7
investigated area [m2]	239	(507.6)	403.2	662+115, 542	392
Number of occupants on investigated area	36	40	54	152	35
AC systerm	Individual	Central	Individual	Individual + central	Individual
Ownership	Private	Corporate	Corporate	Corporate	Government
Age(yr)	2010	2009	2002	2013	2009
BMS system	yes	yes	yes	yes	yes
Façade	double glass	brick + singer glass	brick + singer glass	singer glass	brick + singer glass
Electric capacity	2000+1600KVA	1250KVAx2	16000KVAx2	2500KVAx2	N/A
Occupants density	100%	90%	100%	70%	80%



基準階を中心とした評価



1. 基準階室内環境
2. エネルギー消費量
3. 居住者申告
4. 建物の使われ方
5. 気象データ
6. 建物の設計情報

室内環境

① Interior ② Perimeter

Vertical temperature distribution

Couple wire (sensor)

Data logger

Air temperature and Humidity

Temp / Humidity / CO2 Sensor & logger

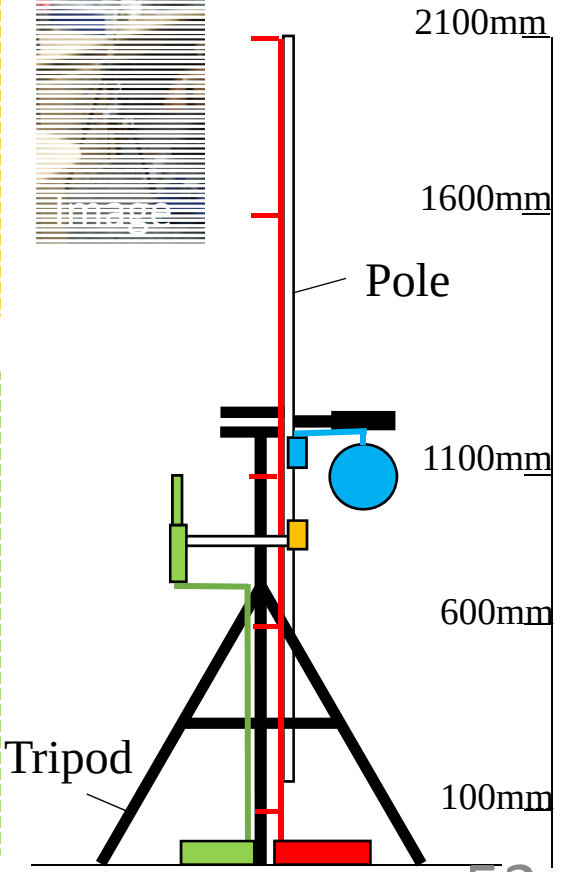
Black ball temperature

Black ball

Temperature sensor & logger

Wind speed (① only)

Wind speed sensor & logger



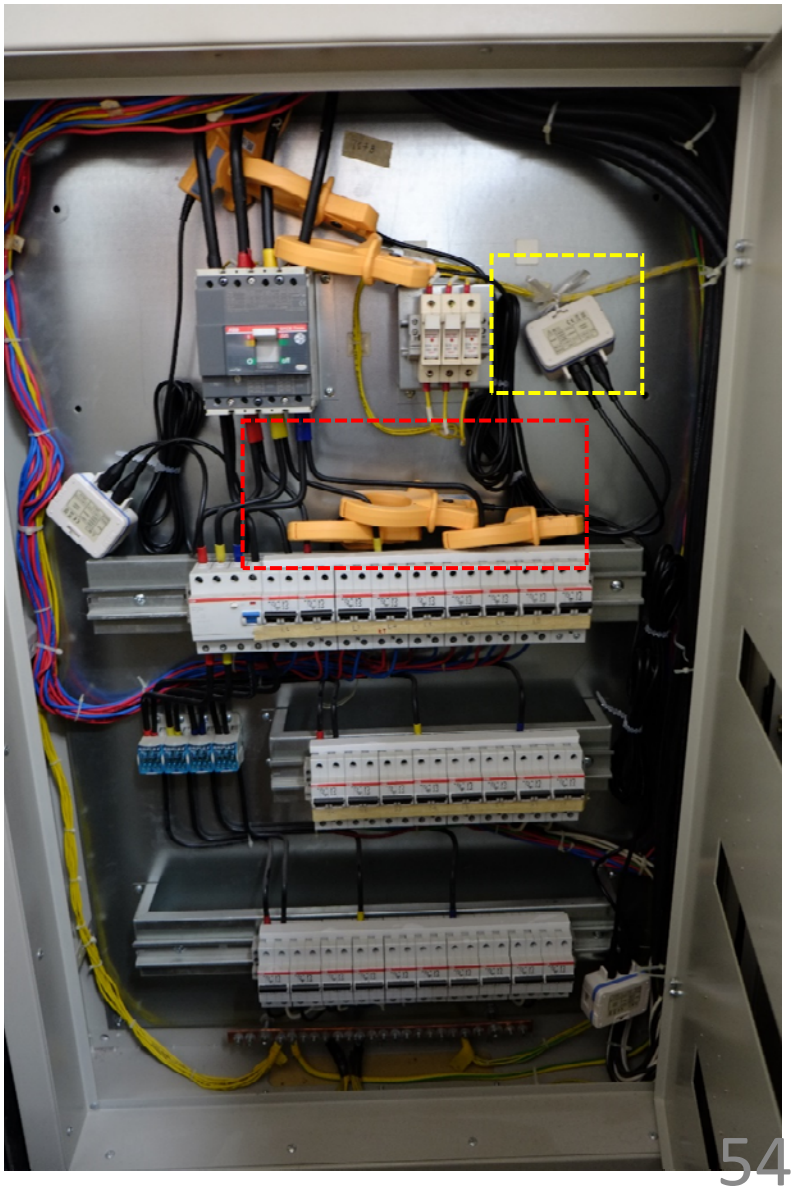
エネルギー消費量

Four electric power need to be measured for the target office separetely
1- Lighting
2- Electrical outlet
3- Air conditioning indoor unit
4- Air conditioning outdoor unit

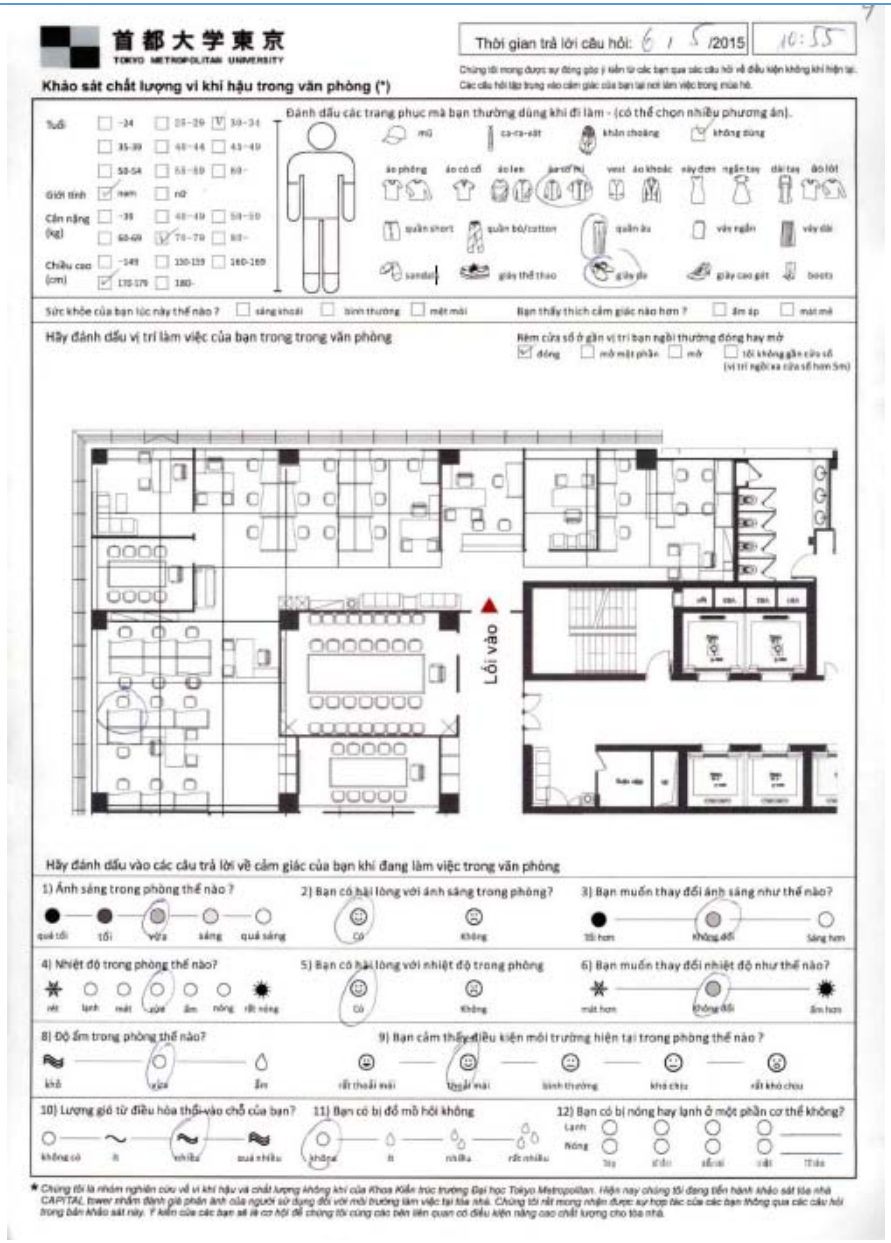
Clamp sensors will be installed to each electrical system, and 1-2 power loggers will be installed for them.

Power logger

Clamp sensor



居住者快適性申告



首都大学東京
TOKYO METROPOLITAN UNIVERSITY

Thời gian trả lời câu hỏi: 6 / 5 /2015 10:55

Khảo sát chất lượng vi khí hậu trong văn phòng (*)

Chúng tôi mong được sự đóng góp ý kiến từ các bạn qua các câu hỏi về điều kiện không khí hiện tại. Các câu hỏi tập trung vào cảm giác của bạn tại nơi làm việc trong mùa hè.

Tuổi: ☐ -24 ☐ 25-29 ☑ 30-34 ☐ 35-39 ☐ 40-44 ☐ 45-49 ☐ 50-54 ☐ 55-59 ☐ 60-

Giới tính: ☑ nam ☐ nữ

Cân nặng (kg): ☐ -39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☑ 70-79 ☐ 80-

Chiều cao (cm): ☐ -149 ☐ 150-159 ☐ 160-169 ☑ 170-179 ☐ 180-

Đánh dấu các trang phục mà bạn thường dùng khi đi làm - (có thể chọn nhiều phương án).

mũ, ca-ra-vát, khăn choàng, không dùng

áo phông, áo cổ cổ, áo len, jacket, vest, áo khoác, váy đơn, ngắn tay, dài tay, đồ lót

quần short, quần bò/cotton, quần âu, váy ngắn, váy dài

sandal, giày thể thao, giày da, giày cao gót, boots

Sức khỏe của bạn lúc này thế nào ? ☐ sảng khoái ☐ bình thường ☐ mệt mỏi

Bạn thấy thích cảm giác nào hơn ? ☐ ấm áp ☐ mát mẻ

Hãy đánh dấu vị trí làm việc của bạn trong trong văn phòng

Rèm cửa sổ ở gần vị trí bạn ngồi thường đóng hay mở
☑ đóng ☐ mở một phần ☐ mở ☐ tôi không gần cửa sổ (vị trí ngồi xa cửa sổ hơn 5m)

Lối vào

Hãy đánh dấu vào các câu trả lời về cảm giác của bạn khi đang làm việc trong văn phòng

1) Ánh sáng trong phòng thế nào ? quá tối, tối, vừa, sáng, quá sáng

2) Bạn có hài lòng với ánh sáng trong phòng? Có, Không

3) Bạn muốn thay đổi ánh sáng như thế nào? Tối hơn, Không đổi, Sáng hơn

4) Nhiệt độ trong phòng thế nào? rét, lạnh, mát, vừa, ấm, nóng, rất nóng

5) Bạn có hài lòng với nhiệt độ trong phòng Có, Không

6) Bạn muốn thay đổi nhiệt độ như thế nào? mát hơn, Không đổi, ấm hơn

8) Độ ẩm trong phòng thế nào? khô, vừa, ẩm

9) Bạn cảm thấy điều kiện môi trường hiện tại trong phòng thế nào ? rất thoải mái, thoải mái, bình thường, khó chịu, rất khó chịu

10) Lượng gió từ điều hòa thổi vào chỗ của bạn? không có, ít, nhiều, quá nhiều

11) Bạn có bị đổ mồ hôi không Không, ít, nhiều, rất nhiều

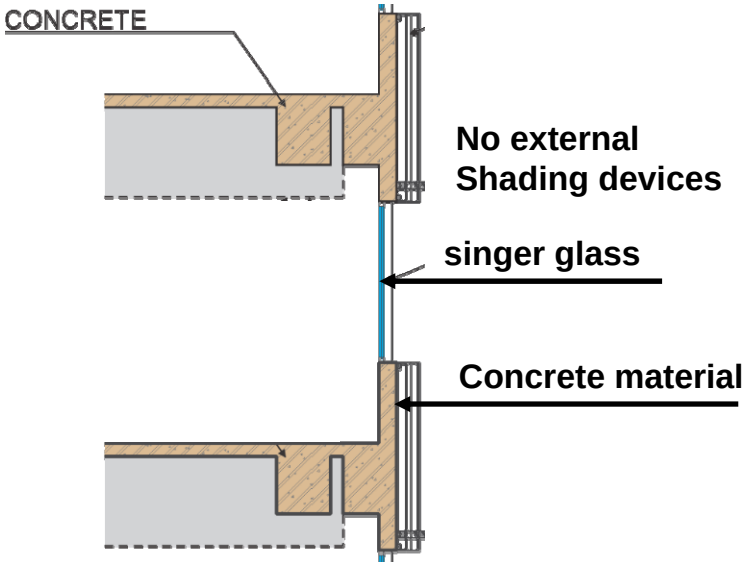
12) Bạn có bị nóng hay lạnh ở một phần cơ thể không? Lạnh, Nóng

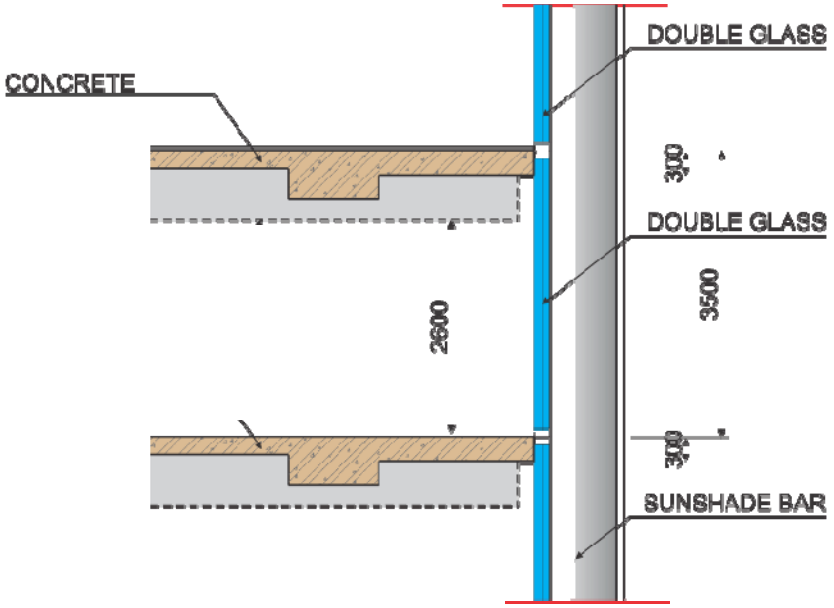
* Chúng tôi là nhóm nghiên cứu về vi khí hậu và chất lượng không khí của Khoa Kiến trúc trường Đại học Tokyo Metropolitan. Hiện nay chúng tôi đang tiến hành khảo sát tòa nhà CAPITAL tower nhằm đánh giá phản ánh của người sử dụng đối với môi trường làm việc tại tòa nhà. Chúng tôi rất mong nhận được sự hợp tác của các bạn thông qua các câu hỏi trong bản khảo sát này. Ý kiến của các bạn sẽ là cơ hội để chúng tôi cùng các bên liên quan có điều kiện nâng cao chất lượng cho tòa nhà.

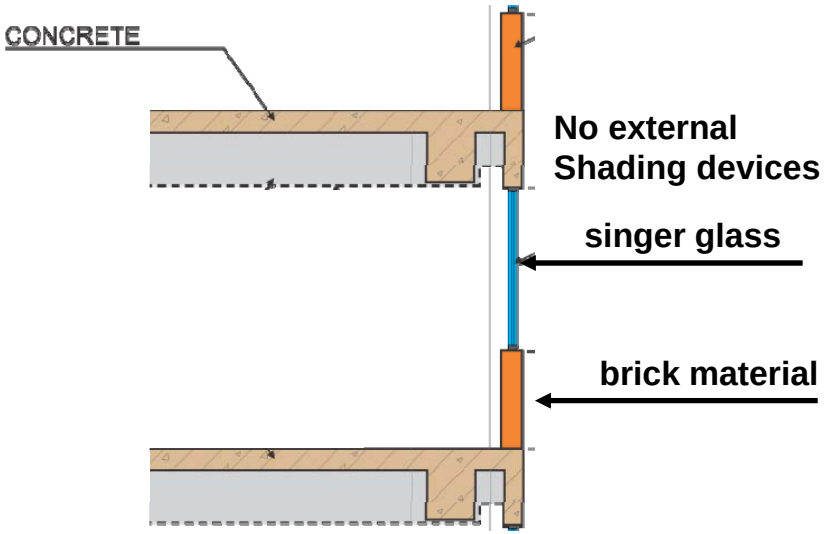
建物の使われ方PV


PV-07
A
PV-01
B
PV-02
PV-04
PV-03
C
PV-05
PV-06
PV-C1
D
male
female
Hot/Cold sense
no answer
-3
-2
-1
0
1
2
3
Cold
Hot
Desktop PC
Multifunction machine
Printer
Supply air
Return air
N

ファサード断面構成の特徴







Reinforced structures concrete

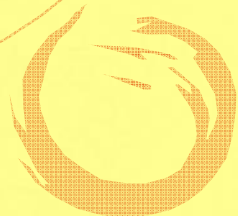
Poor insulation material

Poor Airtightness

Poor Shading solution


DẦU KHÍ VIỆT NAM

IEQ実態



ハノイの外気温年間変動

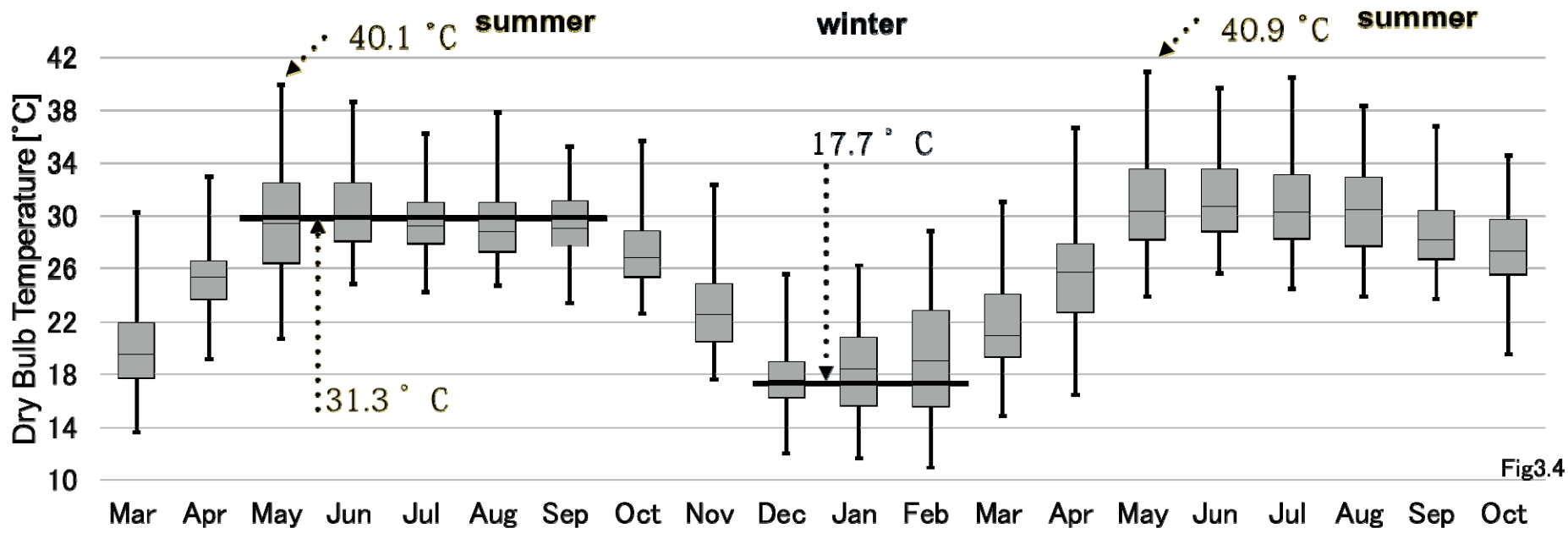
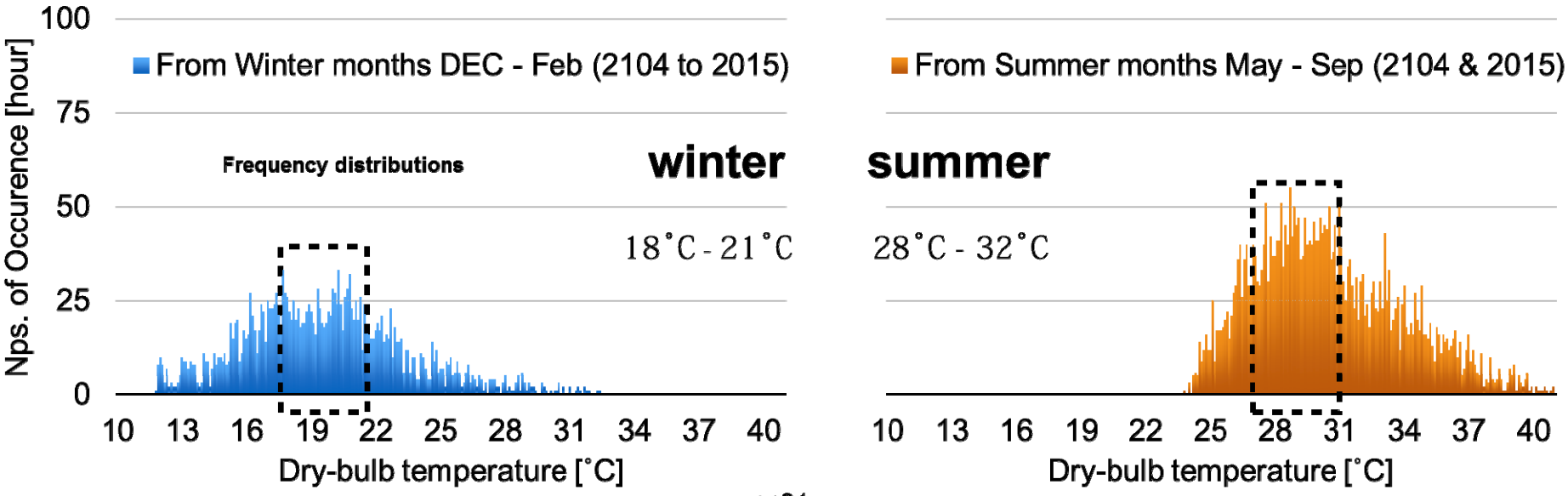
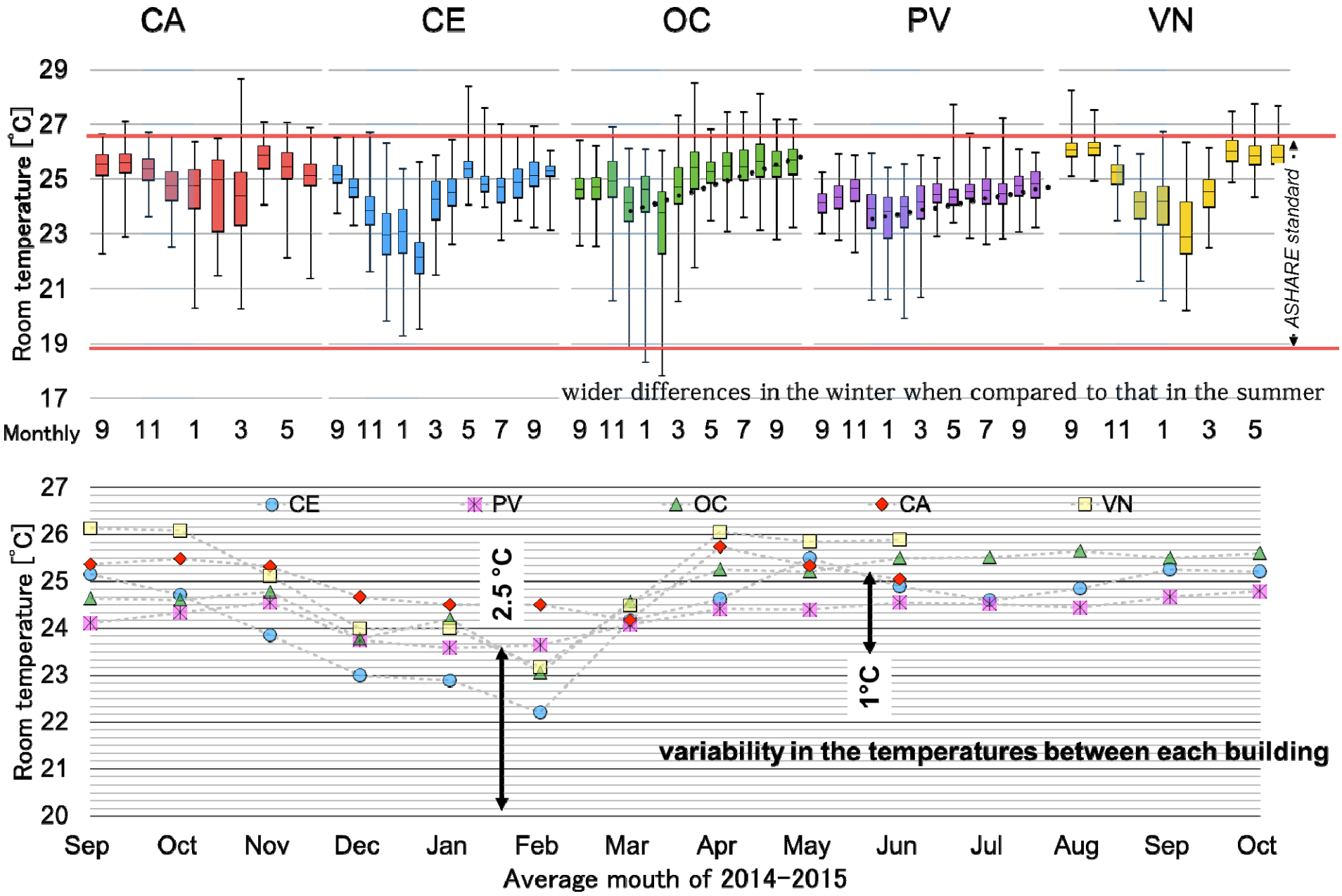


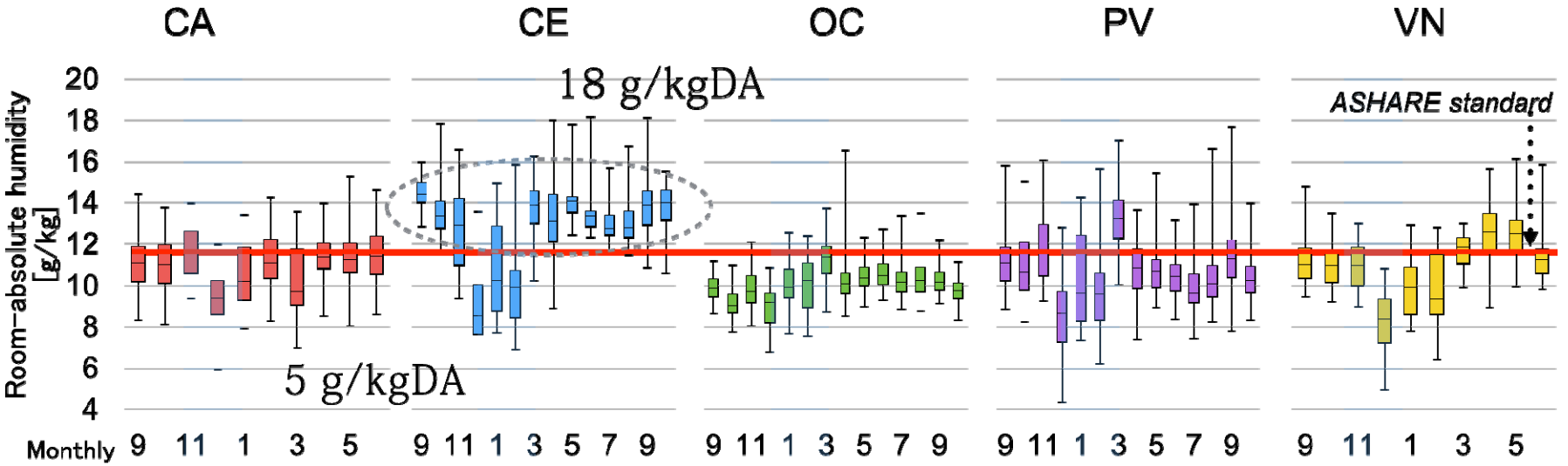
Fig3.4

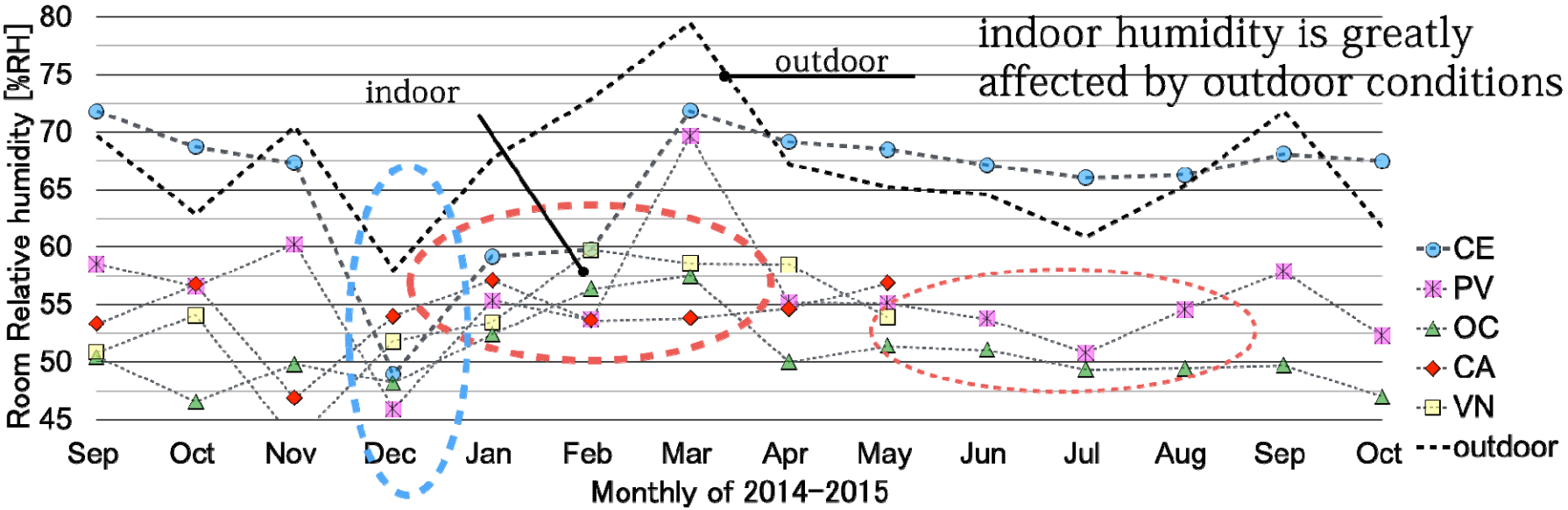


オフィス稼働時間帯における温度出現

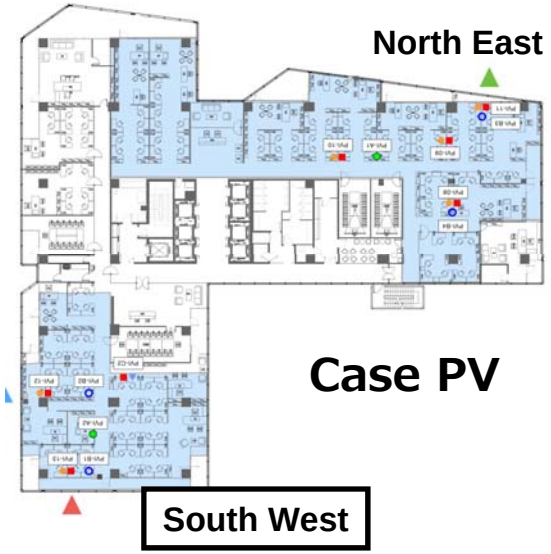


オフィス稼働時間帯における湿度出現





ペリメータとインテリア比較



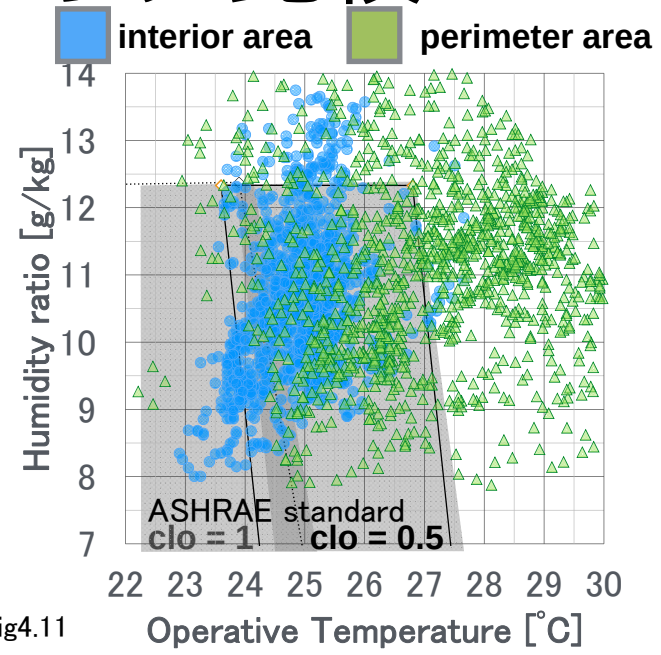
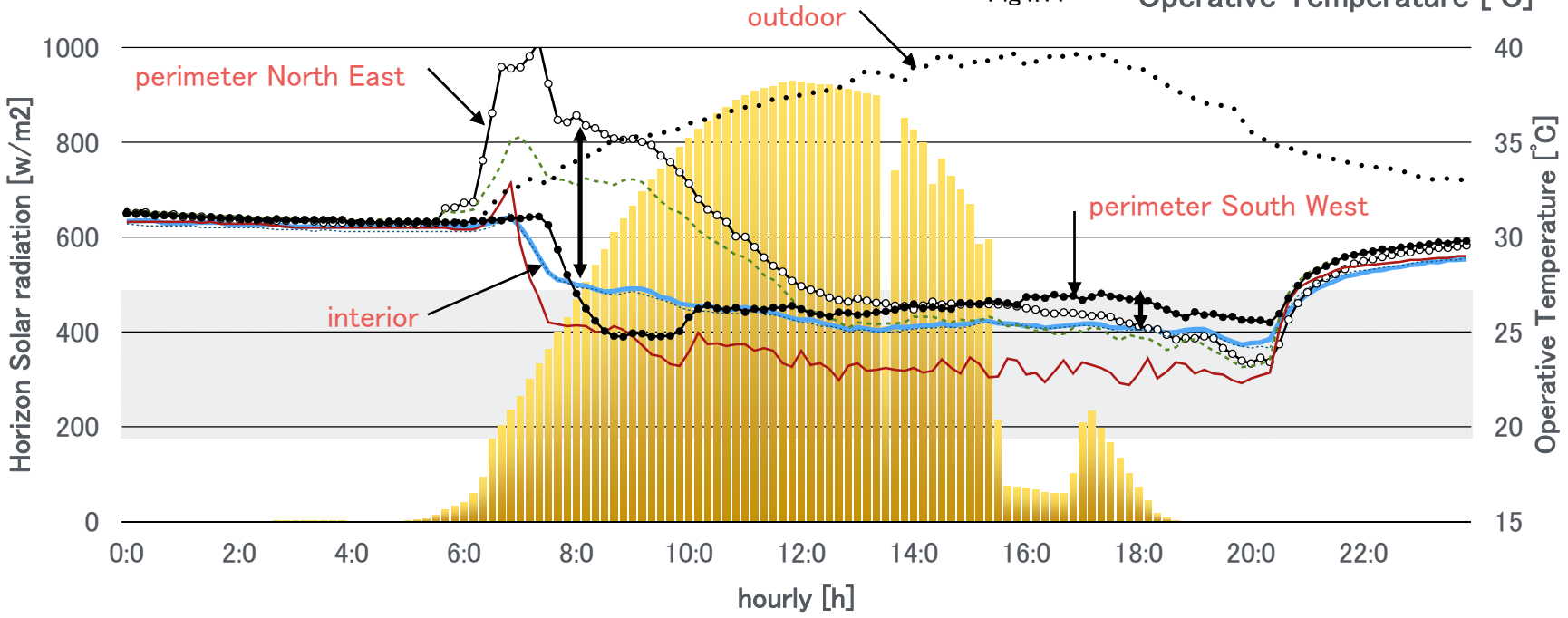


Fig4.11



調査対象居住者のプロファイル

The occupancy profiles (n=244)

Gender

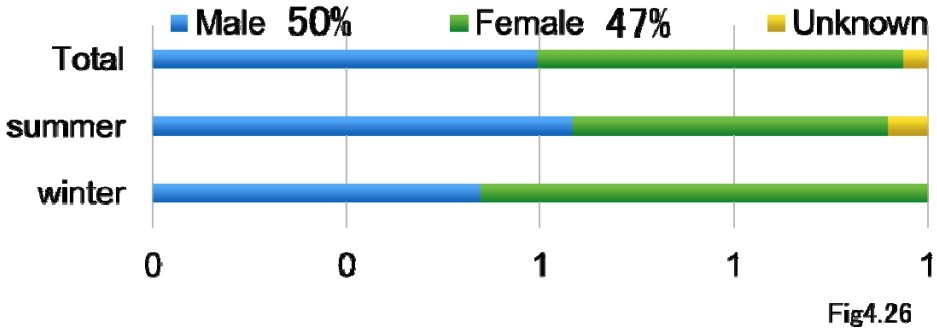


Fig4.26

Age

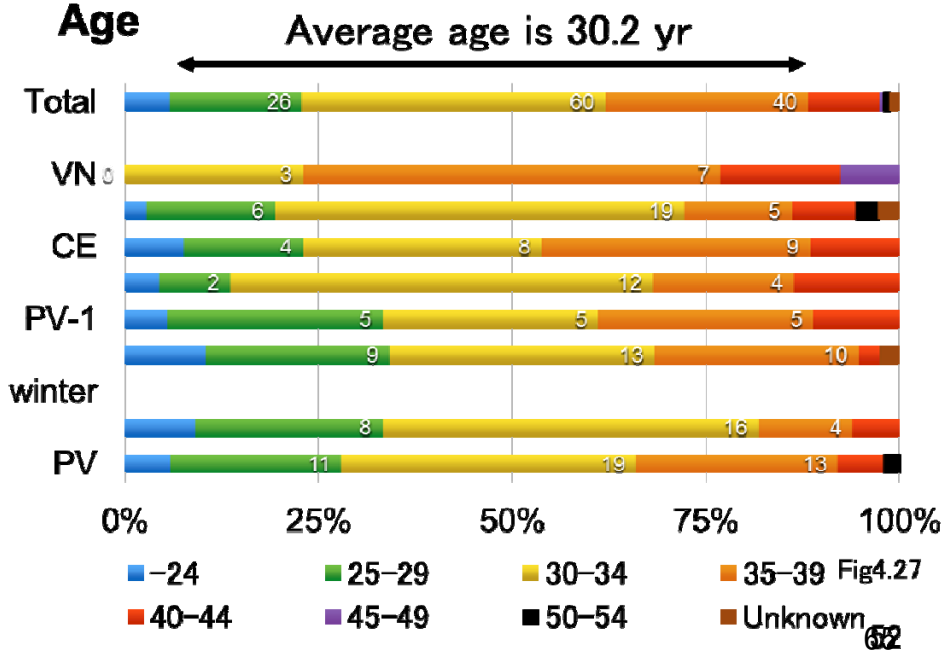


Fig4.27

Overall clothing rates

	Male	Female	Average	frequency
Summer	0.698	0.604	0.653	71.9%
Winter	0.792	0.634	0.707	63.0%

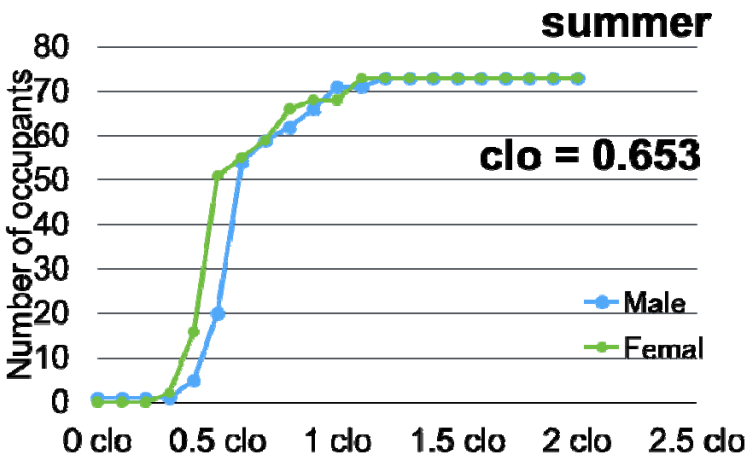
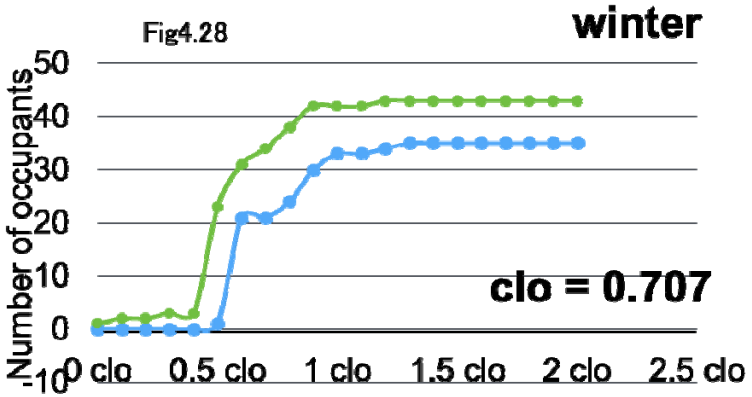
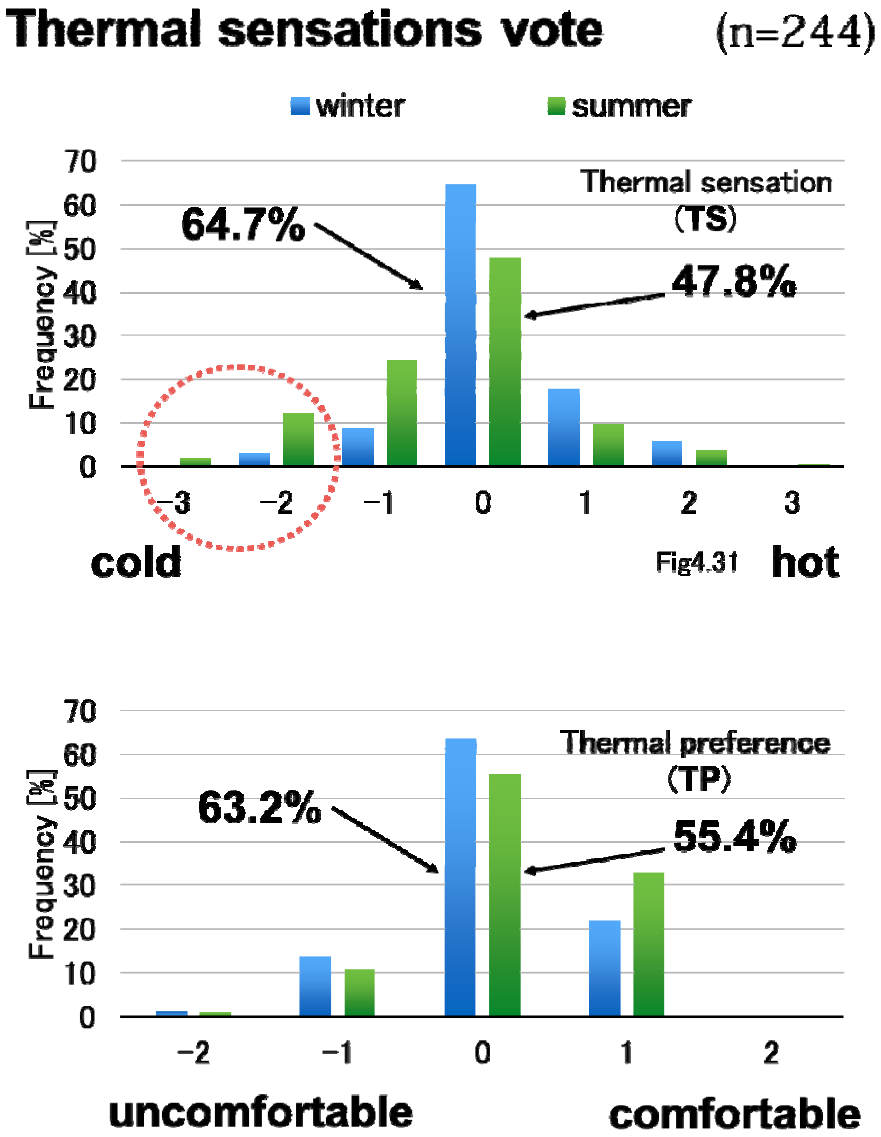


Fig4.28



夏期冬期の温熱感申告

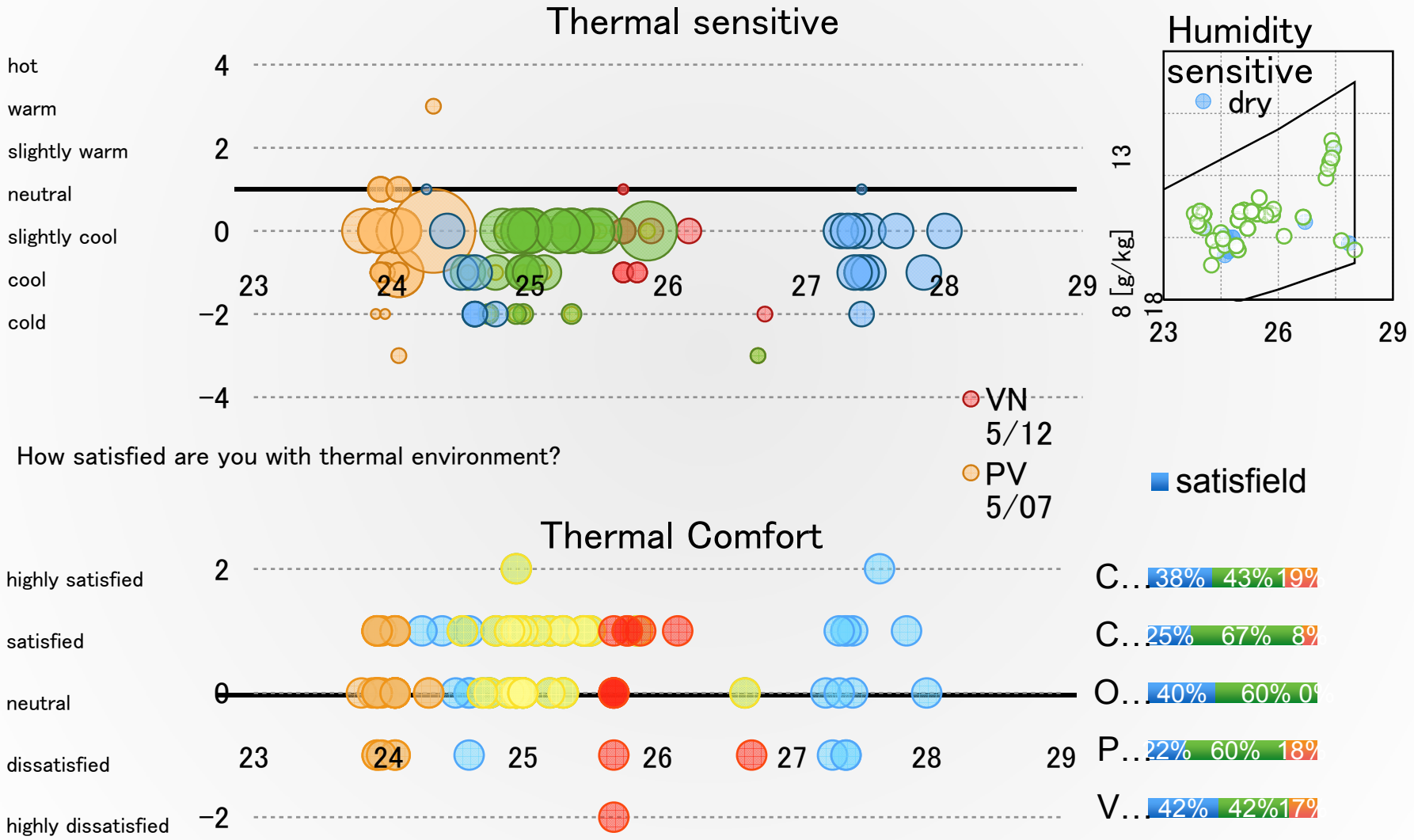


38.2% voted on the **cooler side in summer**

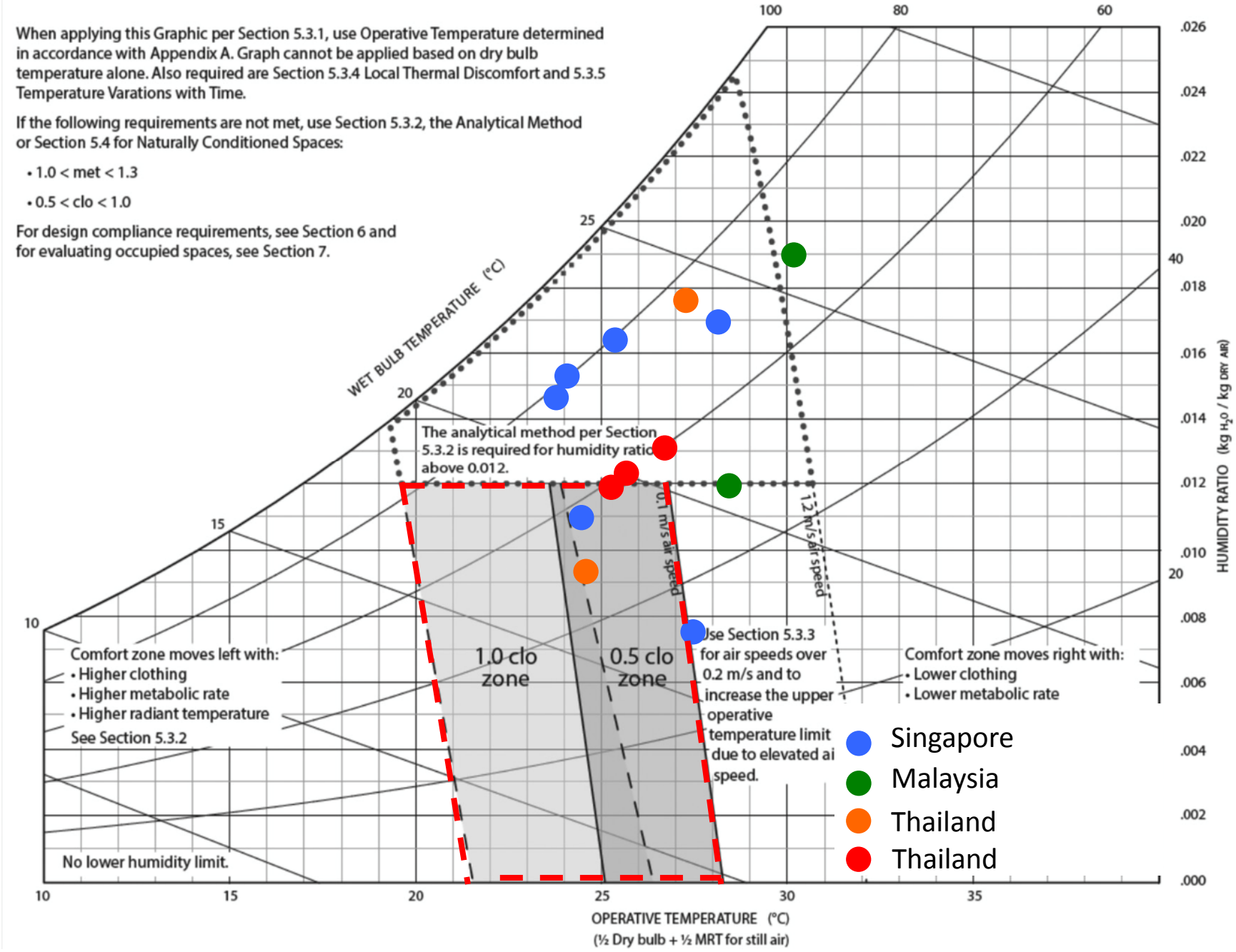
2.94% felt **cold discomfort in summer.**

作用温度とＴＳＶの相関

Correlation between temperature and occupants’ thermal sensation

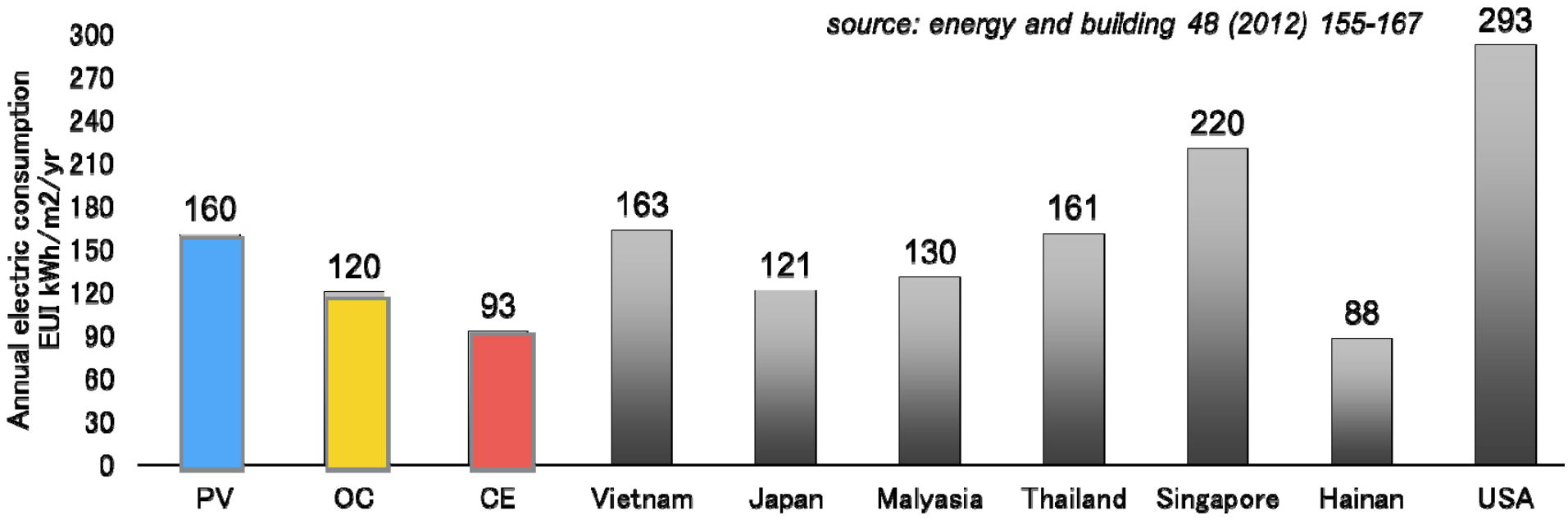


ASHRAE快適域とアジアの調査結果（既往含む）

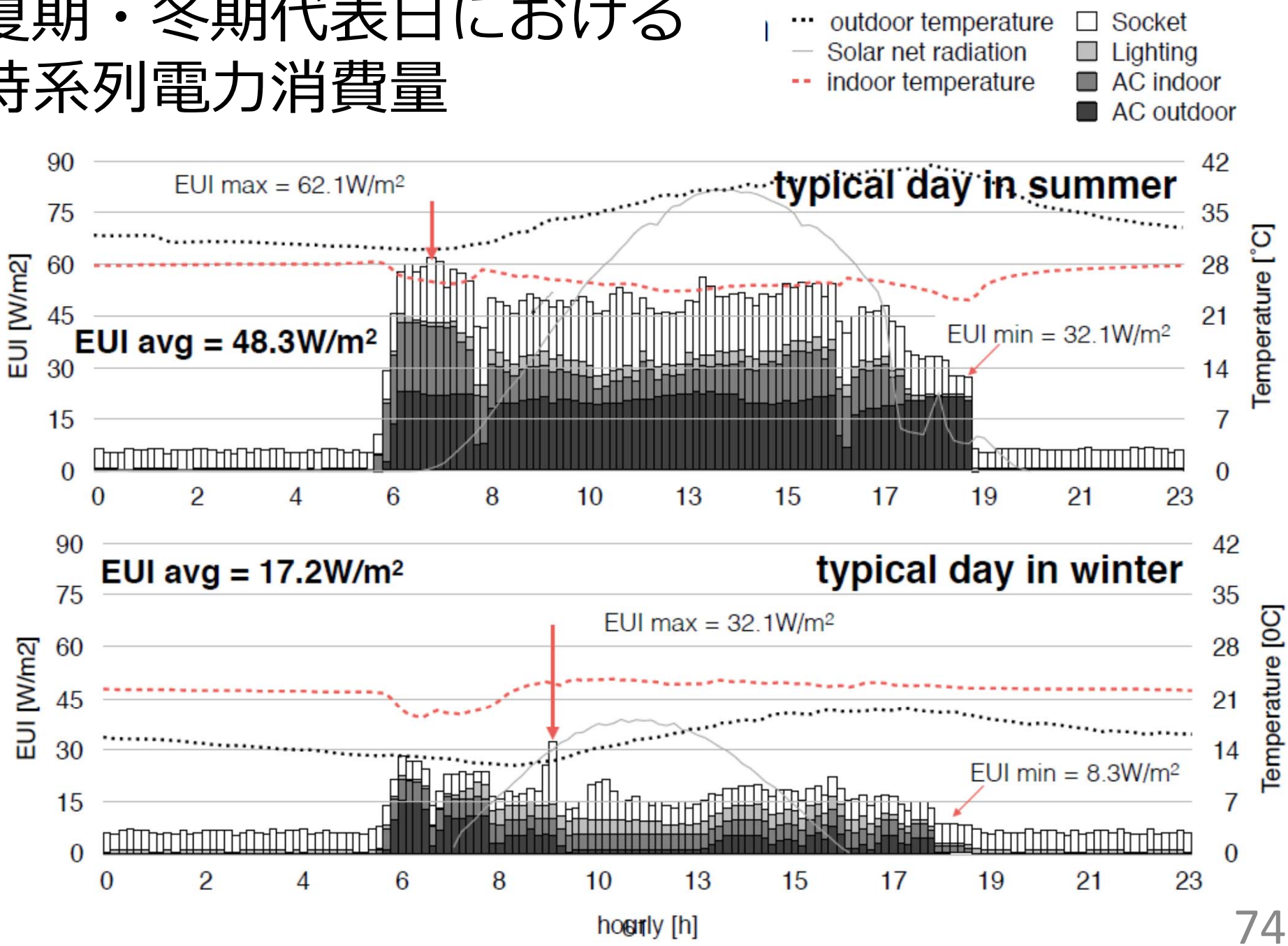


EUI実態・ベースライン検討

年間EUI実績値と各国参照値との比較



夏期・冬期代表日における時系列電力消費量



ASHRAE90.1 ベースラインモデルの主要パラメータ

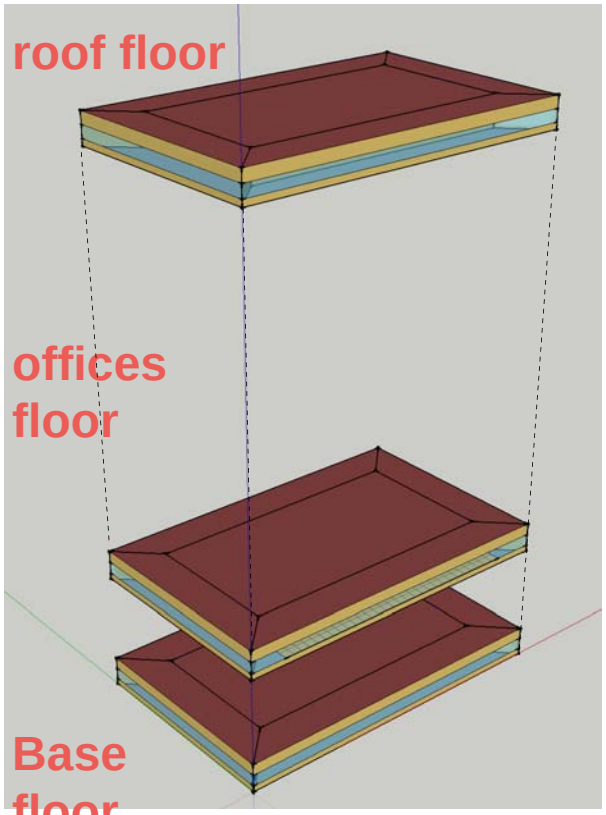
Characteristics	Parameters	QCVN	LOTUS	LEED	Actual	Desgin
Indoor thermal conditions	**Temperature (°C)**	23–25	23–26	21–26	22–25	21–27
	Relative humidity (%)	60–70	60–70	55–65	55 – 65	55 – 65
Indoor design conditions	Occupancy (m2/person)	8–10	8–10	20	9.38	9.38
	Ventilation rate (m3/h/person)	25	25	35	25*	25
	L/s/person	6.9	6.9	8.5	6.9*	6.9
	Lighting power density (W/m2)	11	11	8.8	3.5	3.5
	Equipment power density (W/m2)	12**	15	15	11	11
Envelop features	**Wall heat transfer coefficient (W/m2 K)**	1.8	1.8	3.293	3.02	1.8
	Roof heat transfer coefficient (W/m2 K)	1	1	0.273	0.31	0.31
	Window heat transfer coefficient (W/m2 K)	3.24	3.24	3.24	5.6	3.24
	Shading coefficient (SC=SHGC/0.86)	0.46	0.46	0.25	0.6	0.25
	Window–to–wall ratio	0.4	0.4	0.4	0.4	0.4
Air–conditioning features	System type	VRF	VRF	VRF	VRF	VRF
	coolings' COP	2.84	2.84	3.05	3.05	2.84
	heatings' COP	N/A	N/A	3.2	3.15	3.2

* the actual value is not available, the value was used from QCVN

** value is not available on building codes, the value is refer from general information in Vietnam

EnergyPlusによるEUIシミュレーション

Typical offices for baseline model



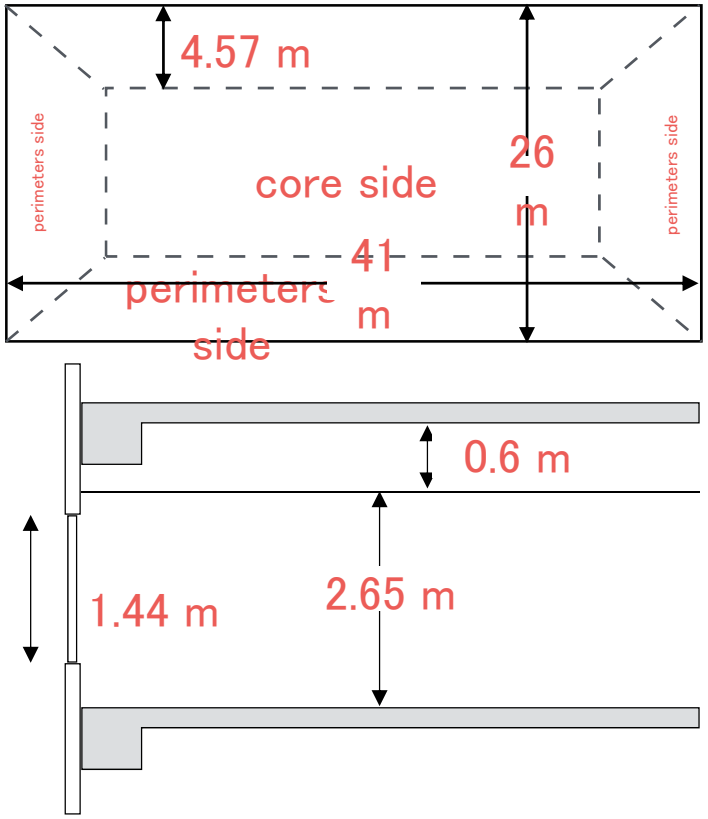


Fig3.1

Location:	Hanoi (latitude °N, longitude °E) Weather	EPW data
Building type and stories	Office building, 20 stories above ground	
Floor area:	Total gross floor area = 21.320 m2	
	Air-conditioning area = 21.320 m2	
Dimension and heights:	41 m x 26 m (square); floor to floor = 3.6 m; window height = 1.44 m; window to wall ratio = 0.4	

基準モデルの想定によるEUI比較

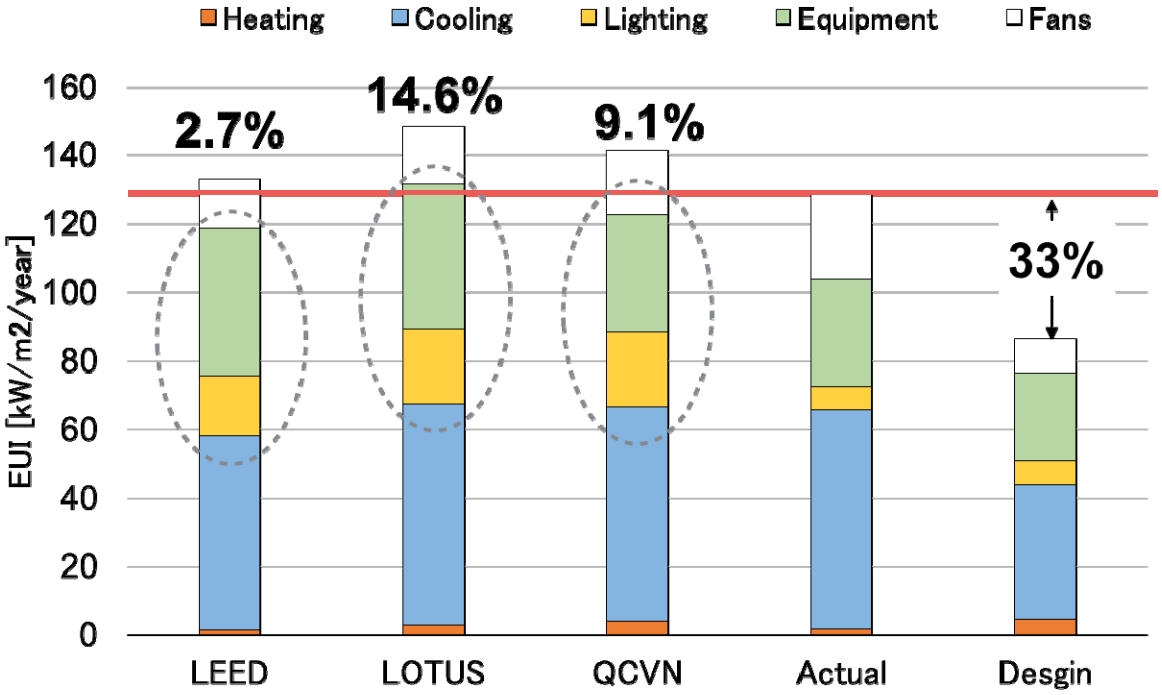
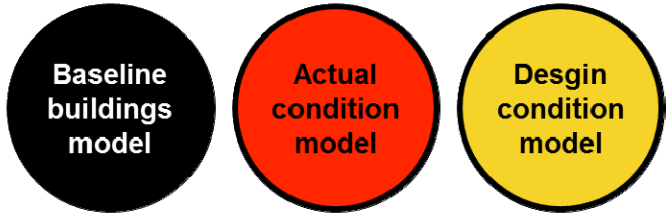


Fig3.5-4

Difference between the existing baselines and the actual condition



% increase		LEED	LOTUS	QCVN	Design
Heating load	%	−0.1	0.9	**1.8**	2.2
Cooling load	%	−5.8	0.5	−1.0	−19.1
Lighting	%	8.3	**11.3**	**11.3**	0.1
equipment	%	**8.8**	**8.8**	2.2	−4.4
Fans	%	−8.6	−6.9	−5.2	−11.9
Total	%	**2.7**	**14.6**	**9.1**	**-33.1**

まとめ

- 東南アジア研究背景
  - 欧米基準の見直し
  - 実態データ不足
- ベトナムオフィスビルの実態
  - 内部発熱が小さい
  - 室内環境は不安定
  - 執務者の申告は鈍い
- 想定される改善内容
  - 室内環境基準の緩和
  - エネルギー評価用基準条件の見直し