JRE CO_2 Reduction Study Report
(Summary Edition)

March 2020

Mitsubishi Jisho Sekkei Inc.

This is the summary of the Final Study Report delivered to JRE on 31 March 2020.

1. Background and Purpose

Background and purpose

Sustainability / Global Trends

In response to the recent increasing interest in global climate change risk, many organizations and companies have taken measures to address it as an important issue. Under the Paris Agreement, the Japanese Government had declared that it would reduce CO_2 emissions by 26% by 2030 as compared to 2013 figures.

SDGs 13s Goal :
「CLIMATE ACTION 」

COP24 （24th Conference of Parties to the United Nations Framework Convention on Climate Change）
（Held in Poland 2018）
Paris Agreement
Global temperature rise　2℃ scenario　→　1.5℃ scenario

Sustainability / Domestic Trends

Many companies in Japan have set CO_2 reduction targets as important KPIs.
In March 2019　MITSUBISHI ESTATE CO., LTD., which is one of the largest developers in Japan, had announced a 35% reduction target by 2030.（2030/2017 ratio）

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Background and purpose

Against the background of these commitments to climate change, Mitsubishi Jisho Sekkei Inc. (hereinafter "MJS") has been entrusted with a task to verify the possibility of reducing CO_2 emissions from the portfolio of 71 buildings owned by Japan Real Estate Investment Corporation (hereinafter "JRE") from Japan Real Estate Asset Management (hereinafter "JRE-AM").
The full report which details this study has already been delivered to JRE and this is the summary edition for disclosure.

Study contents

① Evaluate the current situation and suggest improvements through inspections
② Calculation of CO_2 reduction target value and the potential extra cost for JRE's entire portfolio.
③ Study on applying ZEB for existing assets.

※Mitsubishi Jisho Sekkei Inc. is one of the oldest architectural firm, having originated from The Marunouchi Architectural Office in Mitsubishi Company to improve marunouchi, Tokyo as a center of Business.
We are, currently, participating in the Marunouchi rebuilding and redevelopment business, and are also actively developing overseas businesses. As more existing buildings re-assess their energy efficiency, it is inevitable that the building renovation business shall also expand. Moving forward, we will continue to make further progress by proactively working on long-term consulting operations (CM operations), safety measures such as earthquake resistance and vibration isolation, and environment-related measures such as SDGs and ESG investment from new construction to rebuilding.

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2. Calculation of CO_2 Reduction Target Value and the potential Extra Cost for the entire portfolio

（1）Confirmation before verification／ About JRE-AM CAPEX control

Confirmation of information before verification

MJS begins its consultation with an overview of the target property, including energy usage analysis, renovation history investigation, etc. The accurate data analysis of MJS is a direct result of the information provided by JRE-AM, who had accurately and systematically evaluated and analyzed the data of the buildings owned by it.

About JRE-AM CAPEX control

With the accurate data from JRE-AM and through the review of JRE's portfolio on CAPEX (capital expenditure) control system and track record, the following were confirmed.

①CAPEX control is performed by a dedicated life-cycle cost design organization (LC Design Office).

②The historical records of repairs carried out on each building are organized systematically.

③Energy reduction in the 5-year construction budget has been evaluated quantitatively.

④Energy data from EMS (energy management system) provided by an external engineering company have been evaluated and analyzed.

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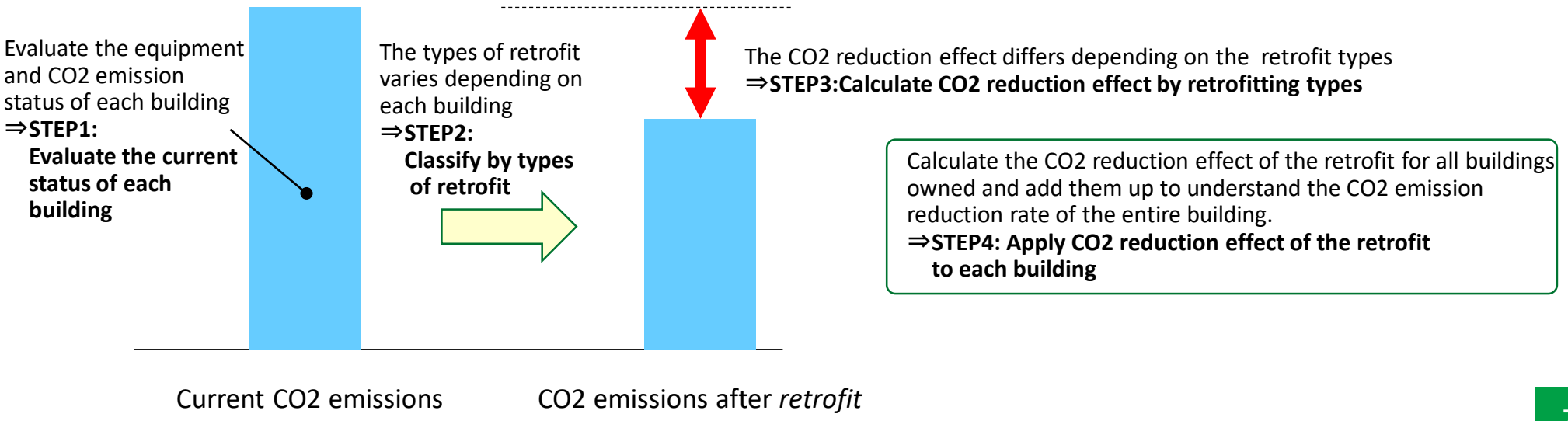
（2）Calculation Procedure and Case Study

CO2 emission calculation procedure for the entire portfolio

The specifications for the facilities of each building owned by JRE vary, and the energy saving effect and CO_2 reduction rate of each building due to the retrofitting of the facilities will differ. In order to reasonably calculate the CO_2 reduction effect of the retrofitting works for the entire portfolio, verification was performed in the following steps.

STEP1：Evaluate the current status of each building
STEP2：Classify by types of retrofit
STEP3：Calculate CO_2 reduction effect by retrofit types
STEP4：Apply CO_2 reduction effect of the retrofit to each building



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（2）Calculation Procedure and Case Study

Procedure of calculation of CO2 emissions for the entire portfolio

STEP1：Evaluate the current status of each building

Evaluate the basic building data ：Total floor area, Energy consumption, CO2 emissions, etc.
Evaluate the facility specifications for the building ：Heat source system , air conditioning system, Lighting system
Compile the history of repair work ：History and repair year of air conditioning repair work and lighting repair work

STEP2：Classify by types of retrofit

Group each building into air conditioning system and lighting system

＜Case 1＞
Retrofit air conditioning equipment with the same capacity＋ Retrofit Light equipment

＜ Case 2＞
Retrofit air conditioning equipment by reducing the capacity＋ Retrofit Light equipment

＜ Case 3＞
Case2 + further efforts for capacity reduction ＋ Retrofit Light equipment

STEP3：Calculate CO2 reduction effect by retrofit types

⇒ Calculating the CO2 emission reduction effect of Case 1 to Case 3

STEP4：Apply CO2 reduction effect of the retrofit to each building

⇒Calculation of CO2 emissions for all the entire portfolio

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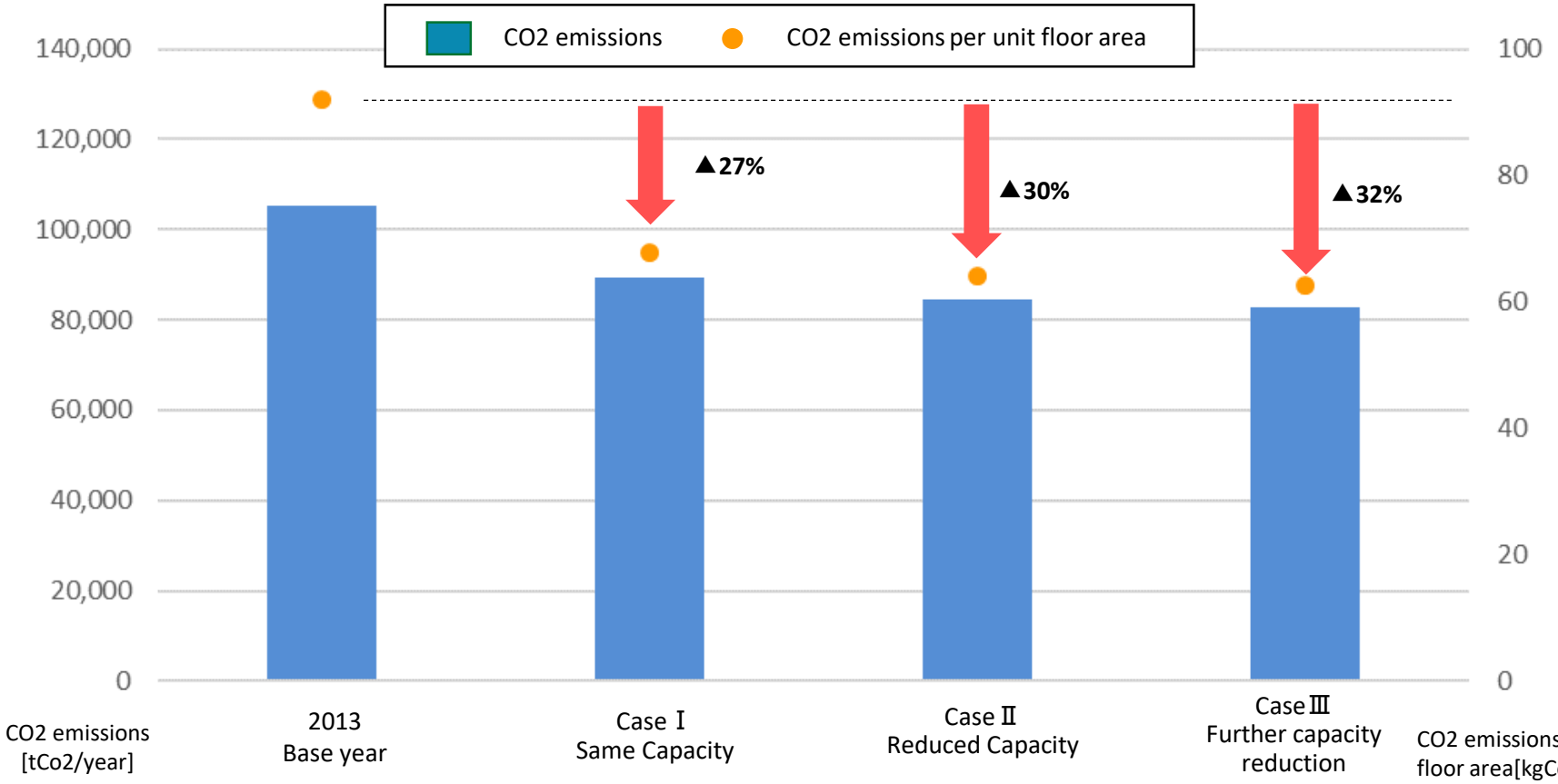
（3）Verification result

CO2 emissions for the entire portfolio in each of the study case



Case Ⅰ：▲ 27%（No increase in construction cost）, Case Ⅱ：▲ 30%（Construction cost increases by approximately 1.1 billion yen）, Case Ⅲ：▲ 32%（Construction cost increases by approximately 3.2 billion yen）The target value for CO2 reduction rate for JRE shall be evaluated based on these results.

⇒With the consideration for shared large-scale properties, properties to be acquired in the future, etc., it is recommended that the appropriate target ~~of~~ for CO2 reduction rate is 25% or more.

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（3） Verification result

The results verify that when compared to the 2013 figures, which is the base year, the CO2 emissions per unit floor area in each case of the retrofit, looks promising, in that for ,Case Ⅰ （Same capacity） ：▲ 27%（No increase in construction cost）, Case Ⅱ （Reduced Capacity） ：▲ 30%（Construction cost increases by approximately 1.1 billion yen）, Case Ⅲ （Further capacity reduction） ：▲ 32 %（Construction cost increases by approximately 3.2 billion yen）. The target value for CO2 reduction rate for JRE shall be evaluated based on these results. Considering the circumstances of shared large-scale properties, properties to be acquired in the future, etc., it is recommended that the appropriate target for CO2 reduction rate is 25% or more.

	2013	Case Ⅰ Same capacity	Case Ⅱ Energy saving	Case Ⅲ Further Energy saving
Emissions(tco2/year)	105,386	89,314	84,590	82,620
Compared to 2013	Reference	-15%	-20%	-22%
Emissions per unit floor area (kgco2/year・㎡)	92.0	67.6	64.0	62.6
Compared to 2013	Reference	-27%	-30%	-32%
Extra cost	—	No additional cost	JPY 1.1 billion	JPY 3.2 billion

※CO_2 emission coefficient is calculated based on actual emission standards

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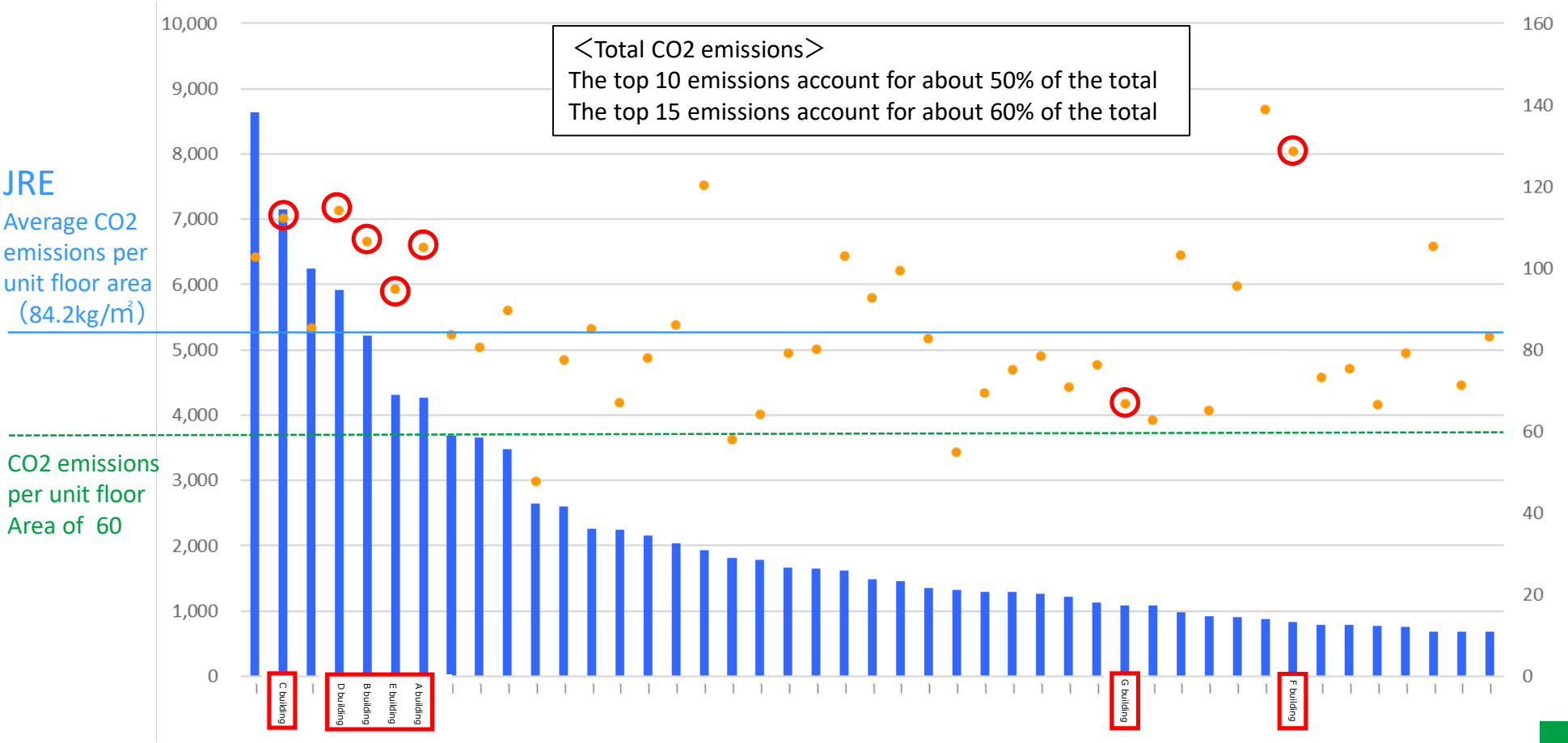
3. Evaluate the current situation and suggest improvements through inspections

Evaluate the current status of CO2 emissions for the entire portfolio

Trends of CO2 emissions and CO2 emissions per unit floor area of the entire portfolio

Based on the data provided by JRE, we organized the CO2 emissions and CO2 emissions per unit floor area of all the entire portfolio. As a result, the average CO2 emissions per unit floor area of the entire portfolio is 88.4 kg / m^2, and it was confirmed that the top 10 emissions account for about 50% of the total.



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Evaluate the current status of CO2 emissions for the entire portfolio

Status of actual inspection and suggestions for improvement

In order to clarify the factors and the points to be improved for the top 10 buildings with large CO2 emissions, actual inspections were conducted. The table below shows 6 buildings with high CO2 emissions per unit floor area . The total CO2 emissions of these six buildings account for about 25% of the total portfolio CO2 emissions.

Target building Summary	Current situation (2018 results)				Renovation measures			Renovation effect			Notes (MJS's findings)
	Total emissions	Occupancy	Comsumption rate	Average	air conditioning	LED	Other	Comsumption rate	Reduction rate per building	Impact on overall reduction rate	
	Co2-t	%	kg/㎡	%				kg/㎡	%	%	
1 A building	4,263	3.8%	105	125%	Central → Central	Changed the lighting of the exclusively-owned area to LED lighting		75	29%	1.1%	・ Hearing of the energy consumption trend revealed that there is an error in the Co2 emissions of the share ratio, so the figures have been corrected. ・The hot and cold water supply to the air conditioner system on each floor of the central heat source is a tertiary pump system, so that the system has a very large transfer power. ・As a further reduction plan, it is possible to further reduce energy consumption by changing the air conditioner on each floor to a type that does not require hot and cold water. ・Energy can be reduced by replacing the lighting equipment in the entire building with LED lighting.
2 B building	5,221	4.7%	106	126%	Acceptance of DHC INV control of pump	Change the lighting of the exclusively-owned area / common areas to LED lighting		90	16%	0.7%	・ Besides the office, there are stores and clinics (the dialysis department is open 24 hours a day), so energy consumption tends to be high. ・Since the tenant can operate the set temperature of the exclusive area, it is thought that energy saving can be achieved by raising tenants awareness of the relaxation of the set temperature. ・Since the cold / hot water pump is controlled by the inverter with the valve closed, the energy saving effect of the inverter is not exerted. Power can be reduced by operating with the valve open. ・Energy can be reduced by replacing the lighting equipment in the entire building with LED lighting.
3 C building	7,155	6.4%	112	133%	Central → Central	Change the lighting of the exclusively-owned area / common areas to LED lighting		80	29%	1.8%	・It seems that the air conditioning capacity in the office area is slightly too large. As a result of the hearing, there is no opinion that the air-conditioning capacity is insufficient, so further energy saving can be achieved by reducing the capacity when updating the air-conditioning. ・Since the tenant can operate the set temperature of the exclusive area, it is thought that energy saving can be achieved by raising tenants awareness of the relaxation of the set temperature. ・Energy can be reduced by replacing the lighting equipment in the entire building with LED lighting.

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Evaluate the current status of CO2 emissions for the entire portfolio

Status of actual inspection and suggestions for improvement

Target building Summary	Current situation (2018 results)				Renovation measures			Renovation effect			Notes (MJS's findings)
	Total emissions	Occupancy	Comsumption rate	Average	air conditioning	LED	Other	Comsumption rate	Reduction rate per building	Impact on overall reduction rate	
	Co2-t	%	kg/㎡	%				kg/㎡	%	%	
4 D building	5,919	5.3%	114	136%	update of Electrical Heat Pump air conditioner	Change the lighting of the common areas to LED lighting		87	24%	1.3%	・ Besides the office, there are stores, so energy consumption tends to be high. ・Since the tenant can operate the set temperature of the exclusive area, it is thought that energy saving can be achieved by raising tenants awareness of the relaxation of the set temperature. ・Most of the lighting in the exclusively-owned area has been converted to LED lighting. Energy can be reduced by using LED lighting for common areas.
5 E building	4,310	3.9%	95	113%	update of Electrical Heat Pump air conditioner	Changed the lighting of the exclusively-owned area to LED lighting		63	33%	1.3%	・Since the tenant's staff number is low (about 0.1 person / m2 in the office), there is a possibility that air conditioning capacity and outside air volume can be reduced. ・The capacity of the air conditioners in the office area seems to be too large. Since adjustments such as suppressing the output of the outdoor unit have also been made, further energy saving can be achieved by reducing the capacity when updating air conditioner. ・Most of the lighting in the common areas has been converted to LED lighting. Energy can be reduced by using LED lighting for exclusively-owned areas.
6 F building	834	0.7%	129	153%	update of Electrical Heat Pump air conditioner	Change the lighting of the exclusively-owned area / common areas to LED lighting		98.0	24%	0.2%	・Since the area of the south side is small and the building on the west side blocks the west sun, the amount of air conditioner load by solar radiation seems to be small. ・Since the tenant's staff number is low , there is a possibility that air conditioning capacity and outside air volume can be reduced. ・Further energy saving can be achieved by reducing the capacity by considering the external appearance, building location situation , and the number of staff in the building, when updating air conditioner. ・Energy can be reduced by replacing the lighting equipment in the entire building(including exclusively-owned areas) with LED lighting.
1-6 total	27,702	24.9%	—	—				—	—	6.4%	

As a result of the actual inspections, it is found that each building has the potential to reduce CO2 emissions in the future. Moreover, it was confirmed that the CO2 emissions of the entire portfolio could be reduced by 6.4% by reducing the CO2 emissions of these 6 buildings through the recommended measures.

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4. Study on applying ZEB

（1）About verification of ZEB conversion of existing building

Background of study on ZEB conversion of existing buildings

In order to deal with climate change risk, it is necessary to reduce energy consumption, and especially, ZEB (Zero Energy Building), is being promoted to reduce energy consumption of buildings in the business sector. JRE-AM has been actively promoting GRESB and BELS certification, etc., but discussions on ZEB initiatives are also actively underway.
From a technical and investment perspective, MJS and JRE-AM have conducted work to identify properties in the portfolio that have the potential to be converted to ZEB.
In addition, we have also determined the specific measures for ZEB conversion.

Measures for ZEB conversion of existing building

- Evaluate the current status of JRE owned properties
- Organize selection points for properties subject to ZEB
- Identify and select properties that can be converted to ZEB
- Assess retrofitting possibilities for selected property
- Trial calculation of energy consumption for selected property (current status, after renovation)

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（2）About ZEB

ZEB definition and evaluation criteria

ZEB in Japan is defined by ZEB Definition Review Subcommittee under Air Conditioning Equipment Committee in The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan. In addition, the ZEB Roadmap Review Committee makes quantitative definitions as shown in the table below.

			non-residential※1 building					
			①Overall rating of the building			②Partial evaluation of buildings (Evaluation of some uses of multi-use buildings)※3		
			Reduction rate of primary energy consumption※4 from the standard value of the evaluation target		Other requirements	Reduction rate of primary energy consumption※4 from the standard value of the evaluation target		Other requirements
			Only energy saving	Including energy creation※5		Only energy saving	Including energy creation※5	
『ZEB』			50% or more	100% or more	—	50% or more	100% or more	・Achieve a reduction in primary energy consumption of 20% or more from the standard value excluding energy generation from the standard value for the entire building.
Nearly ZEB			50% or more	75% or more		50% or more	75% or more	
ZEB Ready			50% or more	under 75%		50% or more	under 75%	
ZEB Oriented	Building uses	Offices, schools, factories, etc.	40% or more	—	・The total area of the entire building※1 must be 10,000 m2 or more. ・Introduce unevaluated technology※6. ・For multi-use buildings, achieve the following primary energy consumption reduction rate for each building use.	40% or more	—	・The total area of the entire building※1 must be 10,000 m2 or more. ・Introduce unevaluated technology※6. ・Achieve a reduction in primary energy consumption of 20% or more from the standard value excluding energy generation from the standard value for the entire building.
		Hotels, hospitals, department stores, restaurants, meeting places, etc.	30% or more	—		30% or more	—	

* 1 Comply with the definition under the Building Energy Efficiency Act (non-residential part: part other than the residential part specified in Article 3 of the Cabinet Order).
* 2 Comply with the usage classification under the Building Energy Efficiency Act(offices, hotels, hospitals, department stores, schools, restaurants, meeting places, factories, etc.).
* 3 It is required that the total area of the entire building is 10,000 m2 or more.
* 4 The target of primary energy consumption is air conditioning equipment, mechanical ventilation equipment other than air conditioning equipment, lighting equipment, hot water supply equipment, and elevators specified by the 2016 energy conservation standards (excluding "other primary energy consumption"). In addition, the calculation method shall be based on the latest energy conservation standards or the equivalent method.
* 5 The target of renewable energy is limited to the site (on-site), and in addition to private consumption, power sales is also included. (However, it is limited to surplus power sales.)
* 6 Unevaluated technologies are those that are publicly announced by The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan. and are expected to have high energy-saving effects.

Source：ZEB Roadmap Follow-up Committee mat

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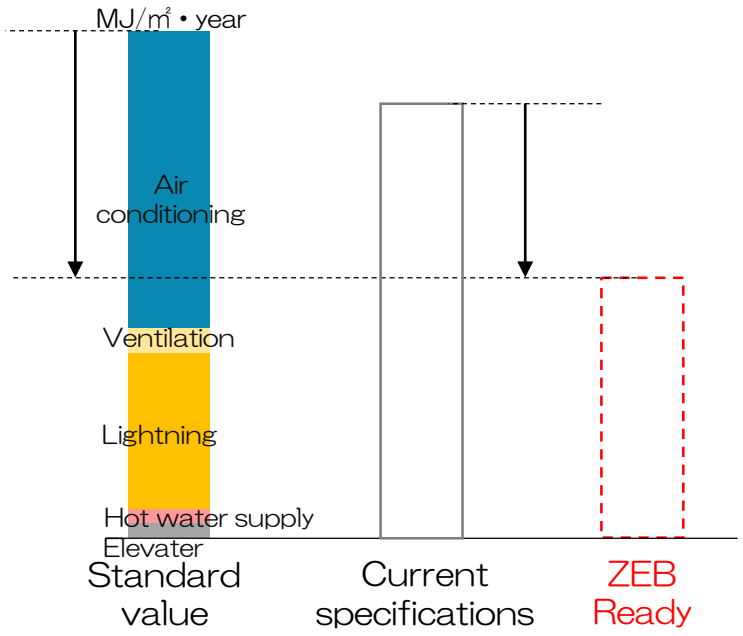
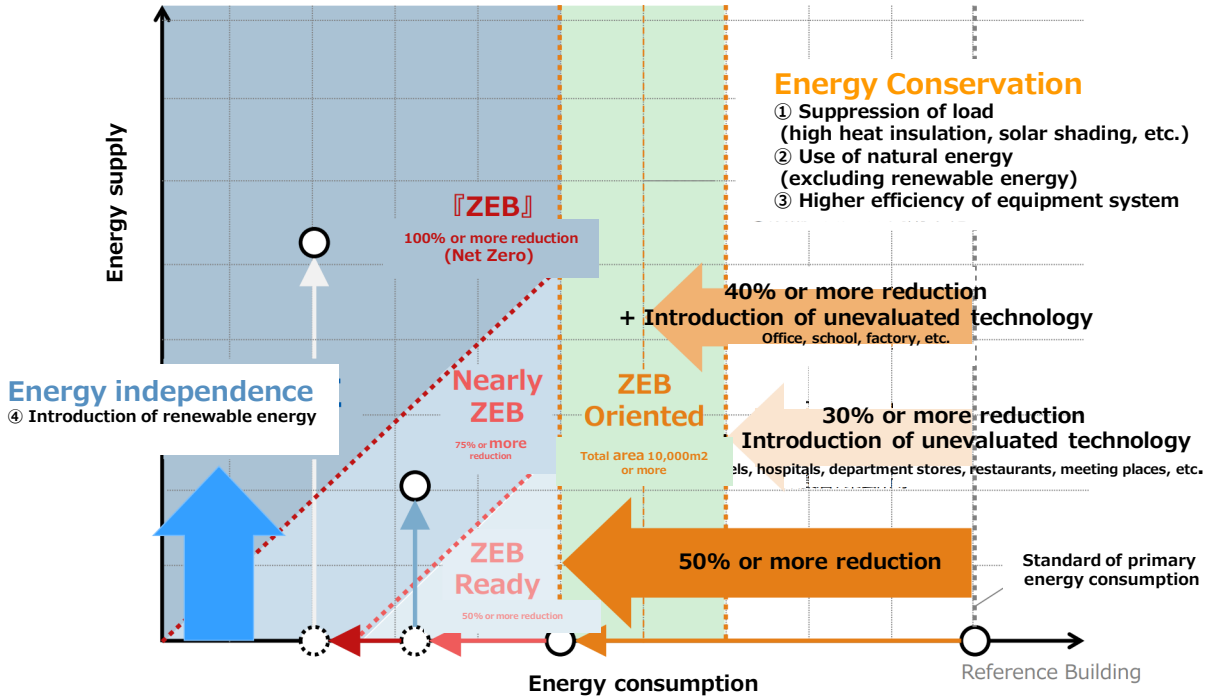
（2）About ZEB

About evaluation of ZEB

The evaluation of ZEB is a comparison from the standard value. For example, if energy can be reduced by 50% from the standard value, it will be "ZEB Ready". The reference value of the 2016 standard can be automatically calculated by the WEB program, which is the primary energy consumption calculation software, depending on the building use. In this study, the policy is to aim at "ZEB Ready" for properties less than 10,000㎡ and "ZEB Oriented" for properties exceeding 10,000㎡.



＜Image of ZEB evaluation＞



Source：ZEB Roadmap Follow-up Committee materials

＜Image of ZEB definition＞

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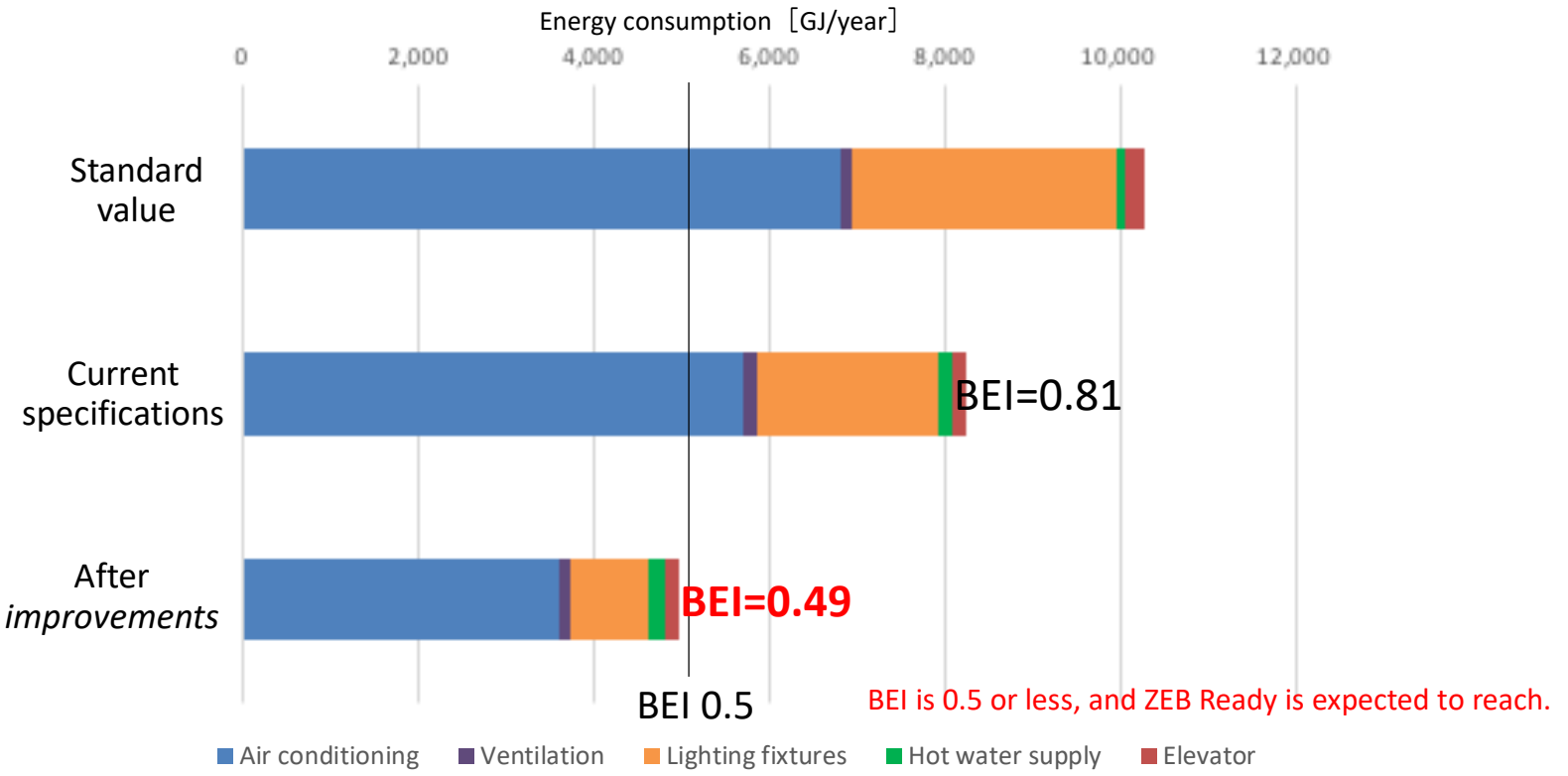
（3）Verification result of Building F

Building overview

■ Location: Tokyo ■ Floor Area: more than 5,000 m^2
■ Age of the building: more than 10 years
■ Air-conditioning system: multiple packaged air conditioning unit system , total heat exchanger on each floor

Proposed Improvements

① Upgrade to the highest efficiency air conditioner ② Change all lightings to LED
③ Review of air conditioning capacity ④ Review of ventilation volume



BEI is 0.5 or less, and ZEB Ready is expected to reach.

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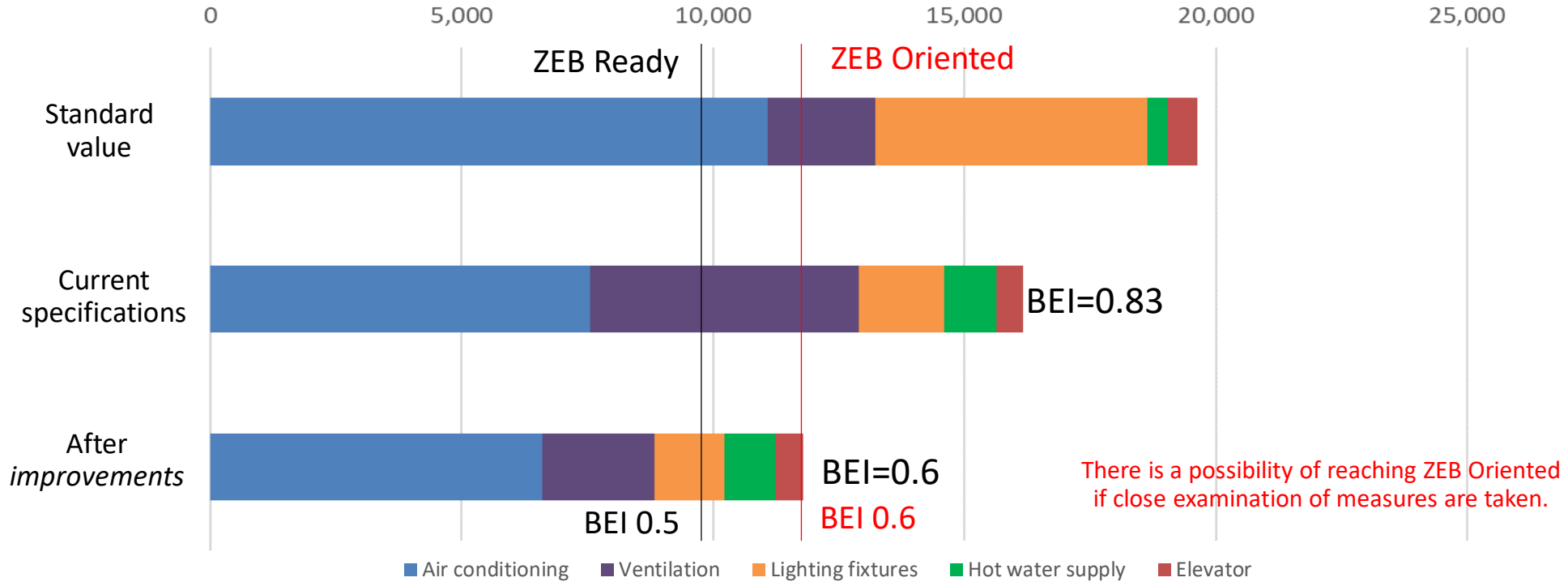
（4）Verification result of Building G

Building overview

■ Location: Tokyo ■ Floor Area : more than 10,000 m^2
■ Age of the building : more than 30 years ■ Air-conditioning system: multiple packaged air conditioning unit system , change to total heat exchanger on each floor

Proposed Improvements

① Centralized ventilation system by Sirocco fan ⇒ Individual air supply / exhaust system for each floor② Review ventilation volume and equipment ③ Introduce lighting control



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(5) Possibility of future ZEB achievements in JRE portfolio

From this study of ZEB, the following findings were obtained:

- Criteria for selecting properties to be considered for ZEB has been identified and determined.
- Through the verifications of the Building F and Building G, we have positively shown that ZEB is achievable by considering the age and size of the building, and analyzing the thermal insulation performance, air conditioning system, lighting system, etc.
- According to JRE's systematically organized portfolio data, there are multiple properties that can achieve ZEB in addition to Buildings F and G.

It is important to continue to evaluate the actual condition of the buildings and to study the application of ZEB in order to achieve ZEB in the future. It is also important to plan in collaboration with the stakeholders such as the tenants, and to keep track of the latest technological trends.

Based on the results of this verification, the Mitsubishi Jisho Sekkei Inc. Renovation Design Department will aim to further evolve by proactively promoting environment-related initiatives such as SDG's and ESG investment.

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