経済産業省

Definition of ZEB and future measures proposed by the ZEB Roadmap Examination Committee

December, 2015

Energy Efficiency and Conservation Division
Agency for Natural Resources and Energy
Ministry of Economy, Trade and Industry

1. Status quo of energy in Japan

2. Definition of the ZEB (net zero energy building) and future measures proposed by the ZEB Roadmap Examination Committee

（1） Introduction

（2） Definition and evaluation methods of ZEBs

（3） Feasibility of ZEBs

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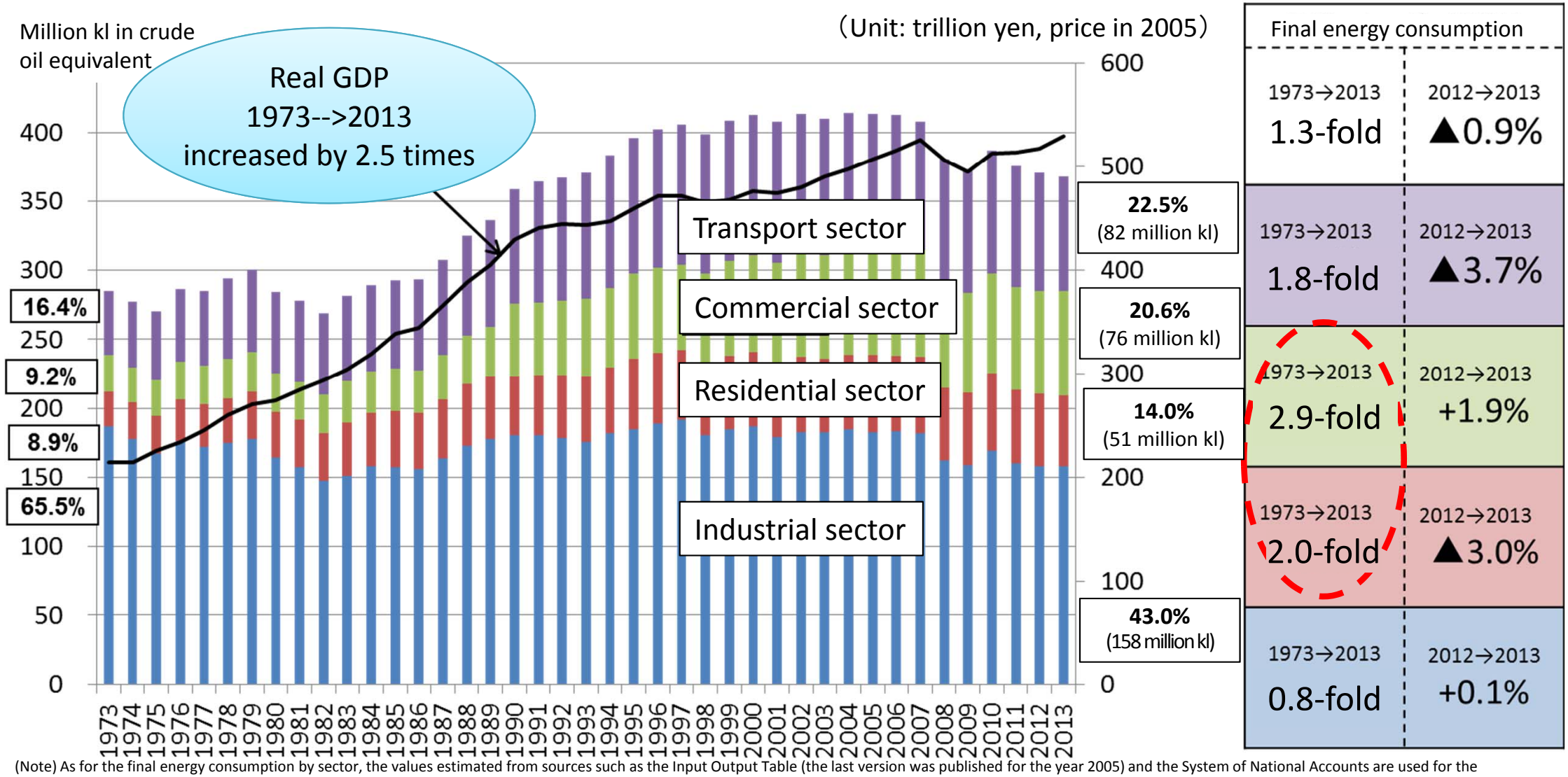
1. Status quo of energy in Japan(Status of energy consumption)

■Although Japan's GDP has increased 2.5-fold since the oil crisis, energy consumption by the industrial sector has dropped by nearly 20%. On the other hand, energy consumption by the civilian sector has increased considerably (2.9-fold for the commercial sector, 2.0-fold for the residential sector).
■To stabilize the energy demand and supply in Japan, it is essential to take measures to reduce energy consumption in the civilian sector.

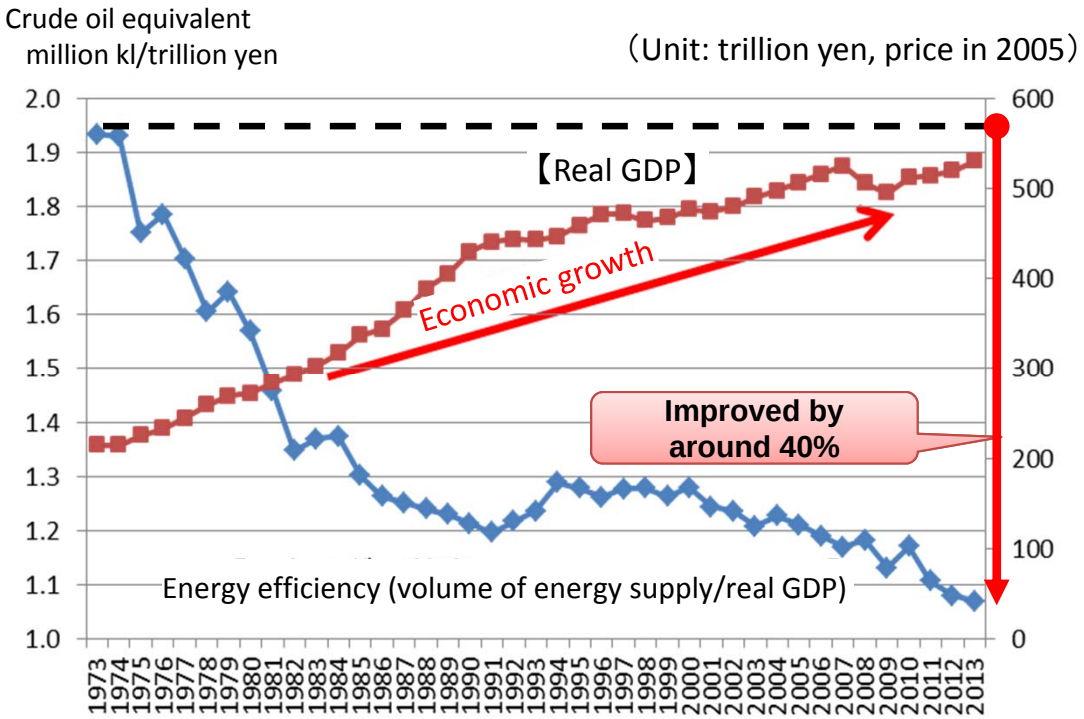


(Note) As for the final energy consumption by sector, the values estimated from sources such as the Input Output Table (the last version was published for the year 2005) and the System of National Accounts are used for the business and industrial sectors (non-manufacturing industry, food-manufacturing industry, small and medium manufacturing industry in other fields). Due to technical factors of the statistics, the short-term decrease in consumption after the Great Eastern Japan Earthquake in the commercial sector has not been sufficiently taken into consideration.
[Sources] *Comprehensive Energy Statistics*, *Annual Report on National Accounts*, *EDMC Handbook of Japan's & World Energy & Economic Statistics*

1. Status quo of energy in Japan (Japan's efforts for energy savings since the oil crisis)

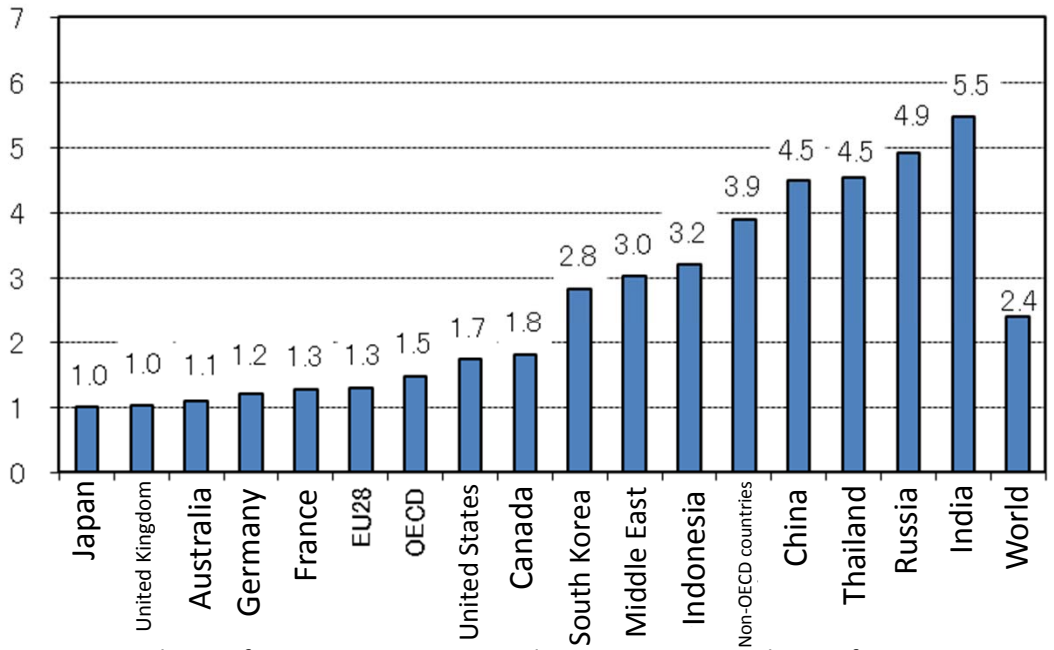
- Thanks to strenuous efforts by both public and private sectors since the 1970s oil crisis, Japan has improved its energy efficiency by around 40% from 1973 to 2013, which is one of the highest energy efficiencies in the world.
- However, more measures are necessary because the efficiency per GDP has been stagnant since the latter half of the 1980s.

【Evolution of energy efficiency in Japan (volume of energy supply/real GDP)】



(Sources) *Comprehensive Energy Statistics, Annual Report on National Accounts*

【Comparison among countries in energy efficiency (2011)】

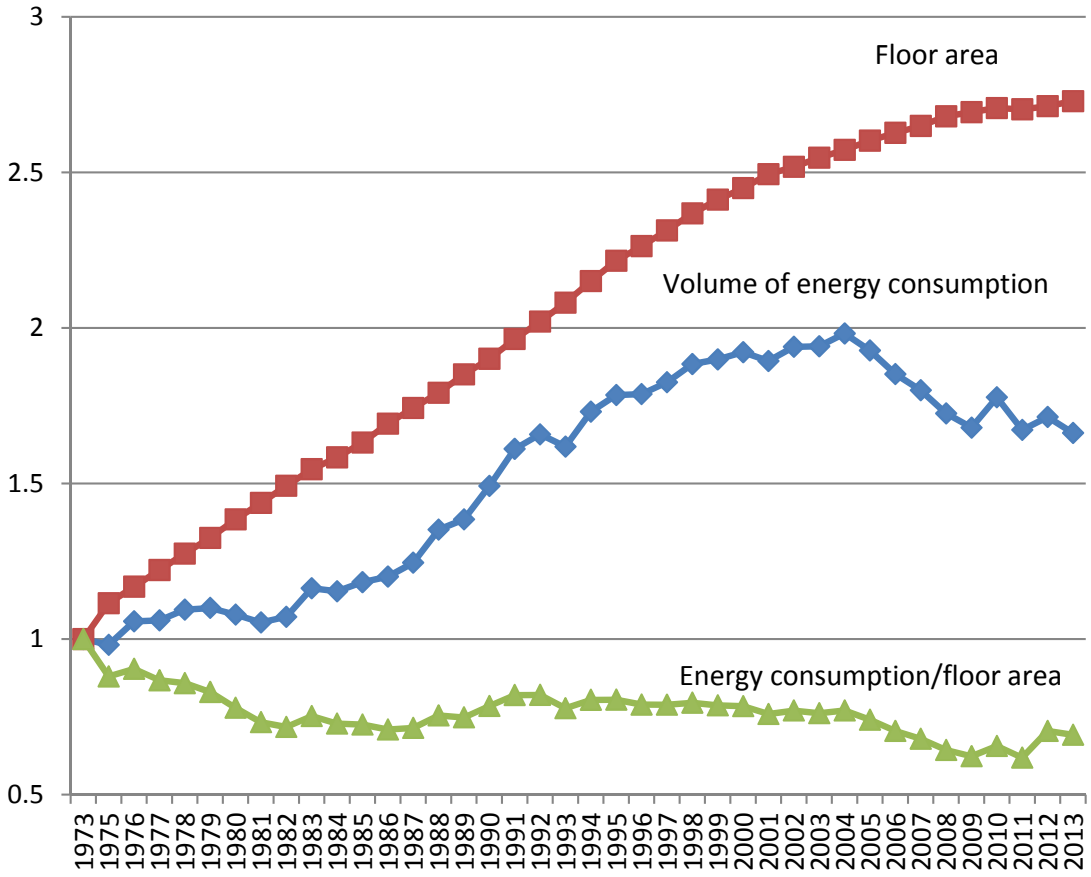


Sources) *IEA Energy Balance of OECD Countries 2014 Edition, IEA Energy Balance of Non-OECD Countries 2014 Edition, EDMC Handbook of Japan's & World Energy & Economic Statistics*
(Note) For the conversion, the value of the primary energy supply (oil equivalent ton)/real GDP for Japan is set to 1.

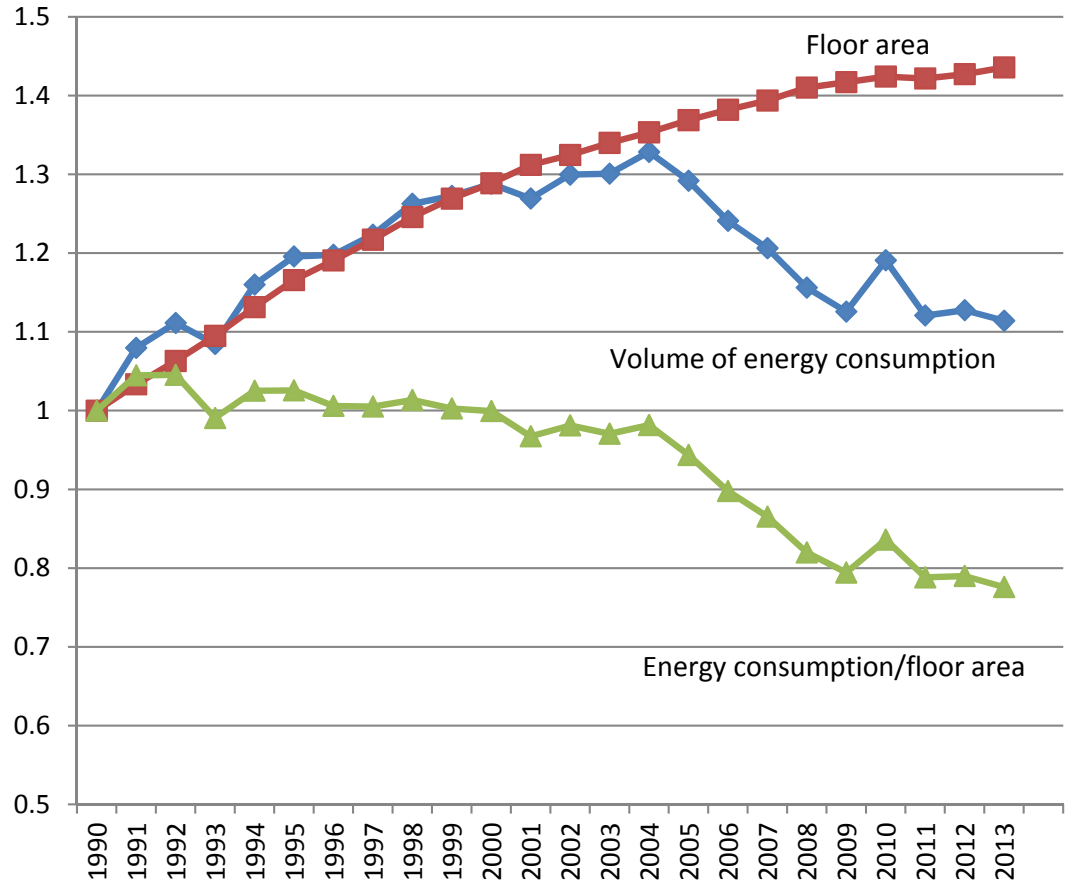
1. Status quo of energy in Japan (Situation of energy consumption in the commercial sector, part 1)

- As for the commercial sector where energy consumption has considerably increased, energy consumption "per square meter" has been leveling off or even improved in recent years.
- Although the floor area has been consistently on the rise, energy consumption has been declining in recent years.

Evolution of energy consumption and floor area in the commercial sector



(The vertical line showing the indices using the value for 1973 is taken as 1.)



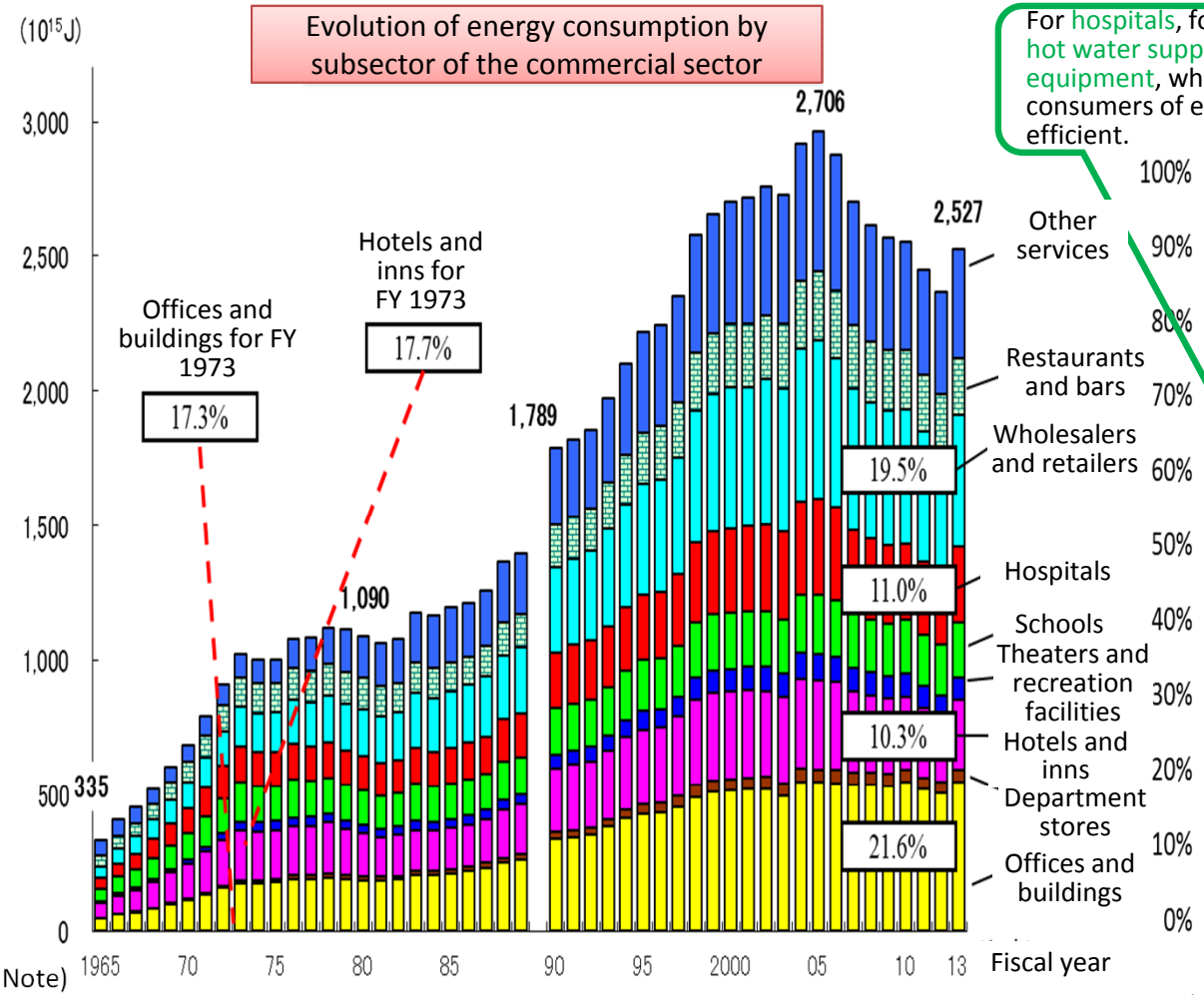
(The vertical line showing the indices using the value for 1990 is taken as 1.)

(Sources) Prepared on the basis of *the Handbook of Japan's & World Energy & Economic Statistics* issued by the Institute of Energy Economics, Japan.

1. Status quo of energy in Japan (Situation of energy consumption in the commercial sector, part 2)

- If the commercial sector is roughly divided into nine subsectors, it is clear that the today's energy consumption by "offices and buildings" and "wholesalers and retailers" has become more important, but in the past "hotels and inns" and "offices and buildings" were largely responsible for energy consumption.
- The ratio of energy consumption per piece of equipment in the entire building largely depends on the building usage.

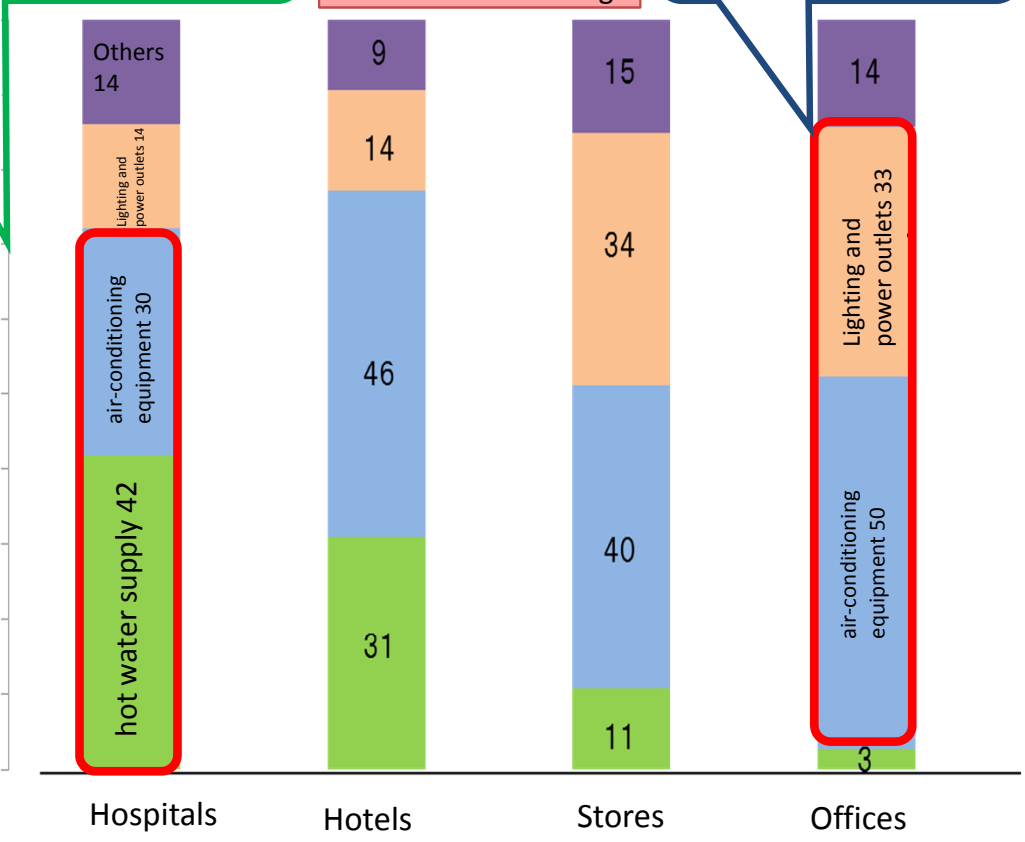
Evolution of energy consumption by subsector of the commercial sector



For hospitals, focusing on savings in the hot water supply and air-conditioning equipment, which are the largest consumers of energy, would be most efficient.

Ratio of energy consumption per piece of equipment in the entire building

For offices, focusing on energy conservation of air-conditioning and lighting equipment, which are the largest consumers of energy, would be most efficient.



(Note)
In the *Comprehensive Energy Statistics*, the methods to calculate the values were modified from FY 1990.

(Sources)
Estimation based on *the Handbook of Japan's & World Energy & Economic Statistics* issued by the Institute of Energy Economics, Japan and *Comprehensive Energy Statistics* by the Agency for Natural Resources and Energy

(Reference)
Workshop Report on the Realization and Development of the ZEB (Net Zero Energy Building)
(Ministry of Economy, Trade and Industry, November 2009)

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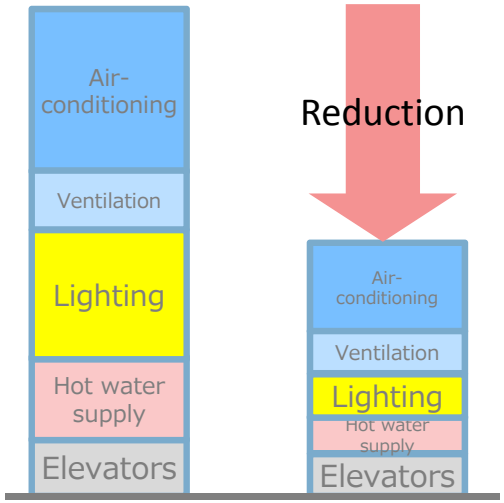
2.（1） Introduction （What is a ZEB (Net Zero Energy Building)?）

- A ZEB is a building with considerably reduced annual energy consumption by saving as much energy as possible via better heat insulation, solar shading, natural energy and high-efficiency equipment as well as creating energy (e.g., with photovoltaic power generation), while maintaining comfortable environments.

Considerable reduction in the annual energy consumption by building

Reduce energy demand and use resources more efficiently



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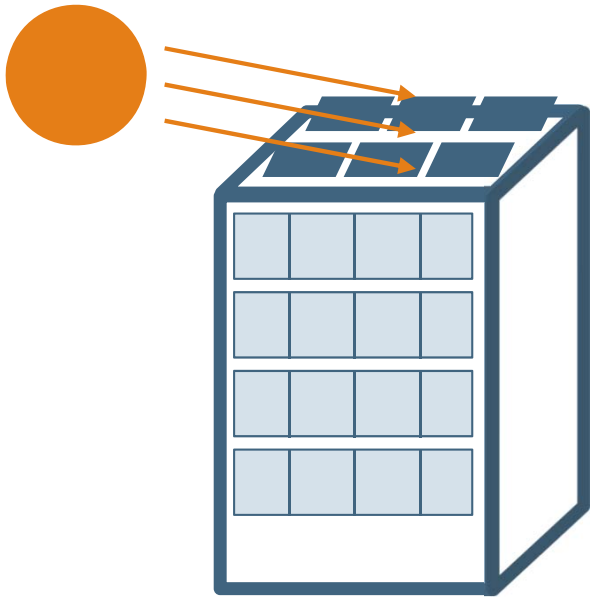
Creation of energy



2.（1）Introduction (Goal of the ZEB and establishment of the ZEB Roadmap Examination Committee)

- The ZEB (Net Zero Energy Building) is receiving a lot of attention because it can minimize indoor energy consumption (e.g., in offices, schools, hospitals, hotels, etc.) and allow buildings to function independently in terms of energy during a disaster.
- Japan's Strategic Energy Plan (adopted at the Cabinet Council in April 2014) establishes the following goals to realize and promote of ZEBs:
  - **Realize ZEBs in newly constructed public buildings by 2020**
  - **Realize ZEBs in average newly constructed public and private buildings by 2030**
- To achieve the above goals, the ZEB Roadmap Examination Committee, which is composed of scholars, experts, and professionals from developers, architects, and general contractors, has been established to examine (1) the definition and evaluation method of ZEBs, (2) the feasibility, and (3) measures to promote ZEBs.

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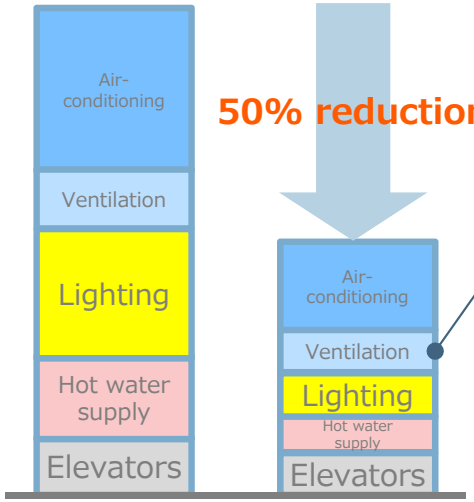
2.（2） Definition and evaluation methods of ZEBs (Challenges)

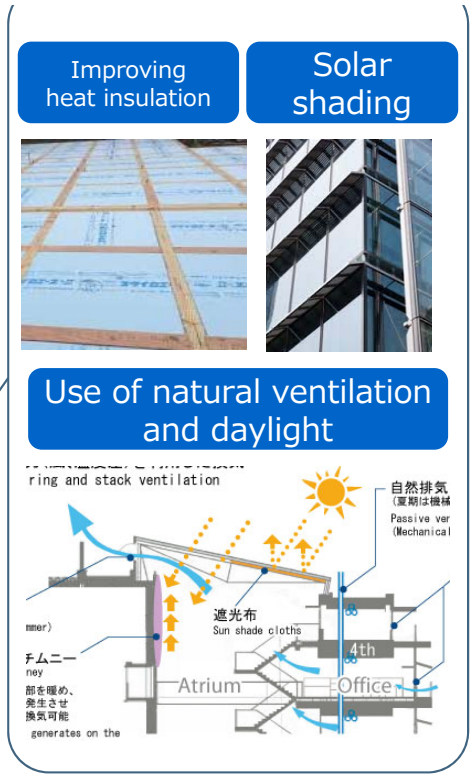
- While a few advanced companies promote ZEBs, it is difficult for consumers to compare and evaluate ZEBs as the definition differs by company.
- If an unrealistic definition or goal is adopted due to physical restrictions related to usage or scale, professionals in the industry may lose motivation.
- Questions to consider to evaluate ZEBs :
  - Should ZEBs be evaluated at the design or management phase?
  - Which equipment (cooling, heating, lighting, hot water supply, etc.) should be included in the evaluation?
  - How should ZEBs be evaluated because it may be very difficult to realize a ZEB in a high-rise or large-scale building even if many solar panels are installed on the roof?

2.（2） Definition and evaluation methods of ZEBs
(Energy-efficient buildings)

- In the design phase of a ZEB, it is important to achieve energy savings by upgrading the building envelope, which has long life and is difficult to renovate, while simultaneously improving the efficiency of the equipment and maximizing the architectural planning method (passive method).
- The ZEB standard (ZEB Ready) should be set so that it is at least 50% higher than the Energy Saving Standard.
- The above energy saving rate should be evaluated at the design phase.



Requiring a minimal amount of energy



Efficiently using energy

* The calculation method should be consistent with the Energy Saving Standard. However, the 50%-higher energy saving rule applies to air-conditioning, hot water supply, ventilation, lighting, and elevators. In addition, reduction due to renewable energy should not be taken into consideration.

2.（2） Definition and evaluation methods of ZEBs (Energy-creating buildings)

- The goal is to achieve net zero energy consumption by creating energy (e.g., via solar power) while fulfilling the **higher than 50% energy saving** (**ZEB Ready**).
- However, the evaluation method should take into account that high-rise and large-scale buildings have limited rooftop areas, and consequently, limited energy production capabilities.
- If **energy savings of at least 75%** is achieved the **Nearly ZEB** status is granted.

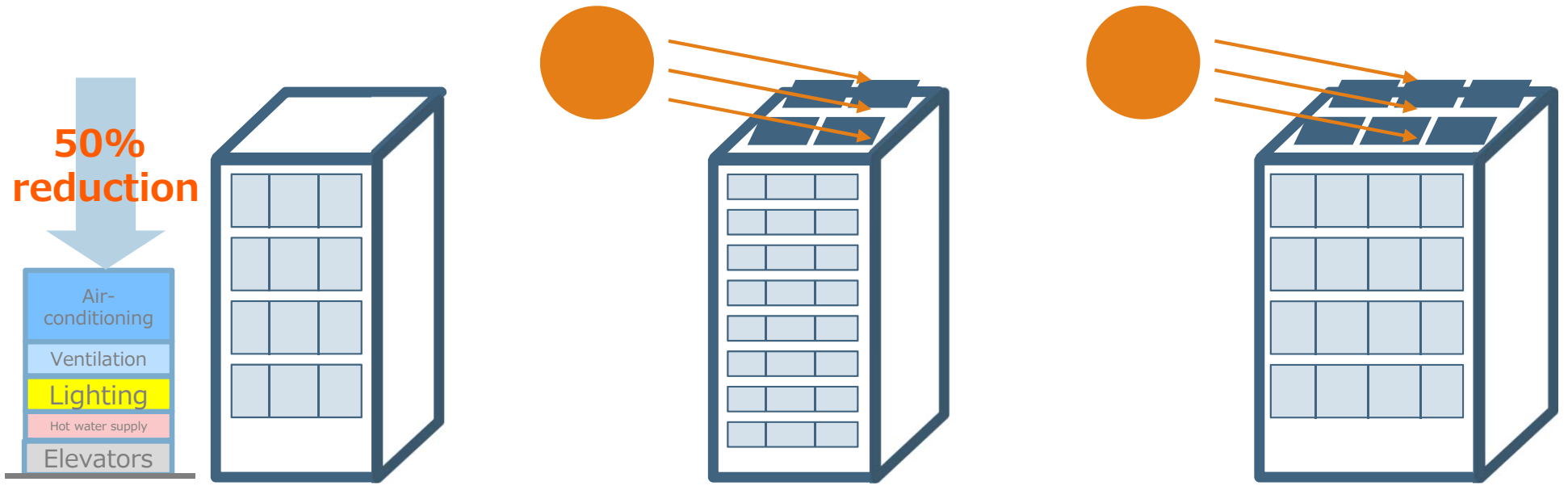
  If **energy savings of 100% or more** is achieved, the **ZEB status** is granted.

* The method to determine 100% or 75% energy savings should follow the Energy Saving Standard. This rule should apply to air-conditioning, hot water supply, ventilation, lighting, and elevators. In addition, the production of renewable energy on site (inside the premises), including the part of electricity sold (only the surplus power sold), should be taken into account.

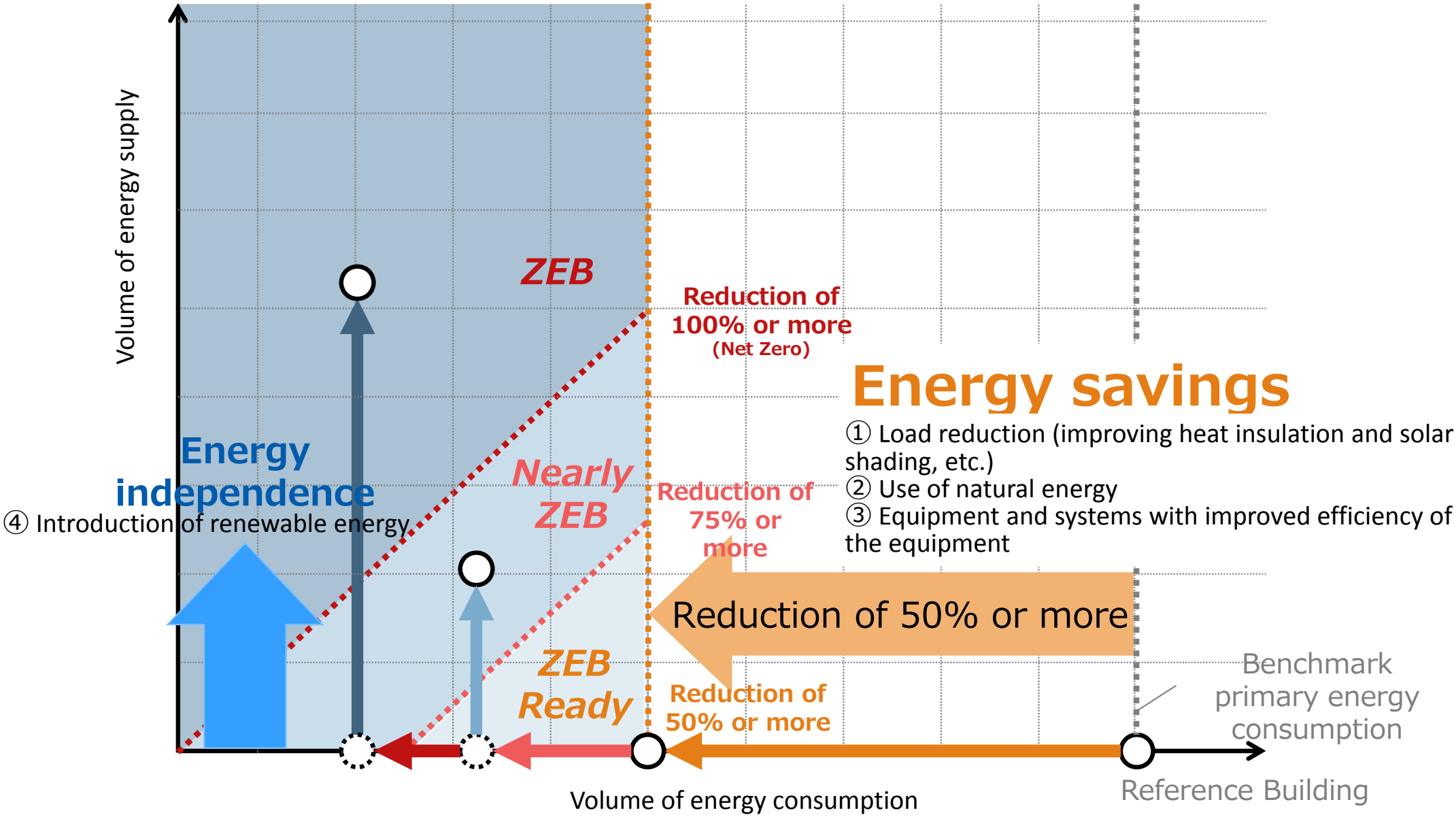
ZEB Ready
(Energy saving of **50% or more**)

Nearly ZEB
(Net energy saving of **75% or more**)

ZEB
(Net energy saving of **100% or more**)



2.（2） Definition and evaluation methods of ZEBs
(Image of ZEB definition)



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2.（3） Feasibility of ZEBs (Challenges)

- Because buildings are not mass-produced goods, the design method has yet to be sufficiently established and shared. Additionally, the economic feasibility of ZEB construction has yet to be evaluated.

- How can ZEBs be constructed?
  - What kinds of architectural planning should be prepared?
  - How much heat insulation material is necessary for walls and ceilings?
  - What kinds of equipment should be introduced?
  - What are the costs associated with ZEB designs?

2.（3） Feasibility of ZEBs (Example of a calculation for a 10,000 m² office building (7-story building)

- A case study was conducted to examine what kinds of technologies and equipment should be introduced to build a ZEB and to determine the cost increase relative to ordinary buildings.
- It has been estimated that a 50% energy savings **(ZEB Ready)** can be achieved in offices, schools, and hotels by adequately selecting currently available high-performance building materials and equipment.

* We estimate that the additional costs for materials and equipment will be approximately 5% of the entire construction cost (a detailed survey is necessary to estimate the additional costs due to changes in architectural planning and structure).

	(Pattern A) Equivalent to the 2013 Energy Saving Standard	(Pattern B) Equivalent to the Energy Saving Standard (glass architecture)	(Pattern C) Equivalent to ZEB Ready
Envelope	・Single layer 8 mm, etc. ・Roof insulation with 50-mm extruded polystyrene foam ・Wall insulation with 25-mm extruded polystyrene foam	• Low-E Double Glazing, full height, with horizontal eaves • Roof insulation with 50-mm extruded polystyrene foam • Wall insulation with 25-mm extruded polystyrene foam	• Low-E Double Glazing, full height, with horizontal eaves • Roof insulation with 50-mm extruded polystyrene foam • Wall insulation with 25-mm extruded polystyrene foam
Air-conditioning	・Air-cooled heat pump, EHP (electric heat pump) ・Secondary pump that controls a number of units and the revolving speed ・Constant air volume control etc.	• Air-cooled heat pump, EHP (electric heat pump) • Secondary pump that controls a number of units and the revolving speed • VAV (variable air volume) control, etc.	• Air-cooled heat pump (controlling number of compressors), EHP • Small-flow pump that controls a number of units and the revolving speed • VAV control, outdoor air cooling, double fan, etc.
Ventilation	・Static pressure: 250 Pa ・Fan efficiency: 40% ・Without control etc.	・Static pressure: 250 Pa ・Fan efficiency: 40% ・Without control etc.	・Static pressure: 250 Pa ・Fan efficiency: 40% ・High-efficiency motor, temperature control, etc.
Lighting	・HF-type appliances ・Without control etc.	・HF-type appliances ・Without control etc.	・LED lighting ・Human sensor, daylight dimming control, etc.
Hot water supply	・ Localized electric hot water storage system ・ Without a hot water saving device ・ With 30-mm piping heat insulation	・ Localized electric hot water storage system ・ Without a hot water saving device ・ With 30-mm piping heat insulation	・ Localized electric hot water storage system ・ Automatic hot water supplying tap ・ With 30-mm piping heat insulation
Elevator	・ AVAF (Adjustable Voltage Adjustable Frequency) (without electric power regeneration)	・ AVAF (Adjustable Voltage Adjustable Frequency) (without electric power regeneration)	• AVAF (Adjustable Voltage Adjustable Frequency)

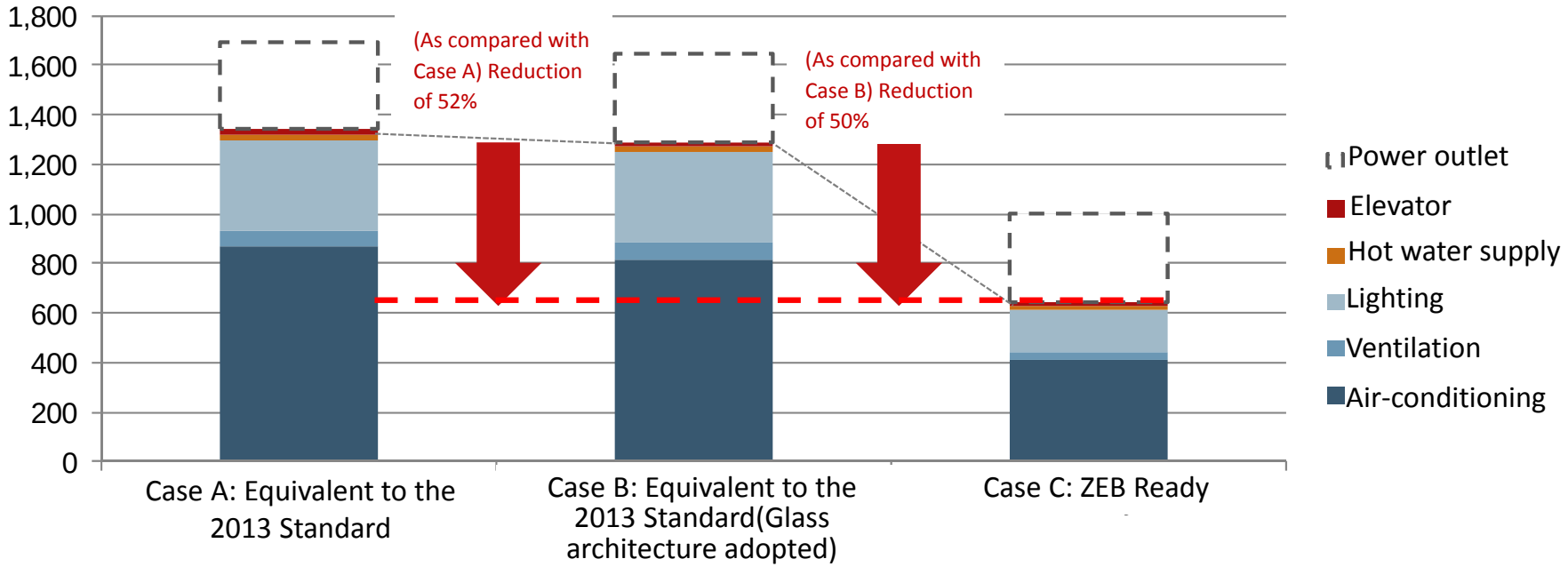
Simulation of the conditions in the latest buildings

Specifications fulfilling the ZEB Ready conditions have been examined.

* Please note that in the table above, the technology for the use of natural energy is not evaluated. A more diverse combination of technology than described above may already exist to realize ZEB Ready.

2.（3） Feasibility of ZEBs (Example of a calculation for a 10,000 m² office building (7-story building)

Reduction volume of primary energy consumption [MJ/ (year/m²)]



Examined cases	Case A: Equivalent to the 2013 Standard			Case B: Equivalent to the 2013 Standard (Glass architecture adopted)			Case C：ZEB Ready			
	Primary energy		Percentage	Primary energy		Percentage	Primary energy		Percentage	Reduction rate
	[GJ/year]	[MJ/ m² year]	%	[GJ/ year]	[MJ/ m² year]	%	[GJ/year]	[MJ/ m² year]	%	Compared with B
Air-conditioning	8,950	864	65%	8,460	817	63%	4,219	407	63%	50%
Ventilation	667	64	5%	667	64	5%	358	35	5%	46%
Lighting	3,802	367	27%	3,802	367	28%	1,723	166	26%	55%
Hot water supply	270	26	2%	270	26	2%	197	19	3%	27%
Elevator	171	16	1%	171	16	1%	152	15	2%	11%
Others	3,676	355	-	3,676	355	-	3,676	355	-	-
Total	17,537	1,693	-	17,046	1,646	-	10,325	997	-	39%
Except power outlets	-	1,338	-	-	1,291	-	-	642	-	50%

PAL	427	439	439	-

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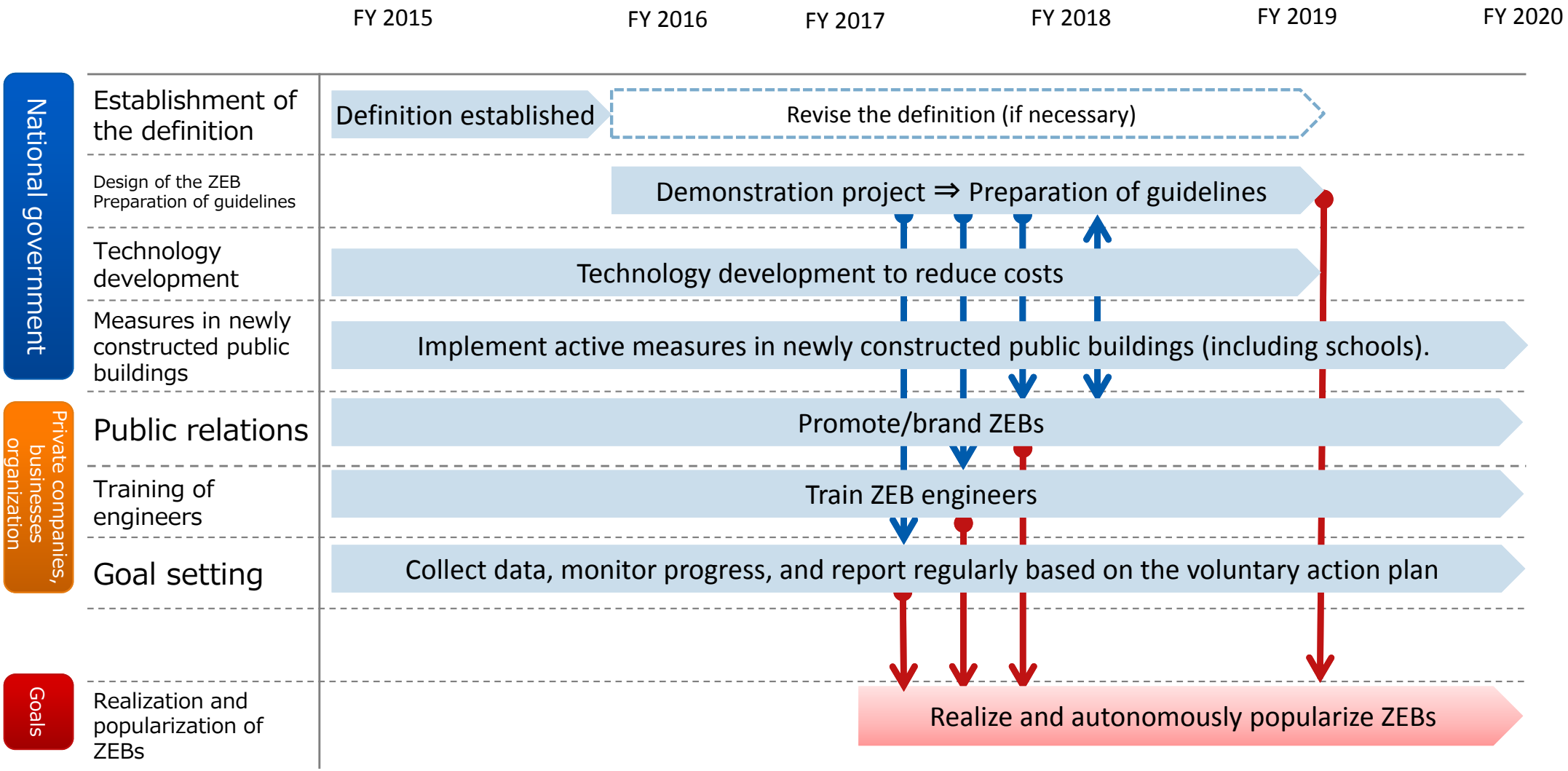
2.（4） Promotion methods of ZEBs (Challenges)

- Has the know-how to design ZEBs been established and disseminated?
  - The techniques, methods, and cost for designing ZEBs are not transparent.
- Is ZEB recognized?
  - What are the advantages of a ZEB building for tenants? (Improved building or corporate value, reduced electricity and heating expenses, better anti-disaster performance due to energy independence, higher comfort and intellectual productivity, etc.)
  - What is the difference from similar indexes for buildings? (Certified low-carbon buildings, etc.)
- Is the cost of building ZEBs minimized?
  - Currently, the additional investment to construct a ZEB might not be necessarily economically rational.
  - Important gap: Although the investment for the ZEB must be borne by the owner of the building, the merits such as the reduction of electricity and heating expenses benefit the tenants, not the owner.
  - For buildings for rent, the scale of investment may be limited based on the difference in basic rent.

2.（4） Promotion methods of ZEBs (The ZEB roadmap)

- Based on the discussions in the Examination Committee, these measures have are proposed for ZEBs.



2.（4） Promotion methods of ZEBs (Draft of the ZEB Roadmap)

<Measures that the national government should take in cooperation with businesses and private companies>

- Draft design guidelines through the ZEB demonstration project
  - The techniques, methods, and costs for designing ZEBs should be clarified (ZEB designing guidelines).
  - To execute the ZEB demonstration project, obtain feedback from those concerned through collection, analysis, and publication of real management data.
- Support technology development aimed at higher performance and lower costs
  - Support technology development necessary to realize ZEBs.
  - Implement active measures for newly-constructed public buildings (including schools).
- Promote and brand ZEBs
  - Easy-to-understand PR activities (including comparisons with other indexes and the merits of ZEBs) should be conducted in cooperation with companies.

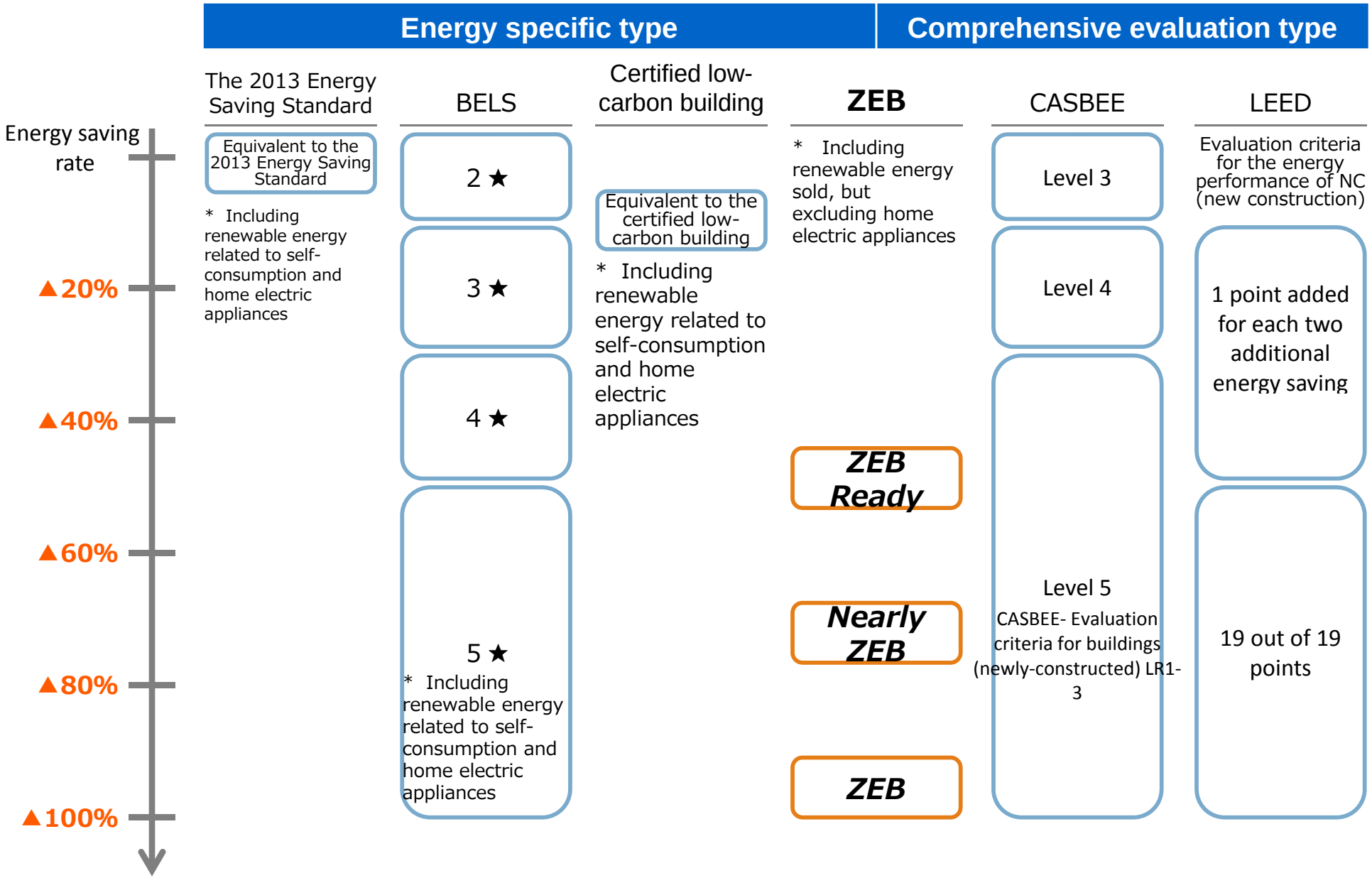
2.（4） Promotion methods of ZEBs (Reference: image of measures necessary for each usage)

- Measures to realize ZEBs are necessary in accordance with the area (ratio of building volume to lot), usage, and structure (stories).

Building usage		Ratio of building volume to lot (%)				
		50-100	100-300	300-500	500-1,000	1,000 or more
Offices	One- to three-stories	Promotion by establishing the definition of ZEB * Design guidelines should be formulated for small and medium companies.				
	Four- to ten-stories		Promotion by formulating design guidelines			
	More than ten-stories			In addition to formulating design guidelines, technology development is also important.		
Schools	Elementary, junior, or senior high schools	Promotion by establishing the definition of ZEB				
	Specialized training colleges and universities	Promotion by establishing the definition of ZEB	Promotion by formulating design guidelines		In addition to formulating design guidelines, technology development is also important.	
Hotels		Promotion by establishing the definition of ZEB	Promotion by formulating design guidelines			
Hospitals		Promotion by establishing the definition of ZEB	Promotion by formulating design guidelines			
Shops		Promotion by establishing the definition of ZEB * Design guidelines should be formulated for small and medium companies.	Promotion by formulating design guidelines			

2.（4） Promotion methods of ZEBs (Reference: comparisons with other indexes)

- **The advantage of ZEBs must be explained while clearly showing the difference from other indexes.**



2.（4） Promotion methods of ZEBs (the ZEB Roadmap)

<Measures that businesses and private companies should take in cooperation with the national government>

- Train engineers
  - Train engineers capable of designing, calculating, diagnosing, and proposing ZEBs

- Set goals and monitor progress for ZEBs
  - Developers, architects, general contractors, and equipment manufacturers should establish, publish, and monitor goals related to the popularization of ZEBs.

- Promote and brand ZEBs
  - Easy-to-understand PR activities should be conducted on the basis of cooperation between businesses and the national government.

Energy Conservation and Renewable Energy Department
Agency for Natural Resources and Energy
Housing Industry, Ceramics and Construction Materials Division
Manufacturing Industries Bureau
Tel: 03-3501-9726 (Energy Conservation and Renewable Energy Department)

The Promotion Project for the Introduction of Innovative Energy Saving Technology for Houses and Office Buildings

Amount of draft budget for FY2016: 11 billion yen (760 million yen)

Project content

Project goal and summary

- 【Zero Energy House (ZEH) Support Project】
  To achieve the goal of ensuring that more than half of newly-constructed houses are ZEHs (*) by 2020, the project supports introducing ZEHs using a combination of high-performance building materials, equipment, and storage cells to reduce the costs of building ZEHs and speed up their popularization

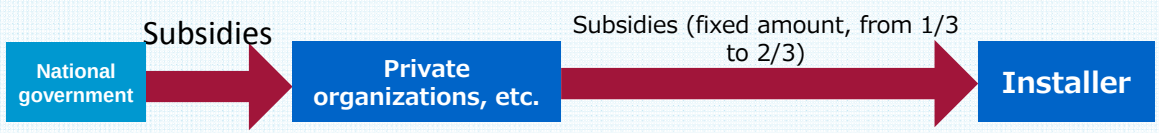
- 【Zero Energy Building (ZEB) Demonstration Project】
  To achieve the goal of the ZEB (*) by 2020 and to create guidelines, the project supports introducing necessary high-performance building materials and equipment as well as innovative activities that aim to realize top-level energy savings.

* ZEH/ZEB (Net Zero Energy House/Building)
Houses/buildings with a net zero annual primary energy consumption

Objective

- By promoting the popularization of houses and buildings with high energy saving performances to reduce energy costs, the project aims to ensure that more than half of the newly-constructed houses will be ZEHs and that buildings will turn into ZEBs by 2020.

Conditions (targeted persons and acts, subsidy rates, etc.)



Project image