

Cooling Energy: Demand, Technology and Institution

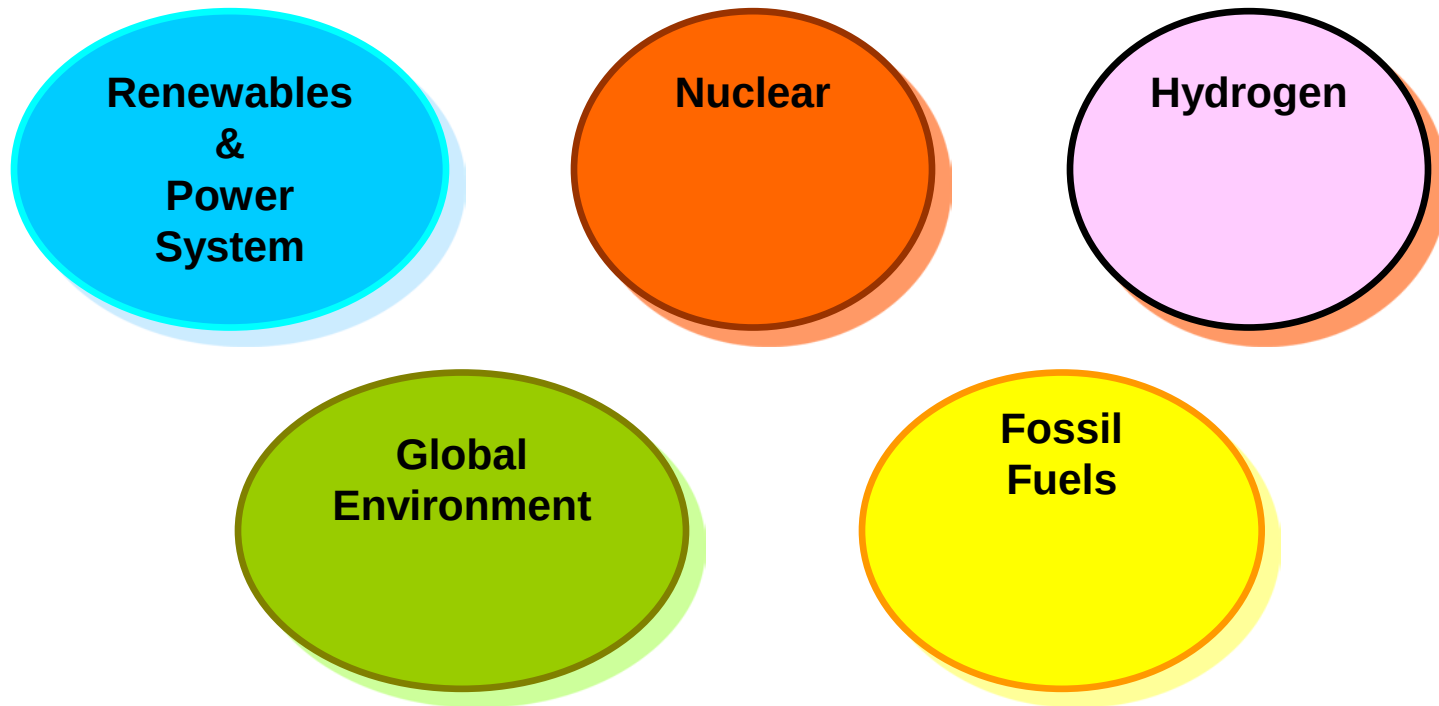
Experts' Group on R&D Priority-setting and Evaluation (EGRD)
IEA Committee on Energy Research and Technology (CERT)
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IAE overview

- Since 1978
- Non-profit organization
- Expertise - energy technology assessment
- Energy areas
- Visit <http://www.iae.or.jp> for further information



Outline

- 1. Building Energy Intensity Trend in Japan**
- Demand
- 2. Labels and Standards**
- Institution
- 3. Toward ZEB/ZEH**
- Technology and Institution
- 4. Summaries**

Outline

- 1. Building Energy Intensity Trend in Japan**
- 2. Labels and Standards**
- 3. Toward ZEB/ZEH**
- 4. Summaries**

Commercial Energy Intensity and Activity Index

Source: IEEJ estimate

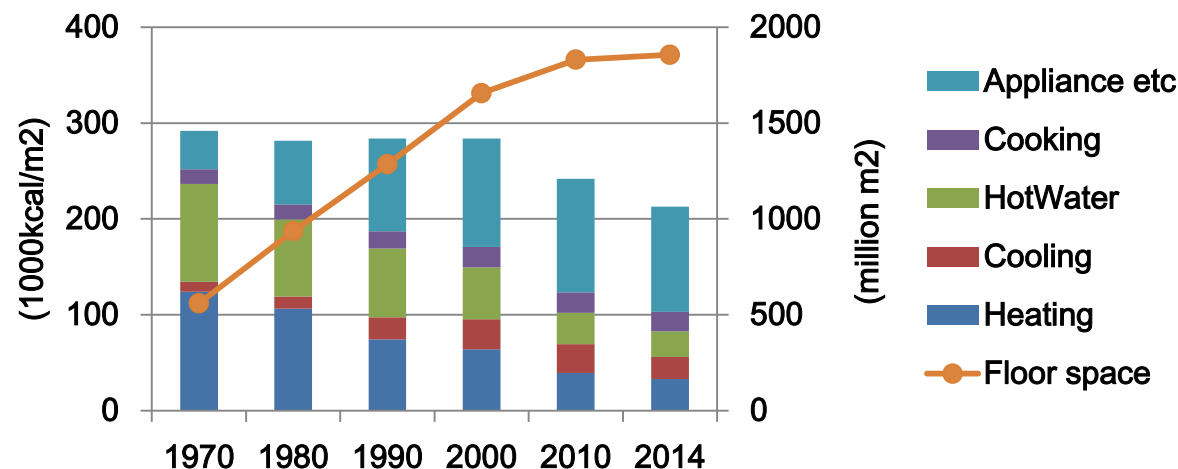
Intensity

(+:incr. factors
-:decr. factors)

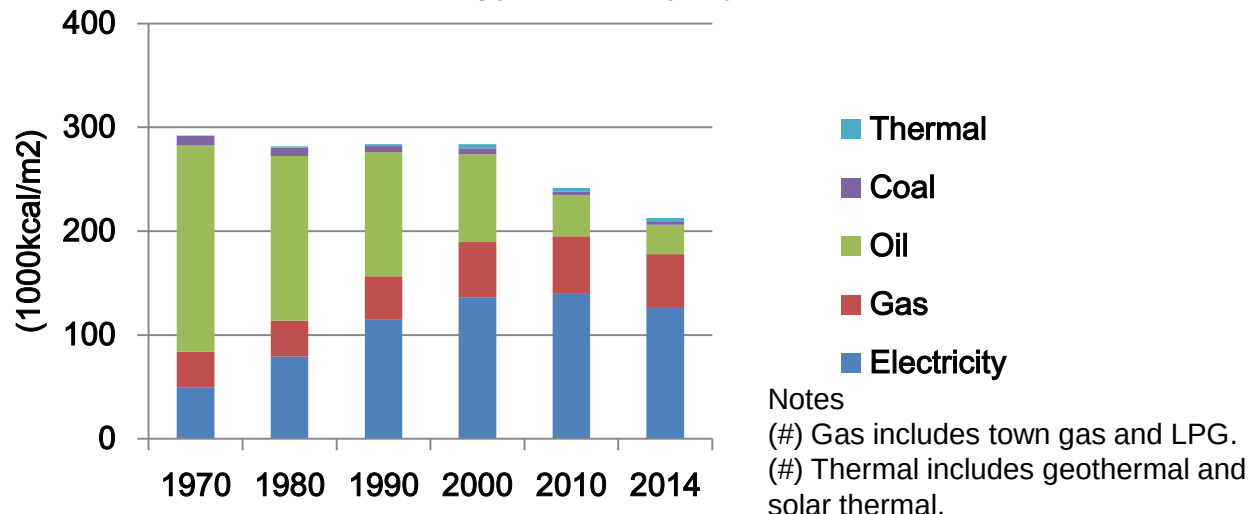
- Equipment efficiency improvement(-)
- Heat insulation (-)
- Size and number of appliances (+)
- Additional cooling demand from appliance heat (+)

□ Floor space increase cancels out intensity effects

Commercial Energy Intensity by Category



Commercial Energy Intensity by Source



Residential Energy Intensity and Activity Index

Source: IEEJ estimate

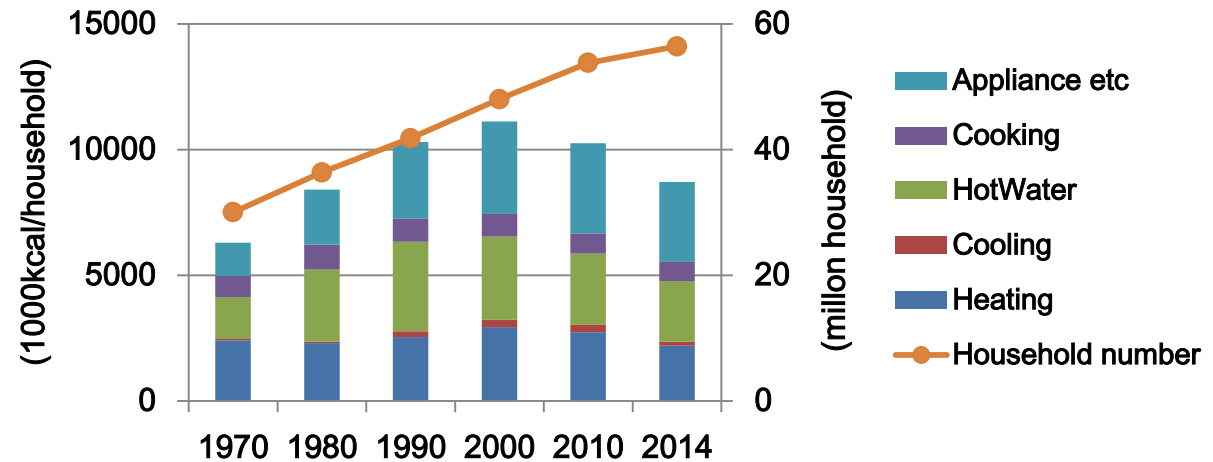
Intensity

(+:incr. factors
-:decr. factors)

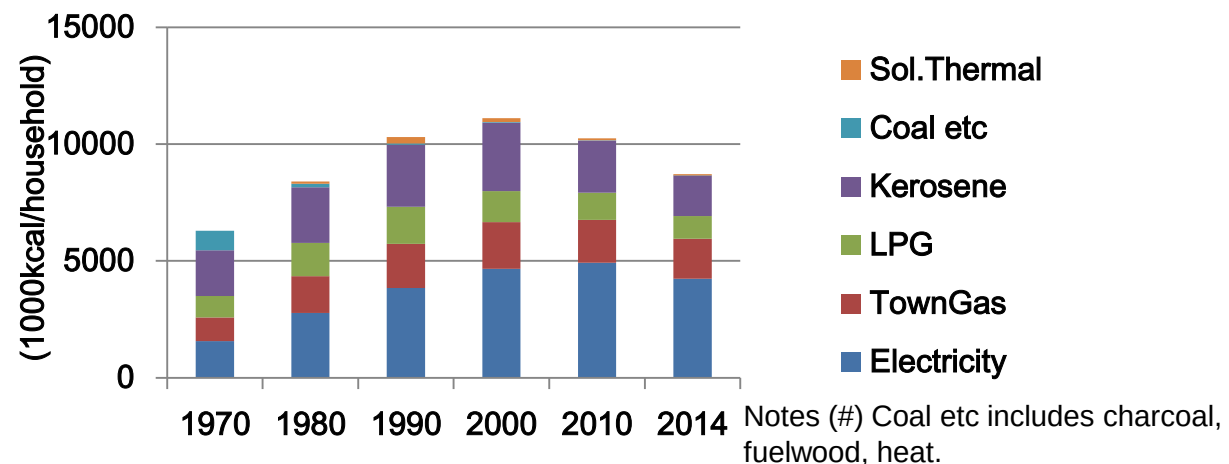
- Household size (-)
- Equipment efficiency improvement (-)
- Size and number of appliances (+)
- Heat insulation (-)

□ Household number increase cancels out intensity effects

Residential Energy Intensity by Category



Residential Energy Intensity by Source

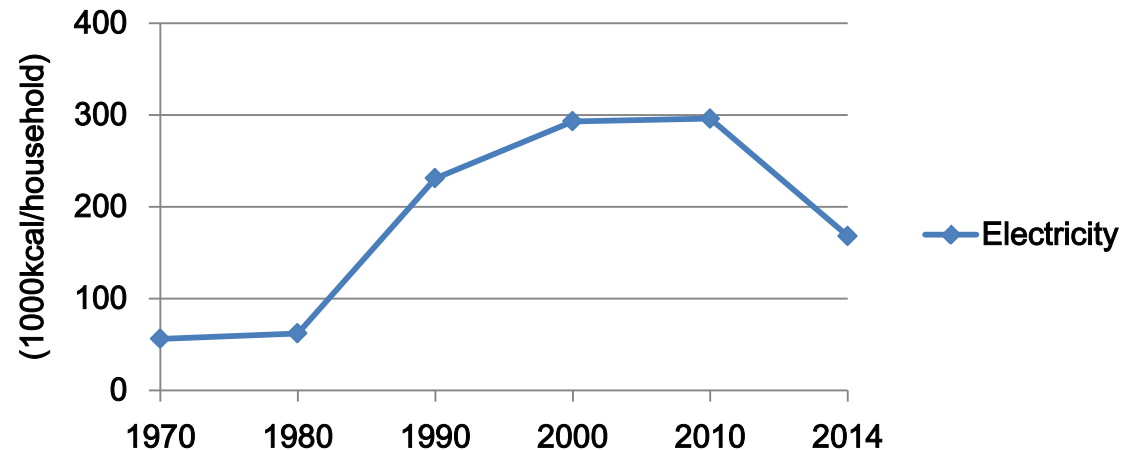


Cooling Energy Intensity of Buildings

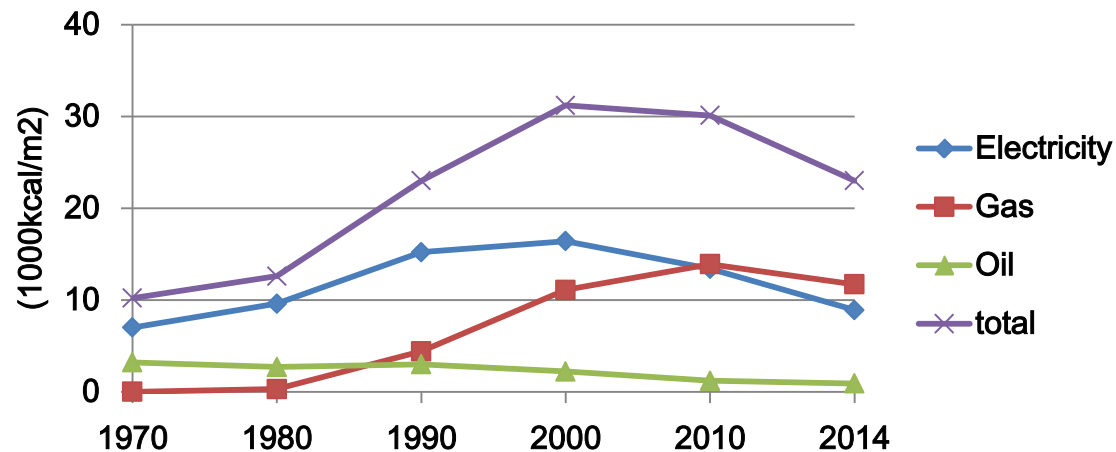
Source: IEEJ estimate

- ❑ Residential cooling energy intensity peaking
 - Equipment efficiency (-)
 - Conservation behavior in recent years (?)
 - Household size (-)
- ❑ Commercial cooling energy intensity peaking
 - Gas share is comparable to electricity
 - Equipment efficiency (-)
 - Conservation behavior in recent years(?)

Cooling Energy Intensity (Residential)



Cooling Energy Intensity (Commercial)



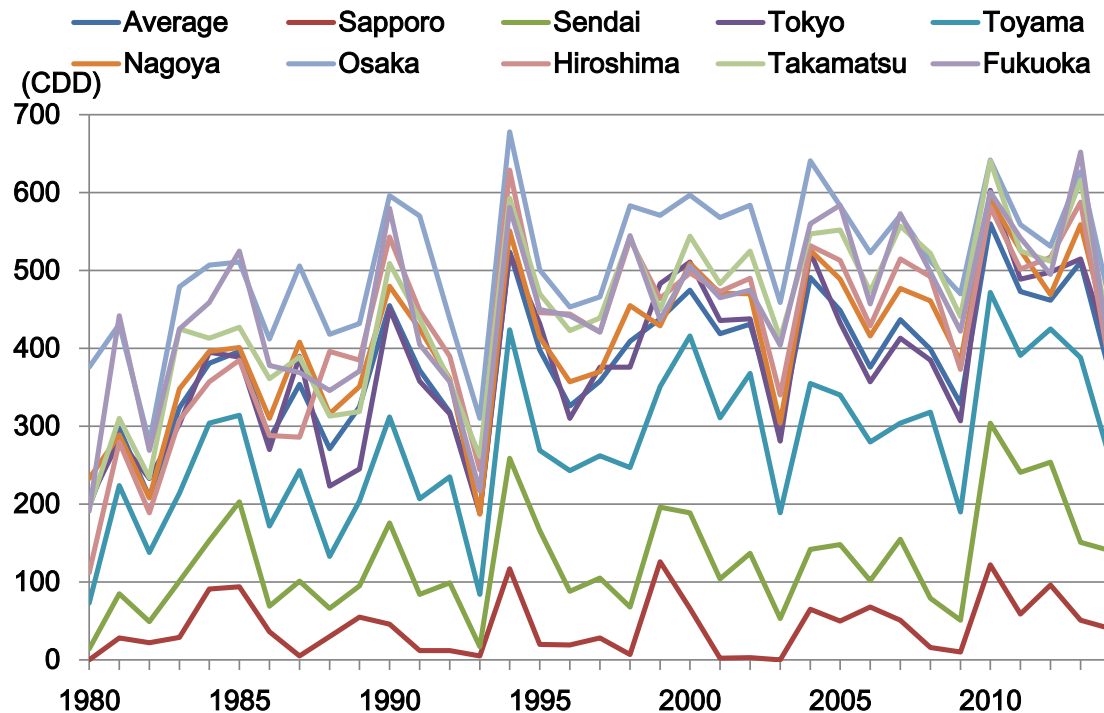
Cooling Degree Day in Urban Areas

- ❑ Large differences among regions.
- ❑ Urbanization would accelerate heat island effects.
- ❑ Inter-annual variability between peak years and off-peak years.

(Notes) * Cooling Degree Day (CDD) = Annual integration of daily average temperature above 24degC.
Offset temperature is 22degC.

* Average numbers are population weighted by 9 regions.

Source: IEEJ estimate



Outline

1. Building Energy Intensity Trend in Japan
2. **Labels and Standards**
3. Toward ZEB/ZEH
4. Summaries

Top Runner Program

- ❑ Mandatory program from 1999. Encourages competition among companies by setting the efficiency targets for next 3 to 10 years.
- ❑ Program has contributed to the significant energy efficiency improvement.
- ❑ Building materials are added recently.

Top Runner Products (Directly related to cooling functions)

1. Passenger cars / 2. Trucks / 3. Air conditioners /
4. Television receivers / 5. Video tape recorders /
6. Lighting apparatuses / 7. Copying machines / 8. Computers /
9. Magnetic disk devices / 10. Electrical refrigerators /
11. Electrical freezers / 12. Heaters / 13. Gas cooking appliances /
14. Gas water heating appliances / 15. Oil water heaters /
16. Electric toilet seats / 17. Vending machines /
18. Power transformers / 19. Jar rice cookers / 20. Microwave ovens /
21. DVD recorders / 22. Routing equipment /
23. Switching equipment / 24. Multifunction office machines /
25. Printers / 26. Heat pump water heaters / 27. AC motors /
28. LED lamps / 29. Heat insulating materials / 30. Sashes /
31. Multi-Paned glazing

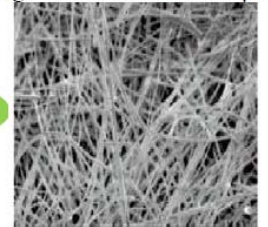


Air-conditioners

(For ones of 4.0kW or less in cooling capacity)

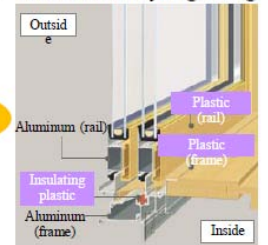
32.3% (FY2005→FY2010)

High-performance glass wool
(fine fibers)
Avg. fiber diameter: 4-5 μm



Insulation

Al-plastic composite sash
+ low-E multilayer glazing



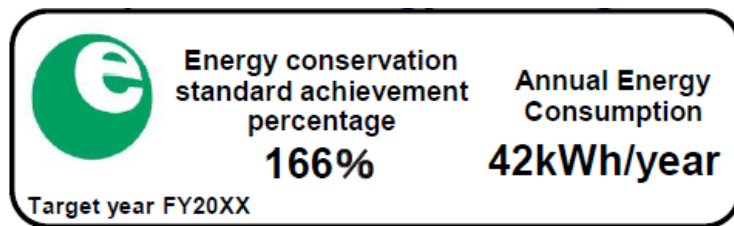
Windows

Source: METI, Japan

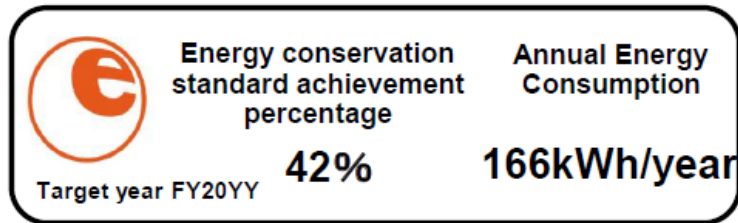
Energy Performance Labeling

- ❑ Labeling for manufactures and retailers started in 2006. Covers most of top-runner products.
- ❑ Labeling for manufacturers and retailers.

Source: METI, Japan



Green :satisfies efficiency



Orange :insufficient efficiency



【Multi-stage rating system】

- Energy-saving performance is indicated from 1 to 5 stars in the market.
- Stars indication will be reviewed yearly.

【Estimated annual electricity cost】

Envelope Requirement of Building Energy Conservation

Category

Source: MLIT, Japan

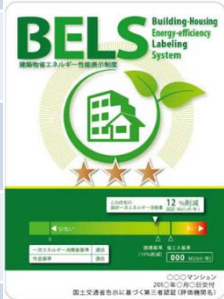
- Floor space : large (2000m²-), medium (300m² - 2000m²), small (-300m²)
- Non-residential, residential

Enforceability as new law effective from April 2016, full operation from 2017

- Obligation, notification, efforts (category dependent)

BELS (Building-housing Energy-efficiency Labeling System)

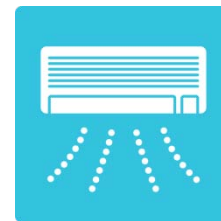
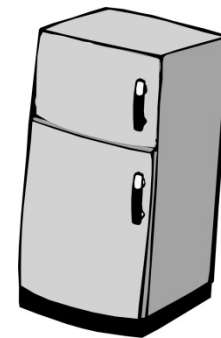
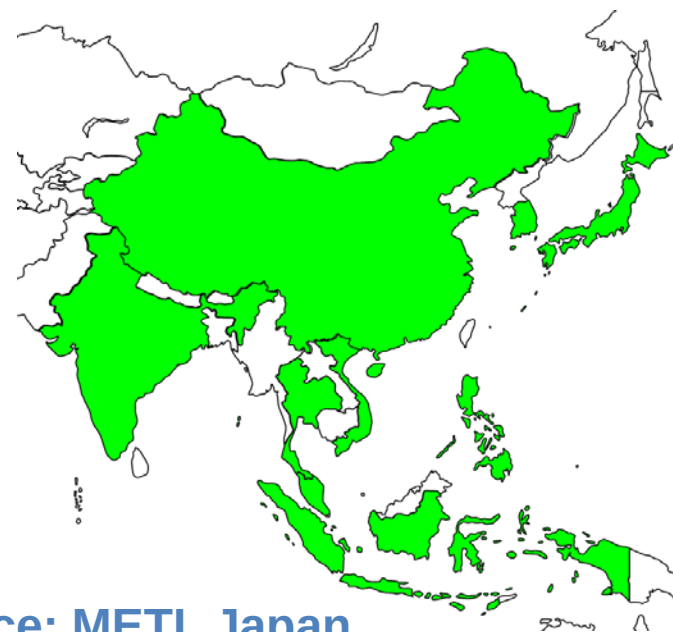
- BEI (Building Energy Index)
= (design primary energy cons (*)) / (reference primary energy cons (*))
(*) excludes appliance energy consumption after completion of building

Ratings	House BEI	Non-House BEI (office, school, factory, etc.)	Non-House BEI (hotel, hospital, department store, restaurant, etc.)
	0.8	0.6	0.7
 	0.85	0.7	0.75
	0.9	0.8	0.8
	1.0	1.0	1.0
	1.1	1.1	1.1

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International Collaboration – Working with Asia

- ❑ Capacity building of energy efficient equipment performance tests.
- ❑ Industrial standard with Asian countries.
Energy efficiency performance evaluation in the product standards (i.e. ISO and IEC).
 - China, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand, Vietnam
 - Product coverage: air-conditioner, refrigerator, LED, building material, etc.
 - Air conditioner is one of important target products. Japan submitted ISO new work item proposal, and new ISO 16358 (#) published in 2013 includes testing and rating methods of high efficient inverter-type air conditioner.

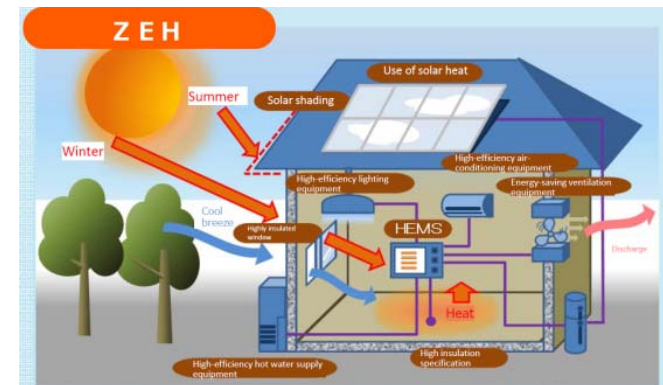


Source: METI, Japan

- (#) ISO/TC 86/SC 6 Testing and rating of air-conditioners and heat pumps
ISO 16358 Air-cooled air conditioners and air-to-air heat pumps
-- Testing and calculating methods for seasonal performance factors

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Source: METI, Japan

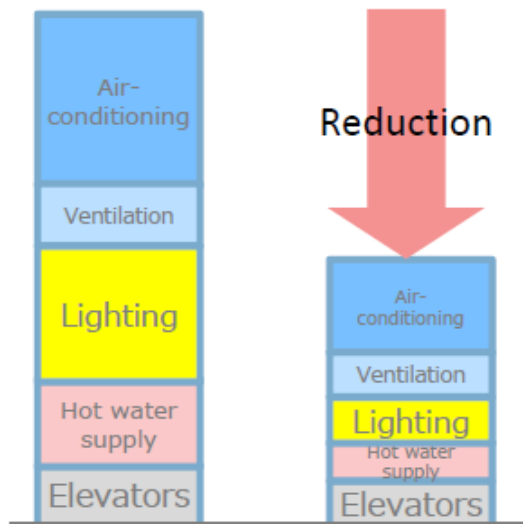


What is ZEB?

Source: METI, Japan

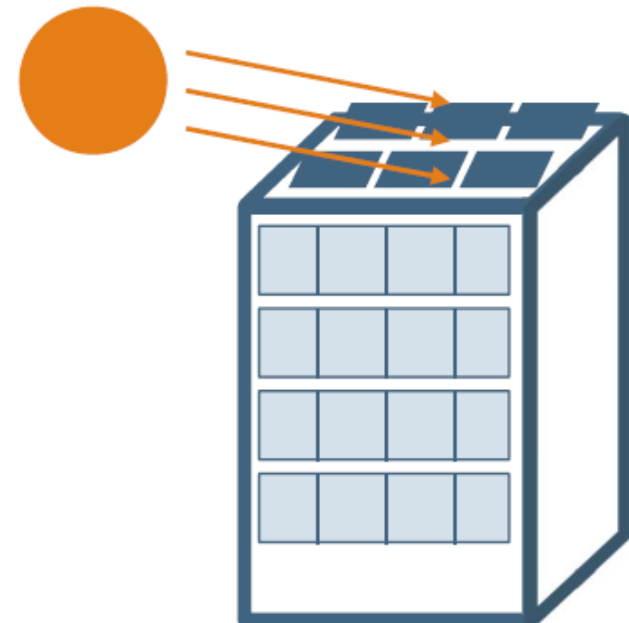
- ❑ ZEB = Net zero energy building
- ❑ ZEB is a building with **considerably reduced annual energy consumption** by saving as much energy as possible via better heat insulation, solar shading, natural energy and high-efficiency equipment as well as creating energy (e.g. photovoltaic power generation),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

Reduce energy demand and
use resources more
efficiently



+

Creation of energy

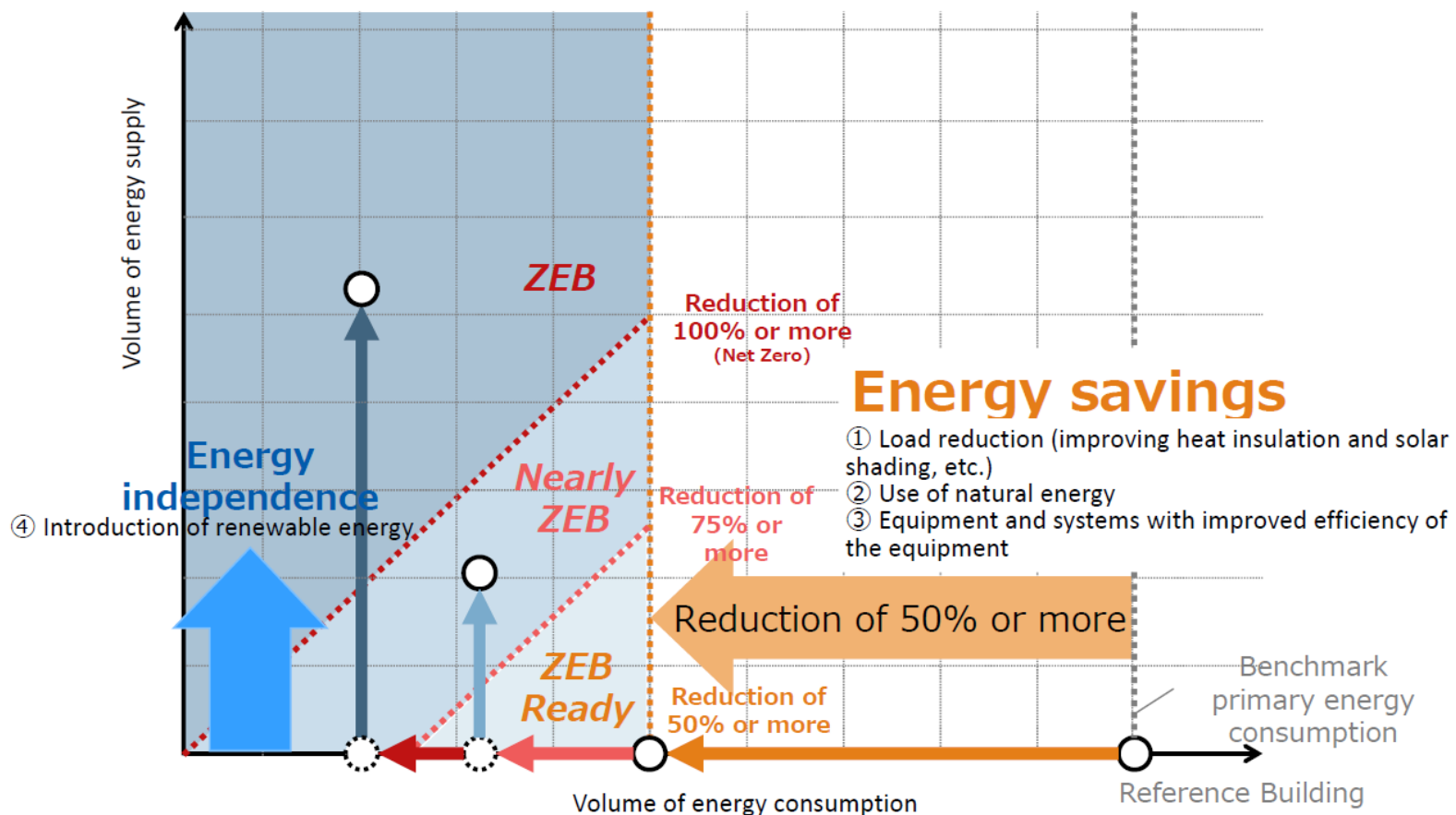


ZEB Definition and Categories

□ ZEB definition and categories

- ZEB ready: 50% or more energy saving wrt reference
- Nearly ZEB: reduction of 75% or more
- ZEB : reduction of 100% or more

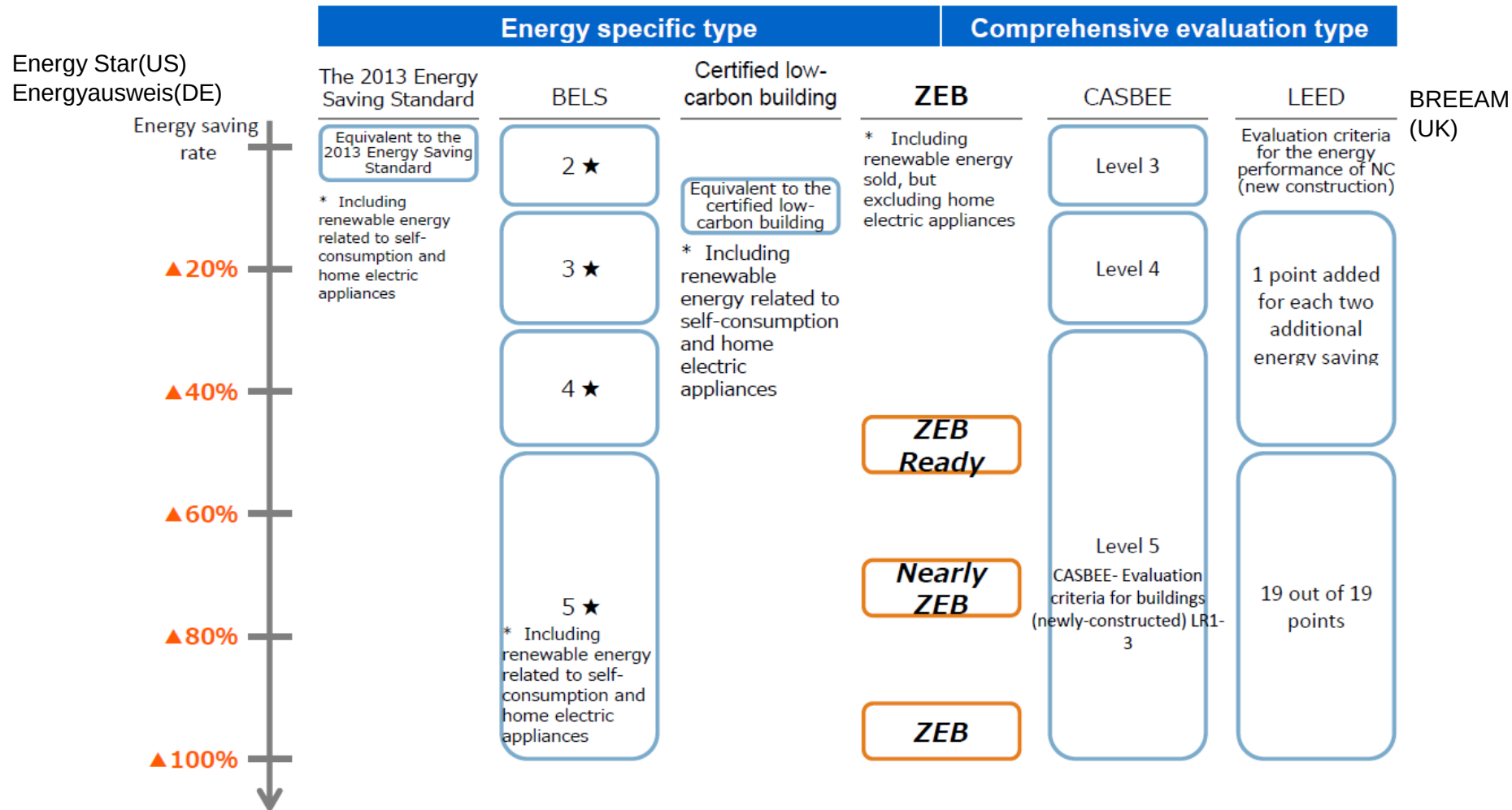
Source: METI, Japan



Promotion of ZEB Diffusion

- Design guidelines, technology development, public outreach
- Standard and labeling

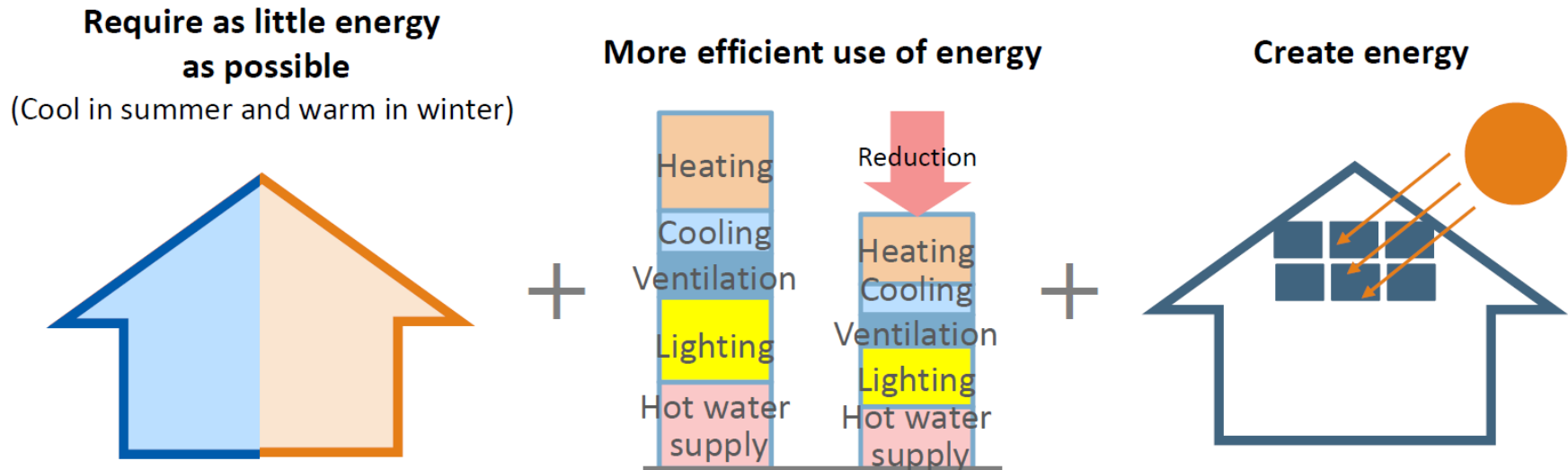
Source: METI, Japan



What is ZEH?

- ❑ ZEH = net zero energy house
- ❑ ZEH is a house with an **annual net energy consumption around zero** (or less) by saving as much energy as possible while maintaining comfortable living environment. This can be achieved through better heat insulation, high-efficiency equipment, and creating energy with photovoltaic power generation.

Source: METI, Japan



Region category	Region 1 (Asahikawa, etc.)	Region 2 (Sapporo, etc.)	Region 3 (Morioka, etc.)	Region 4 (Sendai, etc.)	Region 5 (Tsukuba, etc.)	Region 6 (Tokyo, etc.)	Region 7 (Kagoshima, etc.)	Region 8 (Naha, etc.)
ZEH Standard	0.4	0.4	0.5	0.6	0.6	0.6	0.6	—
Energy Saving Standard	0.46	0.46	0.56	0.75	0.87	0.87	0.87	—

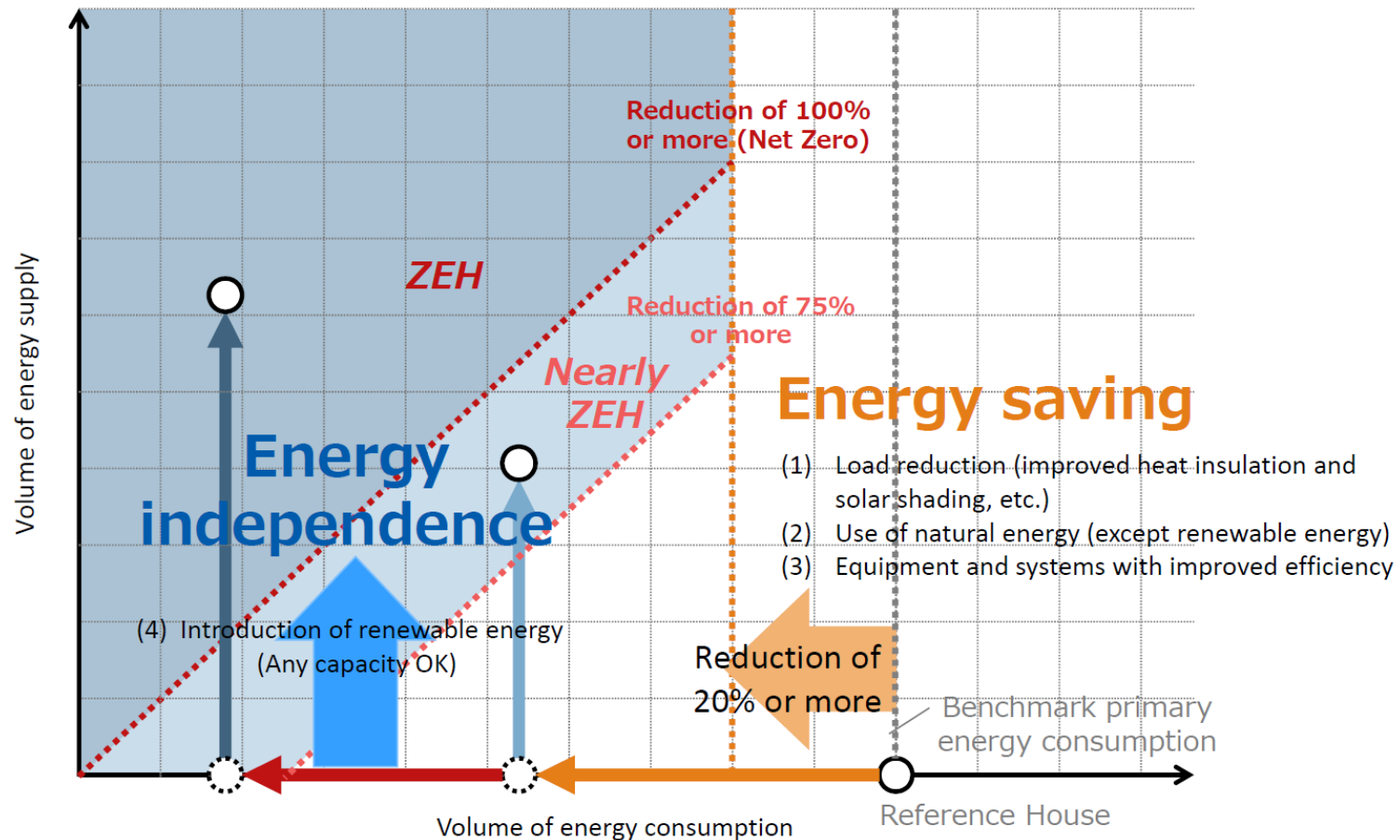
Table: Standards for the average heat transmission coefficient of the envelope (UA value)

ZEH Definition and Categories

□ ZEH definition and categories

- 20% or more energy saving wrt reference
- Nearly ZEH: reduction of 75% or more
- ZEH : reduction of 100% or more

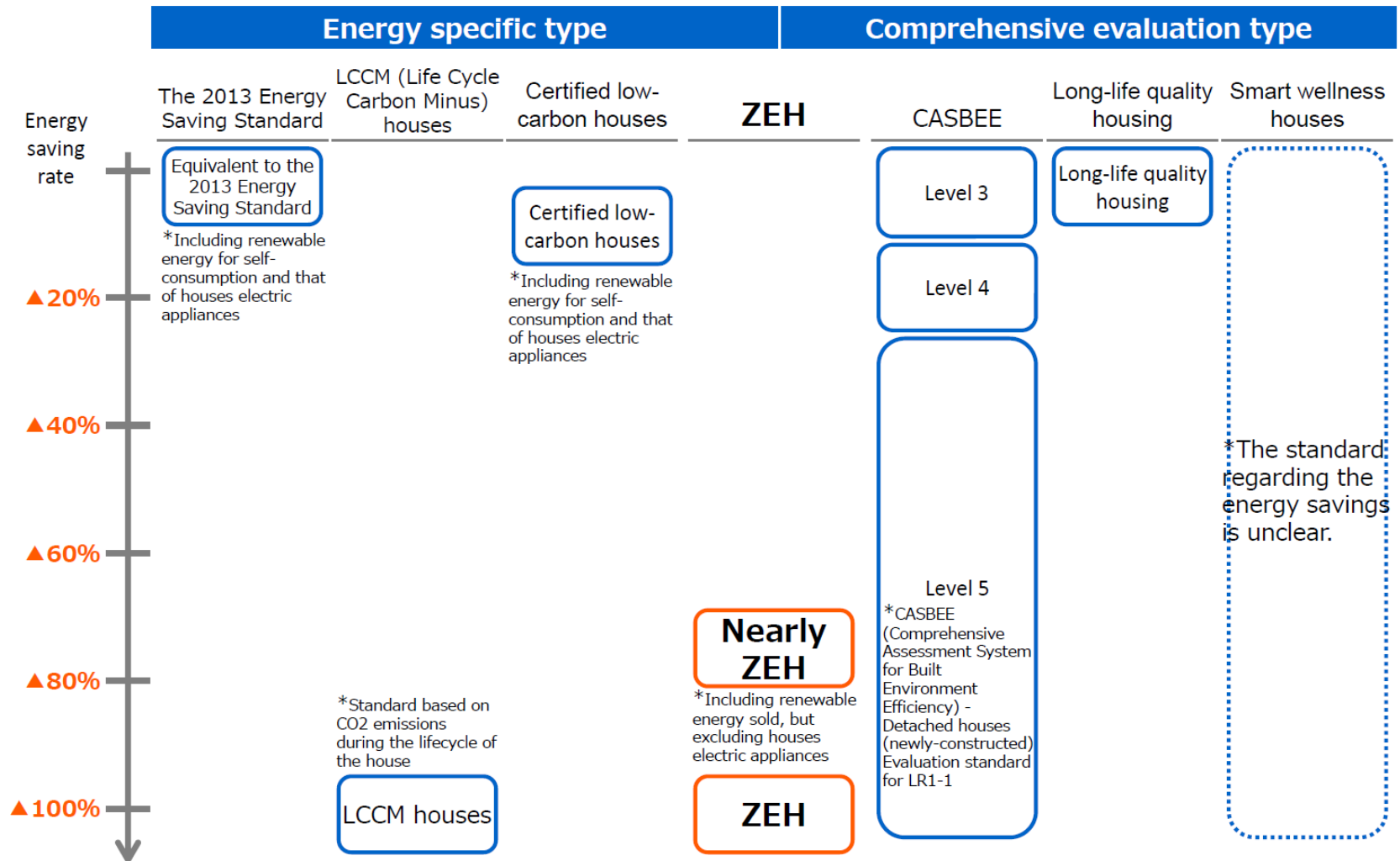
Source: METI, Japan



Promotion of ZEH Diffusion

- ❑ Incentives, SME training, public outreach
- ❑ Standard and labeling

Source: METI, Japan

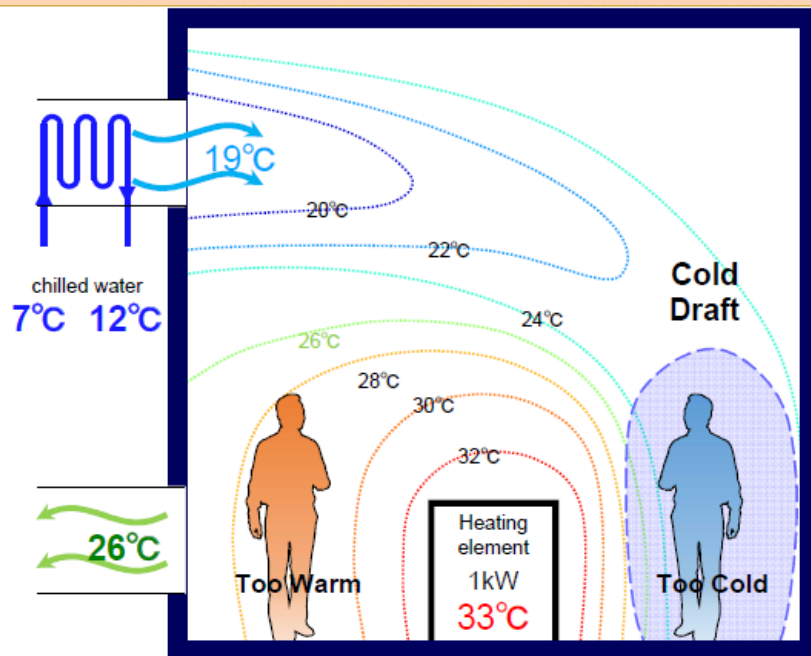


R&D Example: Commercial Building Cooling

- ❑ Developed for ZEB HVAC prototype.
- ❑ Liquid cooling for energy conservation and comfort.

Source: NEDO, Japan

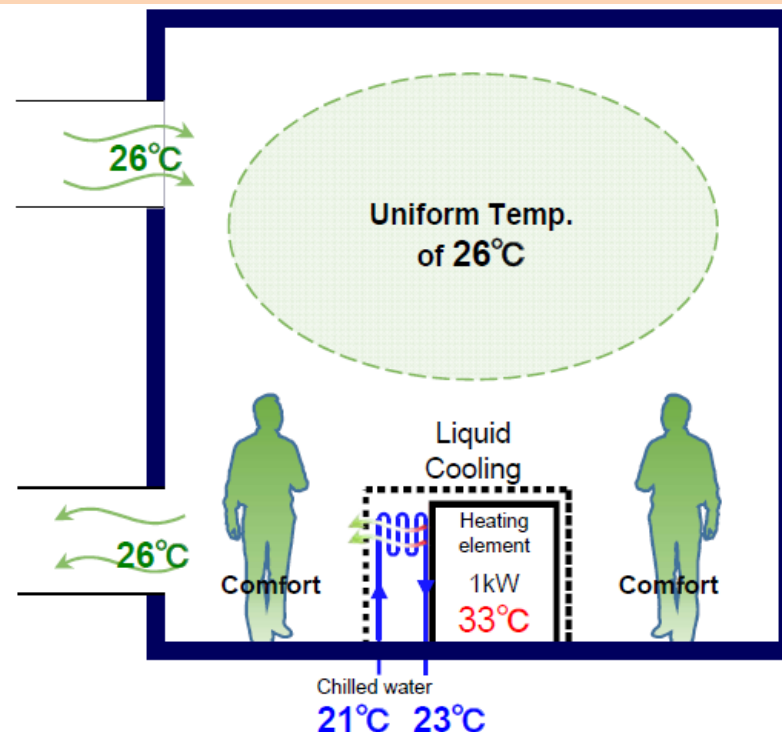
Conventional System



Generated Heat disperses into Room

Low temp. chilled water (7degC).
Temp. distribution is **not** uniform.

Liquid Cooling System



Generated Heat is removed at Source

Chilled water temp. (21degC) is close to
room temp. Uniform temp. distribution.

Concept of New Commercial Building Cooling

System Concept

Source: NEDO, Japan

Subsystem

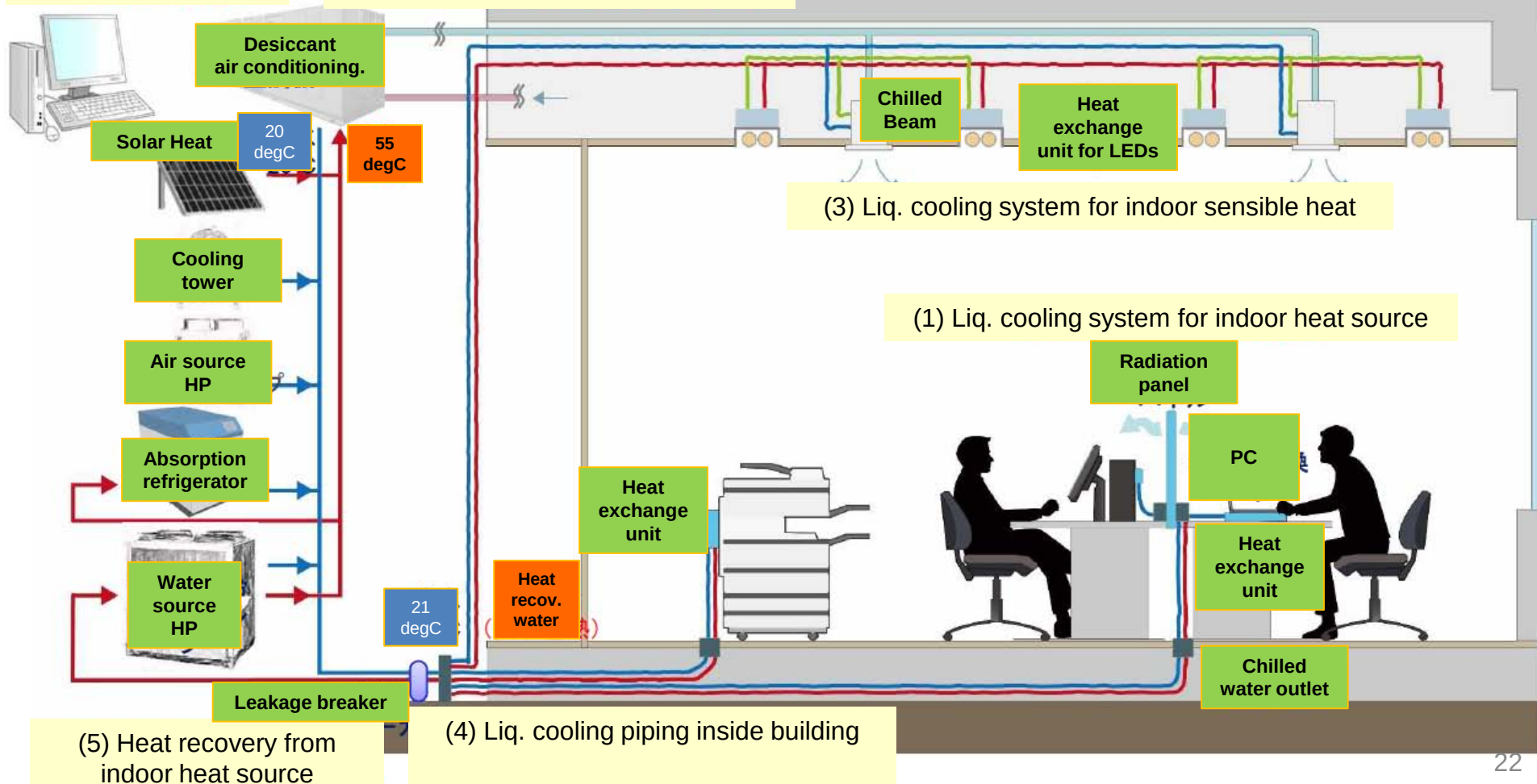
Unit or Equipment

Hot Water

Chilled Water

(6) ZEB energy management system

(2) Desiccant air conditioning for outdoor latent heat exchange



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Summaries (1)

❑ Technological Challenges – We Need innovations

- **Passive technologies** such as:
 - Heat insulation: Thin materials (e.g. vacuum insulation)
 - Building shell : Radiative self-cooling material that reflects solar radiation during days and nights
 - Natural lighting and/or natural ventilation adjusted to local climate and urban design
- **Active technologies**: Cost down of high performance appliances, such as high performance heat pumps, CHP including fuel cells, and latent heat recovery water boilers
- **Energy management technologies**: Innovative energy management technologies such as individual air conditioning.
- **Renewable energy integration**: Renewable integration ready buliding such as built-in photovoltaic panels.

Summaries (2)

❑ Social Challenges

- **Standards:** Standard of energy saving technologies for buildings to assist global diffusion of ZEBs/ZEHs.
- **Regulations and incentives:** Regulation and incentives for buildings to meet energy saving standard and to integrate renewable and unused energy. These regulations must take the needs and appropriateness into account.
- **Life style change:** Energy saving life styles and social-scientific approach for segmented customers including economic incentives.
- **Smart grid integration:** Integrate ZEBs/ZEHs to small-scale smart grid and heat exchange system among buildings to realize zero emission community.

ICEF 2016 – Save the Dates

❑ ICEF (Innovation for Cool Earth Forum)

- Discussion of building sector and other energy issues
- <http://www.icef-forum.org/>
- See 2015 discussions at http://www.icef-forum.org/annual_2015/program/index.html

