EBC webinar “Building Energy Codes, Data Utilization for Improving Energy Efficiency, and Air Cleaning”

EBC
Energy in Building and Communities Programme

Policies for Building Energy Conservation of residential and non-residential buildings in Japan

9 November 2021

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Counselor for Building Regulations
Housing Bureau, MLIT, JAPAN

国土交通省
Ministry of Land, Infrastructure, Transport and Tourism

GHG emission reduction goals of countries

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Country /Region	NDC (2030 goal)	Date of NDC submitted	Net zero by 2050
Japan	-46% (from 2013 level) Japan will continue efforts to meet the lofty goal of cutting its emission by 50%.	NDC submitted on 22 October 2021	Declared
U.S.	-50 to -52% (from 2005 level)	NDC submitted on 22 April 2021	Declared
Canada	-40 to -45% (from 2005 level)	NDC submitted on 12 July 2021	Declared
U.K.	-68% or more (from 1990 level)	NDC submitted on 12 December 2020	Declared
France, Germany, Italy, EU	-55% or more (from 1990 level)	NDC submitted on 18 December 2020	Declared
Australia	-26 to -28% (from 2005 level)	NDC submitted on 31 December 2020	-
Brazil	-43% (from 2005 level)	NDC submitted on 9 December 2020	Declared

Source: Compiled based on the website of UNFCCC and the Ministry of Foreign Affairs of Japan

Köppen-Geiger Climate Classification Map

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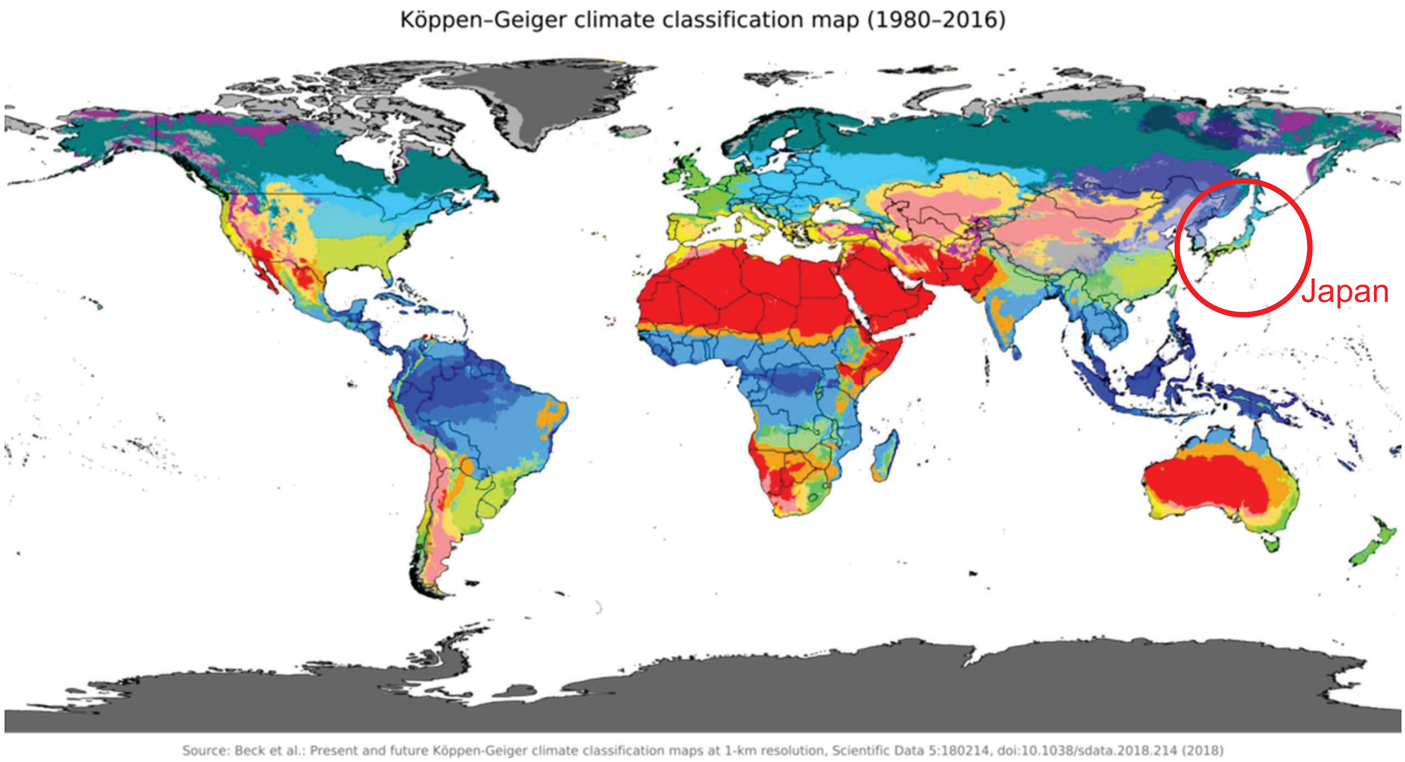

Source: Wikipedia

Location of Japan on top of the European map

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Map Data @2021 Google

Regional Classification by the Building Energy Efficiency Act of Japan

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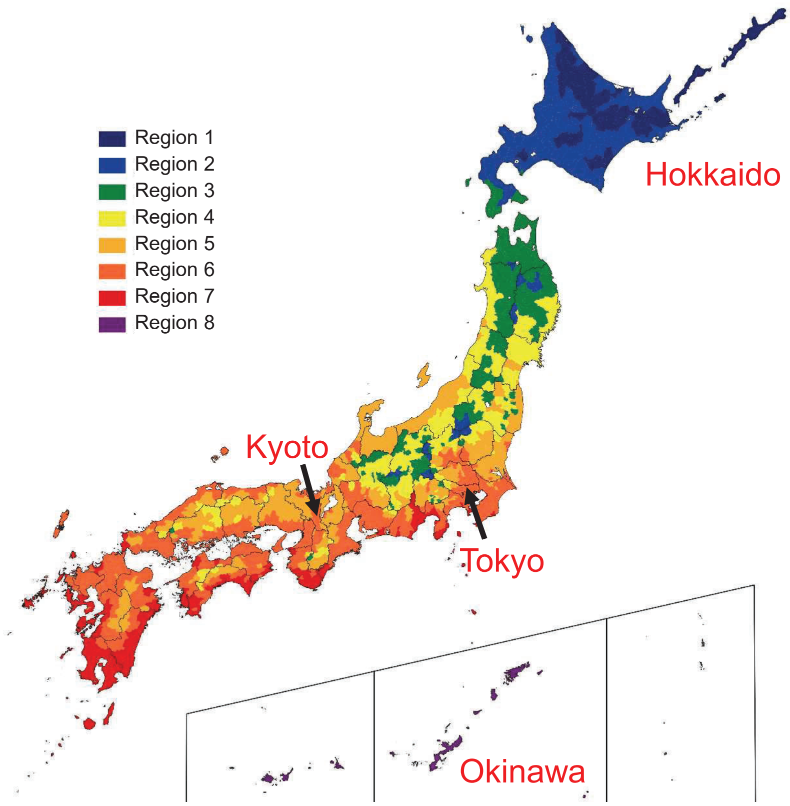

International Comparison of Household Energy Consumption (by Use)

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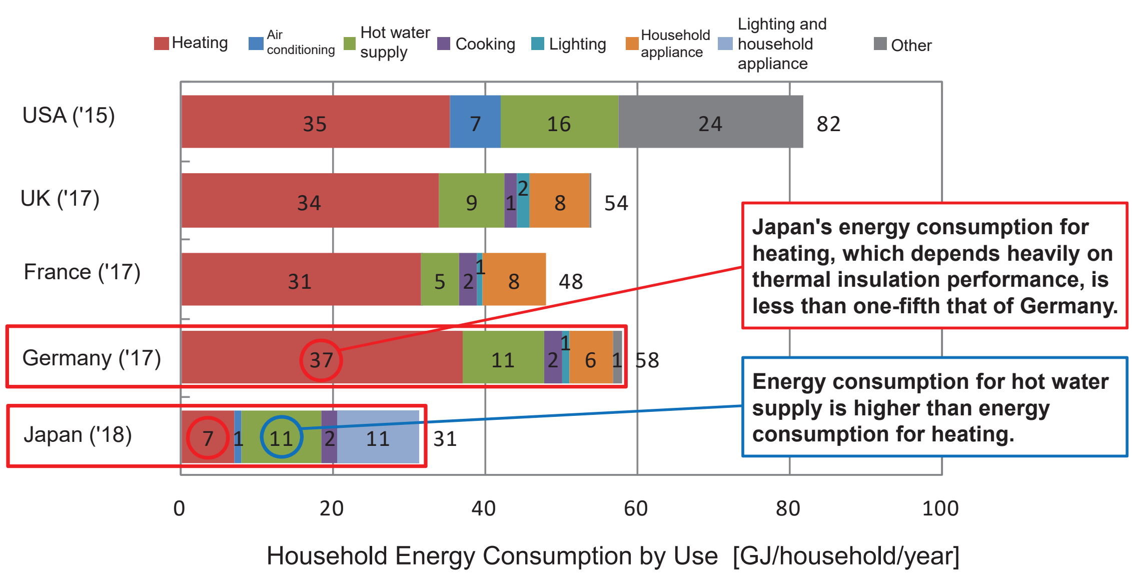
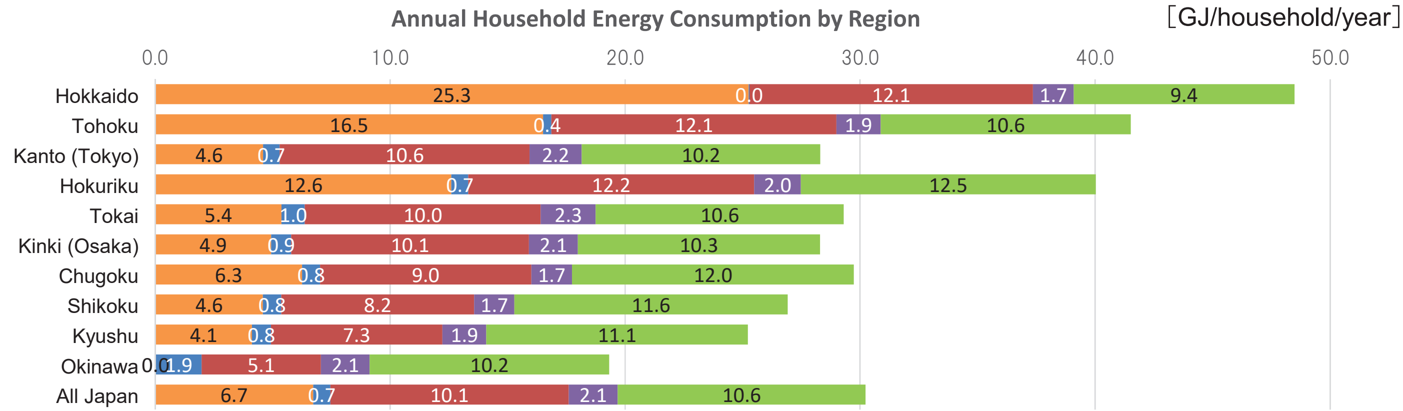
- **Consumption per household in Japan is about one-third of that in the U.S. and about half that in Germany and other European countries.**
- **Japan's energy consumption for "heating" is particularly low, while consumption of "hot water supply" is higher. While people in other countries heat/cool their homes for a long time, most Japanese way of living is "intermittent heating/cooling". Japanese people heat/cool their homes only when they are at home.**

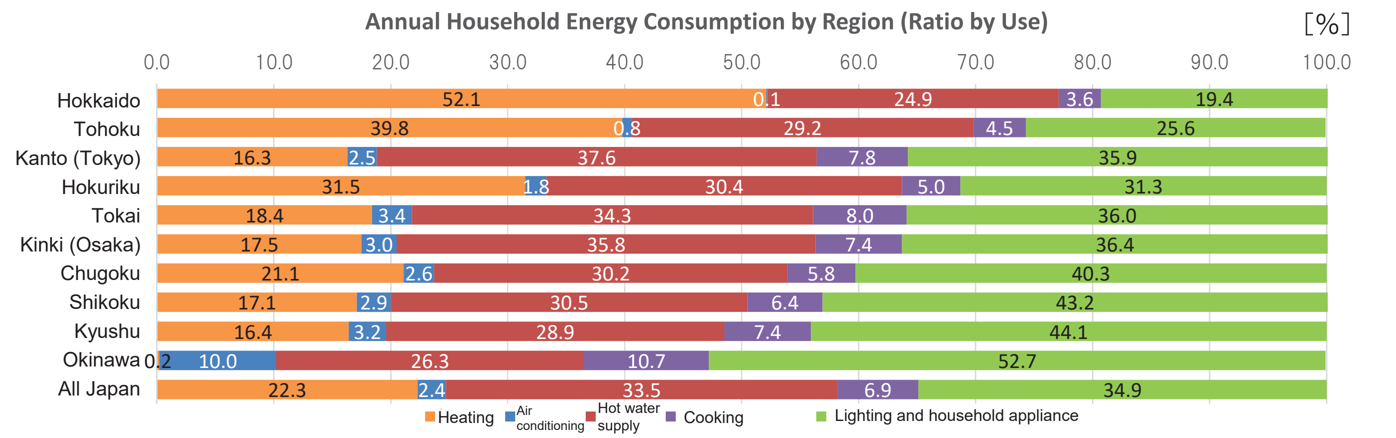


* USA.(Other) includes cooking, lighting, and household appliances.

Source: Compiled by Jukankyo Research Institute Inc. based on statistical data from various countries

Household Energy Consumption in Japan (by Region, by Use)

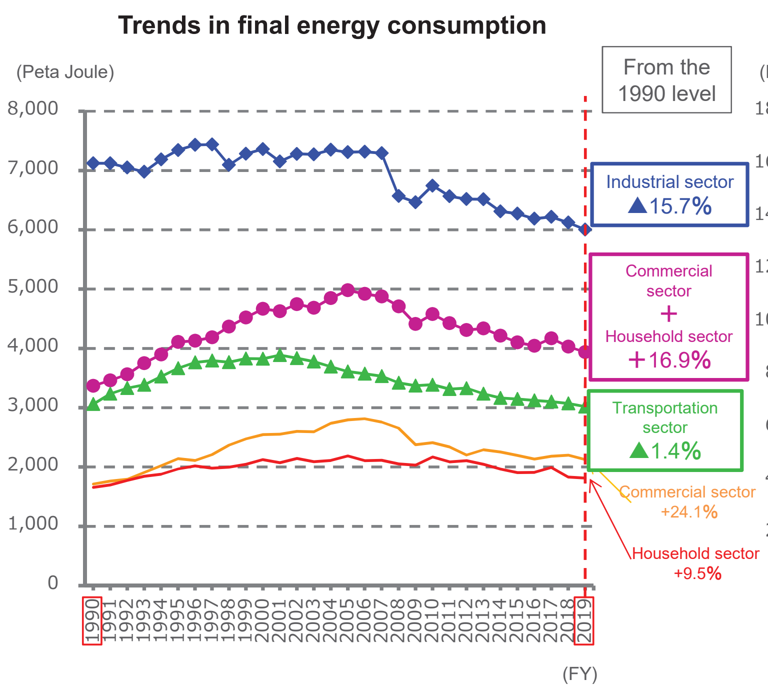


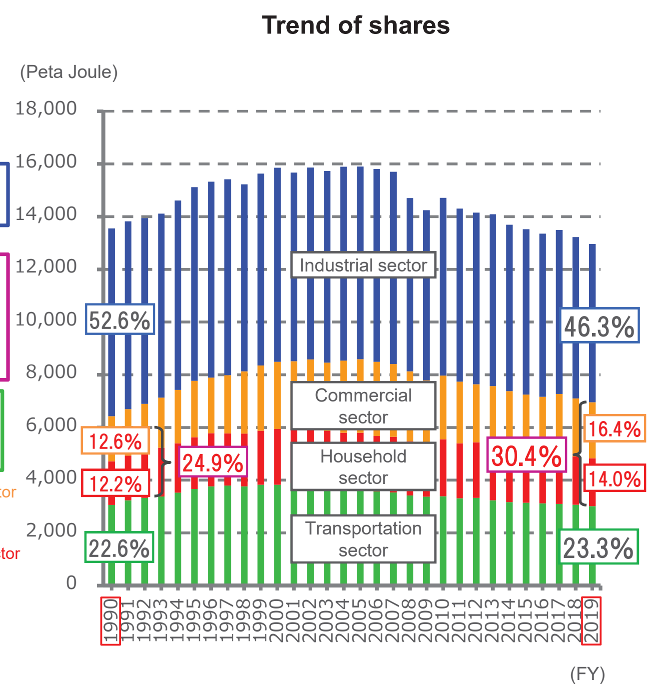


Source: Ministry of the Environment of Japan

Trends in Japan's Energy Consumption by Sector

- **While other sectors (industry and transportation) have decreased, <u>energy consumption in the commercial and household sectors have increased significantly</u> (16.9% from the 1990 level (left Figure)). They accounts for <u>about 30% of total energy consumption</u> (right Figure).**
- **<u>Drastic reinforcement of energy-saving measures on houses and buildings</u> is essential.**





Source: Comprehensive Energy Statistics (ANRE)

Japan's Reduction Targets in the New "Plan for Global Warming Countermeasures" (decided by the Cabinet on October 22, 2021)

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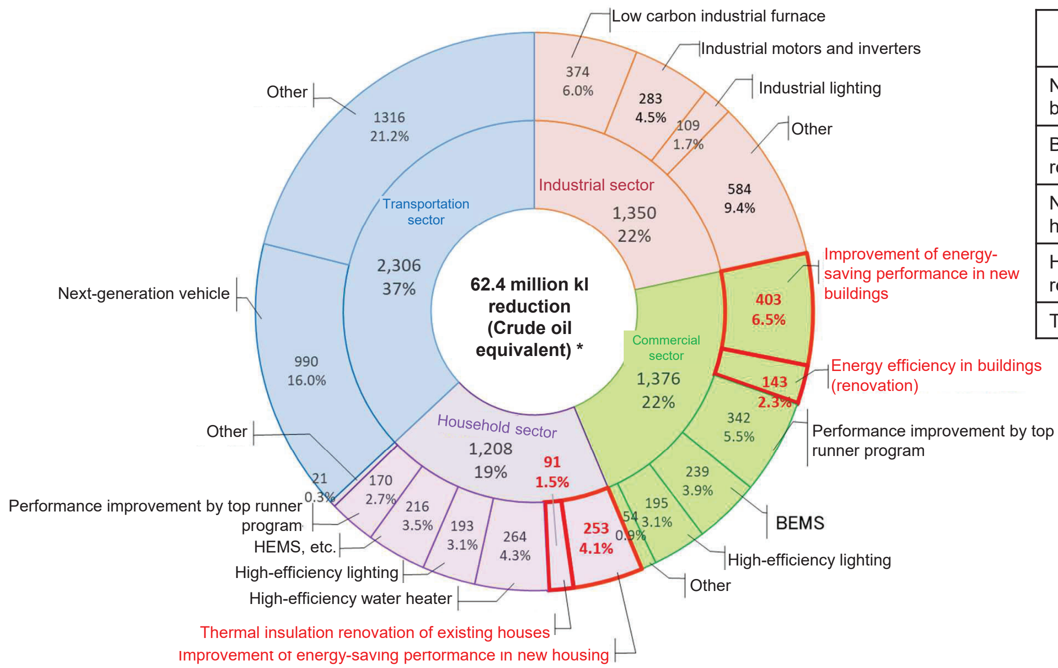

➢ **Reduction targets in the field of houses and buildings**

	Amount of reduction
Newly constructed building	403
Building renovation	143
Newly constructed housing	253
Housing renovation	91
Total	889

* Total does not match due to rounding.

* Reduction target of the previous Plan for Global Warming Countermeasures (May 2016): about 50.3 million kl

Source: Energy Demand and Supply Outlook for FY2030 (Sep. 2021) (Agency for Natural Resources and Energy)

Regulatory Measures under the Building Energy Efficiency Act of Japan

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Upon establishment of the Act (promulgated on July 2015)

	Non-residential	Residential
Large (2,000 m² or more)	Specific building: Obligation of compliance [Linked to the building certification procedure]	Obligation of notification [Instruction, order, etc. to be issued when the standard is not met and issuance is deemed necessary]
Medium (300 m² or more but less than 2,000 m²)	Obligation of notification [Instruction, order, etc. to be issued when the standard is not met and issuance is deemed necessary]	(same as above)
Small (less than 300 m²)	Effort obligation [Improvement of energy-saving performance]	Effort obligation [Improvement of energy-saving performance] Top runner program* [Compliance with the top runner standards] Target housing: Owner-occupied house; Detached house for sale

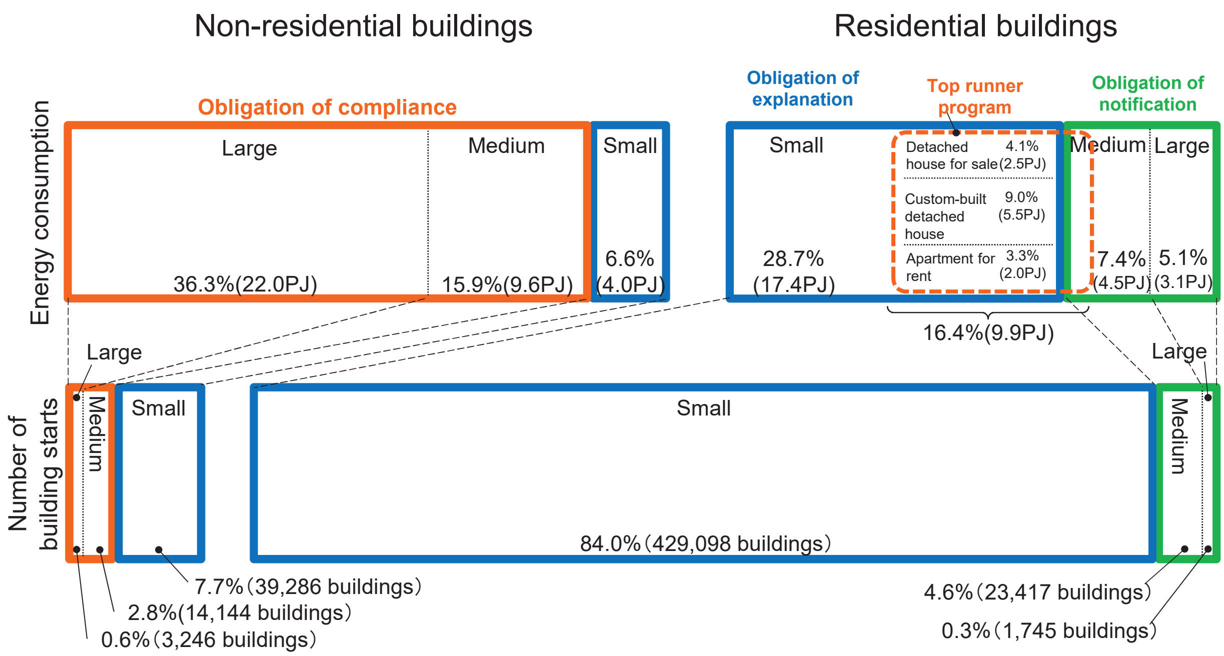
After revision (promulgated on May 2019)

	Non-residential	Residential
Large	Specific building: Obligation of compliance [Linked to the building certification procedure]	Obligation of notification [Instruction, order, etc. to be issued when the standard is not met and issuance is deemed necessary] Streamlining the examination procedures in the competent administrative agency ⇒ Focus on implementation of supervision (instruction, order, etc.)
Medium	Obligation of compliance [Linked to the building certification procedure]	(same as above)
Small	Effort obligation [Compliance with the energy efficiency standards] + Obligation of the architect to explain to the building owner	Effort obligation [Compliance with the energy efficiency standards] + Obligation of the architect to explain to the building owner Top runner program* [Compliance with the top runner standards] Expansion of the target Target housing: Owner-occupied house; Detached house for sale; Custom-built detached house; House for rent: Apartment for rent

* If it is deemed necessary to improve the energy-saving performance of a major housing developer to a considerable extent, such as insufficient compliance with the top runner standards, the developer will be subject to the recommendation, order, etc. by the Minister of MLIT.

Relationship between Energy Consumption and the Number of Building Starts (by Use, by Size)

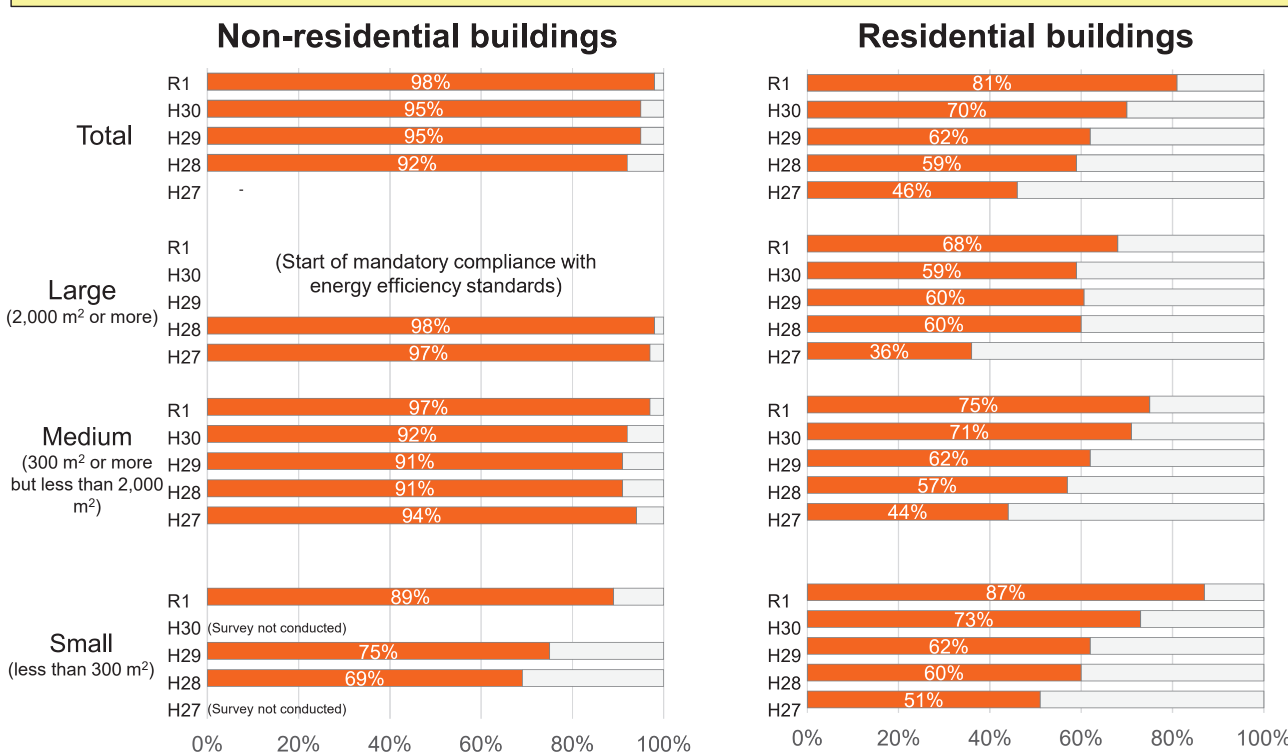
➢ **The number of buildings subject to the obligation of compliance accounts for 3.4% of the total number of building starts (0.6% for large buildings and 2.8% for medium buildings), but their energy consumption accounts for 52.2% of the total energy consumption (36.3% for large buildings and 15.9% for medium buildings).**



* Estimated by assuming that the average energy intensity of buildings is 878 MJ/m^2/year, and average energy intensity of houses is 344MJ/m^2/year, based on the 2017 Energy and Economy Statistical Abstract and the 2017 Statistics on Building Starts.

Rate of Compliance with Energy Efficiency Standards (by Size)

➢ **The rate of compliance with energy efficiency standards for newly constructed housing has been rising year by year, and the rate of compliance in total housing exceeded 80% in FY2019.**



* Calculated in the same manner as the FY2015 standard compliance rate in the Summary of the workshop on the actual state of energy consumption performance in housing and buildings (March 30, 2018).

Outline of the Energy Efficiency Standards for Buildings in Japan

➢ **The Japanese energy efficiency standards for buildings are the standards that are necessary to ensure the energy-saving performance required for buildings as well as building equipment. They consist of two standards: “primary energy consumption” standards and “envelope insulation” standards.**

Primary energy consumption standards (Apply to both residential and non-residential buildings)

Primary energy consumption shall be equal to or less than the standard value.

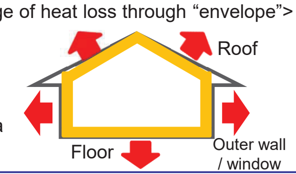
* "Primary energy consumption"
  = Air conditioning energy consumption + Ventilation energy consumption
  + Lighting energy consumption + Hot water supply energy consumption
  + Elevator energy consumption
  + Other energy consumption (OA equipment, etc.)
  - Energy creation by solar power generation equipment, etc. (limited to self-consumption)

Envelope insulation standards (apply only to residential buildings)

Heat loss per surface area of the “envelope” (outer wall, window, etc.), or envelope average heat transmission coefficient, etc. shall be equal to or less than the standard value.

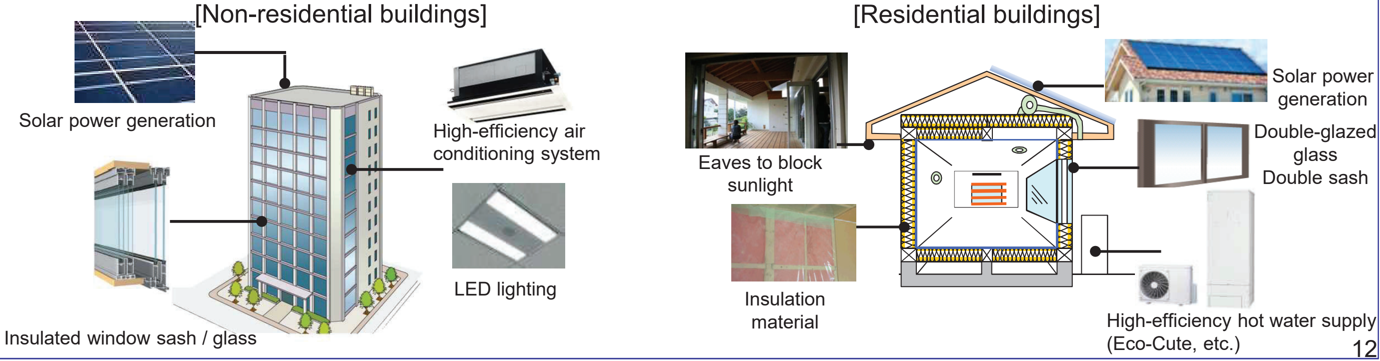
<Image of heat loss through “envelope”>

* Envelope average heat transmission coefficient
  = Total heat loss / Envelope surface area

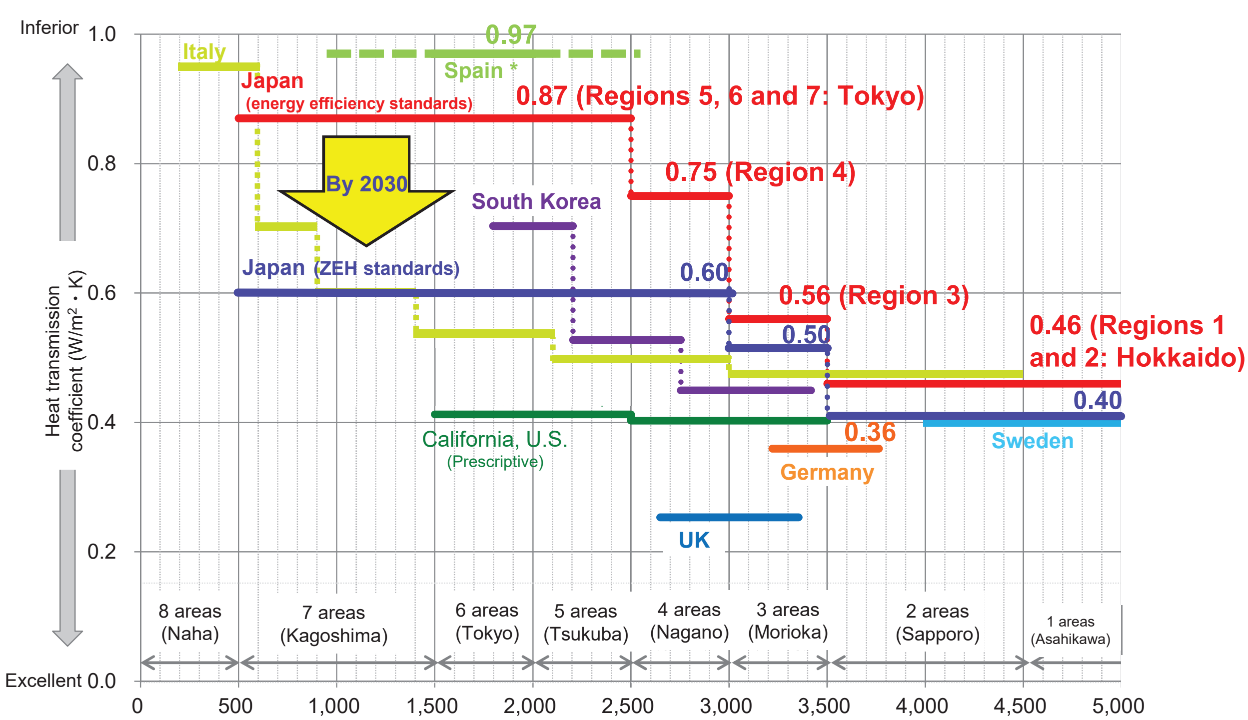


Examples of initiatives to improve energy-saving performance

[Non-residential buildings] [Residential buildings]



International Comparison of the Envelope Average Heat Transmission Coefficient Standards (UA Value) for Residential Buildings

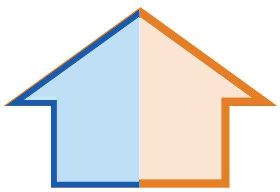


Source: FY2014 Commissioned research by the MLIT
"Commissioned research on energy efficiency regulations, standards, etc. in overseas housing and buildings.
* Compiled by Nomura Research Institute based on the energy efficiency standards for homes in various countries.
* The MLIT made addition to the standards for Spain and Sweden.
* Created in consideration of heating degree days (degree day) in Madrid.

Definition of ZEH (Net Zero Energy House)

➢ "**ZEH**" is defined as "**a house in which energy consumed per year is approximately zero or less on a net basis** by striving to save as much energy as possible through **high envelope insulation and high efficiency equipment** in the house while maintaining a comfortable indoor environment, and by **creating energy through solar power generation and other means**."

(1) High envelope insulation



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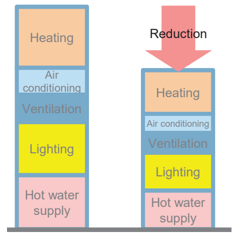
(2) High efficiency improvement of equipment, etc.



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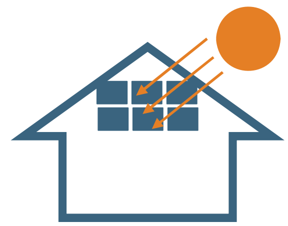
(3) Energy creation



Envelope insulation standards	Primary energy consumption standards: High efficiency improvement of equipment, etc.	Primary energy consumption standards: (Energy creation)
High envelope insulation standards that are stricter than the energy efficiency standards (Standards for the envelope average heat transmission coefficient)	**20% reduction from the energy efficiency standards** Without considering the energy creation by solar power generation, etc.	**Reduce primary energy consumption to net zero or less** Taking into account the energy created by solar power generation, etc., including the surplus electricity sold,

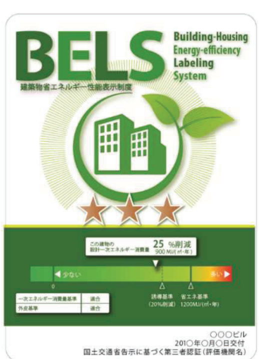
Regional classification	Regions 1 and 2 (Sapporo, etc.)	Region 3 (Morioka, etc.)	Region 4 (Nagano, etc.)	Regions 5, 6 and 7 (Tokyo, etc.)
ZEH standards	0.4	0.5	0.6	0.6
Energy efficiency standards	0.46	0.56	0.75	0.87

Source: "ZEH Roadmap" compiled by the ZEH Roadmap Review Committee of the Ministry of Economy, Trade and Industry (METI) on December 17, 2015,

Energy-Saving Performance Indication System

➢ **In order to indicate excellent energy-saving performance in houses and buildings, the Building-housing Energy-efficiency Labeling System (BELS) is operated as a system that conforms to the guidelines based on Article 7 of the Act.**
➢ **Indicated in five levels according to energy-saving performance through evaluation by a third party.**

BELS (Building-housing Energy-efficiency Labeling System)



Records of BELS
(as of the end of July 2021)

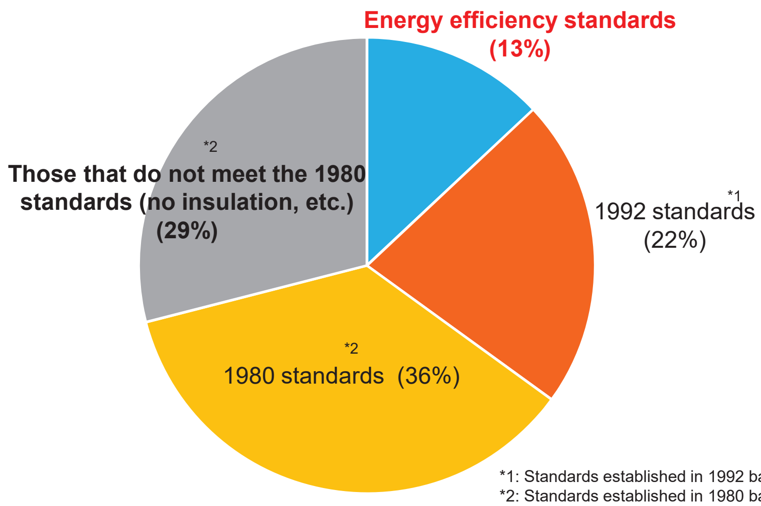
Building type	Number of type
Detached housing	130,577
Residential complex	31,440
Non-residential building	2,195
Total	164,212

Item	Overview
System management entity	**Housing Performance Evaluation and Labeling Council (a General Incorporated Association (GIA))**
Target buildings	**Newly constructed** and **existing houses and buildings**
Evaluation target	**Energy-saving performance at time of design** for entire building *Depending on the evaluation method, floor unit, etc. is also possible.
Evaluator	**Third-party evaluation by evaluation organization** **Evaluator: First-Class Registered Architects, Building Service Engineers, etc.** who have **taken and completed training** held by a third-party
Evaluation indices (Primary energy)	・**Primary energy consumption** and **BEI** (Building Energy Index) = **Design primary energy / Standard primary energy**

Thermal Insulation Performance of Housing Stock

- As of FY2019, about 13% of the total housing stock (about 50 million units) complied with the energy efficiency standards, and about 29% of the total housing stock was uninsulated.
- According to the Housing and Land Survey (2018), the actual number of thermal insulation renovations for the housing stock in less than five years from January 2014 to October 2018 was about 720,000 units.

Thermal insulation performance of housing stock (about 50 million units)



*1: Standards established in 1992 based on the Energy Conservation Act
*2: Standards established in 1980 based on the Energy Conservation Act

Source: Calculated based on the distribution of housing stock by performance according to the MLIT survey, reflecting the number of renovations according to the Housing and Land Survey and the estimated number of newly constructed housing units by performance based on business operator's questionnaire, etc. (FY2019).

Future Policies for Building Energy Conservation in Japan

- For energy-saving measures on housing and buildings, the Building Energy Efficiency Act was established in 2015 to achieve the reduction target based on the Paris Agreement. The Act was revised in 2019 and the measures to achieve the target had been sequentially strengthened.
- Since April this year, we have been considering the direction of strengthening energy-saving measures in the housing and building sectors. We have provided a roadmap for strengthening measures based on this consideration. The new "Plan for Global Warming Countermeasures" also includes the following:

- **Strengthen the Building Energy Efficiency Act**
  - ✓ Mandatory compliance with the energy efficiency standards for all the newly constructed buildings, including residential buildings, by FY2025.
  - ✓ Gradual upgrade of the energy efficiency standards to the level of ZEH/ZEB standards by FY2030 at the latest.
  - ✓ Strengthen the indication of the energy-saving performance of residential and non-residential buildings when they are sold or leased.
  - ✓ Other measures, including those for existing buildings?

- **Promote introduction of renewable energy (by financial incentives, etc.)**
  - ✓ Install solar power generation equipment for 60% of newly constructed detached houses by FY2030. (The target is set by the new "Plan for Global Warming Countermeasures")


ありがとうございました！
Thank you very much!
Merci beaucoup!
Muchas gracias!
Muito obrigado!
・・・・・・・
Nagato City Hall

EBC Building Energy Codes Working Group

EBC
Energy in Buildings and Communities Programme

David Nemtzow (U.S. Department of Energy and BECWG Chair) and BECWG Team

IEA EBC Technology Collaboration Programme Webinar in "Virtual Japan"

9 November 2021

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Contents

EBC
Energy in Buildings and Communities Programme

1. BECWG overview and opportunities to collaborate
2. Webinars and reports
3. Release of report on practices for codes compliance
4. Highlights from BECWG Annual Symposium
   - National roadmaps that incorporate building energy codes
   - Codes to reduce carbon emissions

2

BECWG overview and opportunities to collaborate

EBC
Energy in Buildings and Communities Programme

✓ **Chairs:** David Nemtzow, U.S. Department of Energy, and Michael Donn, Victoria University of Wellington, N.Z.

✓ **Operating Agent:** Meredydd Evans, U.S. Pacific Northwest National Laboratory. Team: Alison Delgado, PNNL; Jack Mayernik, NREL; Jeremy Williams, US DOE

✓ 15 member countries – AU, BR, CA, CN, IN, IE, IT, JP, NZ, PT, SG, SE, TR, GB, US – as well as ASHRAE and International Code Council.

We welcome new members! Feel free to participate in our webinars and get latest news. We would also love to **learn about codes in your country.** To join our mailing list e-mail: Alison.Delgado@pnnl.gov

Activity 1: Exchange on building energy code practices

- Webinars (~4/year), meetings, annual building energy code symposium

Activity 2: Comparative Analysis

- Reports on topics of shared interest (2 papers/year):
  - Codes to reduce carbon (embodied carbon)
  - New technology integration in codes (e.g., DER technologies)
  - Codes and climate resilience (e.g., extreme weather events and how buildings cope with these events)
  - Codes and regulations for data centers
- Activity 3: Dissemination
  - Newsletters, publishing results and lessons, outreach and dialog (Annex 80 resilient cooling, new EE Hub) feedback on IPCC WGIII Buildings Chapter, posting key information on the website

BECWG Webinars and Reports

EBC

- 2 Reports this year:
  - Building Energy Codes in Existing Buildings
  - Codes Compliance Best Practices
- Recent Webinars (To date, 9 total):
  - "Balancing Costs and Benefits of Building Energy Codes: An Evaluation of Methodologies for Assessing Cost-Effectiveness" (April 2021)
  - "Building Energy Codes and Other Mandatory Policies Applied to Existing Buildings" (June 2021)
  - "Codes Around the Globe: A Cross-national Comparison of Building Energy Codes," 2021 National Energy Codes Conference Summer Seminar Series

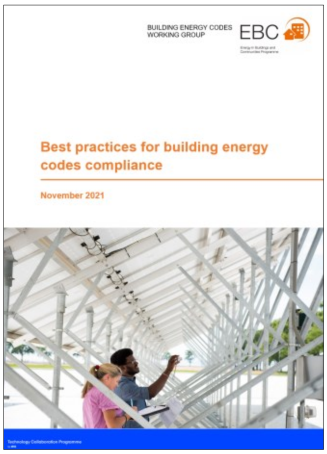
Past Webinar and Technical Presentations:

1. "Defining Future Direction" (May 2019)
2. "Cross National Comparison" (July 2019)
3. "Building Codes Implementation Practices" (September 2019)
4. "Building Energy Issues and the COVID-19 Response" (May 2020)
5. "Towards Net or Nearly Zero Energy Buildings" (May 2020)
6. "Energy Codes for Existing Buildings" (June 2020)
7. "Changing Business-as-usual: Building Code Virtual Diagnostics & Inspections" (September 2020)

* First Annual Symposium (Sept. 2020): 1) Integrating Research and Technology Breakthroughs in Codes, and 2) Adapting/Expanding Code Coverage in Places with Hot Climates

Report on Practices for Codes Compliance (Released 3 Nov.)

Energy in Buildings and Communities Programme



Report link: http://www.globalchange.umd.edu/technology-and-policy/building-energy-codes/iea-ebc-working-group/

- Based on a survey of 38 respondents across 11 countries
- Commonly faced issues related to enforcing code compliance centered around capacity building and training
- Report drew examples of notable practices from different jurisdictions. Major themes include:
  1. Pooling resources to minimize redundant efforts and maximize resources
  2. Requiring accreditations and trainings of inspectors and official government endorsement of third parties
  3. Utilizing a data driven approach to improve code implementation
  4. Utilizing remote inspections to check compliance when beneficial

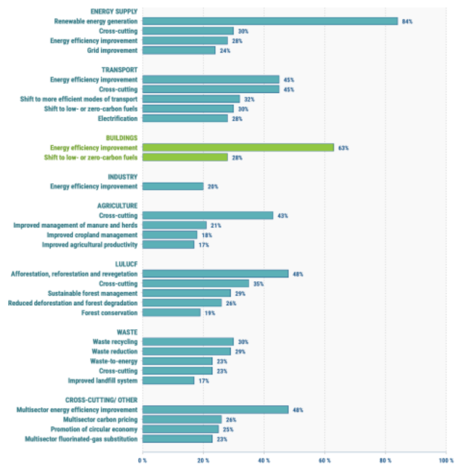
BECWG Annual Symposium, 3 Nov.

Energy in Buildings and Communities Programme

- Some business (new work plan, lots of activity this year)
- 2 technical panels:
  - Codes to Achieve Carbon Reductions
    - Presentations from China, Japan, and the United States
  - National Roadmaps that Incorporate Building Energy Codes
    - Presentations from Brazil, Canada, and a global roadmap for buildings and construction
- Some highlights of the Symposium follow in next 4 slides

Global assessment: Key actions for new buildings

Energy in Buildings and Communities Programme



Note. If a Party communicated more than one measure for one of the frequently indicated mitigation options, it was counted as one Party communicating measures for that option.
Source: UNFCCC 2021

	Current status (2020)	Short term (2030)	Medium term (2040)	Long term (2050)
Building energy codes	44% countries with voluntary or mandatory codes in some of the sector	**Mandatory for most sectors/jurisdictions** Some with voluntary near-zero codes	**Mandatory for almost all buildings** Many with near-zero carbon codes	**All countries and jurisdtictions with near-zero carbon codes**
Compliance with building energy codes	Some enforcement and monitoring of compliance by local jurisdictions	**Monitoring framework in place** About half of buildings compliant with code	**Most new buildings compliant with code** All buildings compliant	**All buildings compliant with code**
Participation of the informal sector	High share of construction in the informal sector	**Tools to enable easier compliance** Most countries monitor informal building	**Tools to enable easier compliance in all countries** Most of the informal buildng sector compliant	**Both informal and formal sector meeting minimum standards of regulation**
Building labelling	Few to half of buildings receiving voluntary labels or certifications	**Most new buildings with voluntary labels** Labelling is mandatory for most buildings	**Most new buildings with mandatory labels** Mandatory for all buildings	**All countries to make building labelling mandatory**
Labelling of building components	Little information on performance of materials or components	**Mandatory labelling for main components** Includes embodied carbon	**Mandatory labelling including carbon** Compliance in all countries	**Mandatory comprehensive labels for roof, wall and glazing materials**
Building passports	Very few have information collection	**About half with basic information** Includes materials	**Most with detailed information** Includes embodied carbon	**Widespread use of comprehensive passports for all new buildings**

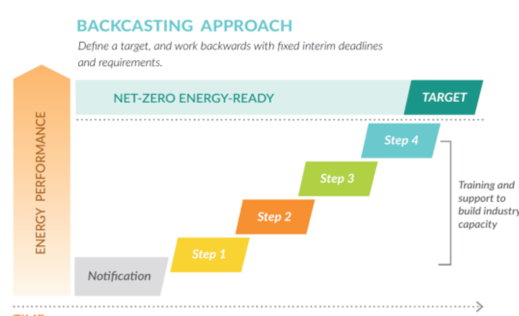
Speaker/source:
Prof. Ian Hamilton, Univ. College London Energy Institute

Building codes as critical action for new buildings
Source: IEA

Canada

Energy in Buildings and Communities Programme

- Growing emphasis on harmonization
  - "Adapt and Adopt" framework has created a patchwork of energy efficiency requirements
- Four major national research topics:
  - Carbon reductions
  - EUI vs. % better approaches
  - Embodied carbon
  - Existing buildings



ENERGY STEPCODE
BUILDING BEYOND THE STANDARD

Speaker/source:
Alex Ferguson, Natural Resources Canada

China: Analysis of mid- to long-term energy savings and carbon reduction potential

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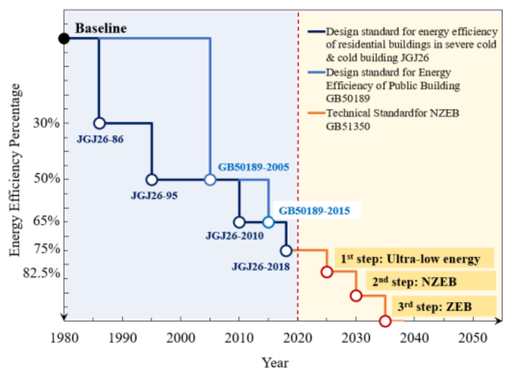
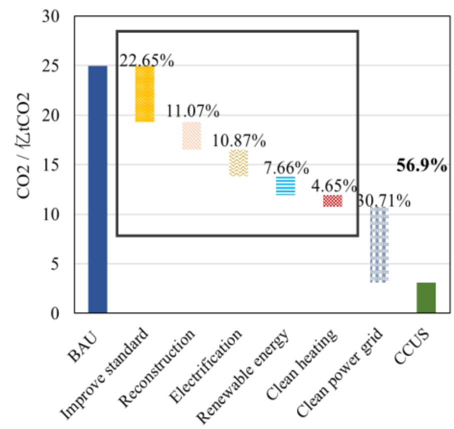
Code improvements over time



Projected carbon emission reductions



Speaker/source: Prof. Shicong Zhang, China Academy of Building Research

Zhang et.al, Building Science,2020. DOI:10.13614/j.cnki.11-1962/tu.2021.08.25

Japan: End-use energy targets in 2030 and distribution of Building Energy Index for total energy use

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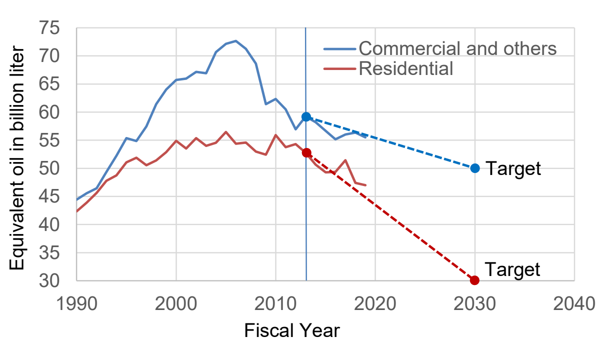
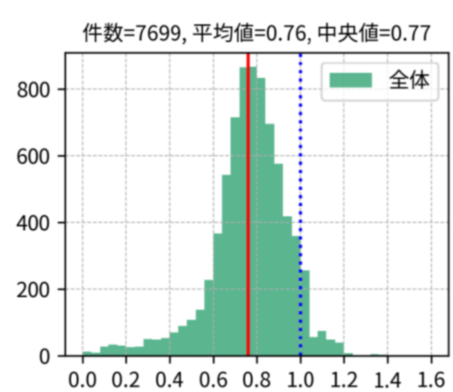


Transition of end-use energy and targets in FY2030



Building Energy Index, Climate Region 6 in FY19

Speaker/source:
Dr. Takao Sawachi, Building Technology Research Institute

Sources: [FY2019 Energy Supply and Demand Report (Revised Report) (meti.go.jp)](); [国土技術政策総合研究所　研究資料 (nilim.go.jp)]()

Thank you!

Link to Symposium presentations:
www.globalchange.umd.edu/technology-and-policy/building-energy-codes/ebc-symposium-2021/

Building Energy Codes Working Group:
www.iea-ebc.org/working-group/building-energy-codes

For more information:
Alison.Delgado@pnnl.gov

Mark your calendars:
IEA's new Energy Efficiency Hub will have a launch event 1 Dec.
www.energyefficiencyhub.org/launch-event
All are welcome!

Additional Slides

United States: Growing emphasis on deep decarbonization and net-zero codes

EBC

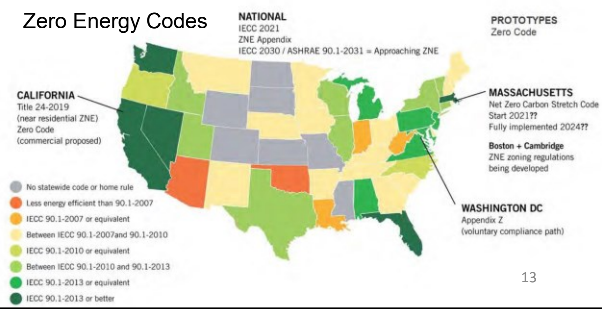
Energy in Buildings and

- No single approach to codes nationally
- Multiple states and cities have deep decarbonization goals
- Building Performance Standards in 6 Northeast states (e.g., 50% by 2030)
- Stretch codes in 10 states
- Net-zero codes or carbon neutrality zoning growing

Energy efficiency – prescriptive or performance path with prescriptive backstop

Electrification – no combustion (with exceptions), EV and demand response requirements

Renewable energy – achieve net zero, renewables demonstrating additionality, no weighting factors, on-site solar requirements



Source/speaker: Mr. Darren Port, Northeast Energy Efficiency Partnerships

13

Brazil: Transition from voluntary to mandatory performance standards

EBC

Energy in Buildings and Communities Programme

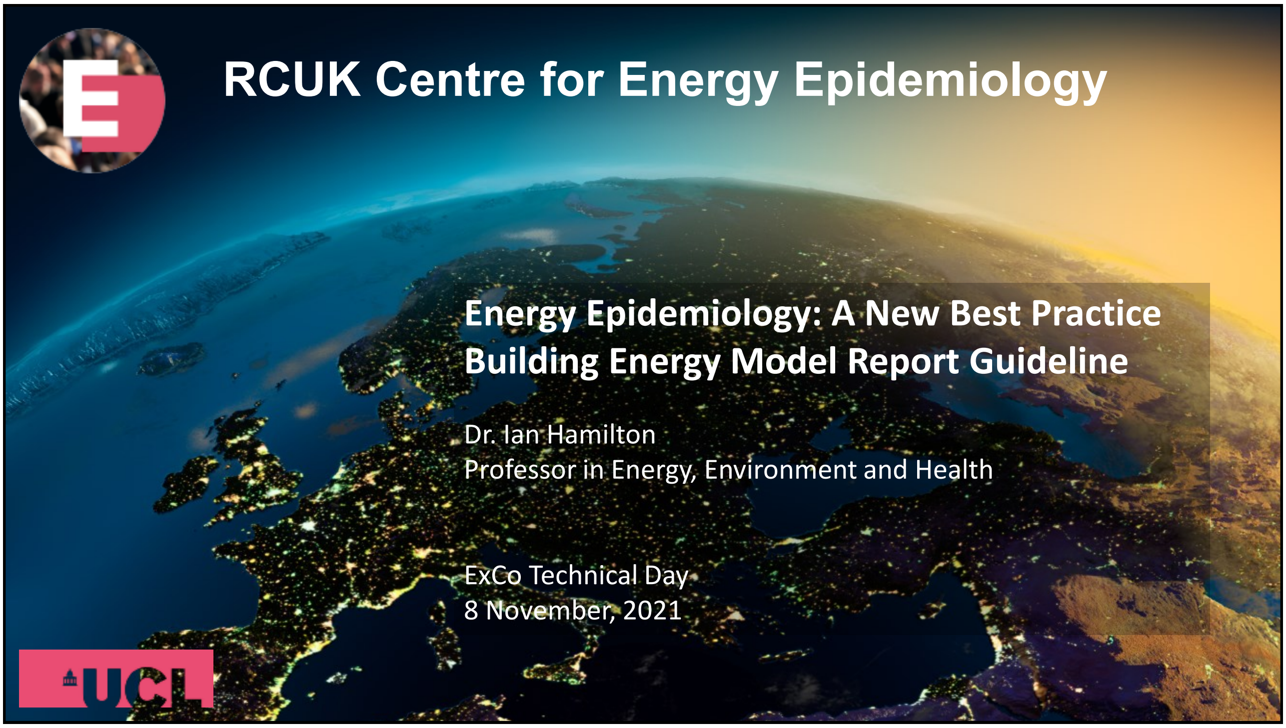
- Carrying out a regulatory impact analysis to make Brazil's energy performance labeling mandatory
- Building performance standards expected to also have a major role as they are adopted by the building industry
- Growing attention on embodied energy and CO2 in building materials with plans to be incorporated in the asset labeling in the future

New label incorporating renewable energy: Local energy generation from renewable energy sources. The system must be installed in the assessed building, or in the same area in which it is located. The systems also must be connected to the building's energy meter, or part of the building they serve.

Source/speaker: Prof. Roberto Lamberts, Federal University of Santa Catarina

14

14


RCUK Centre for Energy Epidemiology
Energy Epidemiology: A New Best Practice Building Energy Model Report Guideline
Dr. Ian Hamilton
Professor in Energy, Environment and Health
ExCo Technical Day
8 November, 2021
UCL

1

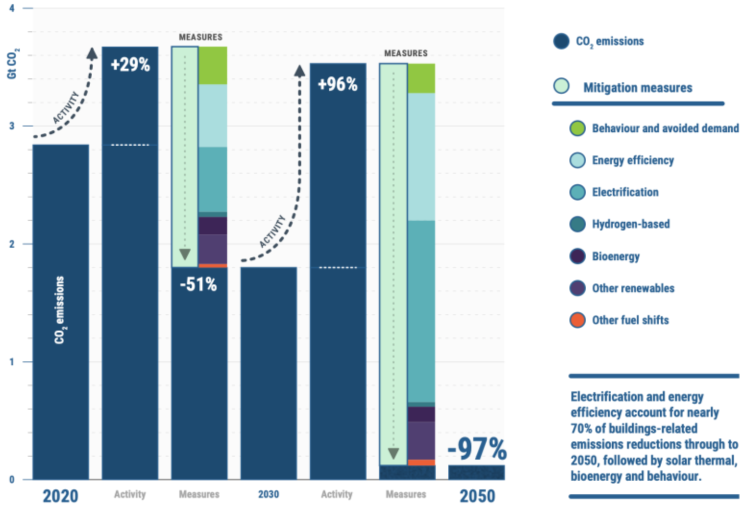

Shifting to a zero-carbon, efficient and resilient building stock

2

UCL Energy Institute

Buildings sector energy use continues to rise

Global direct CO_2 emission reductions by mitigation in building in the net zero energy scenario 2050



RCUK Centre for Energy Epidemiology

Notes: Activity = change in energy service demand related to rising population, increased floor area and income per capita. Behaviour = change in energy service demand from user decisions, e.g. changing heating temperatures. Avoided demand = change in energy service demand from technology developments, e.g. digitalisation.

Sources: IEA 2021c.

Energy

3

UCL Energy Institute

Why change our current research and practice?

Many countries have plans to **significantly reduce energy use** or **improve energy intensity** from the building stock.

Much of this reduction needs to come through more **energy efficient built environments**, which are responsible for almost 36% of global emissions.

Globally energy efficiency refurbishment is estimated to result in the **investments of trillions of dollars**.

RCUK Centre for Energy Epidemiology

Energy

4

UCL Energy Institute

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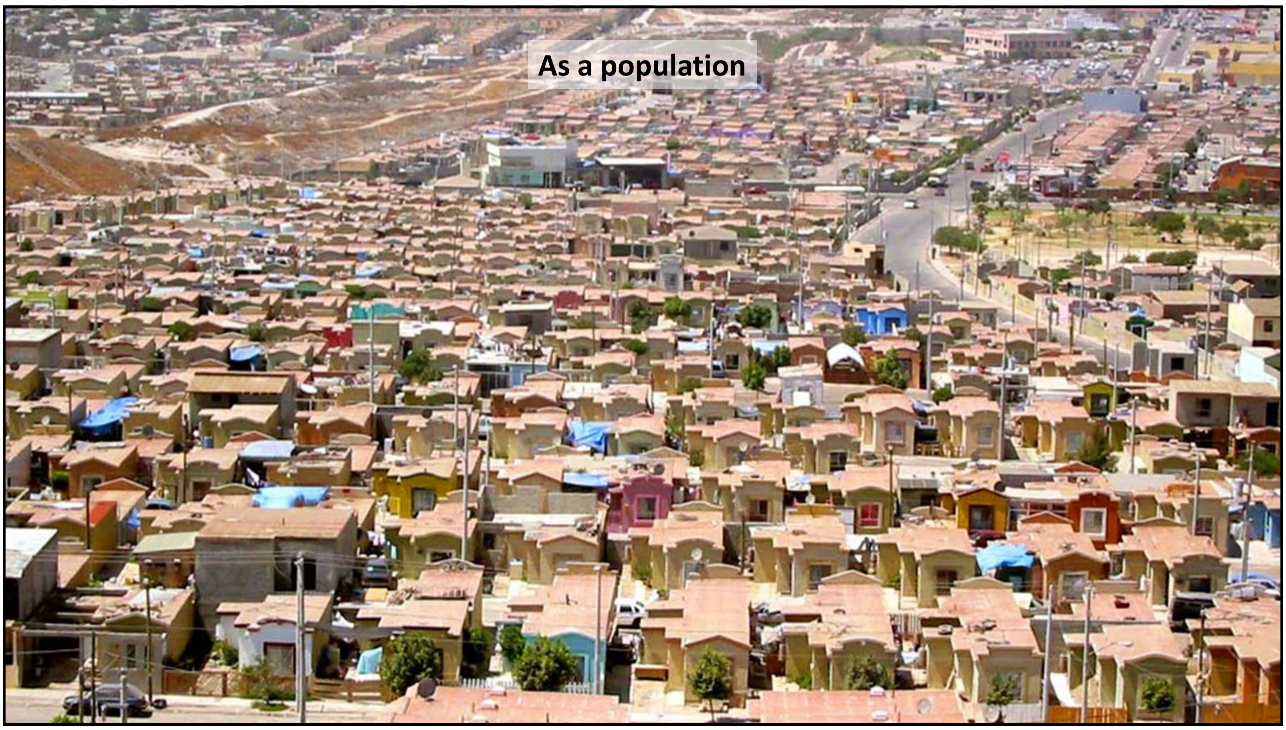
Studying the building… as a group

RCUK **Centre for Energy Epidemiology**

5



6

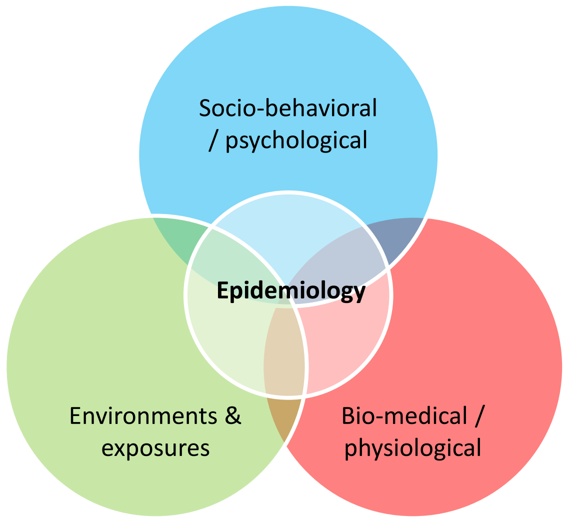
What is 'Epidemiology' and why is it relevant to energy use in buildings?

Epidemiology…

Is **data driven**, emphasis is on empirical evidence, distribution of a condition, understanding of underlying / driving factors

Focuses on understanding what is affecting the **spread and severity** of a condition

Uses research findings to inform **past/future practices and policy**

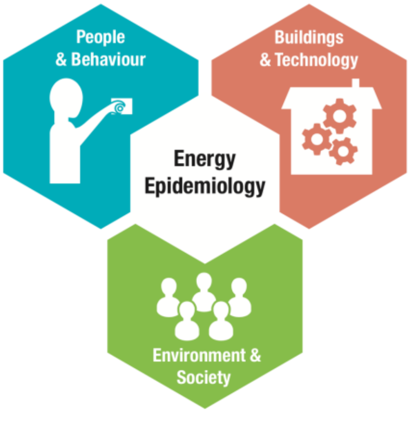


What is energy epidemiology?

epidemiology "epi" - **upon;** "demos" - **the people;** "ology" - **logic, study.** The study of what is upon the people – normally applied to the study of health.

energy epidemiology

The systematic study of the distributions and patterns of energy use and their causes or in luences in populations.



How would the research landscape change, if decarbonizing the building stock was treated like a health risk?

Framework for **interdisciplinary** research

Large-scale **population studies** on the distributions of *prevalence and incidence,* and identifying and understanding the factors affecting theses distributions, using **empirical data**!

Have established data collection **protocols**, analysis, and archiving as a shared resource, and place detailed studies in context.

Protocols for **feedback of findings** (e.g. failure rates, adverse outcomes, unintended consequences) and **systematic reviews** of evidence

Emphasis on **research translation and engagement** with policymakers and industry as part on an on-going progressive research programme.

9

10

How can we better understand building stock models?

Building stock energy models (BSMs) offer a tool to assess the energy demand and environmental impact of building stocks, and can demonstrate and evaluate pathways for reducing their energy demand and respective GHG emissions.

The problem:
The heterogeneity of BSMs, together with a lack of consistency in the description and reporting of the models often hinders the understanding of the model, impeding an accurate interpretation and/or comparison of the results.

The proposal:
Annex 70 have developed reporting guideline in order to improve reporting practices in the field of building stock energy modelling.

How can we better understand building stock models?

Topic	Subtopic
Overview	Aim and scope
	Modelling ap- proach
	System boundary
	Spatio-temporal resolution
Model Components	Building stock
	People Environment
	Energy
	Costs Dynamics
	Other aspects
Input and outputs	Data sources
	Data processing
	Key assumptions

Topic	Subtopic
Quality assurance	Calibration
	Validation
	Limitations
	Uncertainty
	Sensitivity
Additional information	Implementation Access
	Funding and contributors
	Areas of application
	Key references

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Building Stock Model reporting guidelines

Detailed descriptions of the model

Topic	Subtopic	Guiding questions
Overview	Aim and scope	What is the overall aim and scope of the model? What are the main use cases addressed?
	Modelling approach	What is the general modelling approach and how is it structured? What are the main model parts and components included in the model and how do they relate to each other? What are the key steps in the modelling workflow?
	System boundary	What are the system boundaries (temporal, geographical, building types, energy services, economic sectors, etc.) of the model?
	Spatio-temporal resolution	What is the spatio-temporal resolution of the model?

Model topics

Key model features

RCUK Centre for Energy Epidemiology

Energy

13

14

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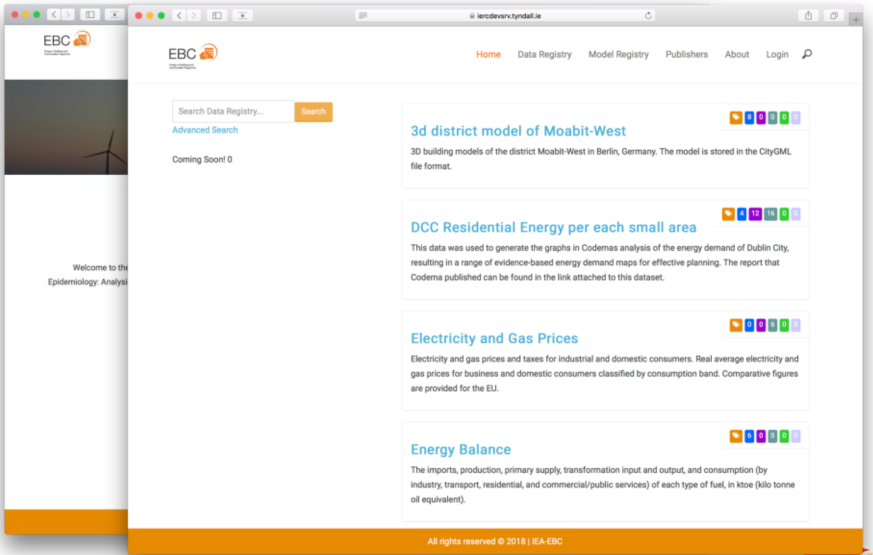
How can we better identify building stock data?

Registry for Building Stock and Energy Data provides a tool for identifying and knowing what data is available around the world among Annex 70 member countries.

The data registry contains information on over 1000 datasets and will be launched in 2022.



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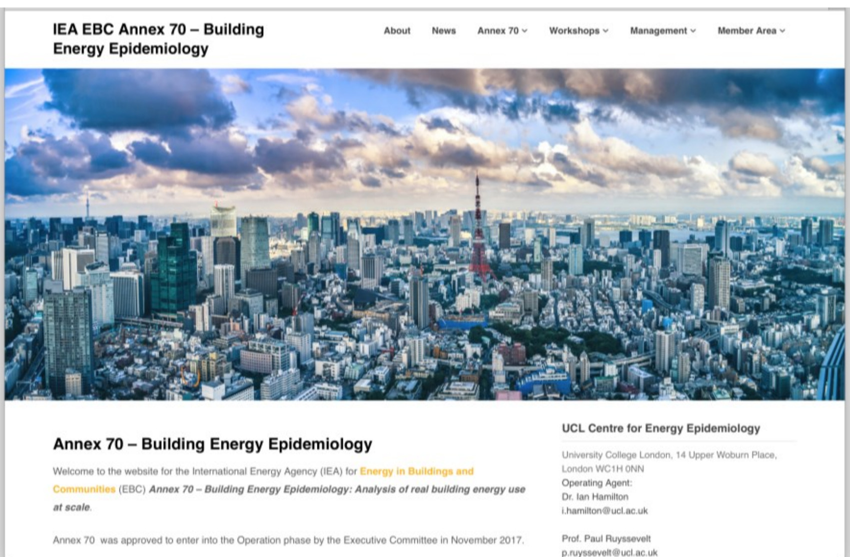
THANK YOU



Ian Hamilton
Professor in Energy, Environment and Health
Operating Agent for IEA EBC Annex 70

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University College London
i.hamilton@ucl.ac.uk

14 Upper Woburn Place
London, WC1H 0NN

RCUK **Centre for Energy Epidemiology**

Energy

16

TAKAGUCHI LABORATORY

WASEDA UNIVERSITY
DEPARTMENT
OF
ARCHITECTURE

Data Collection and Use in Japan
EBC Annex70

Professor, Dr. Hiroto TAKAGUCHI
Waseda University

Real Recorded Database in Japan

Residential

- Family Budget Survey since1946 (Sample size 9000)
- Residential CO2 Survey Since 2017 (Sample size 13000)
- HEMS data from subsidized projects
- Google Nest Amazon Echo Smart Home Kit Family

Yearly — Monthly — Daily — Hourly — Minutes

National Survey — Biased & Occasionally

Commercial

- Energy Conservation Law Periodic report
- Energy Consumption statistics Survey
- • The Energy Conservation Center
  • The Building-Energy Manager's Association
  • Building Owners and Managers Association
  • Tokyo Metropolitan Gov. Cap & Trade report
- BEMS data from subsidized projects

Energy Consumption per company, Not per building

DECC（2007－2018）

Overview of DECC

DECC is "Data-base for Energy Consumption of Commercial buildings"

- In Japan, there was no database with statistical significance on the environmental data for non-residential building.
- DECC project was started to investigate them in Japan and build a database as a collaborative work with more than 30 universities.

◆DECC Committee
- 2007－2018

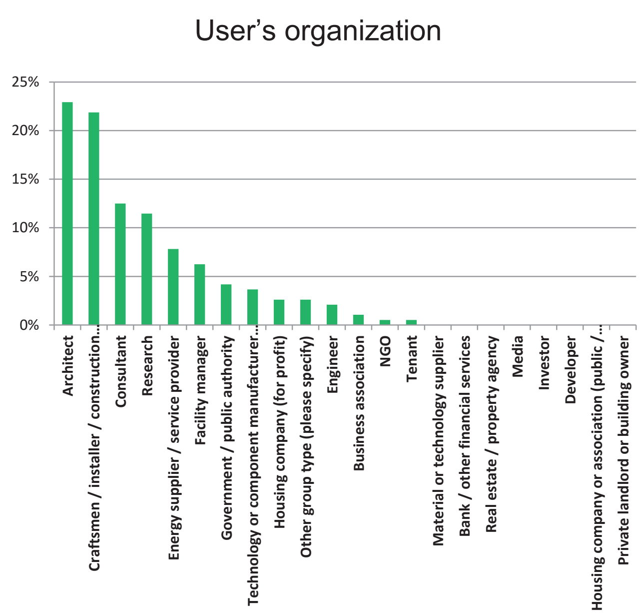
◆Data collection method
- Questionnaire by mail (Total 44000 data)

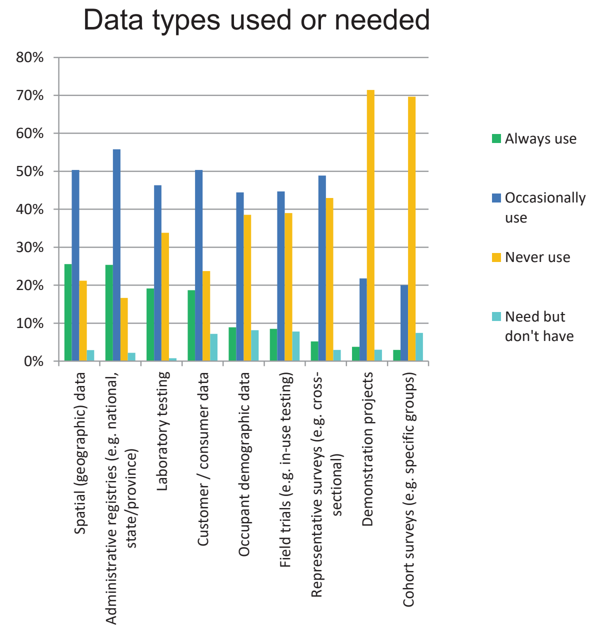
◆Goal of the Project
- Maintain annual, monthly, and hourly data as a database
- The database should be published not only statistically processed data but also anonymized raw data so that users can freely process it according to their purpose → Open data, big data
- Data such as building information, equipment information, and usage status should be also collected at the same time to contribute the analysis of energy consumption structure.
- Ensuring statistical usefulness for the average value of the basic unit
- Not only the average value but also the basic statistical values such as variance and so on should be published.

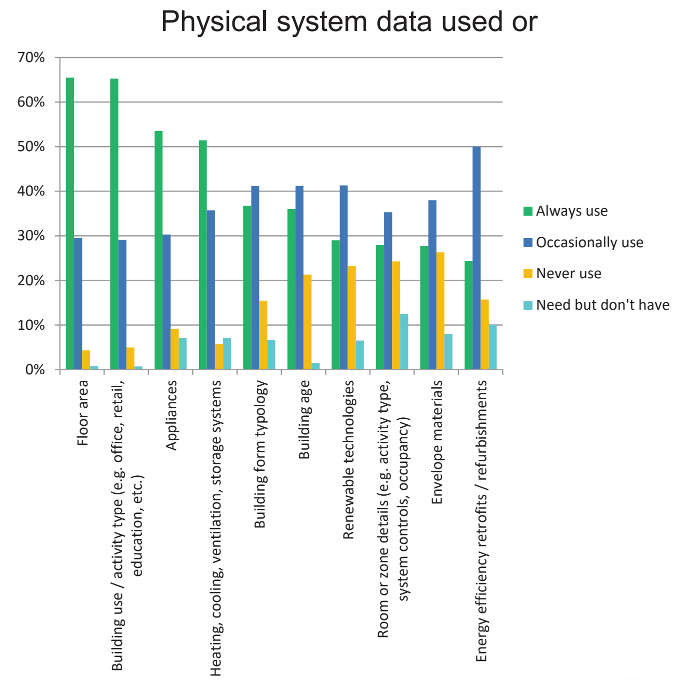
https://www.jsbc.or.jp/decc/

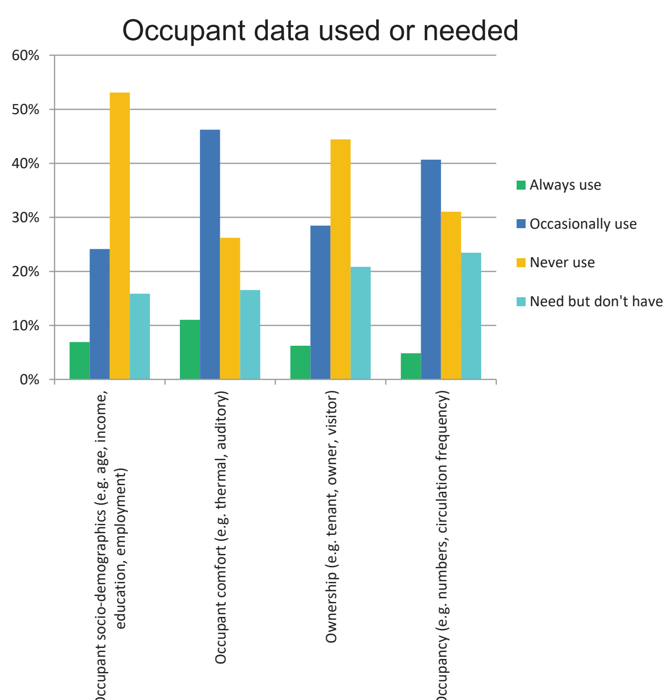
Who uses these data in Japan (Survey on 2018)

Part of Subtask A, Annex70









Who are the actors or organizations that could help address your organization's unmet data needs and through what mechanisms?

- Disclosure of data collected by the government
- Census by the Ministry of Land, Infrastructure and Transport
- Volunteer organization's collection
- Collection of BEMS data
- Data disclosure by energy company, like Green button
- Legislation design to limit confidentiality

Building Energy Efficiency Act in Japan, 2016

＜Project owner＞

- Building confirmation application
- Submission of plan to ensure energy efficiency performance

Building Permission

Review of conformity to energy-efficiency standards

Conformity Review Report

Web Program

Confirmation certificate

Start construction

Procedures to modify plan (if necessary)

Complete construction/Apply for final inspection

Final inspection

Inspection certificate

Operation

Primary energy consumption amount
= air-conditioning system
+ ventilation system
+ lighting system
+ hot water supply
+ elevator primary
+ other (Plug load)
- PV and cogeneration system

http://www.mlit.go.jp/common/001178846.pdf
（Translated）

Discussion

- For housing, monthly actual energy consumption data is being accumulated.
- At this moment, there is no comprehensive database for commercial buildings (DECC is dormant)
- BEMS and HEMS data are being accumulated as an obligation of subsidized projects.
- There is no common protocol of measurement data for BEMS and HEMS, so individual analysis work is necessary to use.
- The spread of smart meters has begun to progress.
- Efficient data collection method using smart meter is expected.

Thank you very much

Energy in Buildings and Communities Programme

IEA-EBC ANNEX 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications.

Bjarne W. Olesen

Center for Indeklima og Energi

Department of Civil Engineering

Technical University of Denmark

ANNEX STRUCTURE
Operation Agents

- Dr. Bjarne W. Olesen, Technical University of Denmark.
- Dr. Pawel Wargocki, Technical University of Denmark.

- PREPARATION PHASE 01-07-2018 TO 30-06-2019
- WORKING PHASE 01-07-2019 TO 30-06-2023
- REPORTING PHASE 01-07-2012 TO 30-06-2024

ANNEX STRUCTURE

- Subtask A: Energy benefits using gas phase air cleaning
  - Subtask leader: Alireza Afshari, Denmark
  - Co-leader: *Sasan Sadrizadeh* , Sweden
- Subtask B: How to partly substitute ventilation by air cleaning
  - Subtask leader: Pawel Wargocki, Denmark
  - Co-leader: Shin-Ichi Tanabe , Japan
- Subtask C: Selection and testing standards for air cleaners
  - Subtask leader: Paolo Tronville, Italy
  - Co-leader: Jinhan Mo, China
- Subtask D: Performance modelling and long-term field validation of gas phase air cleaning technologies
  - Subtask leader: Karel Kabele, Czech
  - Co-leader: Jensen Chang , US

Concept for calculation of design ventilation rate
ISO CEN ASHRAE

People Component

Building Component

Breathing Zone
Outdoor Airflow

$$V_{bz} = R_p P_z + R_a A_z$$

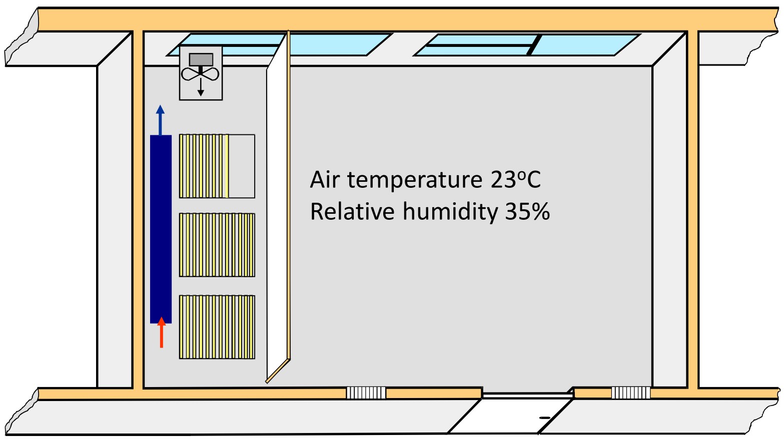
Minimum l/s/Person

Number of People

Building Area

Minimum l/s/m²

Experimental setup



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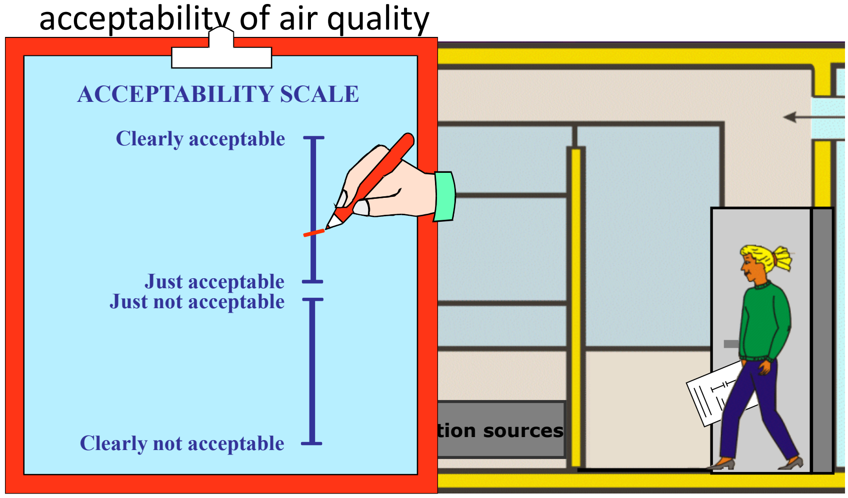
Sensory measurements

- Panel of 50 untrained subjects assessed acceptability of air quality



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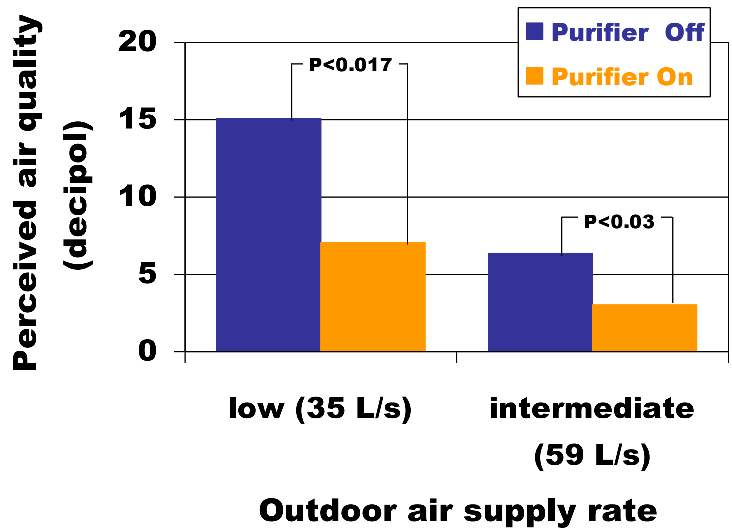
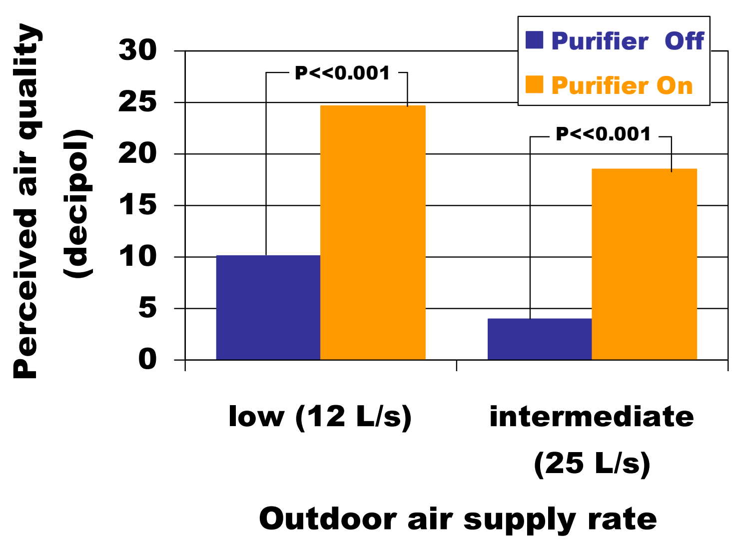
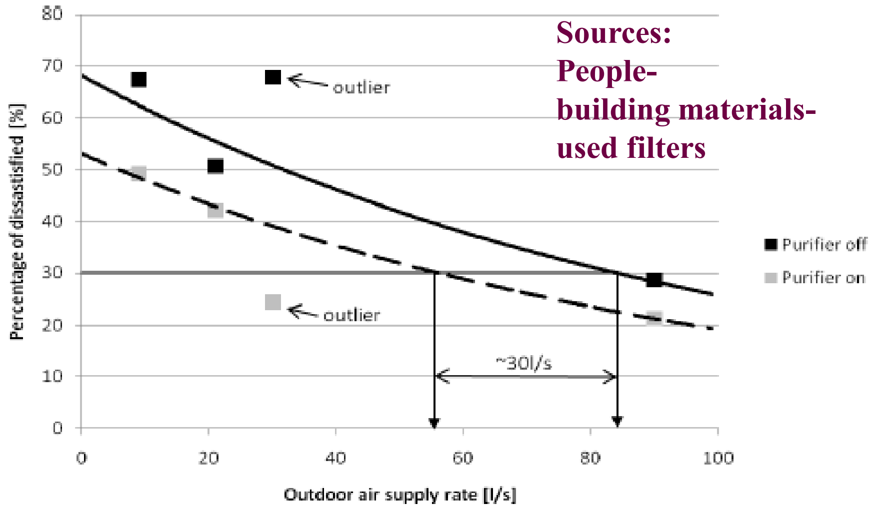
Results: Bldg mat, PCs, filters



Results: Human bioeffluents



Effect of air cleaning on perceived Air Quality



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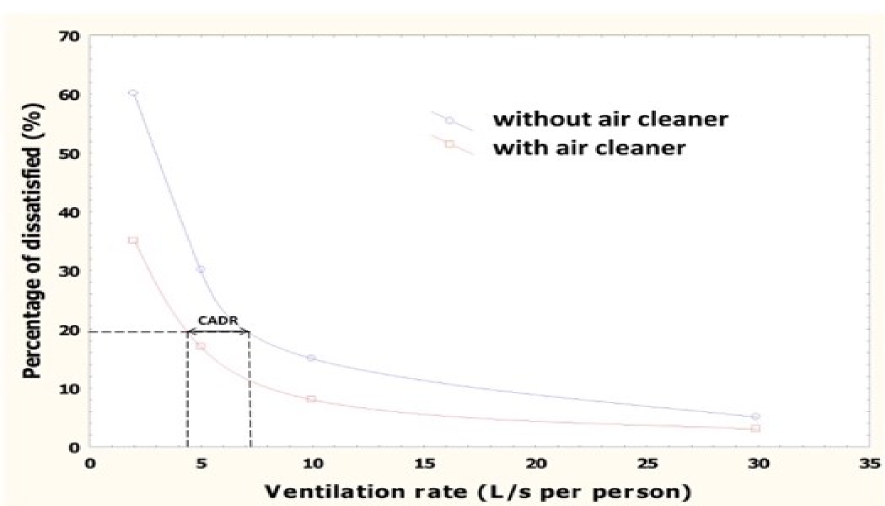
Clean Air Delivery rate per person



10

• ISO 10121:2014 "Test method for assessing the performance of gas-phase air cleaning media and devices for general ventilation

INTERNATIONAL STANDARD **ISO 10121-1**

First edition
2014-04-15

Test method for assessing the performance of gas-phase air cleaning media and devices for general ventilation —

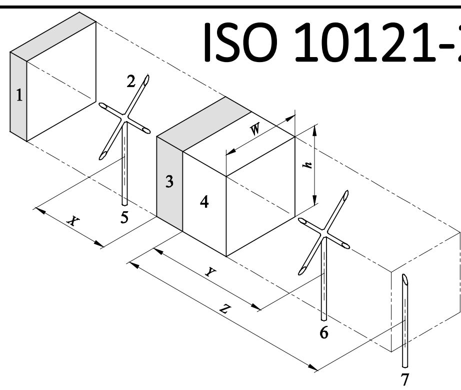
Part 1:
Gas-phase air cleaning media

INTERNATIONAL STANDARD **ISO/FDIS 10121-2**

Test methods for assessing the performance of gas-phase air cleaning media and devices for general ventilation —

Part 2:
Gas-phase air cleaning devices (GPACD)

ISO 10121-2:2014



Key

1 diffusor and Δp device
2 sampling points – should be of "fork" type or similar with multiple inlet points to make a compounded sample over the whole cross section
3 GPACD under test
4 GPACD section of test duct
5 upstream sampling point for T_U, RH_U, p_U and C_U at X mm before the GPACD
6 Downstream sampling point for T_D, RH_D, p_D and C_D at Y mm after the GPACD
7 Q, air flow rate sampling point at Z mm after the GPACD
W internal width of the test duct along the GPACD section, 3+4
h internal height of the test duct along the GPACD section, 3+4

Figure 1 — Normative section of test stand showing ducting, measurement parameters and sampling points

This part of ISO 10121 aims to provide an objective test method to estimate the performance of any full size gas filtration device (GPACD) for general filtration regardless of media or technique used in the device.
To ensure objectivity for test equipment suppliers, no specific design of the test apparatus is specified
This part of ISO 10121 can also be used with technologies such as scrubbers, absorbers, non-sorptive devices or packed columns as long as they fit into the test apparatus, can be meaningfully judged by the test method and are intended for general ventilation applications, both residential and non residential.

Table 2 — Challenge gases and concentrations for the simplified benchmark test

Challenge gas and concentration for the initial efficiency determination (6.3)								
Parameter	**Selected gas**	**Challenge level**	**Unit**	**Reference analysis technique**	**Face velocity [m/s]**	T_U **[°C]**	RH_U **[%]**	**Maximum permissible efficiency decay during test**[b]
Acid	SO_2[a]	450	ppb(v)	UV fluorescence[d]	2,5	23	50	5 %
Base	NH_3	450	ppb(v)	chemiluminescence[d]	2,5	23	50	5 %
VOC	toluene	5	ppm(v)	PID[d] or FID[d]	2,5	23	50	5 %
Challenge gas and concentration for the capacity determination (6.4)								
Parameter	**Selected gas**	**Challenge level**	**Unit**	**Reference analysis technique**	**Face velocity [m/s]**	T_U **[°C]**	RH_U **[%]**	**Minimum permissible efficiency decay after 12 h**[c]
Acid	SO_2[a]	9/90[c]	ppm(v)	UV fluorescence[d]	2,5	23	50	>10 %
Base	NH_3	9/90 [c]	ppm(v)	chemiluminescence[d]	2,5	23	50	>10 %
VOC	toluene	9/(90)[c]	ppm(v)	PID[d] or FID[d]	2,5	23	50	>10 %

[a] For other acid gases SO_2 may not be representative. In applications for H_2S, NO, NO_2, etc. it may be better to test with the gas in question.

[b] A test for initial efficiency should not decay during the test but this may be the case if the selected low concentration is well beyond challenge capacity of the filter. Therefore, a maximum permissible efficiency decay during the initial efficiecy test is given. A GPACD not filling this demand may still be tested according to 5.4.

[c] The lower or higher concentration is selected depending on filter type/ weight/ purpose/ data sheet. The lower concentration is preferred for toluene while the higher concentration may be needed for all gases to reach the minimum permissible efficiency decay after 12 h.

[d] The reference techniques are the ones preferred in this part of ISO 10121. However, other techniques may be used provided that the test supplier can show doccumented correlation versus the reference technique.

EXPRESSION OF PERFORMANCE

- Clean Air Delivery Rate (CADR)

$$\mathbf{CADR = \varepsilon_{PAQ} \cdot Q_{AP} \cdot (3{,}6/V)}$$

where:
$Q_{AP}\cdot$ is the air flow through the air cleaner, l/s;
V is the volume of the room, m^3.

Air Cleaning Efficiency

$$\mathbf{\varepsilon_{clean} = 100(C_U - C_D)/C_D}$$

where:
E_{clean} is the air cleaning efficiency;
C_U is the gas concentration before air cleaner;
C_D is the gas concentration after air cleaner.

$$\varepsilon_{PAQ} = Q_o / Q_{AP} \cdot (PAQ / PAQ_{AP} - 1) \cdot 100$$

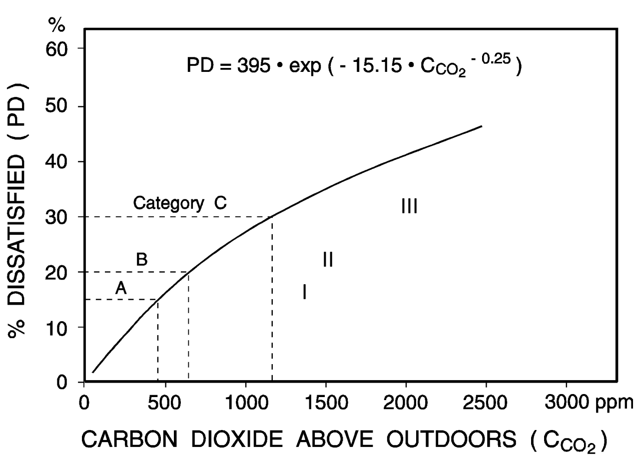
where:
ε_{PAQ} is the air cleaning efficiency for perceived air quality;
Q_o is the ventilation rate without air cleaner, l/s;
Q_{AP} is the ventilation rate with air cleaner, l/s;
PAQ is the perceived air quality without the air cleaner, decipol;
PAQ_{AP} is the perceived air quality without the air cleaner, decipol

- Higher Air Quality Category

EXPRESSION OF PERFORMANCE

- Reduced Energy Use
  - Heating/Cooling of Supply Air
  - Reduced energy for humidification and/or De-humidification
  - Fan Energy
  - Energy Use of Air Cleaner
  - Heat Recovery or not
- Noise level
  - Reduced air flow in AHU
  - Noise from air cleaner
- Draught level
  - Reduced air flow in occupied space
  - Draught from portable air cleaner

CO_2 as reference



$$Q_h = \frac{G_h}{C_{h,i} - C_{h,o}} \cdot \frac{1}{\varepsilon v}$$

where

Q_h is the ventilation rate required for dilution, in m^3 per second;

G_h is the generation rate of the substance, in micrograms per second;

$C_{h,i}$ is the guideline value of the substance, in micrograms per m^3;

$C_{h,o}$ is the concentration of the substance of the supply air, in micrograms per m^3;

ε_v is the ventilation effectiveness.

Issues

- International Standards for Ventilation (Indoor Air Quality) like EN16798-1, ISO17772-1 and ASHRAE 62.1 are mainly based on criteria for the Perceived Air Quality (PAQ), sometimes expressed as levels of CO_2 as a tracer for emission from occupants.
- If air cleaning is used, an equivalent level of air quality will be reached at higher CO_2 concentrations.
- It is also assumed that when ventilation is used for PAQ, the required ventilation will also dilute other substances like Radon, VOCs.
- The decreased ventilation rate when using gas phase air cleaning may not be sufficient.

ΔCO_2 levels considering a 30 % reduced ventilation rate due to air cleaners

Space type Single office	*Occupancy [m^2 per person]*	*Category*	*Derived from qtot*	
			Very low-polluting building	*Low-polluting building*
			Indoor CO_2 level above outdoor level ΔCO_2 *[ppm]*	
Without air cleaner	10	IEQ_I	370	278
		IEQ_{II}	**529**	**397**
		IEQ_{III}	926	694
		IEQ_{IV}	**1389** (1010)	**1010** (794)
With air cleaner	10	IEQ_I	529	397
		IEQ_{II}	**756**	**567**
		IEQ_{III}	**1323** (1029)	**992** (817)
		IEQ_{IV}	**1984** (1100)	**1443** (911)

Issues

- Today, gas phase air cleaners are tested based on a chemical measurement, which do not account for the influence on PAQ and human bio effluents as a source of pollution.
- Studies have shown that some gas phase air cleaning technologies will not work when humans are the source, and the evaluation is done by PAQ.
- There is a need for new test standards
- Testing with PAQ requires a measurement of subjective reactions
- Testing with human bio effluents as a source requires the use of humans as a source

Testing Issues

- If only a test with chemical measurements is done, should it be allowed to reduce the building component?
- How to standardise the building source?
- How to standardise the human bio effluent source?
- It is a relative measurement, which makes some of the issues less important
- A test method using PAQ is voluntary; but will give the industry a possibility to show that their air cleaner can improve the IAQ and the ventilation rate can be decreased.

IEA EBC Annex 78

Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaning products

Shin-ichi Tanabe, Prof. Dr.
President, Architectural Institute of Japan
Waseda University

1

WASEDA University

- **Indoor air — 16000**

Part 44: Test method for measuring perceived indoor air quality for use in testing the performance of gas phase air cleaners

(DIS voting stage)

2

ISO/TC 146/SC 6 Indoor Air

Scope of ISO/TC 146/SC 6

- Standardization of any matters within the scope of ISO/TC 146 dealing with **indoor air**
- Gases, particles, odours, micro-organisms, and emissions from building products and furnishings
- **Definition of the indoor environment**:

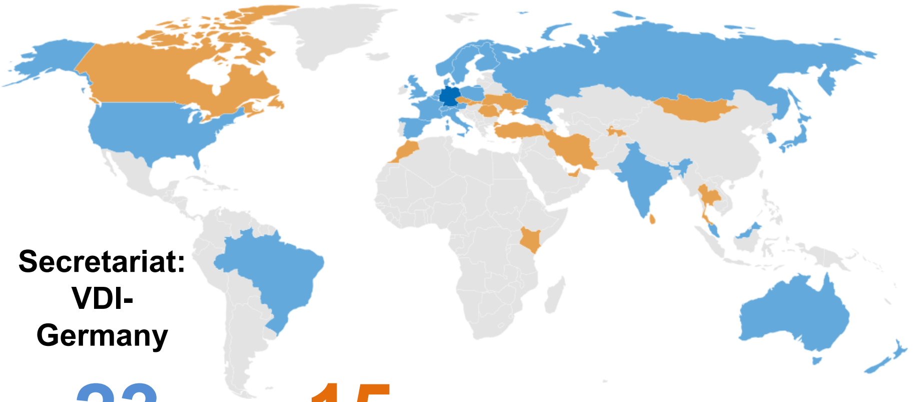
  Dwellings, having living rooms, bedrooms, DIY rooms, recreation rooms and cellars, kitchens and bathrooms;

  workrooms or work places in buildings which are not subject to health and safety inspections in regard to air pollutants (for example offices, sales premises);

  public buildings (for example hospitals, schools, kindergardens, sports halls, libraries, restaurants and bars, theatres, cinemas and other function rooms);

  cabins of vehicles

ISO/ TC 146/SC 6 – Member Countries



Secretariat: VDI-Germany

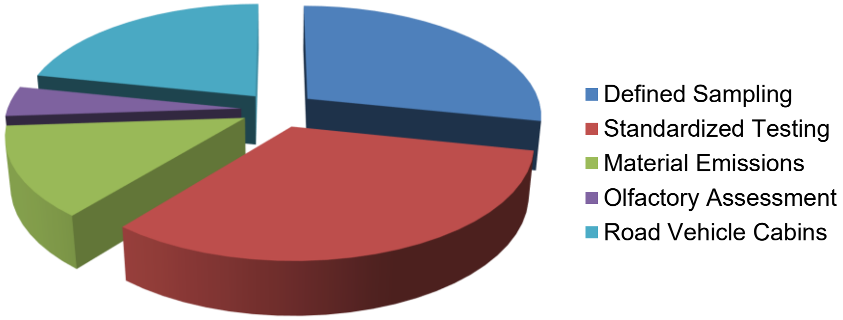
23 **Participating members**

15 **Observing members**

6 liaisons internal
1 liaison external

ISO Standards on Indoor Air Quality

Total Number: 53 (50 published)



VDI DIN

5

New Liaison

WASEDA University

✓ **Resolution 509 (2021)**

ISO/TC 146/SC 6 decides to start a liaison with IEC/TC 59 JWG 17 dealing with household and similar air treatment electrical appliances.

IEC: International Electrotechnical Commission

IEC/TC 59 JWG17: Household and similar air treatment electrical appliances (ISO TC142)

Department of Architecture, WASEDA University

6

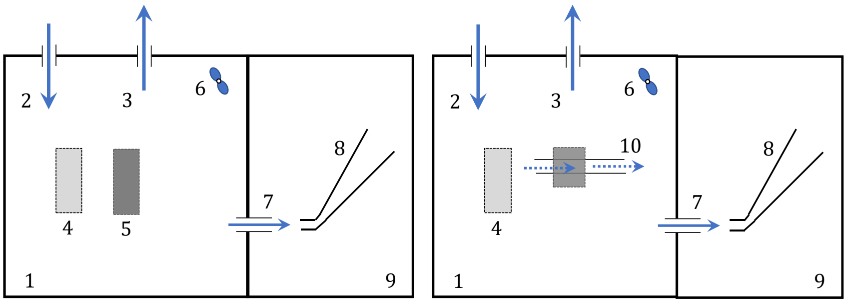
Scope (Draft)

WASEDA University

- ✓ This part of ISO 16000 specifies a general laboratory test method for **measuring perceived air quality** that is applied for assessing the performance of air cleaners for gas-phase pollutants.
- ✓ Perceived air quality is evaluated by human subjects (panels). **This method applies to gas phase air cleaners**, and can be performed in laboratories. Only gas-phase pollutants that can be sensed by human subjects are considered.
- ✓ This document is based on sensory test specified in **ISO 16000 28 (building products) and ISO 16000 30 (indoor air)**, and is harmonized with the standard for testing gas phase air cleaners that will be standardized by **ISO/TC 142(Cleaning equipment for air and other gases)**.

Test Chamber Method

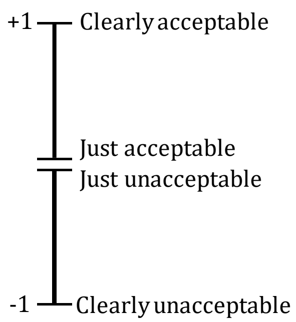
WASEDA University

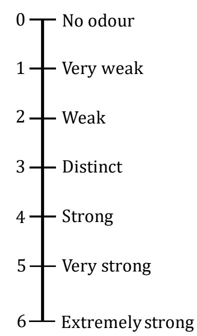


1. Test chamber/room
2. Clean and temperature/humidity conditioned air supply
3. Exhaust outlet
4. Odour emission source(s)
5. Air cleaner(s)
6. Mixing fan
7. Tube or duct
8. Sniffing device, complying with relevant specifications and requirements of ISO 16000-28.
9. Front/anterior space in which human panel enter
10. In duct air cleaner(s)

Acceptable scale
Perceived odour intensity with category scale

WASEDA University





Annex81: Data Driven Smart Buildings

Data Driven Smart Buildings

Stephen White (Operating Agent, CSIRO, Australia)

IEA Technology Collaboration Programme on Energy in Buildings and Communities Webinar
"Building Energy Efficiency and Indoor Air Quality"

9th November 2021, 12:00-15:00 UTC / GMT

Data-Driven Smart Buildings

Why are we interested?

- Poorly maintained and improperly controlled HVAC equipment wastes up to 30% energy
- HVAC offers a large untapped resource of flexible load that can support increased use of variable renewable electricity sources

  … and other bundled comfort and productivity services

Can 'digitalization' unlock energy savings and flexible demand?

FDD savings and costs snapshot

	Year 1	Year 2
Median savings	6%	**9%**
Median savings ($/sf/yr)	$0.17	**$0.24**

Costs	Per point	Per building	Per sq ft
Base software and installation (one-time cost)	$8	$12,500	$0.05
Annual software + MBCx service provider ($ per year)	$5	$3,503	$0.02

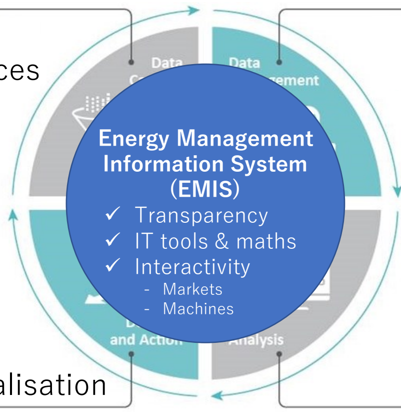
Many additional results on measures IDd, enablers, barriers, payback …

US DoE Smart Energy Analytics Campaign
- 104 organizations, 6500+ buildings
- ~2 year payback time

What is Digitalization/ Industry 4.0/ Smart-Building?

- Energy meter
- IoT sensors and devices
- BMS
- Geospatial

- Data federation
- Semantic data models
- Access controls



- Product dispatch
- Automated settlement
- Human interfaces & visualisation

✓ Model Predictive Control
✓ Fault Detection and Diagnosis
✓ Grid Interactive Buildings

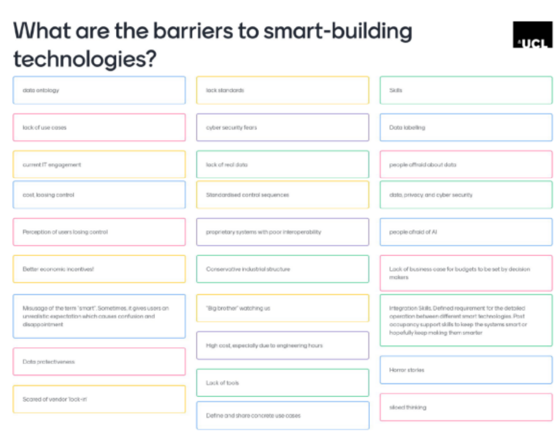
"Platform" for multi-stakeholder participation

Barriers to realising savings from digitalization

Data/System Integration Barriers
- Poor hardware/software interoperability
- Lack of standards for managing data
- Cyber security, privacy and data-leakage fears
- IT dept. engagement and conservative industry structure

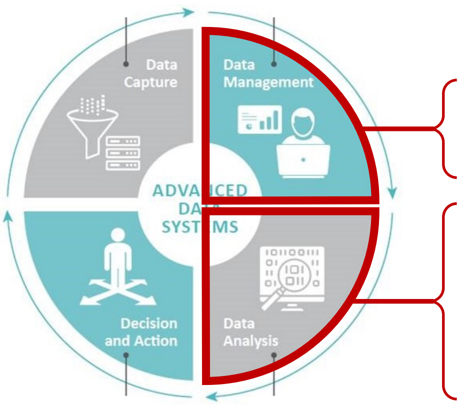
Skills Barriers
- Lack of system-integration skills
- Diverse hardware/software implementation practices

Commercial Barriers
- Commercial lock-in/ purchasing fears
- Siloed product offerings
- Lack of innovation/ narrow range of services
- Lack of clarity regarding the value for stakeholders



Poorly understood concept of a "digital-ready" building
Not packaged up as a clear "product" that anyone can buy or train for

Our role



- ✓ Community of practice: networking and knowledge sharing
- ✓ Support the development of data management standards & platforms
- ✓ Transparent software “Application” benchmarking
- ✓ Drive innovation and value in data-driven services
  - Data sandpits
  - Competitions

The Annex

Data-Driven Smart Buildings Annex

- **A. Open Data and Data Platforms** — Australia & Singapore
  - A1: Open Data Concepts and Data Governance
  - A2: Open Data Platforms
  - A3: Data Information Models
  - A4: Data Sets
  - A5: Open Data Platform Utilization
- **B. Model Predictive Control** — Canada & Norway
  - B1: Test cases
  - B2: Control-oriented modelling methods
  - B3: MPC Simulation and Evaluation
  - B4: MPC Implementation
  - B5: Roadmap for MPC
- **C. Applications and Services** — USA & Sweden
  - C1: Benchmarking algorithms
  - C2: Automated fault detection, diagnostics and re-commissioning
  - C3: Building2Grid
- **D. Case Studies and Business Models** — UK & Denmark
  - D1: Case studies
  - D2: Data-driven innovation strategies
  - D3: Dissemination

Competitions

What does success look like?

- Imagine if you could download energy efficiency tools like you download an "App"?
- Who would like to go first?

Annex81: Data Driven Smart Buildings

Japan's Activities and Challenges

Yasunori AKASHI (Professor, The University of Tokyo)

IEA Technology Collaboration Programme on Energy in Buildings and Communities Webinar
"Building Energy Efficiency and Indoor Air Quality"

9th November 2021, 12:00-15:00 UTC / GMT

Annex81: Data Driven Smart Buildings

Japan’s Activities and Challenges

Yasunori AKASHI (Professor, The University of Tokyo)

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Participation in Annex81

■Three main motivations for Japan’s participation
- Urgent issue for decarbonization of buildings
- Importance of data driven operation in existing buildings
- Deeply related to the creation of new value and business in the field of building services

■Domestic committee for Annex 81
- 13 companies, 1 NPO, 2 universities (20 people)

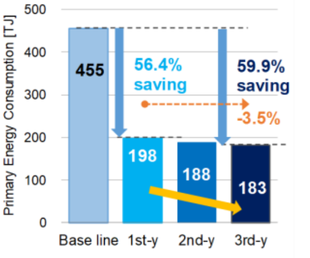
	Industry/Univ., NPO	Affiliation	Number of People
Chairperson & Secretaries	University	The University of Tokyo, Tokyo Denki University	3
	NPO	Building Services Commissioning Association	1
Members	Design	NIKKEN SEKKEI, NTT Facilities, P.T.Morimura & Associates	4
	Construction	Dai-Dan, Kyudenko, Shinryo, Takasago Thermal Engineering, TONETS	7
	HVAC Manufacturer	DAIKIN	1
	Automatic control	Azbil	1
	Energy	Kansai Electric Power, OSAKA GAS, Tokyo Electric Power	3

Example 1 from Japan #1

■In the meetings of Annex81, we provided two examples in Japan on data-driven operations in building systems.

■Example 1: Commissioning(Cx) of Kyoto Station Building

- A complex building (station, hotel, department store, theater, etc.) with the total floor of about 23,600m2 (built in 1997)
- Fully applied the Cx process to the large-scale water-side system retrofit project (2010-2019)
- First case of business-based Cx implementation with Cx fees in Japan
- The energy saving of 60% targetd in the OPR has been achieved
  - 8% reduction has been achieved using the measured data of EMS in the FPT and operational optimization during the first three years after the completion



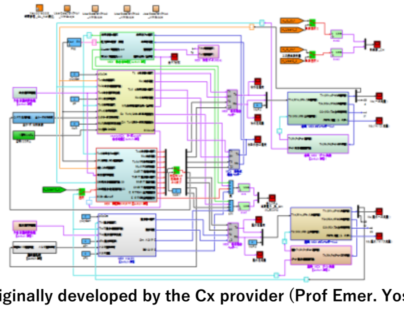
Annual primary energy consumption

Award
- The Energy Conservation Grand Prize, METI Minister Award (Grand prix) 2020
- ASHRAE Technology Award 2021, First Place

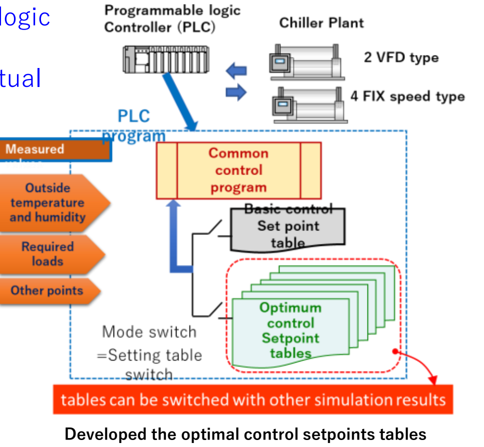
Example 1 from Japan #2

■For the aspects of simulation and data-driven operation in this example,

- Development of the detailed simulation with automatic controls
- Development of the applications for the optimal control logic of the chillers using the simulation
- These applications and the data of EMS optimize the actual operation, resulting in the additional 8% energy saving.



Simulation originally developed by the Cx provider (Prof Emer. Yoshida, Kyoto Univ.)

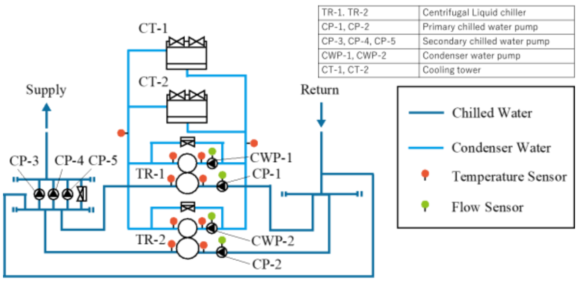


Developed the optimal control setpoints tables

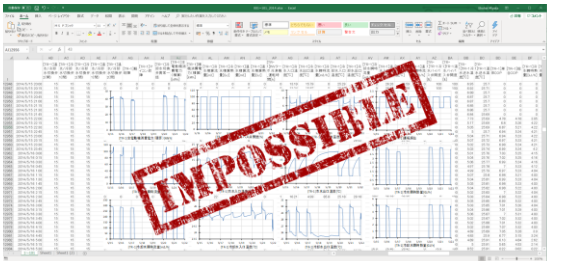
Example 2 from Japan #1

■Example 2: Automated Fault Detection and Diagnosis (AFDD) in a HVAC water-side system of a semiconductor plant

- Conventional manual FDD and optimization are extremely inefficient, so they are rarely implemented, including in general building systems.
  - Since it is not possible to know in advance which faults are occurring, it is necessary to check all data in the end.
- However, some reports indicate that the FDD and operational optimization can reduce building energy consumption of 10-30%.



Schematic of HVAC water-side system

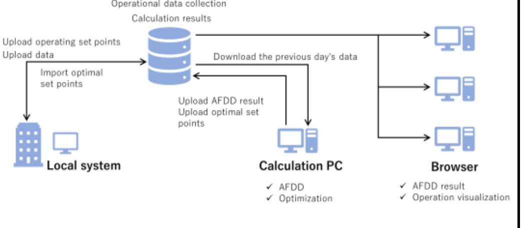


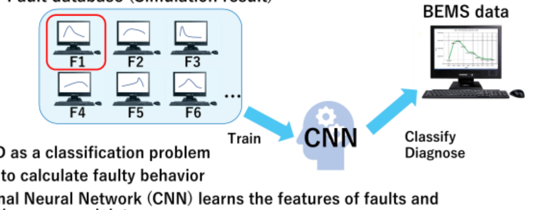
Conventional manual FDD and optimization

Example 2 from Japan #2

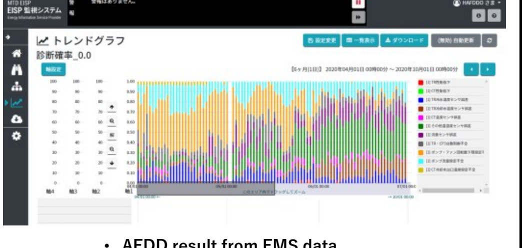
■For the aspects of simulation and data-driven operation in this example,

- Development of the detailed simulation with automatic controls
- Development of the applications for AFDD using the simulation and machine learning
- Now, these applications are being demonstrated in the actual system to verify the effectiveness of the AFDD method.





Regard AFDD as a classification problem
- Simulation to calculate faulty behavior
- Convolutional Neural Network (CNN) learns the features of faults and diagnoses the measured data.
- AFDD results was verified by manual data analysis.

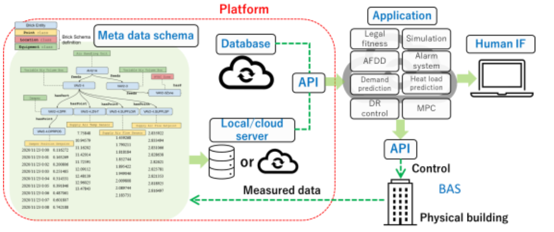


- AFDD result from EMS data
- Demonstration system is running everyday

Shohei Miyata, Jongyeon Lim, Yasunori Akashi, Yasuhiro Kuwahara & Katsuhiko Tanaka (2020) Fault detection and diagnosis for heat source system using convolutional neural network with imaged faulty behavior data, Science and Technology for the Built Environment, 26:1, 52-60, DOI: 10.1080/23744731.2019.1651619

What we learned from the examples/Annex81 for Japan

- Data and applications can improve building energy performance in the operation.
- Various data and applications need to be utilized in buildings on a plug-and-play basis. It will upgrade building energy performance according to the building usage.
- In Japan, there is very little use of such data and applications. The construction industry in Japan is just at the tipping point.
  - An open platform is still not used in most buildings.
  - A Cloud EMS is used in each example, but it does not have mechanism to efficiently manage large amounts of data such as a Graph DB.
- Important points for promoting decarbonization of existing buildings
  - Developing data-driven system that can be installed relatively easily during retrofit or normal time,
  - Making building owners and occupants understand the value of installing the technologies with the value of data-driven smartification,
  - Human resources for system integration and application development



Data platform, meta data schema, applications for data-driven operation