EEDAL‘24, Kitakyushu, Japan, 7-9 October 2024

Common goals, but differentiated pathways – findings from a comparative study of policies for energy efficiency in residential buildings in Germany/EU and Japan

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Overview

1. The GJETC
2. Building energy use in comparison
3. Policies and measures in comparison
4. Potential for cooperation and further research needs

The Wuppertal Institute for Climate, Environment and Energy

Global think tank for sustainable development, owned by federal state of NRW

Founded: 1991

Around 300 employees,

4 Research Divisions:

- Future Energy and Industry Systems
- Energy, Transport and Climate Policy
- Sustainable Production and Consumption
- Circular Economy

GJETC at a Glance

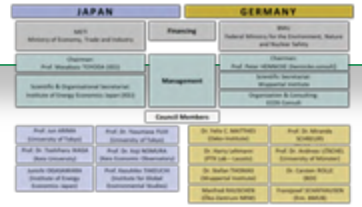
A role model for international cooperation on climate and environmental issues since 2016
Wuppertal Institute/ECOS and Institute of Energy Economics, Japan

Concept and Functions

Innovation Lab

Stakeholder Dialogues with Young Scientists

Platform for scientific exchange of the next generation on key issues



Consulting Body

Outreach Events

Studies + Topical Papers

Science-based Input and Consulting for Policymakers

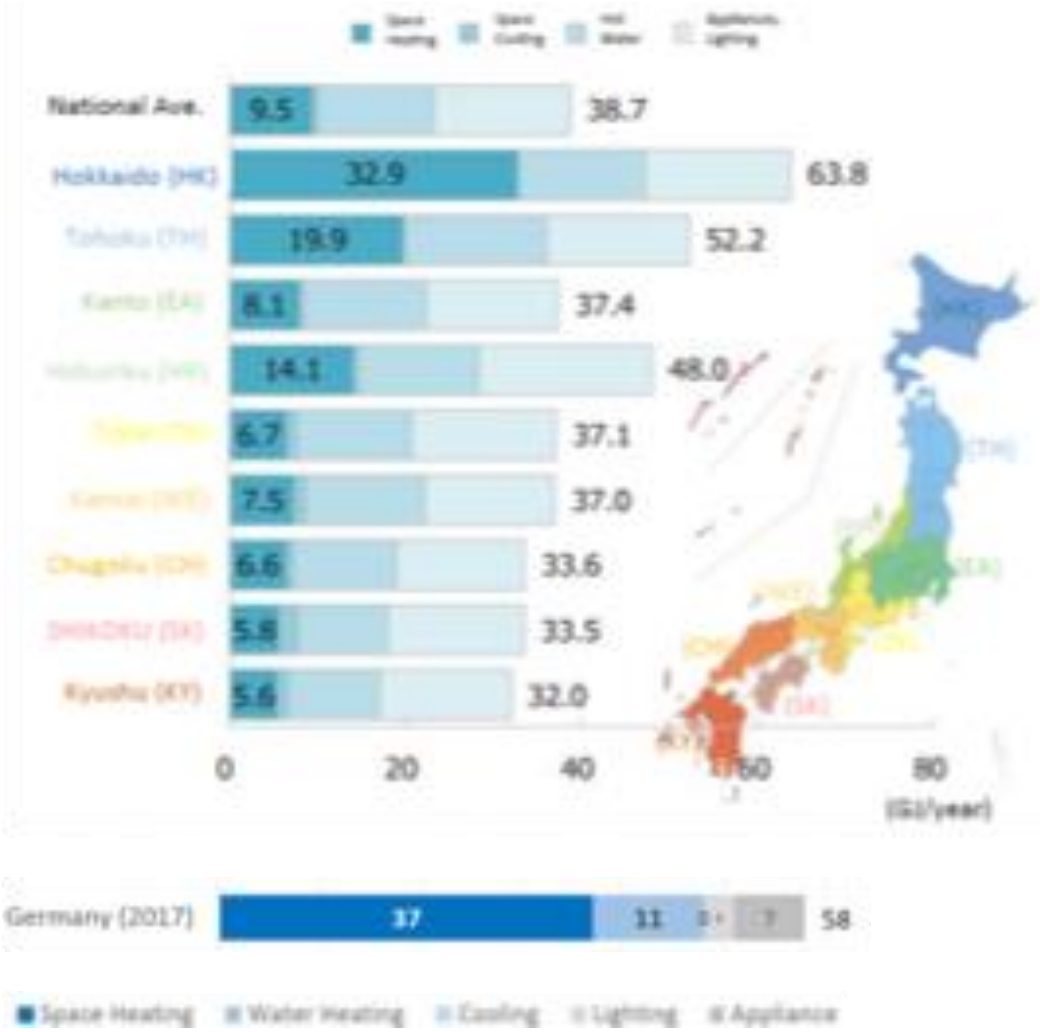
Innovation Hub

Innovation Roundtables with the Industry

Initiation and development of joint demonstration projects on key technologies

Building energy consumption

Residential energy consumption per m^2 by end use



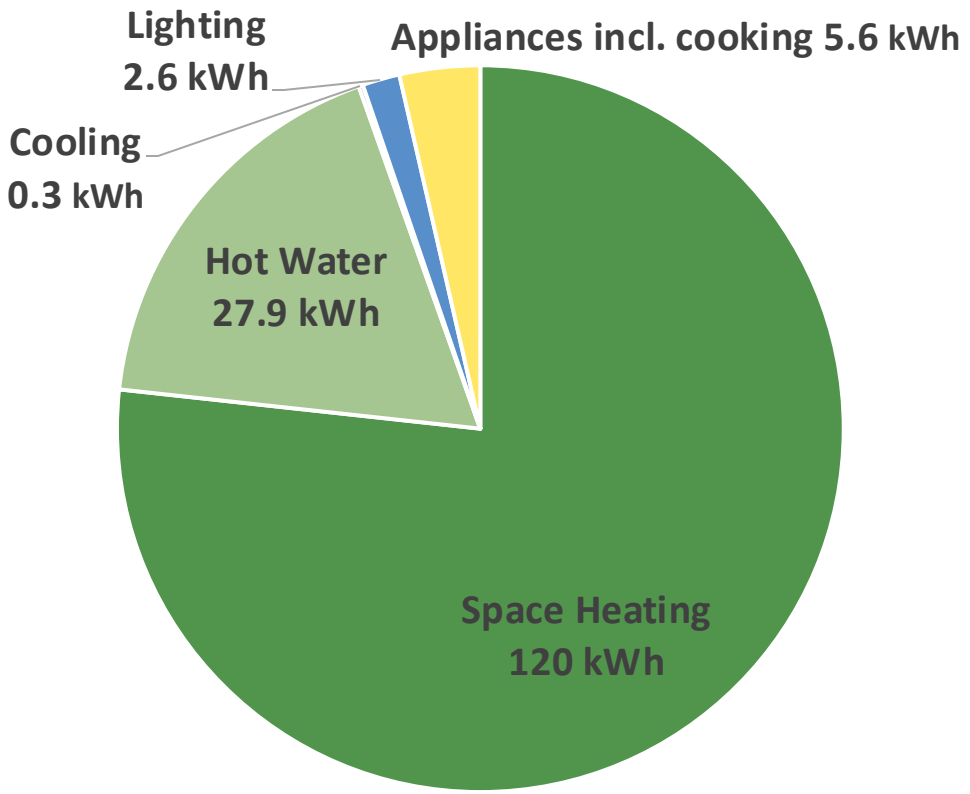
Climate in Germany does not vary much within the country

Sources, for Japan: MLIT, Jyukankyo Research Institute (2018) ; for Germany: Nakagami, H. (2020)

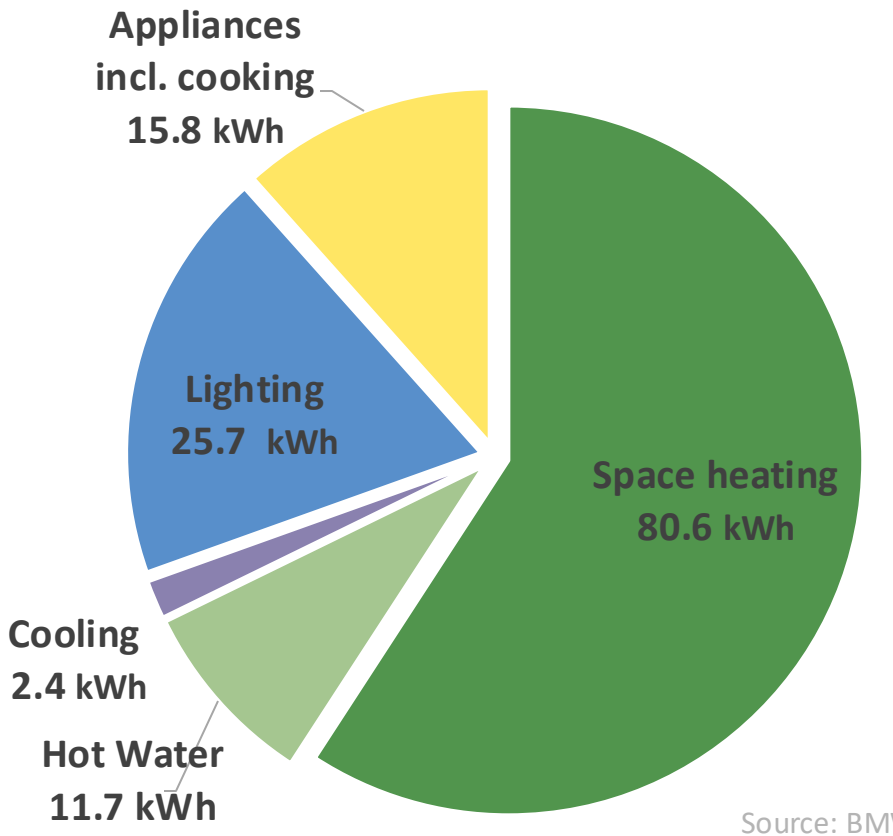
Country-specific characteristics of the building stock

Energy intensity in German (non-)residential buildings

kWh/m²/2020 (residential buildings)



kWh/m²/2020 (non-residential buildings)



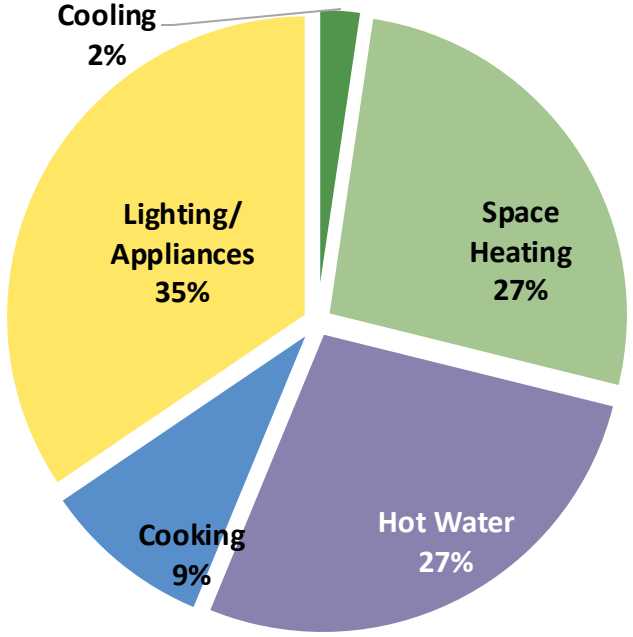
Source: BMWK Energy Data 2022

Country-specific characteristics of the building stock

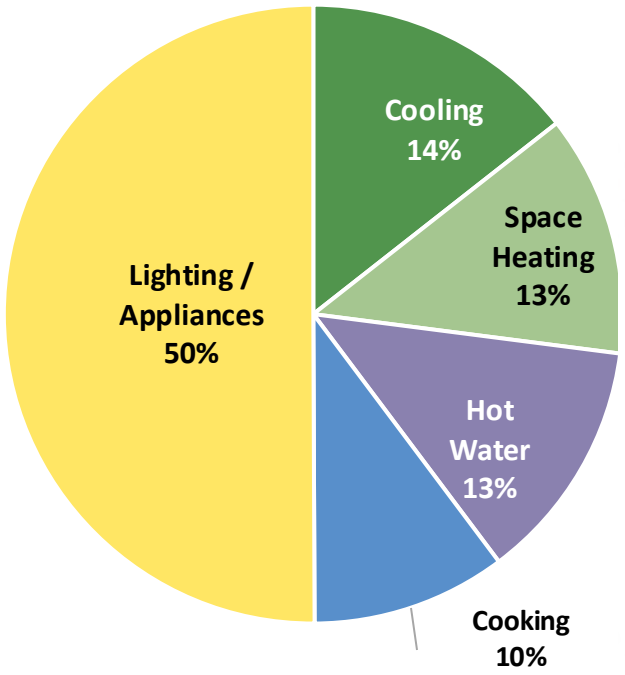
Energy intensity and consumption in Japan

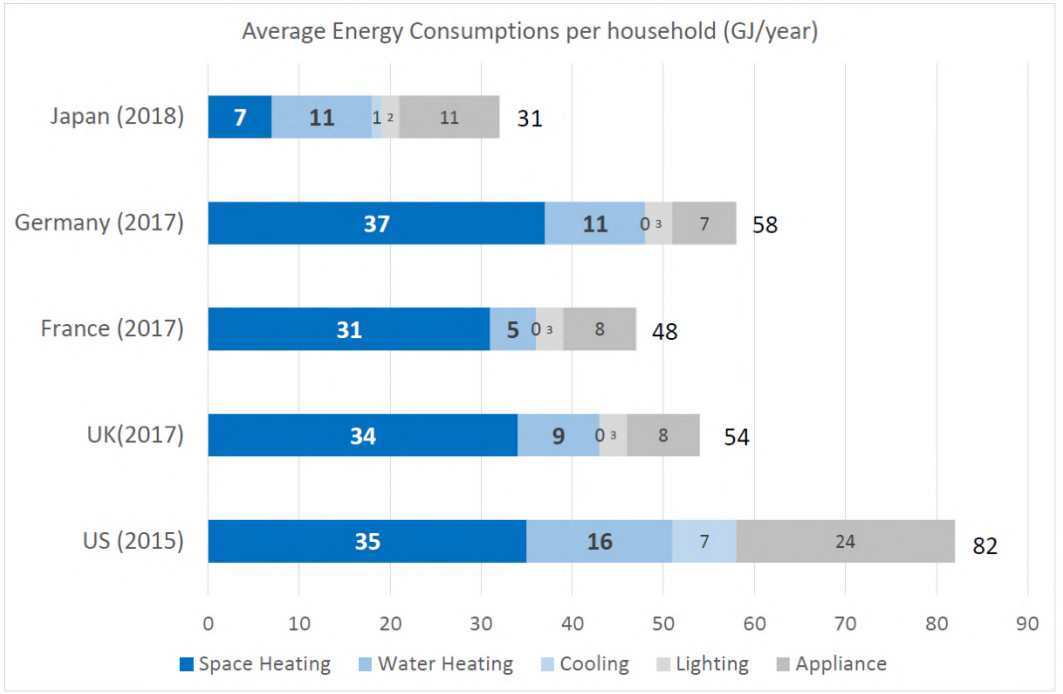
- By energy use, Major **in heating for room and water in residential sector** and **in lighting/appliances in Non-residential sector.** Growing in lighting/Appliances growing in resident sector, driven mainly by increasing buildings and ownership of appliances.
- By energy type, **the proportion of electricity high** due to more prevalent home appliances. Subsequent increase in electricity prices and growing environmental awareness leading increased use of energy-efficient appliances.

Residential

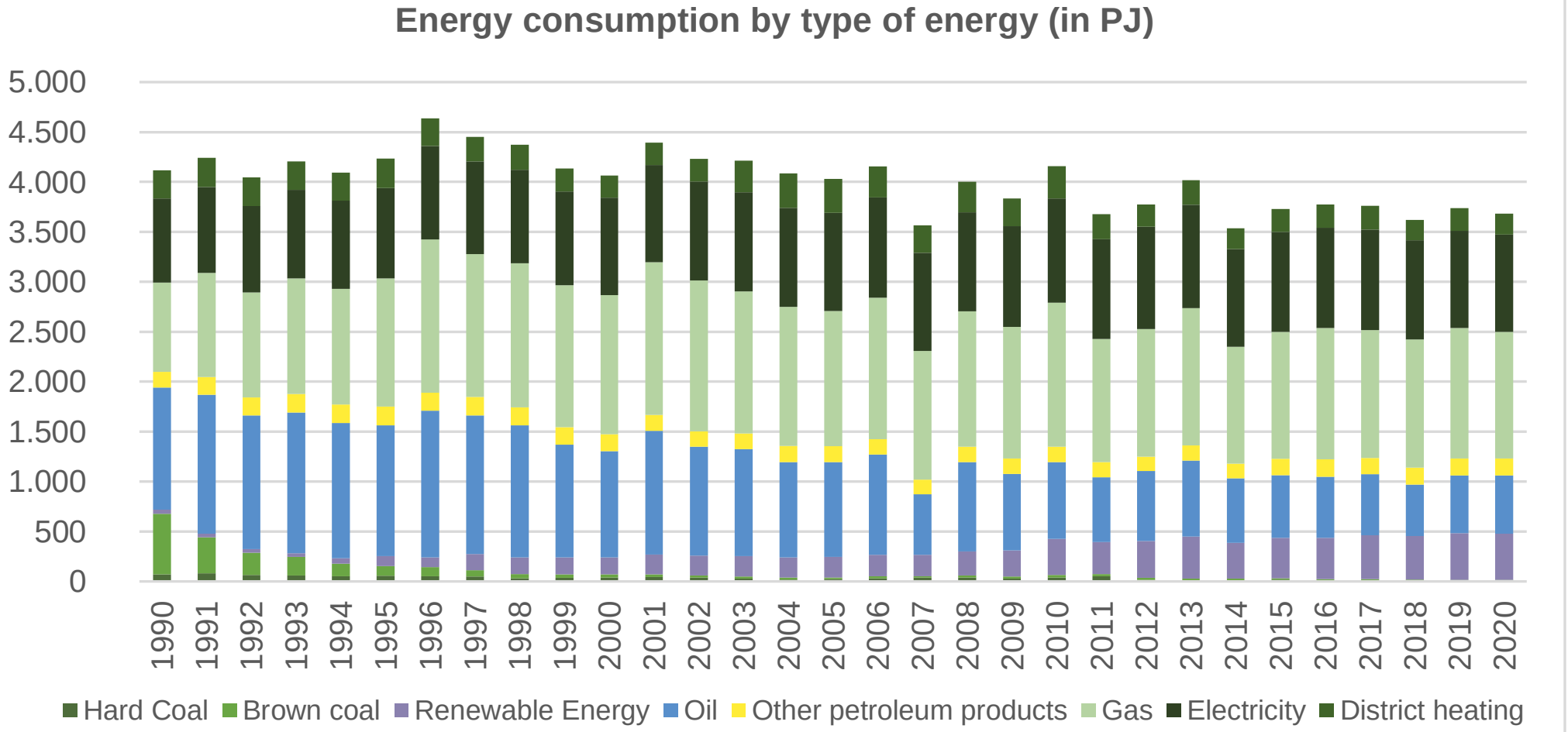


Non-Residential





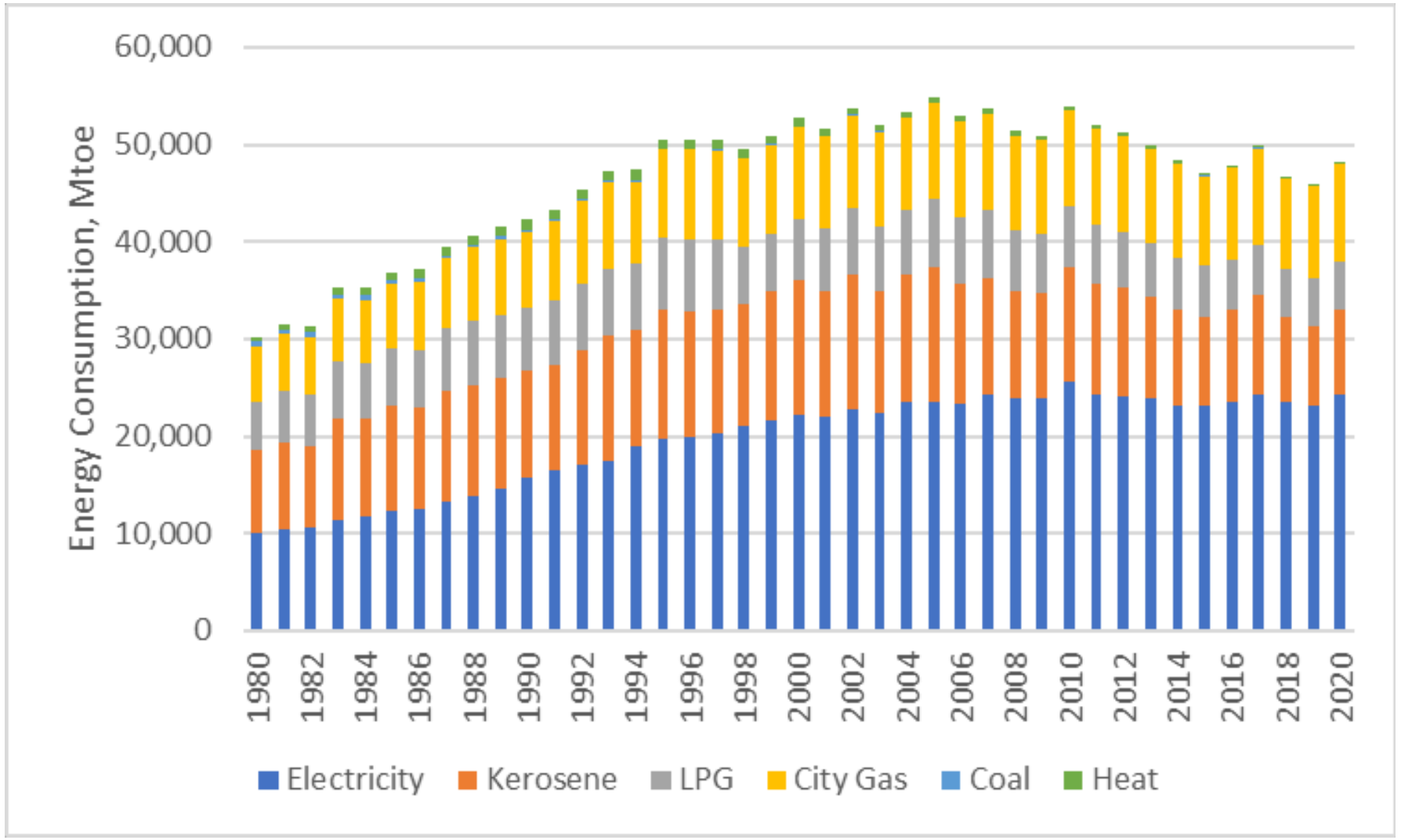
Energy sources in Germany (incl. non-residential)



Source:

BMWK (2022)

Energy sources in Japan (residential buildings)



Source:

BMWK (2022)

Trends in energy efficiency retrofits and renewable energies

Renewable Energy in Building Efficiency Standards

Germany	Japan
German Building Code soon to require at least 65% renewable energies in newly installed heating (from 2026/28). Some federal states already mandate the installation of photovoltaic systems in new build. Recent trend: 'balcony solar' (one or two panels of 300-400W per dwelling in multi-family houses), now permitted without landlord consent	Local municipals are leading the deployment of renewables. Tokyo metro government and Kyoto City are implementing mandatory roof-top PV ordinance in new constructions.

Housing Retrofits

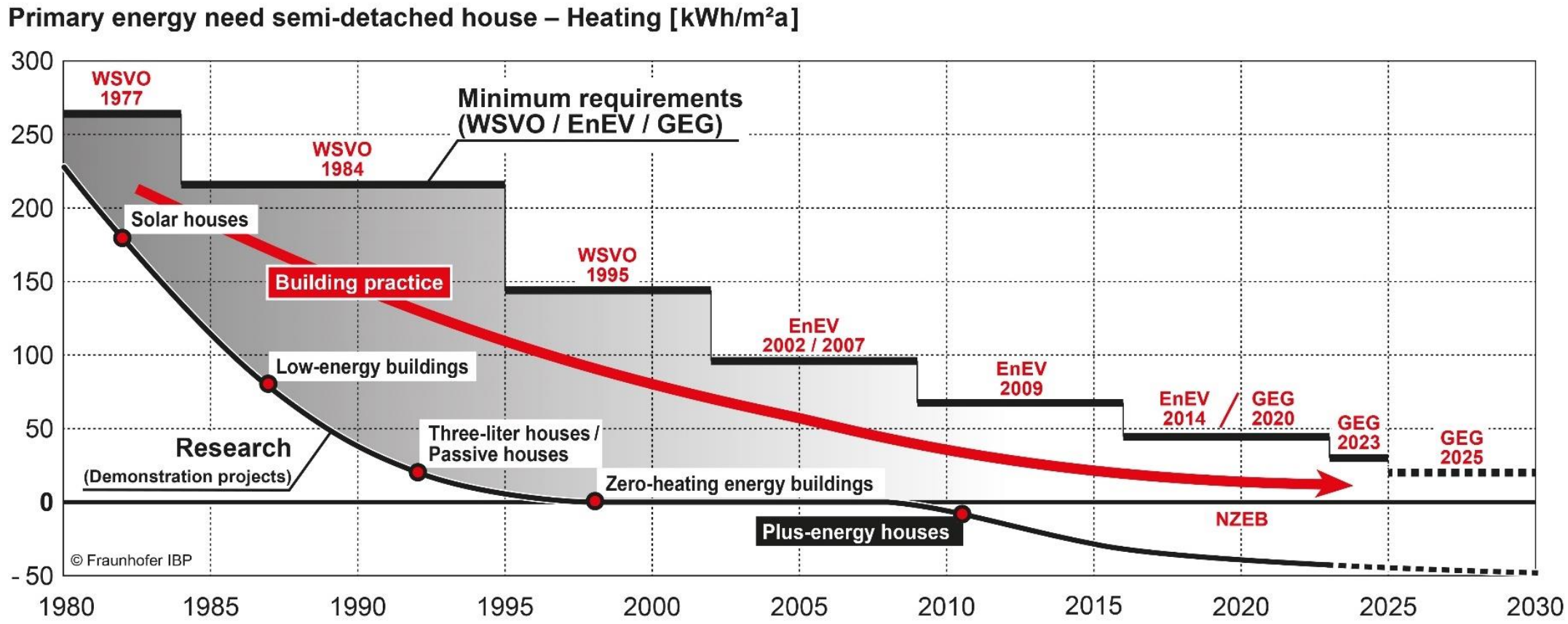
Germany	Japan
Although German building EE policy focuses renovation, with financial support (subsidies/grants/low-rate loans) and professional advice, EE renovation rates remain around 1%/yr. Energy cost savings and better market valuation with the efficiency labeling system can recover retrofit investments in less than twenty years.	Most residents exchange a room air conditioning and a hot water boiler in a 10-15 years cycle. Envelope retrofits usually take longer investment recovery years, up to 37 years in residential housings. The retrofit does not improve a building/housing market value.

Policies and measures

Policies and measures in comparison

	Germany	Japan
Energy Efficiency Building Code	- Energy performance Requirement (a) new buildings (b) existing buildings undergoing major renovation - Renewable Energy Integration and stronger energy efficiency (2022 revision) 2023: Efficiency House 55 Standard	Building Energy Conservation Law (updated 2019 and 2021) - Mandatory min. Envelope performance - Standard average efficiency standard on housing builders. - Additional efficiency levels for ZEH/ZEB Level with incentives
Energy Efficiency Certification/Label	Energy Performance Certificate (EPC) Top A+ to Low H for residential - EPC to be shown at sale or lease	Voluntary Energy consumption performance label and Insulation Performance label
Energy Efficiency Standards for Appliances	EU Ecodesign - energy efficiency and recycleability	Top-Runner Program implemented in 1998. Gradually expanded to 29 appliances and 3 building materials, update every few years.
Retrofits Incentives	Federal fund for efficient retrofits, 5 bil. € in 2022, and increased to 12-16 bil.€ in 2023-2026.	Grants for energy efficiency renovations (window, sach, door, insulation, boiler)
Embedded Carbon	Increase of wooden materials	

Development
Of Energy-saving Construction in Germany



Source: Hans Erhorn, Head of Department of Energy Efficiency and Indoor Climate, Fraunhofer IBP

Major policies related to the improvement of the energy performance of buildings: Energy Conservation Law Japan

1979	Energy Conservation Law	
	Envelope Standard	**Primary Energy Use Standard**
1980	Class 2 Standard	
1992	Class 3 Standard, Heat Loss(Q) and Solar Heat Gain (μ) Coefficient	
1999	Class 4 Standard, adding Air Tightness (C)	
2006		Energy Performance reporting (non-res.,FS>2000m²)
2009		Energy Performance reporting (non-res. 2,000>FS>300m²) Top Runner Housing (Built Single Home suppliers)
2013	2013 Standard, Heat Loss (Ua), Solar Heat Gain (ηa) Coefficient	Primary Energy Use Standard, with 8 climate regions
2015	**Building Energy Conservation Law**	
2016	2016 Standard	**Mandatory** Energy Performance (non-res.,FS>2000m²)
2021		**Mandatory** Energy Performance (non-res.,2,000>FS>300m²)
2025		**Mandatory, all new housing and buildings**

Points in common and differences

- **Points in common**
  - Policy package with legal requirements, financial incentives, and information as main elements for buildings
  - Appliance MEPS/top runner and labelling
  - Objective to increase share of wood in construction
- **Major differences**
  - Focus on EE renovation/retrofit in Germany, while so far new build in Japan
  - Focus on heating energy savings in Germany, appliances and HEMS/BEMS in Japan
  - Later introduction of mandatory new build requirements in Japan, currently less volume of financial incentives, building energy label voluntary in Japan

Recommendations

For further Improvement of the Policy Package in Germany

- need of clear **market signa**ls following the so-called „Putin shock“ to push investments
- Upgrade or introduce **requirements for new built** (building shell EH 40, PV obligation)
- Create network of **One-stop-shops** for building renovation (coordinated advice through whole process, practical support or even implementation)
- **reduce demolition rate** by setting clear priority on renovation over new built
- set **sustainable constructions** as standard (integrate LCA-standards into the Building Energy Act)
- increase the ambition level with regard to **renovation**: serial construction/pre-fabrication, digitalization, municipal heat planning

Recommendations
for the further improvement of the policies in Japan

- **Target setting and continuous monitoring by the government for the introduction of renewable energy in building**
  - The government to set reduction targets of renewables installation on buildings by 2030 and 2050.
  - Monitoring the progress by each municipality and identifying obstacles for further promotion by the government needed.
- **Reinforcement of retrofit policies for existing buildings**
  - Limited consumers who willingly implement energy-saving measures, due to no evaluation for the retrofit cost which can not be recovered at the time of resale.
  - As a breakthrough, policy to encourage businesses to implement energy-saving retrofits, by regulating the allocation of the number of new construction sales based on the results of energy-saving retrofits.

Potential for cooperation and further research needs

Conclusion and Outlook

Learnings

Germany/EU can learn from Japan: Tighter standards on energy efficiency and labelling for some appliances, particularly heat pumps/air conditioners	**Japan can learn from Germany:** Tighter standards on insulation, heat recovery ventilation, and renewable energy incorporations towards ZEH/ZEB.
Both countries need improvements: - The target volume of deployment (annual rate of retrofits, phase out fossil fuel boiler, heat pump...) - Management of building floor spaces and embedded carbon emissions - A better retrofit market: a transparent certificate (EnergyRenovation Passport), One-Stop-Shop service …..	

Possible further Research Areas

- How to make policies for energy efficiency and sufficiency as well as integration of renewable energies and using the flexibility potential more effective?
- Connecting German knowledge on building envelope efficiency and Japanese knowledge on heat pumps and BEMS/HEMS
- A cost-efficient building retrofit technique by connecting German knowledge on building envelope energy efficiency and Japanese experience in serial prefabrication housing
- Combining knowledge from Japan and Germany on the subject of “Building with Wood”

Thank you for your attention

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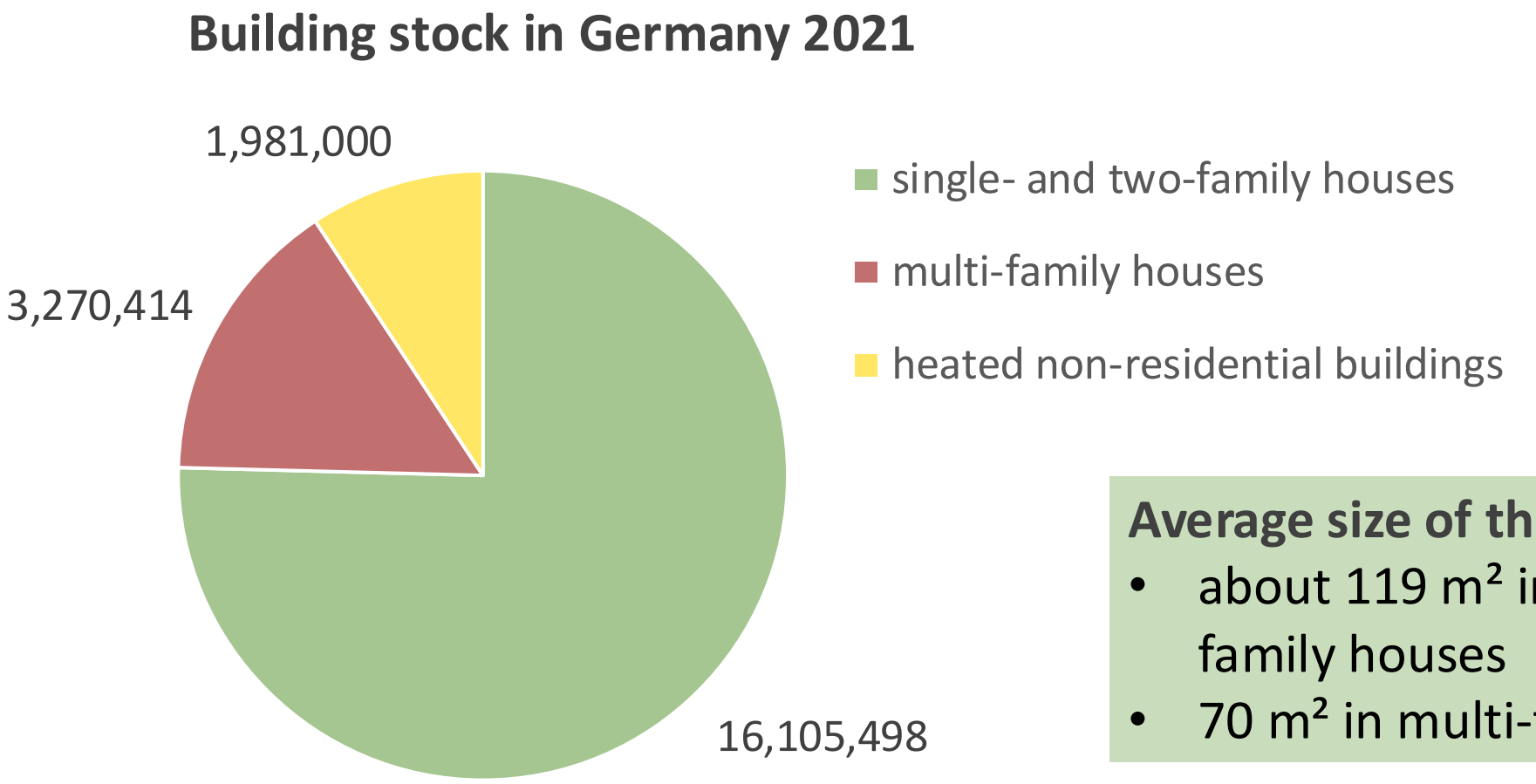
https://gjetc.org

Reserve slides

Country-specific characteristics of the building stock

Size, age and growth of the building stock: Germany I



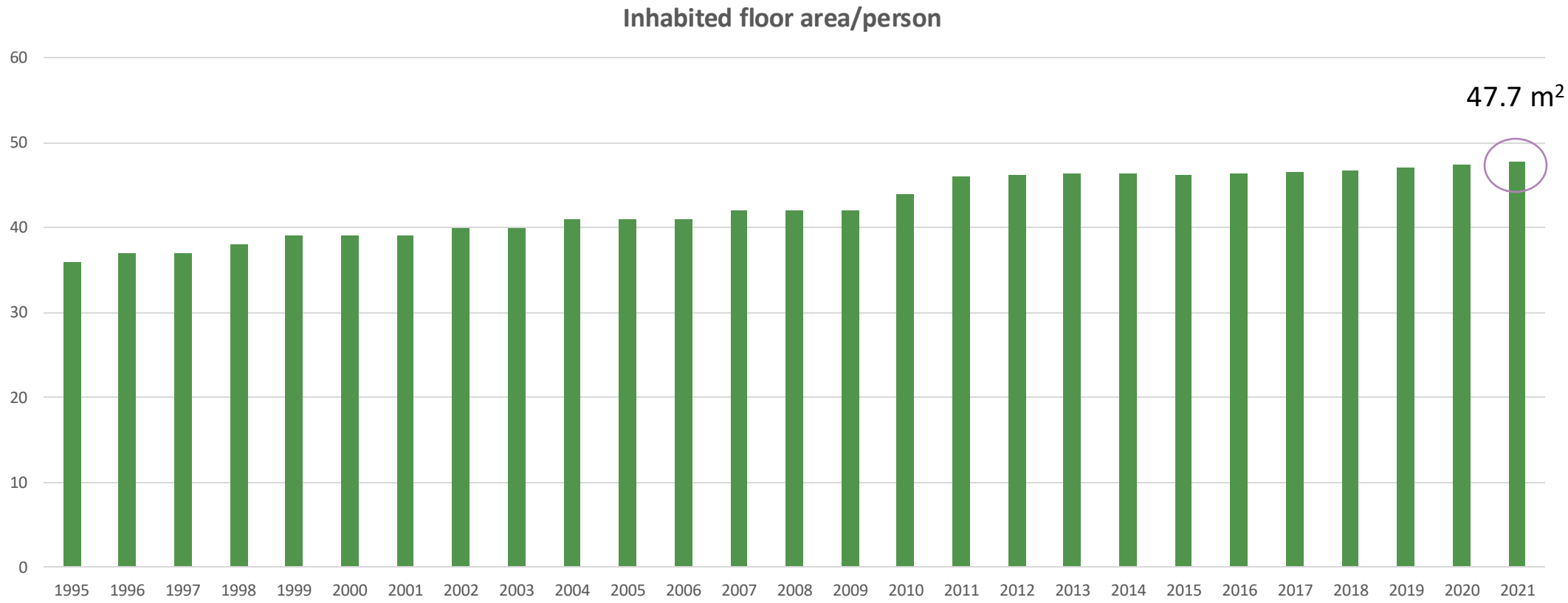
Source: dena 2022, based on Destatis 2022

Average size of the dwellings:

- about 119 m² in single- and two-family houses
- 70 m² in multi-family housings

Country-specific Characteristics of the Building Stock

Size, Age and Growth of the Building Stock: Germany I



→ gradual increase of the size of housings and the per capita floor area from 1990-2009

Source: Destatis 2023

New Buildings

Energy Requirements in Germany

With the coalition agreement and the "relief package" of March 24, 2022, the German government decided to tighten the energy requirements for new buildings in the Building Energy Act (GEG).

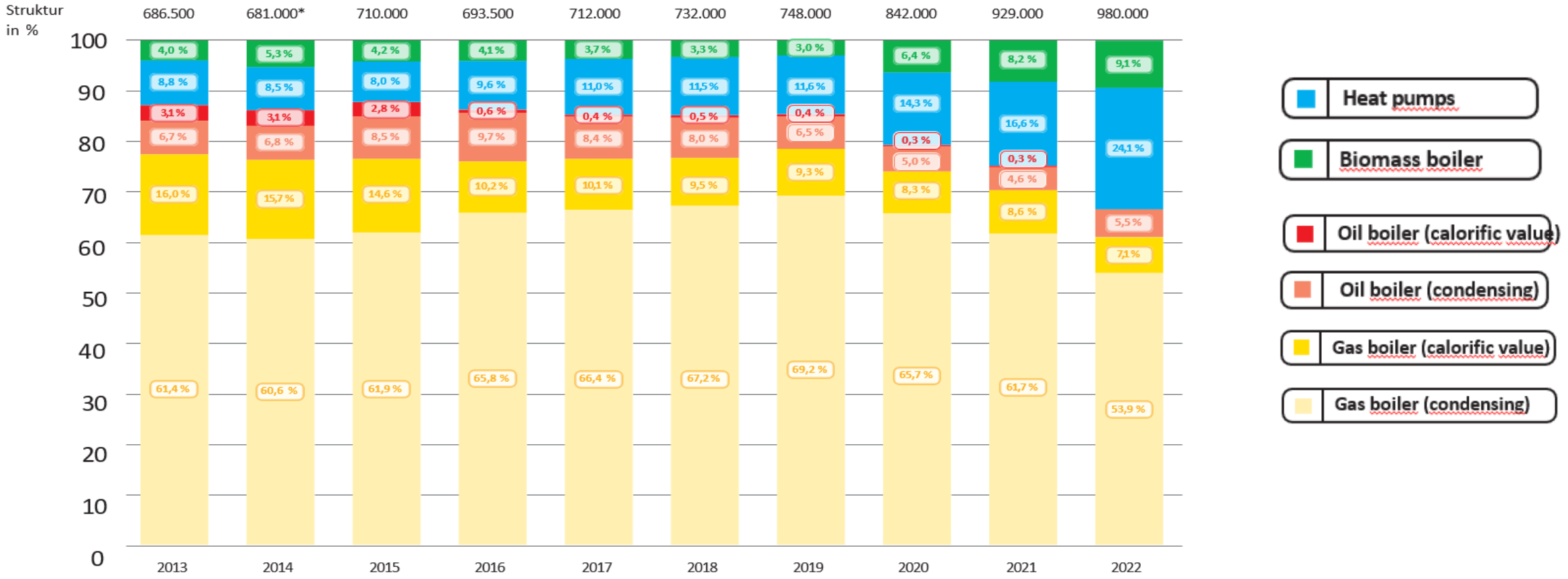
Since 2016, new buildings must be constructed in such a way that the **primary energy requirement is a maximum of 75% of a reference building**.

As of Jan. 1, 2023, the new-build standard was tightened to the previous subsidized standard ***Efficient House 55***, but only for the primary energy requirement, not for thermal insulation

Source: Öko-Zentrum NRW

New Buildings

Share of heating systems in new residential buildings



Source: BDH 2023

Heating Systems

… to be powered by at least 65% Renewable Energy

From 2024, every newly installed heating system is to be powered by at least 65% renewable energy. **This means:**

- … in new buildings and when replacing existing heating systems, a **renewable heat generator** must always be installed **for the base load** that covers at least 65% of the heat demand.
- … **fossil heat generators** may **only be used as a supplement** for peak loads on particularly cold days.
- … the **standard business** of heating engineers (exchange of gas/oil for gas) is no longer permitted.

This also means new challenges:

As early as 2020, there was be a **shortage of around 65,000 skilled craftsmen** in Germany

There is a **high need for qualifications** in renewable energies

Investment decisions for building owners are becoming increasingly complex, so the **need for consultancy** is also rising

Heating Systems

Heating with Renewable Energies

Prioritization of the federal government:

1. **Environmental heat** (heat pumps)
2. **Heat networks** (district heating)
3. **Solar energy** (PV, solar thermal)

Biomass (wood, biogas):
No longer a priority, funding rates have been reduced

Solar energy

Some federal states have already imposed obligations to install photovoltaic systems on buildings

Goal for heat pumps

- 6 million heat pumps by 2030
- 12 million heat pumps by 2045

Source: Adobe Stock #178793328 #459057038 #443787611

Energy standards

Efficiency house standards: residential building renovation (BEG)

Subsidy as loan with repayment subsidy since 01.01.2023					
Efficiency house standard	Interest advantage max.	Repayment subsidy	EE class or NH class	WPB-Bonus	SerSan-Bonus
Efficiency house historic building	15 %	5 %	5 %	-	-
Efficiency house 85	15 %	5%	5 %	-	-
Efficiency house 70	15 %	10 %	5 %	10 % (only 70 EE)	-
Efficiency house 55	15 %	15 %	5 %	10 %	15 %
Efficiency house 40	15 %	20 %	5 %	10 %	15 %

Eligible costs max. 120,000 euros per housing unit, for the EE class max. 150,000 euros per housing unit.

Financial Incentives
For energy-efficient Renovation

Funding for financial incentives and soft loans for the energy efficiency of buildings and the use of renewable heat is provided since ca. 2005

The last major revision of the programs was on 01.07.2021.

Renovation rate used to be ca. 1 % per year; should accelerate to at least 2 %, better 3 to 4 % per year

Funding focuses on the refurbishment of buildings; little funding is provided for new construction.

The total amount of government spending for these programs used to be around **€2 billion/year** (~2,890億円) and was increased to around **€5 billion/year** (~7,226 億円) in 2021/22 as a countermeasure against the recession caused by Covid-19. The government plans to increase it to **€12-14 billion/year** (~17,343 億円 to ~20,234 億円) in 2023 to 2026.

Financial Incentives

EE and NH Class – Bonus of 5% for Renovation

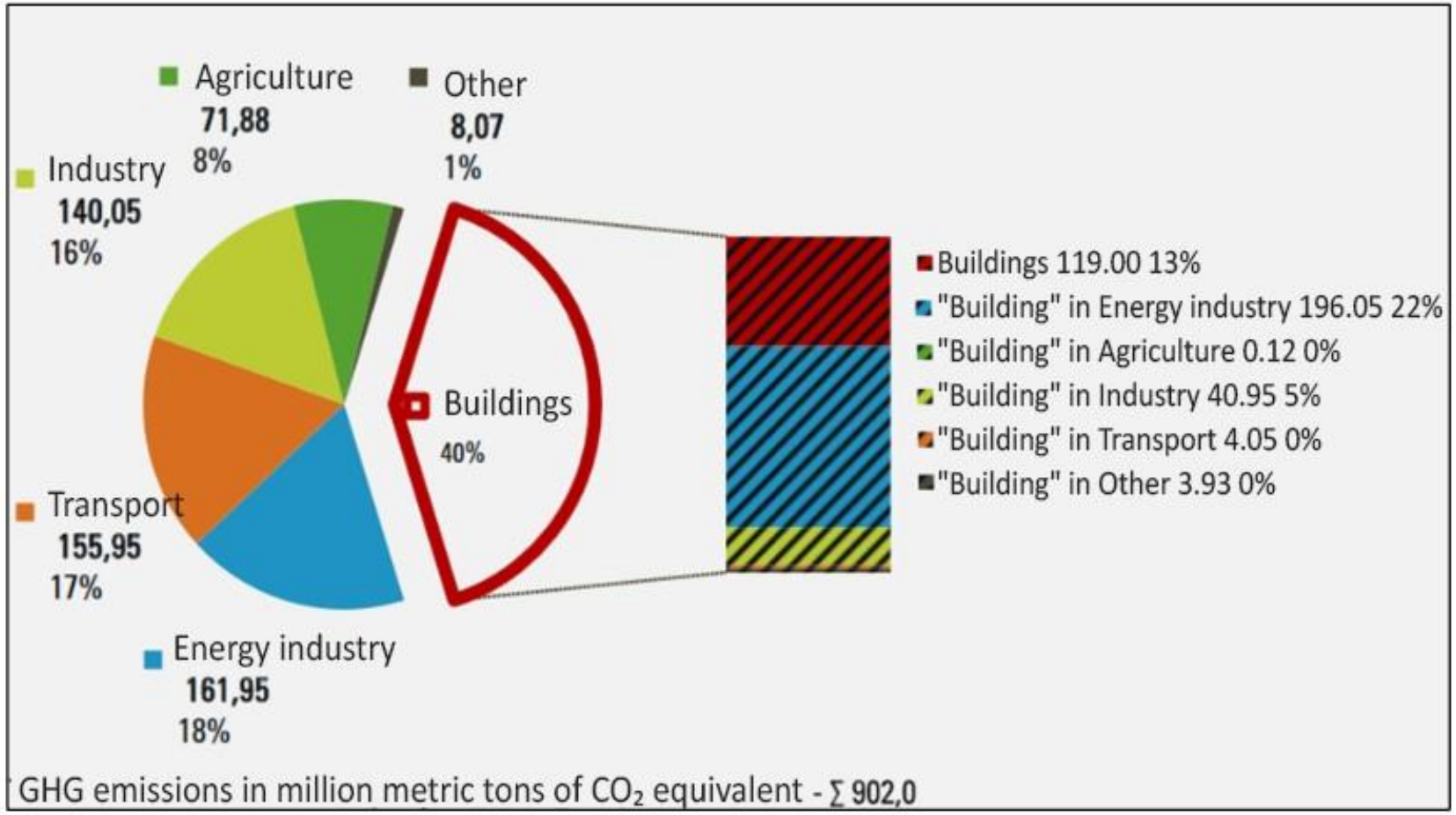
- The heating and cooling demand of the efficiency house calculated according to GEG must be covered by the use of renewable energies and/or unavoidable waste heat for a minimum share of 65% for the “EE class” (renewable energy class).
- A “NH class” (sustainability class) is achieved when a sustainability certificate is issued for an efficiency house/building by an accredited certification body.

Financial Incentives

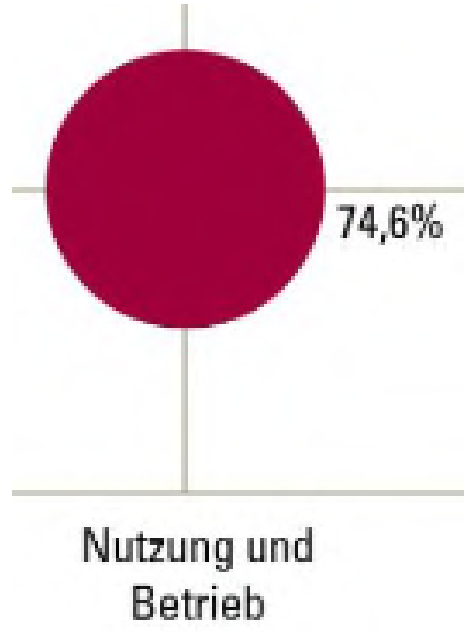
WPD Bonus and SerSan-Bonus

- A bonus of 10 percentage points is granted for the worst performing buildings in terms of energy efficiency (**Worst Performing Building - WPB**) if they are renovated to the level of Efficiency House 40, 55 or 70 EE. The bonus is cumulative with the EE or NH class. A “NH class” (sustainability class) is achieved when a sustainability certificate is issued for an efficiency house/building by an accredited certification body.
- **Serial refurbishment** (“SerSan”) is the energy-efficient refurbishment of existing buildings using off-site prefabricated facade or roof elements and their installation on existing buildings. The off-site prefabricated elements have such a high degree of prefabrication that the on-site craftsmanship required is significantly reduced compared to conventional refurbishment.

Environmental Footprint (t CO_2-eq) of Buildings



of which ca. 75% is caused by use and operation



Source: BBSR No. 17, 2020

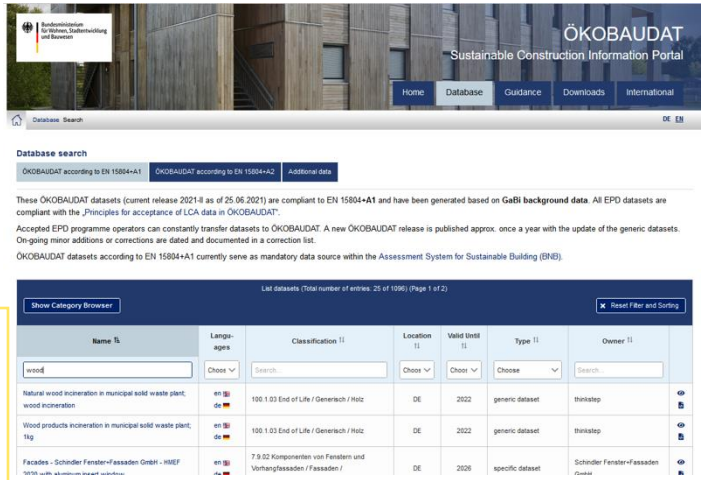
Lifecycle Assessment: Embodied Energy/GWP (t CO_2-eq)

Product stage			Construction process stage		Use stage					End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling-potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
					B6	Operational energy use								
					B7	Operational water use								

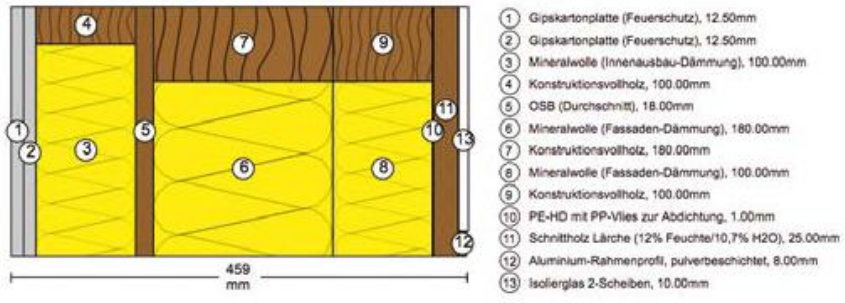
previously: energy use only for building operation -> GEG (Legal Requirements)

today: lifecycle assessment including energy use + building materials (production), replacement during use and waste processing + disposal
-> QNG (state subsidity programs)

Lifecycle Assessment and Embodied Energy



More than 1400 datasets for building products - EN 15804 compliant

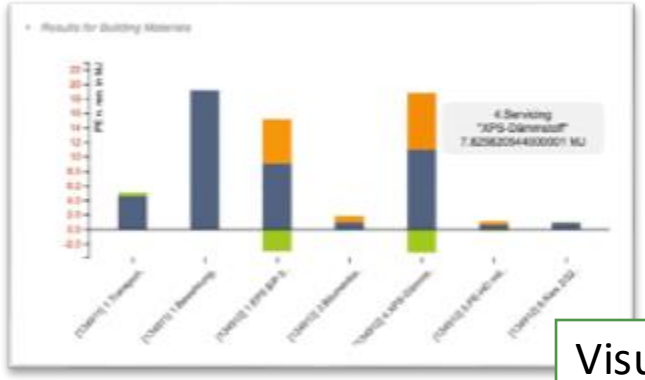


1 Gipskartonplatte (Feuerschutz), 12.50mm
2 Gipskartonplatte (Feuerschutz), 12.50mm
3 Mineralwolle (Innenausbau-Dämmung), 100.00mm
4 Konstruktionsvollholz, 100.00mm
5 OSB (Durchschnitt), 18.00mm
6 Mineralwolle (Fassaden-Dämmung), 180.00mm
7 Konstruktionsvollholz, 180.00mm
8 Mineralwolle (Fassaden-Dämmung), 100.00mm
9 Konstruktionsvollholz, 100.00mm
10 PE-HD mit PP-Vlies zur Abdichtung, 1.00mm
11 Schnittholz Lärche (12% Feuchte/10,7% H2O), 25.00mm
12 Aluminium-Rahmenprofil, pulverbeschichtet, 8.00mm
13 Isolierglas 2-Scheiben, 10.00mm

eLCA software

Life cycle modules in accordance with EN 15804. Source: EN 15804

Product stage			Construction process stage		Use stage					End of life stage				Benefits and loads beyond the system boundary
Raw material supply	Transport	Manufacturing	Transport	Construction-installation process	Use	Maintenance	Repair	Replacement	Refurbishment	De-construction demolition	Transport	Waste processing	Disposal	Reuse-Recovery-Recycling - potential
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
					B6	Operational energy use								
					B7	Operational water use								



Visualization of Results for Building Materials

Recommendations

For further Improvement of the Policy Package in Germany

	Stopping growth in floor area	Energy efficiency	Green heat
Signal to market	Sector targets Climate and Energy: Fit for 1,5 degrees		
	Targets on maximum floor area	Targets on renovation rate & depth, oil and gas phase out	
Direction & Support	Strenghten governance: dena, BfEE, Länder energy agencies		
	Financial support to local one-stop-shops and city district management		
Cost effectiveness	Step up CO_2 price faster and further after 2025, use revenues to fund the transition; make price pass-through to tenants depend on energy efficiency standards		
Information basis		By 2028: Building Renovation Passports for all buildings built before 2001; Master plans for cities/districts	
Standards & Funding	Support remodelling, moving	Min. energy performance standards in existing buildings, KfW40+ in new build; funding to make it cost-effective, incl. for tenants	
Infrastructure			heat networks and green feed-in
Innovation		For example project aggregation, industrial preconstruction, support for increase in production	
Capacity	Capacity building, digitalisation and communication campaigns		
Incitement	Demonstration and pilot projects, networking and exchange		

Source: Wuppertal Institute 2022

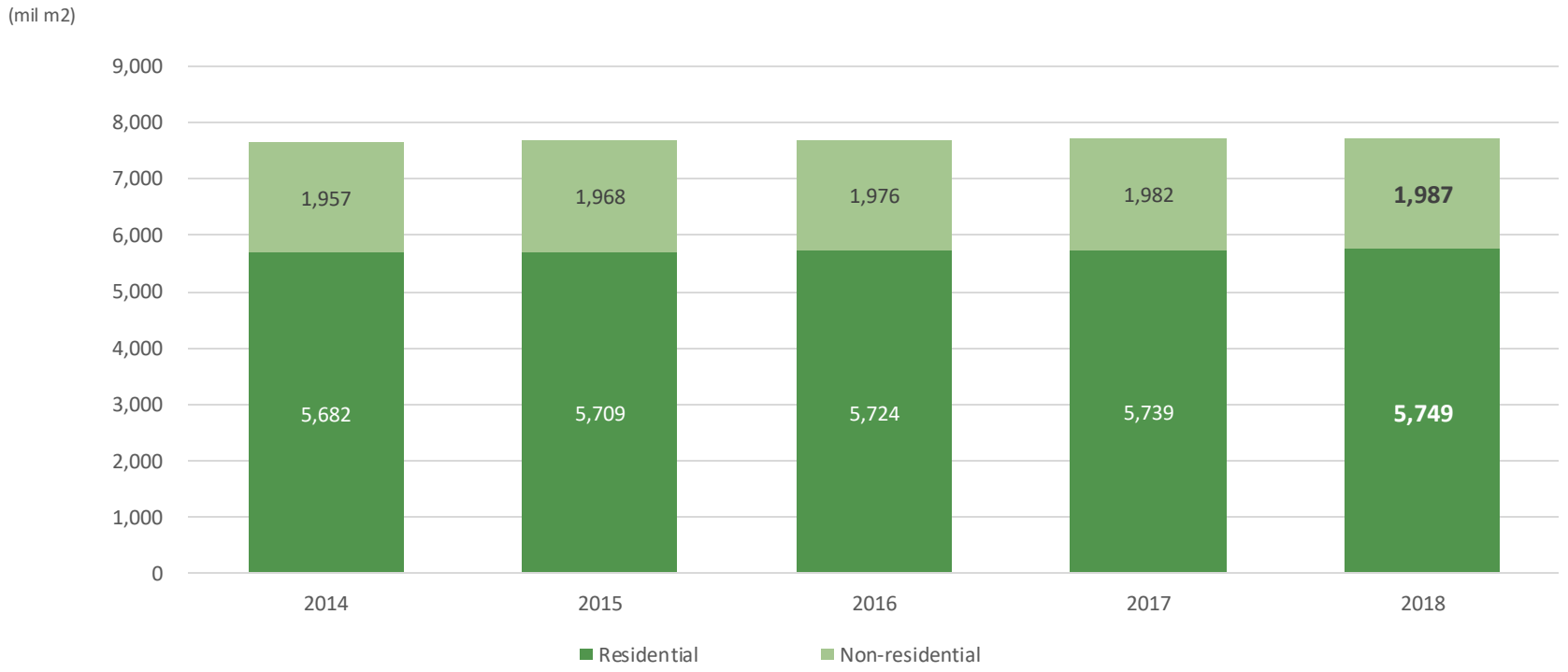
Japan

Building characteristics

Country-specific Characteristics of the Building Stock

Size, Age and Growth of the Building Stock

- **7,735 million m2** as the total size of existing buildings in Japan; **74% for residential** with 3/4 being single-family homes or row houses, with 60% owner-occupied. **Non-residential buildings for 26%**, with 30% being schools, government buildings, etc.
- **45.4 m2/capita** as the floor space per capita as of FY 2018, **rising since 2005** due to the decline in the population.

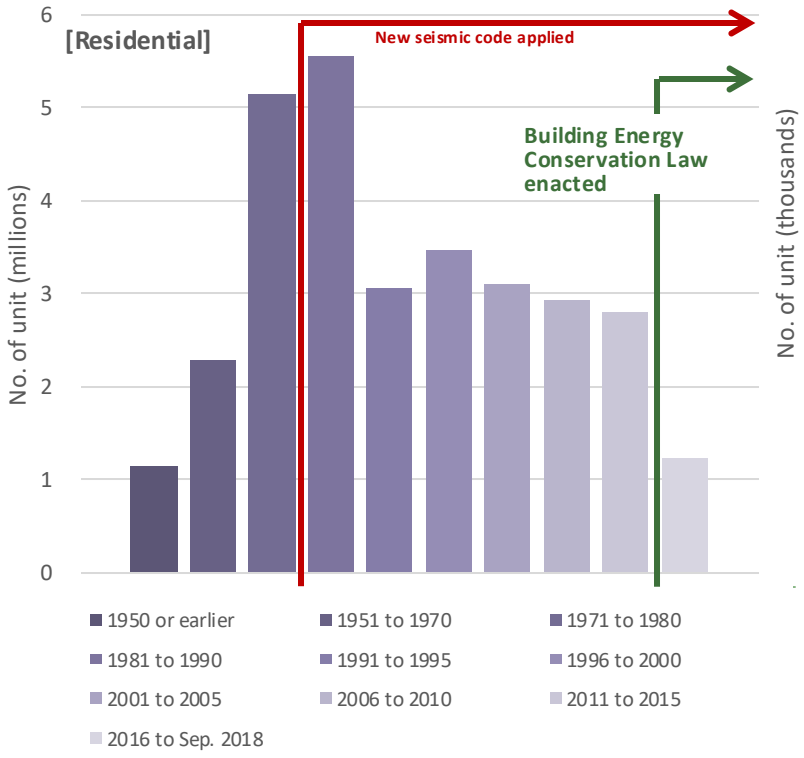


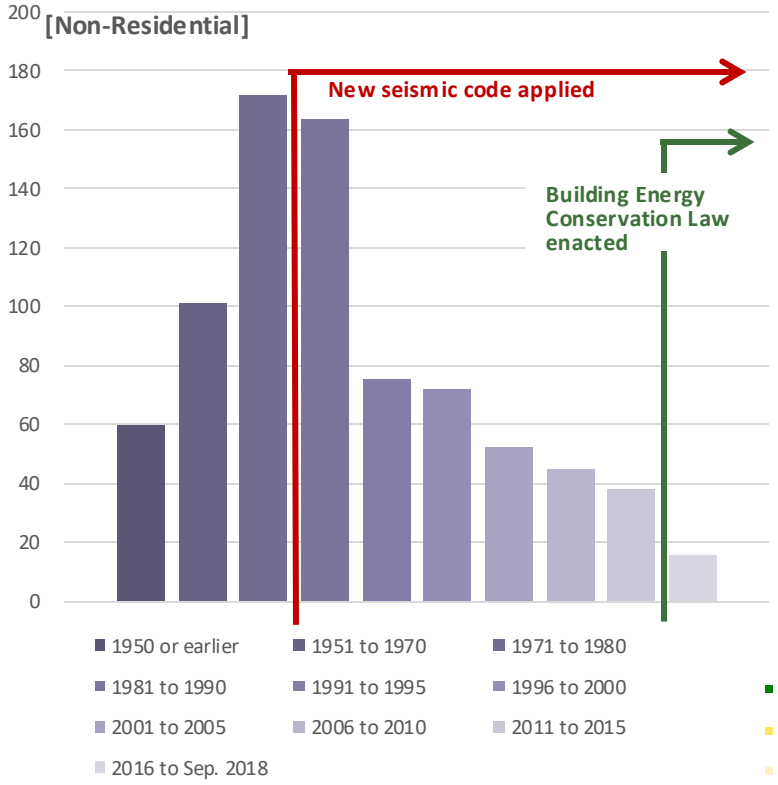
Source: Building Stock Statistics, MLIT(2018)

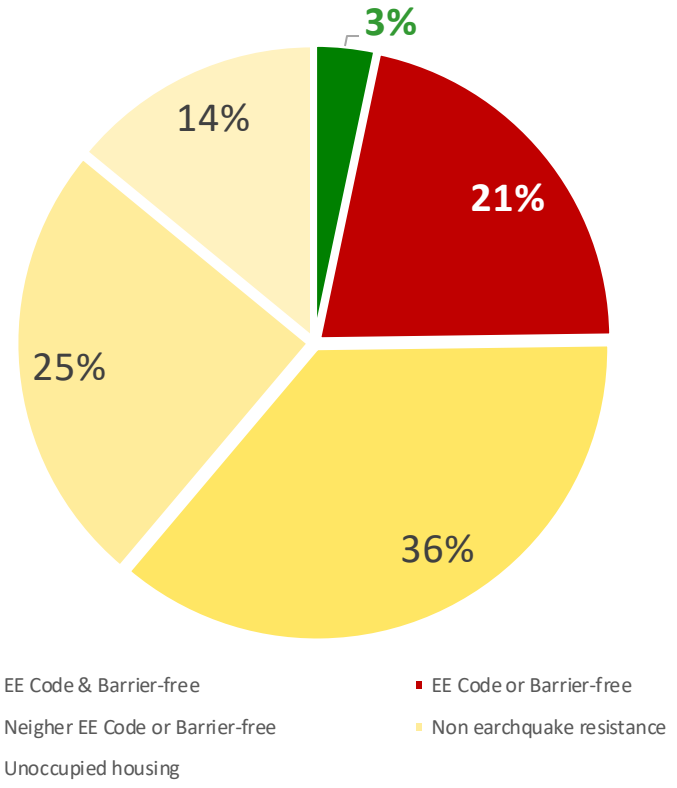
Country-specific characteristics of the building stock

Size, age and growth of the building stock

- **Post WWII new housings** in 1950s and 1960s were low quality. The new housing market continued expanding in 1970 and 1980s with the fast economic growth.
- The first **earthquake resistance standard** took place in 1979 and the **energy conservation standard** took place in 2015.





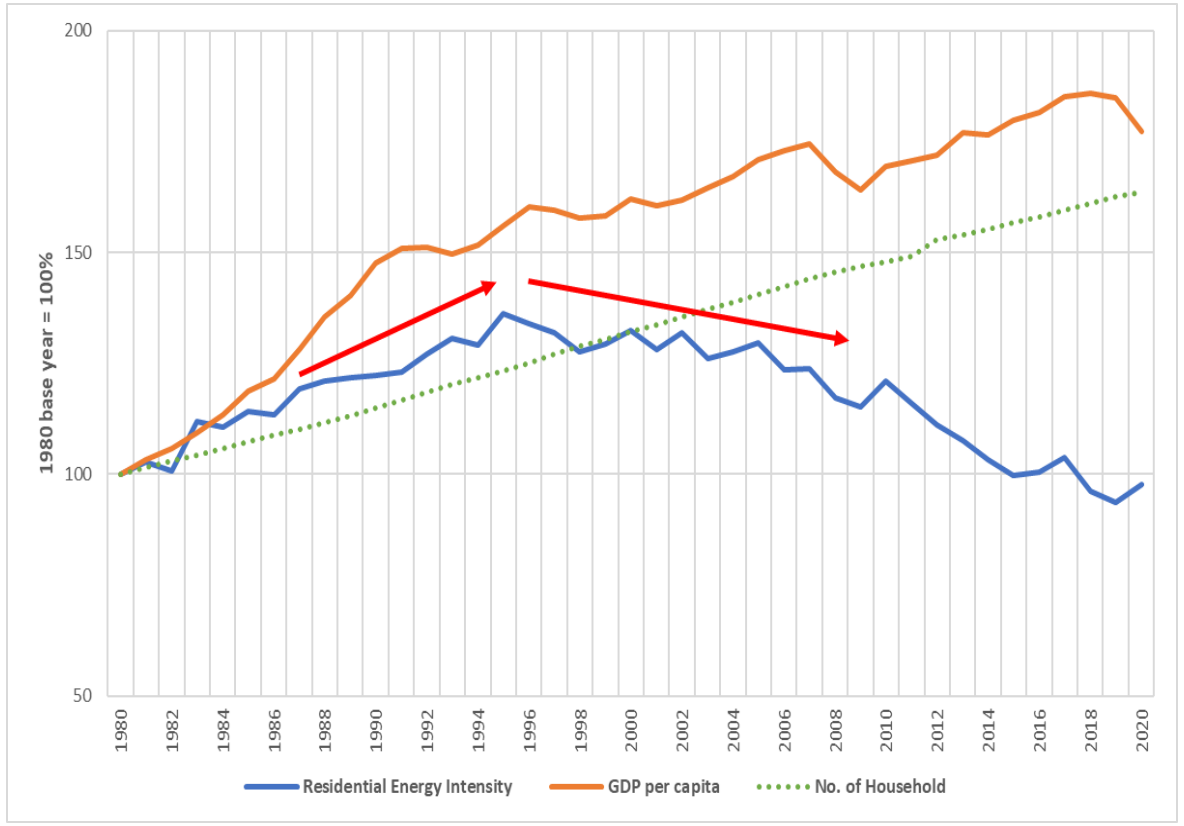


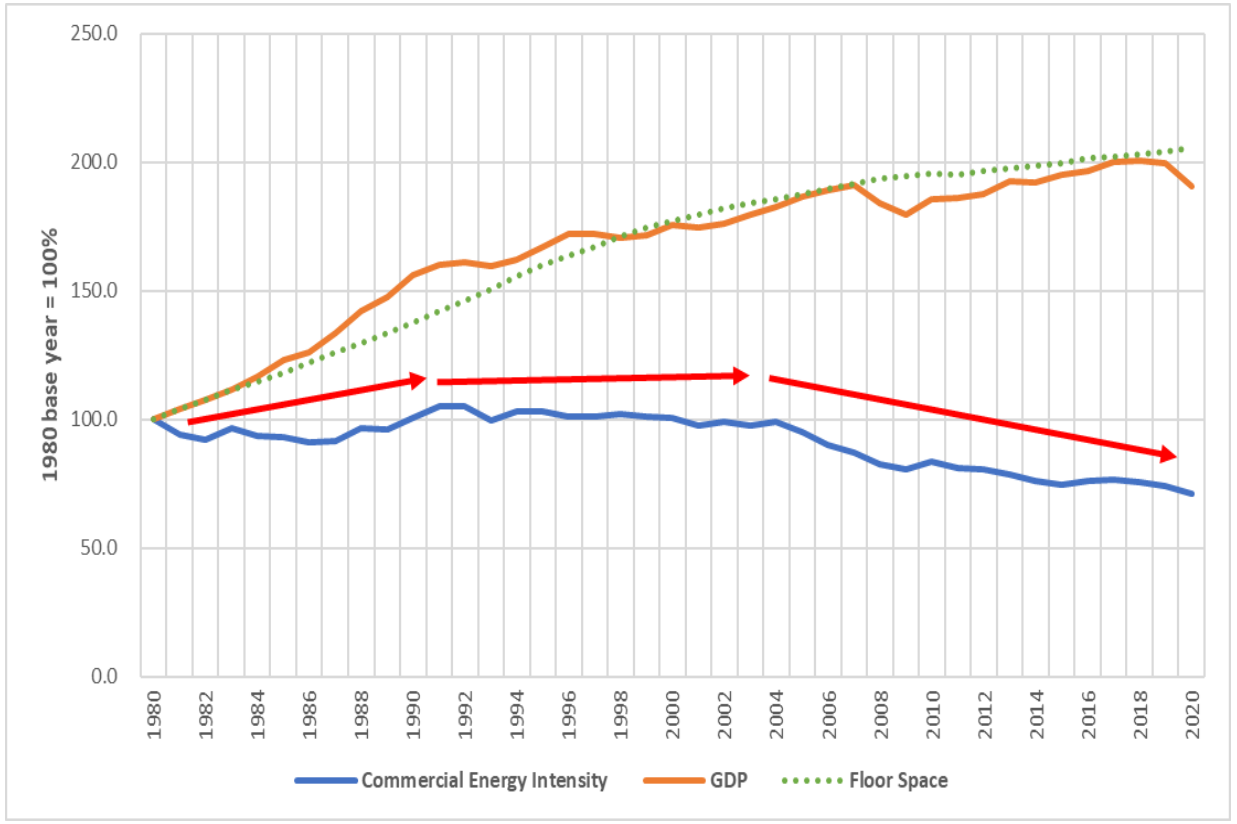
Source : Building Stock Statistics, MLIT(2018)

Country-specific Characteristics of the Building Stock

Energy Intensity and Consumption

- **Energy Intensity (energy intensity) improving in both residential and commercial sectors**
- The diffusion of high-efficiency equipment **with the introduction of the Top Runner Program**, a 1% annual improvement effort target for the commercial sector, and soaring energy prices.





Japan

Policies

Major policies related to the improvement of the energy performance of buildings: recent policies

Building Energy Conservation Act (2015) gradually expands to all new buildings and housings

	Building Energy Conservation Act (2015)		2022 Amendment	
	Non Residential	Residential	Non Residential	Residential
Large (FS >2,000m^2)	**Mandatory (2017 Apr.)**	Performance Reporting	Mandatory (2017 Apr.)	**Mandatory (2025 Jun.)**
Medium (300<FS<2000m^2)	**Mandatory (2021 Apr.)**	Performance Reporting	Mandatory (2021 Apr.)	**Mandatory (2025 Jun.)**
Small (FS<300m^2)	Advisory notice required	Advisory notice required	**Mandatory (2025 Jun.)**	**Mandatory (2025 Jun.)**

Major Policies related to the Improvement of the Energy Performance of Buildings: Existing Policies

Act on Rationalizing Energy Use ("Energy Conservation Law", 1979~)

- The emphasis on promoting energy conservation in the industrial sector at the time of enactment
- Coverage expanded to the business and residential sectors in response to climate change measures and the increasing energy consumption.

Top-Runner Program (1998~)

- Introduced to achieve the target of reducing global warming gas emissions in response to the adoption of the Kyoto Protocol in 1997.
- Major in machinery and appliances (automobiles, home appliances, building materials, etc.). Coverage of about 70% of home appliances and 32 items as of today.
- In 2013, insulation materials and windows (sashes and double-glazing glass) newly added to the scope from the perspective of promoting energy conservation measures in the private sector and quickly stabilizing the supply and demand of electricity.

Major Policies related to the Improvement of the Energy Performance of Buildings: Building Conservation Law

Building Energy Conservation Law (2015)

- Enacted to strengthen drastic energy conservation measures in the building sector, where energy consumption has increased significantly in the wake of the Great East Japan Earthquake and tsunami, which has further strained the energy supply and demand in Japan.
- The following measures introduced to improve the energy efficiency of buildings,
  1) Obligation to comply with energy conservation standards for large-scale nonresidential buildings
  2) Top Runner Program for resident sector
  3) Energy conservation standards compliance labeling system
- Subsequent revisions in 2019 and 2022 and obligation to comply with energy conservation standards and the subject of Top Runner Program expanded.

Major Policies related to the Improvement of the Energy

Roadmap for Energy Conservation Measures in Houses and Buildings Toward a Decarbonized Society (2021)

- A joint effort by MLIT, METI and MOE to summarize the basic approach **to achieving carbon neutrality by 2050** and how to proceed with the effort.
- Targets at housing and buildings in 2030 and 2050

  FY 2030：Aim to ensure ZEB/ZEH level energy efficiency for new buildings

  FY 2050：Aim to ensure ZEB/ZEH level of energy efficiency and conservation performance on a stock average.
- Measures

  ①For residential and commercial sectors:

  1) Raise the level of energy conservation/volume zone of energy conservation performance/top-up efforts to achieve higher energy conservation performance,

  2) Strengthen the Top Runner Program for equipment and building materials,

  3) Energy conservation performance labeling efforts,

  4) Measure for existing stock

  ①For energy transformation sectors: Diffusion of renewable energy

  ②Sink-feedback measures: Expand use of wood

Major Policies related to the Improvement of the Energy

Revision of building-related laws such as the Building Energy Conservation Law (2022)

- The goal to achieve a decarbonized society by introducing renewable energy equipment such as solar panels into buildings and promoting the use of timber, with the expectation of reducing energy consumption by the equivalent of 8.89 million liters by FY2030, compared to FY2013.
- Outline of the revisions

1) **Expansion of the scope of application of energy conservation standards:** Conformity standards were introduced for new buildings of all sizes, residential and non-residential, for new medium-sized and larger non-residential buildings.
2) **Expansion of the scope of the Residential Top Runner Program:** In addition to detached houses for sale, custom-built houses, and rental apartments above a certain level, condominiums for sale will also be covered.
3) **Promotion of renewable energy:** Municipalities taking the initiative in designating areas where solar panels and other renewable energy equipment must be installed, and in promoting plans for the introduction of renewable energy, including the types of renewable energy sources.
4) **Expanding the use of wood:** Fire prevention regulations and structural regulations to be streamlined to promote the increased use of wood as a building material.
5) **Establishment of a low-interest loan program for energy-efficient home improvements:** no-guarantee/security.

Major policies related to the improvement of the energy performance of buildings: recent policies

Housing Suppliers Top Runner Program will guide to ZEH Level Performances.

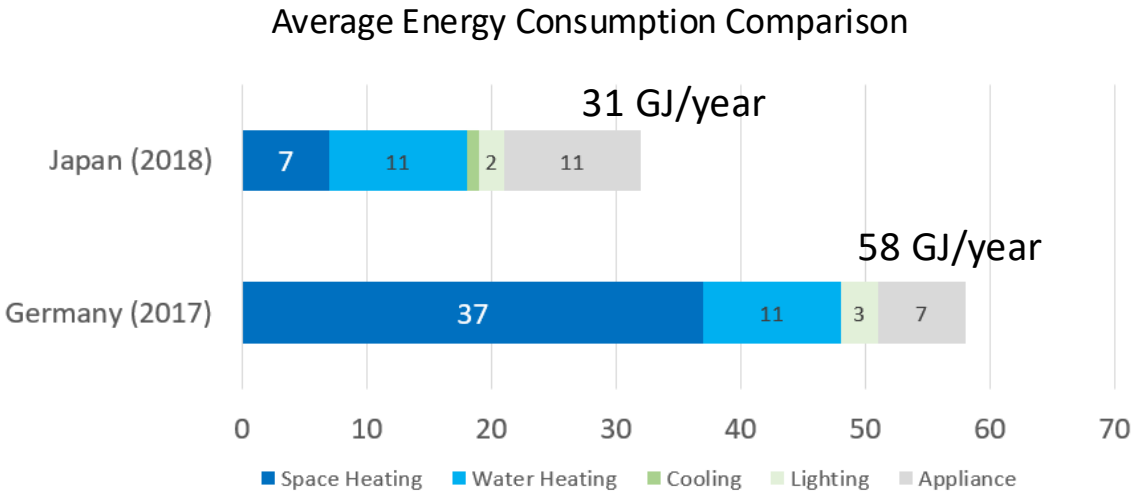
Housing Suppliers	Standard Design Built Detached Homes	Custom Built Detached Homes	Multi Dwelling Apartments (low, lease/owned, wood or steel)	**Condominiums (mostly high, owned, steel)**
	Housing Developer >150 units	Constructors > 300 units	Constructors >1,000 units	Constructors >1,000 units
Envelope	All units must comply the Act requirements			
Primary Energy Reduction from the Act Requirement **(ZEH Level)**	The average reduction of sold units.			
	another 15%	**another 25%**	**another 10%**	**another 20%**
Year of Application	From 2020	From 2024	From 2024	From 2026

Comparison

Building (Housing) Energy Consumption Characteristics

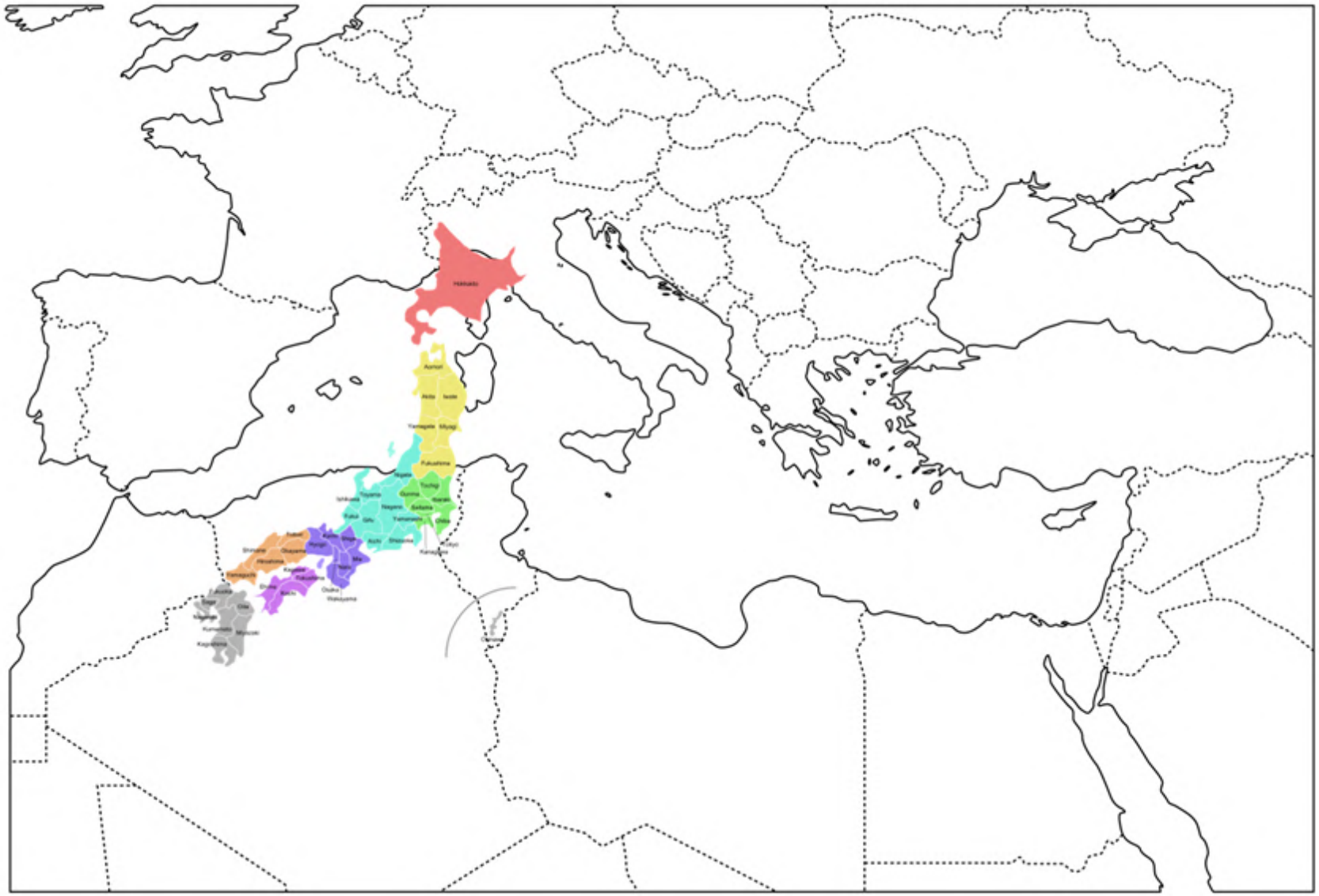
- a geographical latitude
- the typical space heating system

Germany		Japan	
Berlin	52°.52 N	Sapporo	43°.06 N
Frankfurt	50°.11 N	Tokyo	35°.69 N
Stuttgart	48°.77 N	Osaka	34°.69 N
Central Heating		Partial/intermittent (occupant rooms) air conditioning	



In Germany, the improvement of the insulation (of the envelope) of both new and existing buildings is considered important.
In Japan the focus is more on new buildings and the improvement of the energy performance of appliances, although retrofit of insulation to existing buildings would bring benefits too.

Comparison



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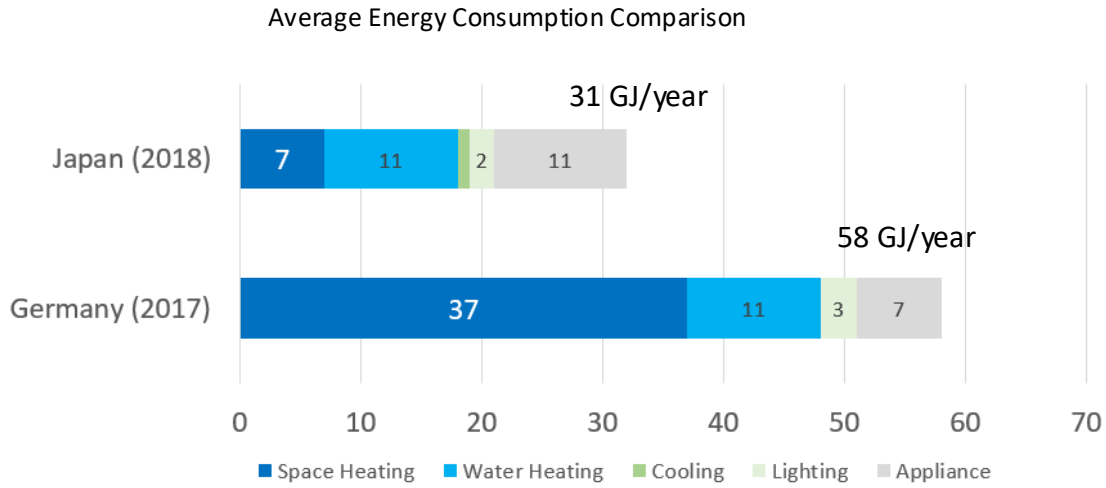

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