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High-performance energy efficiency standards in buildings in UNECE Region.

Topic 3. Energy Efficiency standards in new construction. Private and municipal multi-apartment buildings and public buildings. Practical experience in UNECE countries.

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Types of regulation

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Energy efficiency requirements can be set in different ways and the basic types are:

• **Prescriptive.** This method sets separate energy efficiency requirements for each building part and for each part of the equipment. Individual components must achieve compliance with their specific targets.

Types of regulation

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- **Trade-off.** Values are set for each part of the building, but a trade-off can be made so some values are better and some are worse than the requirements.
- **Model building.** Values are set as in the trade-off, and a model building with the same shape is calculated with those values. A calculation has to demonstrate that the actual building will be as good as the model building.
- **Energy frame.** An overall framework establishes the standard for a building's maximum energy loss. A calculation of the building has to show that this maximum is respected.
- **Performance.** Energy performance requirements are based on a building's overall consumption of energy or fossil fuel or the building's implied emissions of greenhouse gas.

Energy Efficiency standards in new construction

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Many countries have implemented incentives and disincentives to help push contractors and home builders to comply with the codes.

There are three ways that codes are enforced:

A.The country has specific policy packages and incentives that complement or motivate compliance with building codes. Such mechanisms can include green loan programs, financial schemes and incentives, and public incentives including tax credits, and some countries will even give owners incentives such as relaxed building height and size restrictions, such as in Japan.

B.If the building does not comply with the code, then they are refused permission for occupancy or construction.

C.Enforcement of building codes include fines and fees for noncompliance

Residential energy building code enforcement standards examples

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Country	Are there enforcement standards?	Code enforcement type	A, B, C
Australia	Accreditation or approval of materials or components and issuing of certificates of occupancy or compliance. Incentives for building efficiency, such as green loans program, voluntary building industry initiatives, national rating systems	Inspections during and after construction. Fees and charges for noncompliance	A, C
Canada (Ontario)	Local enforcement with third-party inspection. Schemes and incentive programs are available.	During construction; post-completion inspection of boilers; inspection of HVAC systems. Refusal of permission to occupy, refusal of permission to construct, and fees for noncompliance	A, B, C
China	Local enforcement with third-party inspection	On-site inspection occurs during construction. Refusal of permission to occupy, refusal of permission to construct, and fines for noncompliance	B, C
France	Local enforcement with third-party inspection. Accreditation of applicants and inspection. Label schemes, subsidies, funds, loans, tax incentives, levies, obligations, white certificates, audits, feed-in tariffs, training schemes	During construction and post-completion. Refusal of permission to occupy and fines for noncompliance	A, B, C
Germany	Accreditation of applicants. The government-owned banking group Kreditanstalt für Wiederaufbau (KfW) plays a central role in the promotion of energy savings by providing subsidies.	None. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, B
India	None	None	None
Italy	A forum among central government ministries, regions, provinces, and communes, supported by various agencies and bodies that facilitate monitoring implementation	Inspection of boilers and air-conditioning, but procedure is still under discussion	A, C
Japan	Local enforcement, mandatory reports submission with review by local authorities. Encourages more efficient building designs by giving owners incentives like access to relaxed building height and size restrictions and financial support for very efficient buildings.	No inspection for compliance	A
Mexico	None	None	None
Russia	Regional and local administration and enforcement	Energy audits post-completion, prior to occupancy	None
South Korea	Local government building officials execute the codes. The property owner must fill out an energy-saving worksheet and submit it to local governmental offices to obtain a building permit.	Local governments may audit the buildings after construction.	A, B

Residential energy building code enforcement standards examples

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Spain	Local enforcement with third-party inspection. Grants for energy efficiency in buildings (2004–20), gas and electricity tax revenue disbursed to regional governments and topped up with private funds (65%), and the grants are proportional to different energy requirements and efficiency measures related to the codes and the energy performance certificate labels.	During construction and post-completion. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, C
United Kingdom	Local enforcement, accreditation of applicants, post-occupancy control. Energy performance certificates, positive labeling for building beyond the minimum building code level, energy offsets/green certificates	During construction	A
United States	Local enforcement, third-party inspection, post-occupancy control commissioning requirements. Sales and use tax exemption for renewable energy equipment, solar renewable energy certificates. Local option—Clean Energy Loan Program, Be SMART Home Efficiency Loan Program, Be SMART Multifamily Efficiency Loan Program, Home Energy Loan Program	During construction, post-occupancy airtightness testing required prior to compliance. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, B

Commercial and public energy building code enforcement standards. Examples

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India	Local enforcement, accreditation of applicants	During construction and post-completion. Refusal of permission to occupy and refusal of permission to construct for noncompliance	B
Italy	A forum among central government ministries, regions, provinces, and communes, supported by various agencies and bodies that facilitate monitoring implementation	Post-construction inspection of boilers and air-conditioning, but procedure is still under discussion	A, C
Japan	Local enforcement, mandatory reports submission with review by local authorities	No inspection for compliance	None
Mexico	The code has not been enforced due to a lack of adoption by local governments into their building construction regulations. Municipalities that are in charge of setting construction rules for their territories have not made any efforts to include energy efficiency requirements in their building codes. The building energy efficiency code has thus not become effective.	None	None
Russia	Regional and local administration and enforcement. They have certificates called Energy Passports. They are mandatory in public buildings and integrated into the code process for all new buildings.	Energy audits post-completion, prior to occupancy	None
South Korea	Local government building officials execute the codes. The property owner must fill out an energy-saving worksheet and submit it to local governmental offices to obtain a building permit. Buildings that rate highly are eligible for financial incentives, like low-interest loans. The Korean Energy Management Corporation is planning to provide financial support to energy-efficient activities, including cogeneration, energy savings, and the use of renewable energy.	Local governments may audit the buildings after construction.	A
Spain	Local enforcement, third-party inspection. Grants for energy efficiency in buildings (2004–20), gas and electricity tax revenue disbursed to regional governments and topped up with private funds (65%), and the grants are proportional to different energy requirements and efficiency measures related to the codes and the energy performance certificate labels.	During construction and post-completion. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, C
United Kingdom	Local enforcement, accreditation of applicants, post-occupancy control. Energy performance certificates, positive labeling for building beyond the minimum BC level, energy offsets/green certificates	On-site during construction	A
United States	Local enforcement, third-party inspection, post-occupancy control commissioning requirements. Sales and use tax exemption for renewable energy equipment, solar renewable energy certificates, local option—Clean Energy Loan Program, Be SMART Home Efficiency Loan Program, Be SMART Multifamily Efficiency Loan Program, Home Energy Loan Program	During construction, post-occupancy airtightness testing required prior to compliance. Refusal of permission to occupy and refusal of permission to construct for noncompliance	A, B

Performance-based requirements in building energy codes

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- Thermal characteristics and geometry of the building (envelope and internal partitions, etc.)
- Air-tightness
- Space heating system and hot water supply units
- Air-conditioning system(s)
- Mechanical and natural ventilation
- Built-in lighting system (mainly in the non-residential sector)
- Design position and orientation of buildings
- Passive solar systems and solar protection
- Indoor and outdoor climatic conditions
- Thermal bridge

Performance-based requirements in building energy codes

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Building Energy Codes. Experience of UNECE countries. Albania

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Albania has taken important steps toward energy efficiency standards for new building construction. Law No. 8937 defined minimal thermal efficiency standards for new construction, and Law No. 10113 mandates compliance with energy efficiency standards.

Coverage

- Single family houses
- Apartment blocks
- Commercial
- Public buildings

- new non-residential
- new residential

Values of the performance-based requirements for new buildings: 55 kwh/m^2 annual,

Energy levels are considered in building codes:
heating, cooling, hot water, lighting, ventilation.

Building Energy Codes. Experience of UNECE countries. Uzbekistan

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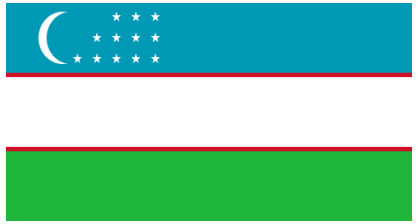

The main share of housing construction (87%) falls on individual housing. 97% of households in the Republic have their own home or apartment, including 99.5 % in rural areas. The main type of housing is a separate house (77.1%). In the housing stock, the share of multi-apartment houses built before 1991 is 83.2%.

Coverage

- Single family houses
- Apartment blocks
- Commercial
- Public buildings

- new non-residential
- new residential

Performance-based requirements for new buildings: are strictly set for typical rural family hoses developed and co-financed by Governmental Programs

Energy levels are considered in building codes:
heating, cooling, hot water, lighting, ventilation. Total primary energy use.

Building Energy Codes experience of UNECE countries. Armenia

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Armenia introduced in 2016 a mandatory building energy code with the adoption of a new regulation “Thermal Protection of Buildings”, which was developed based on Russian Building Energy Code from 2003 (updated in 2012) with application of some methodologies and approaches of European codes and standards. It links building envelope elements/components and heat losses with established energy limits, taking into account differences in climatic conditions.

Coverage

- Single family houses
- Apartment blocks
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- Public buildings

- new non-residential
- new residential

Specific values of energy consumption

Residential and public buildings: walls – 0,29-0,56 W/m^2.K, floors -– 0.22-0,37 W/m^{2}K, roofs -0,23-0,42 W/m^{2}K, windows - 2.04-3.33 W/m^{2}K

Building Energy Codes. Experience of UNECE countries. Russia

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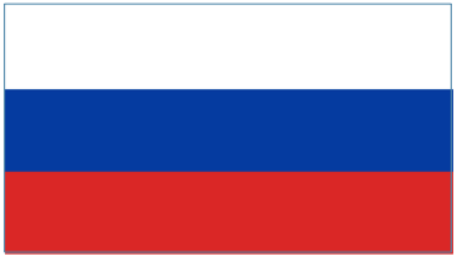

In Russia, about 80% of apartment buildings were built before 1999 according to outdated building codes. New legislation in the field of energy efficiency sets standards for energy consumption regulation to stimulate energy saving and amends the current legislation to ensure compliance with energy saving regulations.

Coverage

- Single family houses
- Apartment blocks
- Commercial
- Public buildings

- new non-residential
- new residential

National classification of buildings covered in building energy code:

A++, A+, A, B+, B, C+, C, C-, D, E

Energy levels are considered in building codes:

heating, cooling, hot water, lighting, ventilation. Total primary energy use.

Building Energy Codes experience of UNECE countries. France

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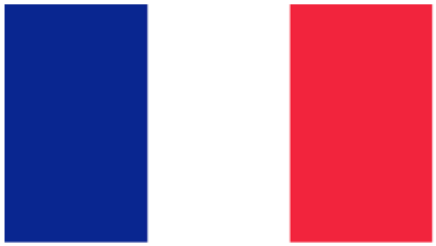
Thermal regulations RT 2005 set insulation, envelope, and HVAC standards for energy efficiency for all new and existing buildings in France. France has had prescriptive building energy efficiency requirements since 1955. The first performance-based standard was implemented in 2005 following the release of the Energy Performance of Buildings Directive (EPBD) requirements in 2002.



Coverage

- Single family houses
- Apartment blocks
- Commercial
- Public buildings

- new residential (No RT 2006 & 2010)
- new non-residential

Building Energy Codes requiriments:

Insulation: Average U value <=0.36 W/m^2.K
Ratio of global average linear thermal transmittance <=0.28 W/m^2.K
Air Leakage: 0.60 m^3/h.m^2 at 4 Pa for single family building
1 m^3/h.m^2 at 4 Pa for multi-family building

Building Energy Codes experience of UNECE countries. Denmark.

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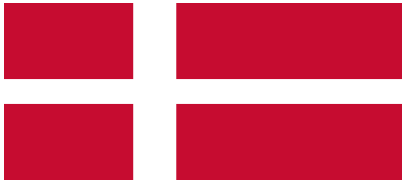

The Danish building code plays a key role in ensuring energy efficiency in both new and existing buildings. The code is reviewed and updated at least every five years to reflect developments in technology and prices.

Building Energy Codes experience of UNECE countries. Denmark.

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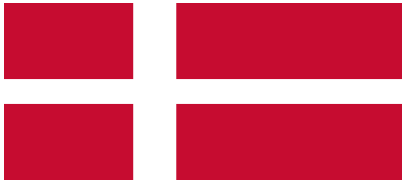

Prescriptive requirements in building energy codes

Insulation

U-Values (W/m^2.K): Walls 0.3 Windows 1.8 Floor 0.2 Roof 0.2

Skylights: Energy gains through rooflights must not be less than - 10kWh/m2/year, in 2015 it should not be less than - 17kWh/m2/year Low energy residential buildings (2015): 1.01 l/s.m^2 at 50Pa

Space Heating System: Ventilation installations must incorporate heat recovery with a dry temperature efficiency of no less than 70% (80% for single dwellings) Heat pumps for heat recovery must have a minimum coefficient of performance of 3.6 in heating mode.

Water Heating System: Domestic water systems supplied by a domestic ventilation heat pump must have a minimum COP (coefficient of performance) at the draw off point of 3.1.

Renewable Energy: Solar heating systems must be provided when the expected hot water consumption exceeds 2000l per day and able to meet 95% of demand

Comparison of U-values

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Comparison of energy efficiency demands in Building Codes, or standards for energy efficiency in new buildings, is complicated, because the demands will dependent on local traditions and climate conditions in the individual country or state. Sometimes the conditions even vary substantially within one country or state.

Regulations (building codes) can be set in different ways:
-some codes set value for the whole buildings energy performance
-other codes have requirements on the individual parts of the building and the heating and cooling systems etc.

The aim is to compare U-values for different building parts and building regulations with the major aim of reducing heating.

Comparison of U-values

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- When prescriptive values in building codes are compared based on heating degree days there are some differences between the regions. Requirements for ceilings and floors are relatively high in North America, and values for ceilings are higher than comparable climates especially in Southern Europe and Japan.

- Requirements for walls are higher in Northern Europe than in North America and Japan, while the values for walls are higher in the US than in similar climates in Southern Europe. Requirements for windows are higher in Europe than in North America.

Comparison of U-values

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- In the US and Canada most values are close to or slightly better than the model building codes for energy efficiency and they seem to be quite homogenous. Values in Europe vary substantially and especially there is a large difference between high values in the North and more differentiated and lower values in the South of Europe.

- The highest requirements for U-values are found in the Nordic countries and in Ontario in Canada. Sweden has the highest requirements found in this comparison of U-values closely followed by Denmark and Norway.

Beyond the Building Codes

Building codes and energy standards for minimum energy efficiency set minimum requirements for energy efficiency for all new buildings. In many cases it is as shown above possible and feasible to build with a much higher efficiency thereby improving the economy over the long term.

No building codes or energy standards found in this study limit constructors or future owners to go for higher energy efficiency. But still the vast majority of new buildings are constructed exactly with minimum requirements of energy efficiency.

Beyond the Building Codes

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However, some buildings aim for much higher efficiency standards and among these are:

- Low Energy Buildings
- Passive Houses
- Zero Energy Buildings and Zero Carbon Buildings
- Plus Energy Buildings

Other types of buildings also aim at higher standards beyond the requirements in energy efficiency standards and buildings codes, for example, Green Buildings, Intelligent Buildings, Integrated Design, Sustainable Buildings or Ecological Foot Print.

Potentials for energy efficiency in new buildings

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For new buildings most regulations are far from the least cost optimum if costs are calculated for 30 years based on investment, interest rates, mortgage costs, and accumulated energy costs.

Conclusion on potential in new buildings

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- If passive houses became more commonly adopted on the market these technologies would become less expensive which could increase the cost effectiveness of these houses and increase the saving potential even further.

- A targeted policy to increase the development of more efficient solutions through demonstration projects, research and development could accelerate this development. Such a policy could help Zero Energy Buildings to become a feasible solution.

- The conclusion is that passive houses are already a feasible alternative in many cases, and while zero net energy buildings will increase costs, they are not dramatic and it must be expected that these buildings can become feasible in the next 1-2 decades.

Practical task

- PRACTICAL TASK TOPIC 7 PART 2.