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

Topic 1. Existing legislation and responsible governmental agencies. Examples from UNECE countries.

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Building energy codes

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Key policy instrument used by governments to limit buildings' pressure on the energy sector and environment while providing occupants with comfort and modern living conditions.

In some countries known as
-"energy standards for buildings",
-"thermal building regulations",
-"energy conservation building codes"
-"energy efficiency building codes"

The terms "building energy codes" or "energy standards" for new buildings generally refer to energy efficiency requirements for new buildings whether they are set in building codes, specific standards or other ways, unless otherwise stated.

Building energy codes – responsibility level

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EE building codes have several levels of responsible parties in implementation and quality inspection:

Country Level (Federal)

-Ministries of Energy, Industry, Construction, Economical Development or similar

-Governmental Energy and Energy Efficiency Agencies

-State policies and normative development institutions

Local Level (Regions, Municipalities, Cities)

-Local administration

-Local Energy Ministry/Department

-Public services departments (healthcare, education …)

Building energy codes

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Effective building energy codes consist of a set of mandatory requirements designed to reduce the energy consumption of buildings. Building energy codes are used as mandatory tools to stipulate desired energy efficiency characteristics for buildings.

Countries may use different approaches in the design of their building energy codes. A prescriptive approach sets minimum energy performance requirements for each component of the building – windows, walls, and heating and cooling equipment. A performance approach requires an integrated design based on a holistic assessment of the building's energy performance.

Existing Energy Efficiency Standards in Buildings in the UNECE Region

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In 2018, UNECE developed study **Mapping of Existing Energy Efficiency Standards and Technologies in Buildings in the UNECE Region**

This Report lays out the status of building energy standards stringency, technical requirements, enforcement and compliance, use of energy efficient building materials and products in selected countries of the UNECE region

Existing Energy Efficiency Standards in Buildings in the UNECE Region

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Research work was focused on:

- Main regulatory documents;
- Building Energy Codes stringency and coverage;
- Performance-based requirements in Building Energy Codes;
- Prescriptive requirements in Building Energy Codes;
- Energy Performance Certificates;
- Requirements for enforcement and compliance;
- Requirements for building materials and products.

Building energy codes stringency and coverage. Existing specific standards and technical requirements

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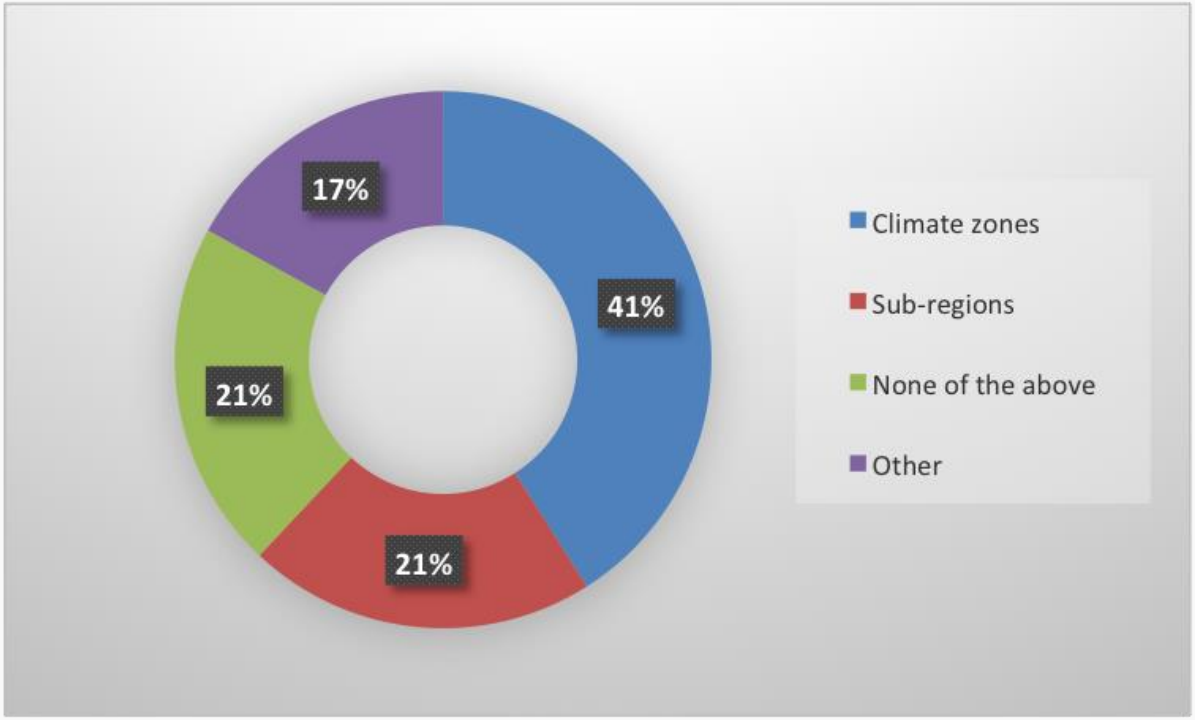
Presence of specific standards for climate zones, sub-regions, etc.

Existence of specific standards for climate zones (41 percent), followed by sub-regions (21 percent).



Building energy codes stringency and coverage. Existing specific standards and technical requirements

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Examples:

• **Montenegro** indicated that climate data is used for calculation of total primary energy consumption in buildings by three climatic zones, **Bosnia and Herzegovina** reported two climatic zones.

• **Albania** is divided into three climatic zones: zone A is the mildest along the sea, zone B is the medium zone and zone C is the coldest in the mountainous area. About half of the buildings are located in climate zone B, while climate zone A has about one third of the buildings. The least buildings, about 16 percent of the stock are located in climate zone C.

• **United States**, many states require additional energy calculation compliance based on localized climate requirements. **Canada** also has specific standards for climatic zones and sub-regions thus provinces and territories may adopt the federal model code with some modifications, creating some differences between provinces or sub-regions.

Sub-Regions of the study

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Sub-region A:
Germany, France, Italy, Portugal, Switzerland, Spain, United Kingdom

Sub-region B
Bulgaria, Croatia, Czech Republic, Slovakia

Sub-region C
Belarus, Turkmenistan, Uzbekistan, Kazakhstan, Armenia, Belarus, Turkmenistan, Uzbekistan, Kazakhstan, Armenia, Russian Federation, Ukraine, Azerbaijan, Republic of Moldova, Georgia

Sub-Region D
United States, Canada

Sub-region E
Bosnia and Herzegovina, Montenegro, Serbia, the former Yugoslav Republic of Macedonia, Albania

Coverage of building energy codes for different buildings types

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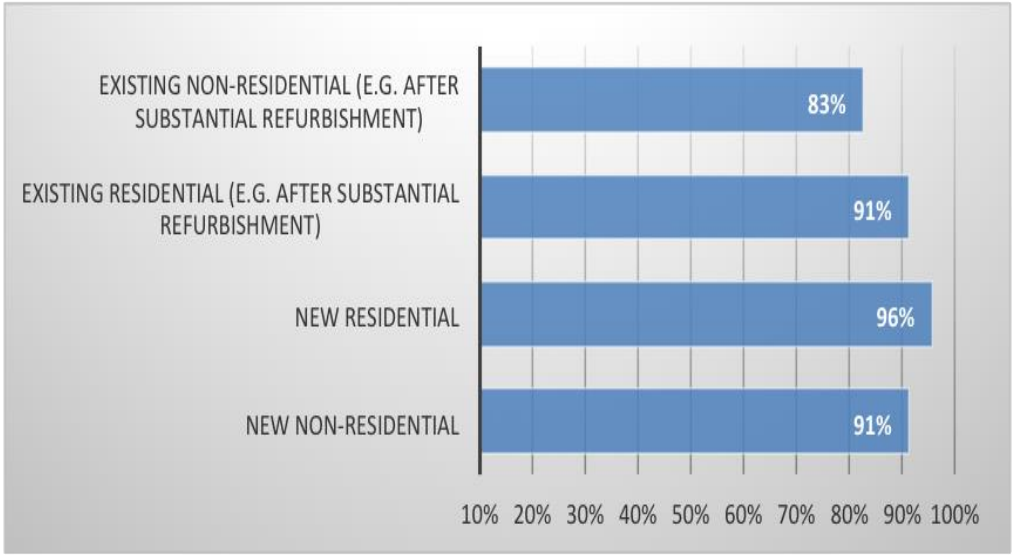
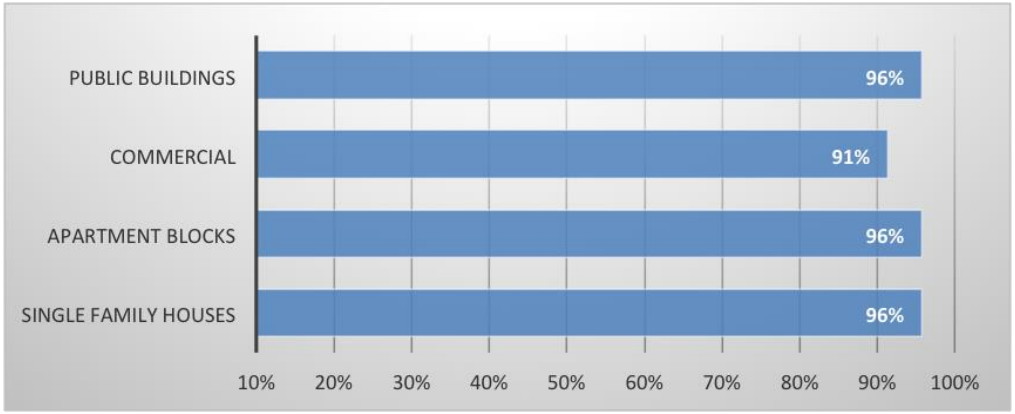
- Majority of buildings covered by building energy codes are new residential (96 percent), followed by equally distributed existing residential and new residential buildings (91 percent).
- Existing non-residential buildings represent the lowest percentage (83 percent percent) of coverage.
- Public buildings, apartment blocks and single-family houses represent equally 96 percent coverage, with commercial buildings having a slight lower share of 91 percent in the UNECE region.





Coverage of building energy codes for different buildings types

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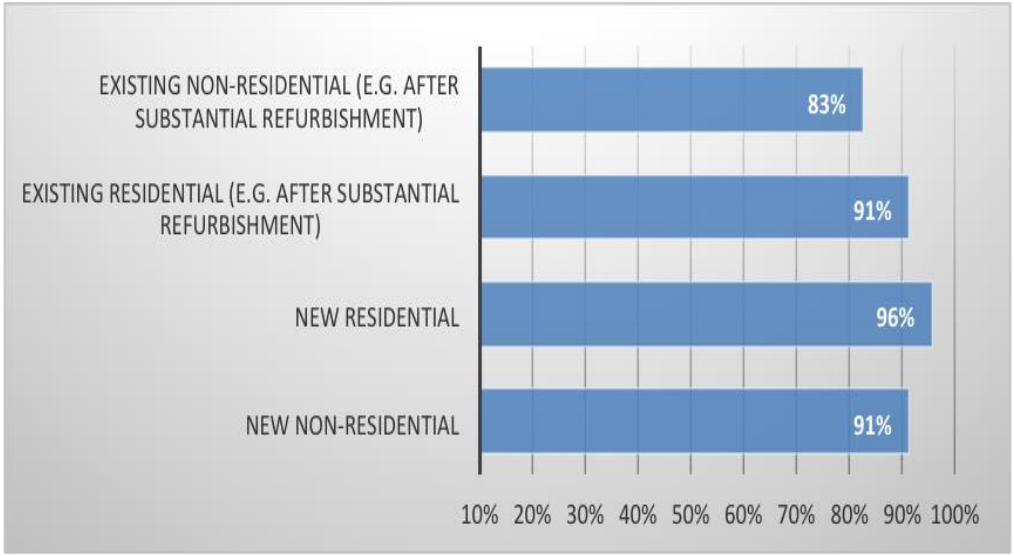
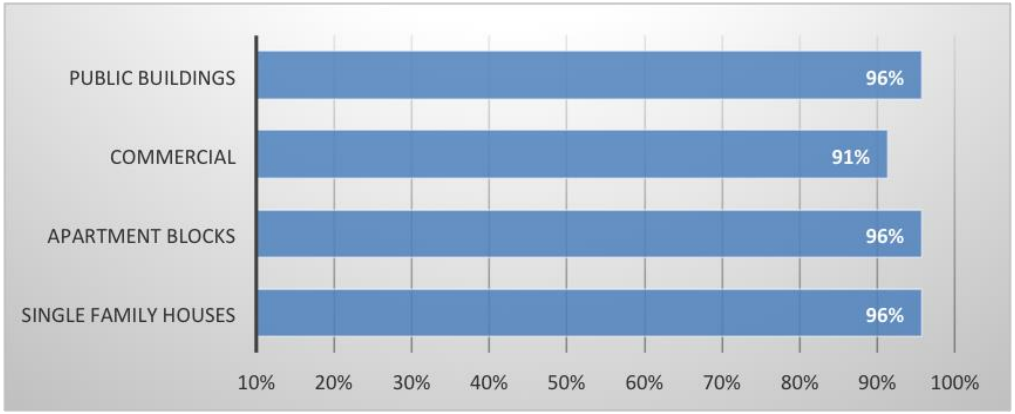
- New residential and existing residential both share the same percentage (93 percent),

- Coverage of new non-residential and existing non-residential buildings is slightly lower (87 percent and 81 percent respectively) in sub-region C compared to UNECE region.





Building energy codes stringency and coverage. Existing specific standards and technical requirements

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Examples:

• Building energy code in the **Republic of Moldova** does not contain provisions to cover new residential buildings, while

• Building energy codes in **Georgia** does not cover new and existing non-residential buildings.

• Public buildings and apartment blocks in sub-region C present an equal (94 percent) coverage which is slightly lower compared to the UNECE region, with commercial buildings representing 81 percent.

•**Azerbaijan and Kazakhstan** do not currently have provisions to cover single family buildings types.

•**United States** indicated that the building energy codes covered all types of buildings, while **Canada** has provisions to cover only new residential and non-residential buildings in its building energy codes.

Stringency of building energy codes in the UNECE region

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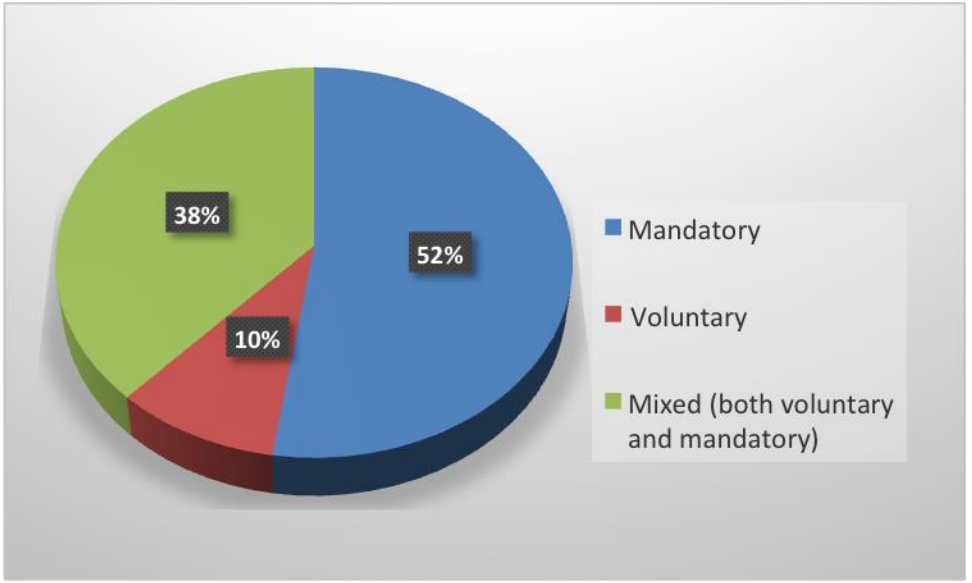
• Most countries have mandatory building energy codes in place while some countries still apply building energy codes only to specific types of buildings, such as single- or new multifamily buildings in the residential sector. The more comprehensive the code, the more types of buildings the code should apply to.



Performance-based requirements in building energy codes

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- **Many** building energy efficiency regulations started with requirements for the building shell, and nearly all efficiency regulations for new buildings include requirements for the building envelope. As the building's envelope improves, regulations focus on the energy efficiency of HVAC systems. Finally, when all parts of building and HVAC systems are covered, regulations address other installations and renewable energy.

- **According** to the survey results, 90% of respondents confirmed the existence of performance-based requirements for new buildings, followed by 77 % for existing buildings and 33 % for energy efficiency development systems.

Energy levels considered when defining energy performance of a building

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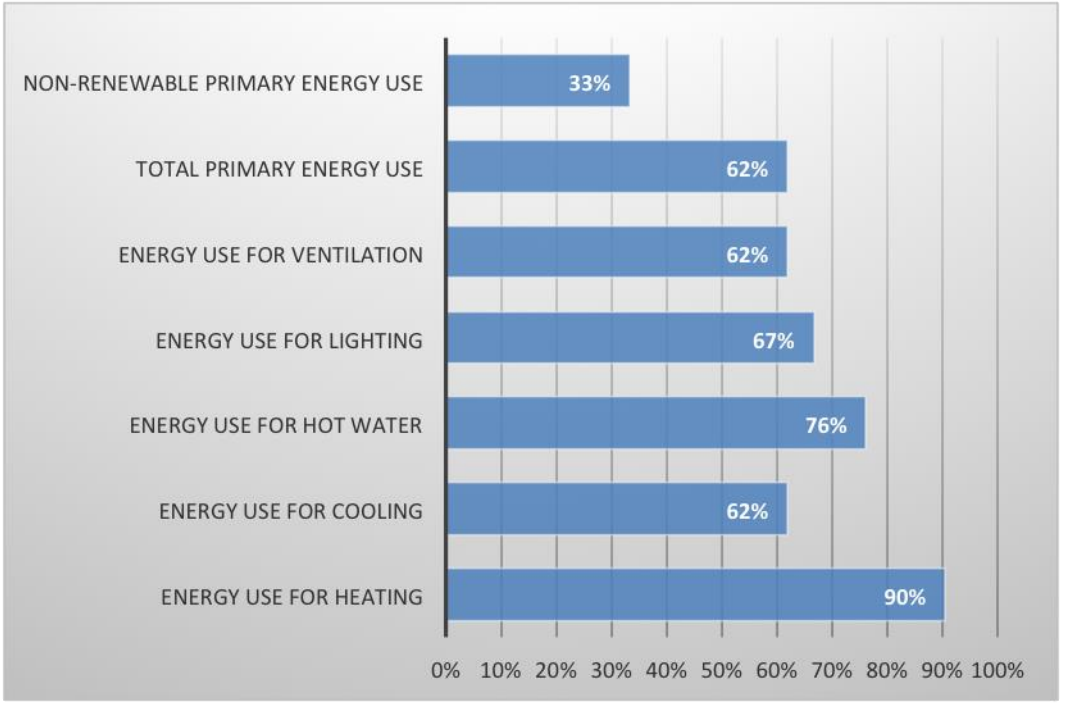
Usage of different energy levels considered when defining energy performance of a building, with 90 percent energy use attributed to heating, hot water (76 percent) and lighting (67 percent).



Prescriptive technical requirements in building energy codes

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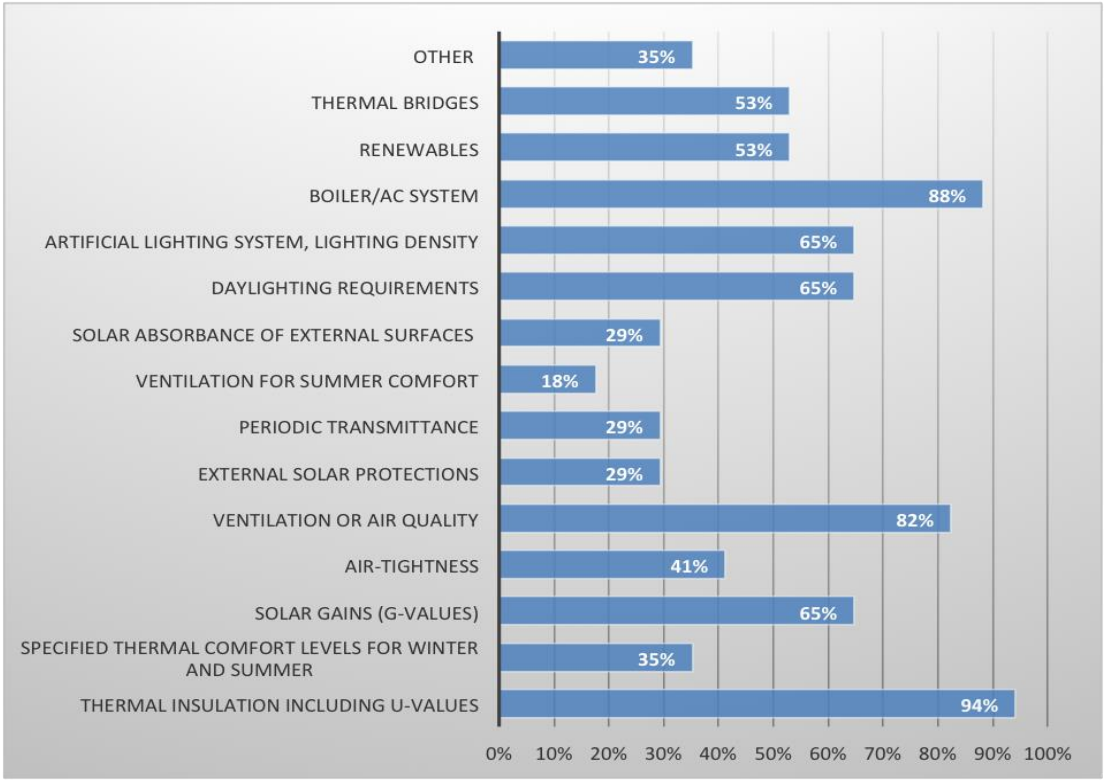
Large majority of the UNECE countries have requirements for thermal insulation including U-values (94 percent), followed by boiler/AC system (88 percent) and ventilation or air quality (82 percent).
Lighting density, daylighting and solar gains (G-values) are equally distributed (65 percent) with both renewables and thermal bridges representing 53 percent.



Types of buildings covered by the Energy performance certificate (EPC)

EPC is an important instrument to enhance the energy performance of buildings.

Main aim of the EPC is to serve as an information tool for building owners; occupiers and real estate actors and visualize EE as a marketing attractive add-on. Therefore, it can be a powerful market tool to create demand for energy efficiency in buildings by targeting such

Types of buildings covered by the Energy performance certificate (EPC)

Coverage of the EPC for different types of buildings. The results suggest that most of buildings covered by the EPC are those new non-residential (41 percent). 24 percent of responses indicated that none of the building types were covered by EPC, followed by new residential buildings (18 percent).

Existing residential buildings represent the lowest percentage (6 percent) of coverage. Public buildings represent 88 percent coverage, followed by equally distributed single-family houses (82 percent) and commercial buildings (82 percent), with apartment blocks having a slight lower share of 76 percent in countries of the UNECE region.

According to the responses received, in some countries, e.g. Albania, Belarus, Georgia, Kazakhstan and the former Yugoslav Republic of Macedonia, the EPC is not currently used.

Types of buildings covered by the EPC

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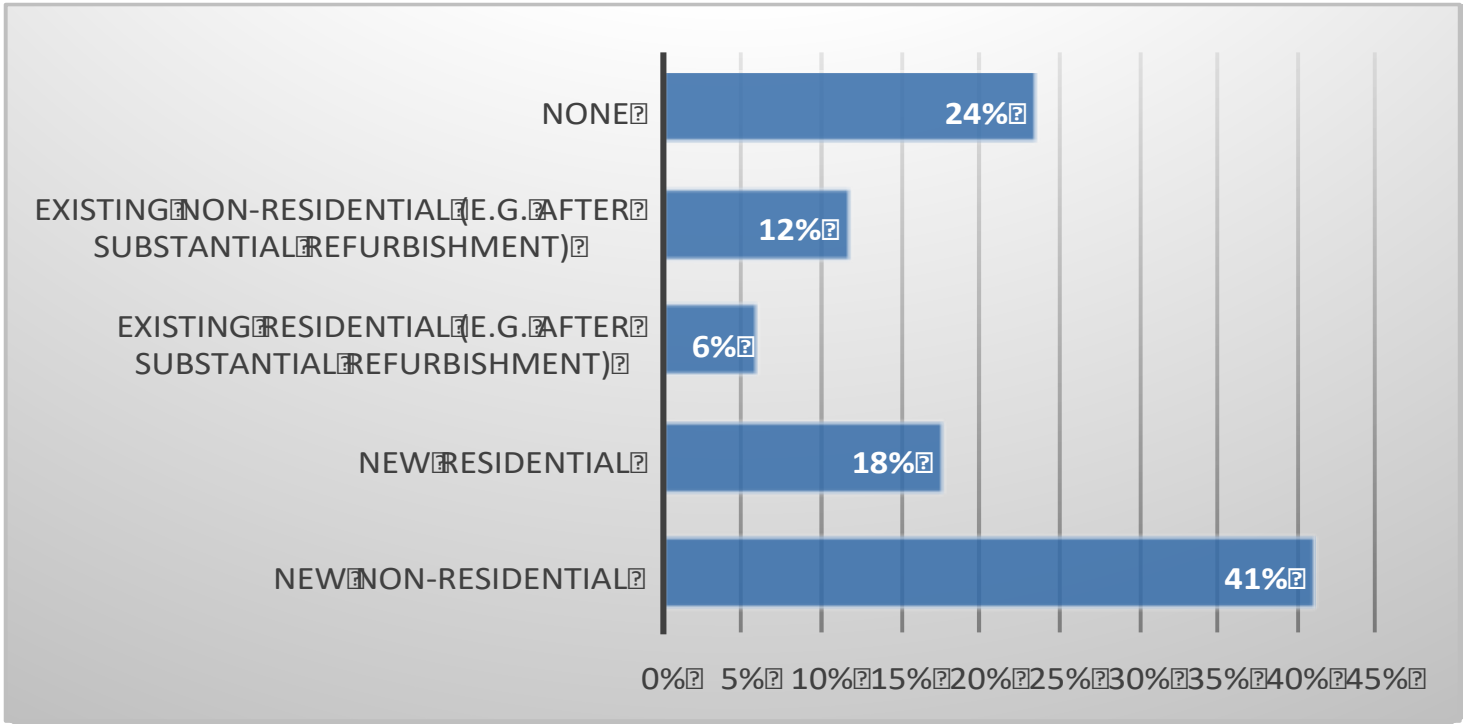
Type of buildings covered by EPC in countries of the UNECE region



Policy requirement level for EPC

- In the countries of the UNECE region the majority of the EPC requirements are mandatory (56 percent), followed by mixed (33 percent) and voluntary requirements (11 percent).

- 50 percent of respondents confirmed the existence of a national registry database for EPC, followed by 39 percent who replied that it does not exist and 11 percent who did not know.

- In Spain, for example, there is no national registry database for EPC, although the policy level requirement for EPC is mandatory in this country.

Penalties, incentives and other mechanisms for improving compliance

65 percent of member countries confirmed the existence of specific incentives for compliance in country's building energy code, while 35 percent indicated otherwise.

At present, some countries, e.g. Albania, Azerbaijan, Belarus, Croatia, Kazakhstan, Montenegro, Republic of Moldova, Russian Federation, Serbia, Turkmenistan and Ukraine, do not have incentives for improving compliance.

Penalties, incentives and other mechanisms for improving compliance

In Italy, there are fiscal detractions if someone goes beyond the minimum requirements (about 60 percent), but also if someone just does a retrofit work (50 percent).

In Switzerland, financial incentives are given to improve the thermal efficiency of the envelope and heating systems. The Swiss Buildings Program supports measures to improve the energy efficiency of real estate assets, such as roof and facade insulation, heat recovery, optimization of technical facilities and the use of renewable energy.

A number of responses indicated that the compliance and enforcement of building energy codes is currently undertaken with less rigour and attention to detail.

Penalties, incentives and other mechanisms for improving compliance

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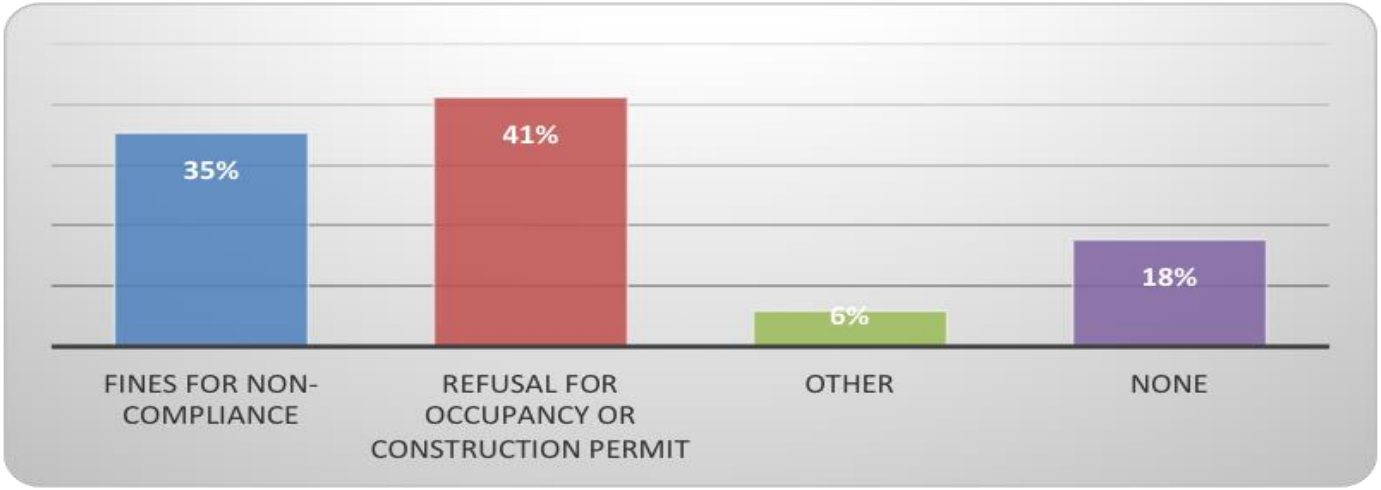
Penalties each country uses for non-compliance with the regulations. In particular, a large proportion of responses (41 percent) indicated that refusal for occupancy or construction permit was widely used, followed by fines for non-compliance (35 percent). Much smaller proportion of responses (18 percent) stated that penalties for non-compliance were not used.



Analysis of the comprehensiveness and stringency of the Building Energy Codes

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Building energy codes in sub-regions A and B provide greater coverage and stringency compared to sub-regions C and D, although it is noteworthy that countries of the sub-region C have made a considerable progress to ensure that building energy codes apply to different types of buildings.

The average scores for this metric do not differ significantly across sub-regions, with countries in sub-regions A and B having an average score of 4.9, followed by sub-region E (4.6), D (4.5) and C (4.2). Many countries employ mandatory or mixed stringency while Azerbaijan has a voluntary requirement for compliance.

Comprehensiveness and stringency of the Building Energy Codes. Best practice

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France

France has established a mandatory and comprehensive code system. As a member of the European Union, France was required to comply with the Energy Performance of Buildings Directive (EPBD) passed in December 2002. France implemented the Directive in 2005 by updating their National Building Regulation. The 2005 regulation set a 15 percent efficiency rate, and a 40 percent efficiency rate goal, aimed to be met by 2020. France's building regulation also sets minimum standards for existing buildings, and defines the necessary renovations for them. In addition to the mandatory building energy codes, France established complementary categories for efficient buildings and "White Certificate Trading," requiring energy suppliers to meet mandated targets for energy savings through their customers.

Comprehensiveness and stringency of the Building Energy Codes. Best practice

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California

California has a long history of building energy code development with a continuous increase in stringency and enforcement. California's building standards in 2016 (to be enforced as of 2017) set net-zero energy requirements for all new residential buildings by 2020, for new commercial buildings by 2030, for new state buildings and half of major retrofits by 2025, and for half of existing commercial buildings by 2030. The new standards include: a basic set of mandatory requirements for all buildings, a set of performance requirements that vary by building type and climate zone, and a set of prescriptive packages as an alternative to the performance-based approach.

Comprehensiveness and stringency of the Building Energy Codes. Best practice

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Armenia

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 standards, e.g. EN 15217:2007; EN15316-1:2007; EN15603-1:2007; ISO 16818:2008; and ISO 23045-2008. It links building envelope components and heat losses with established energy limits, taking into account differences in climatic conditions. It also includes a requirement for issuing a building energy passport and an energy efficiency label with energy efficiency classes. Armenia has developed two National Standards AST 362-2013 “Energy conservation. Building energy passport. Basic rules. Standard form” and AST 371-2016 “Methodology for performing energy audit in residential and public buildings”.

Technical requirements in Building Energy Codes

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Technical requirements of the country's building energy codes cover different energy uses and functions:

- Thermal insulation;
- Heating and hot water;
- Air conditioning systems;
- Natural and mechanical ventilation;
- Solar gains (G-values);
- Lighting efficiency;
- Design, position and orientation;
- Air-tightness;
- Thermal bridging;
- Renewables;
- Indoor and outdoor climatic conditions; and
- Passive solar systems and solar protection.

Technical requirements in Building Energy Codes

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Results of analysis

Nearly all of the countries indicated that their energy efficiency standards incorporated provisions for the building envelope which influenced design choices for the roof, walls, floor and windows. While some building energy codes include energy consumption of installed equipment and appliances, some include lighting and others do not (e.g. Kazakhstan, Serbia, Turkmenistan and the former Yugoslav Republic of Macedonia). The treatment of renewable energy systems in building energy codes also varies. Building energy codes in countries for sub-regions A and B tend to consider more the renewable energy systems compared to sub-regions C, D and E.

Technical requirements in Building Energy Codes

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Small number of countries which are still to implement requirements on heating, cooling, lighting or ventilation, many member States have now these requirements in place. The most advanced building energy codes or standards for energy efficiency in buildings today include all these aspects. It should be the aim to include most of these elements in building energy codes or the calculation of energy performance, especially when requirements are high, since this will increase the saving potentials and will prevent sub-optimization of the demands for some parts of a building.

Technical requirements in Building Energy Codes. Best Practice

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Spain

Spain's building energy efficiency requirements have both prescriptive and performance based elements. Their codes cover residential and non-residential buildings and require a performance-based reference building calculation (manual or simulation) to show compliance for most building types. A prescriptive path can be used for buildings in specific locations. This path covers many technical requirements such as the thermal envelope and energy efficiency standards for HVAC, hot-water, lighting, and auxiliary systems. In addition, their code covers design, position, and orientation of building as well as requirements for technical installations.

Energy Performance Certification in individual countries

Use of EPC in sub-regions A and B provides greater coverage and stringency with the average score of 5.4 and 5.5 respectively, compared to sub-regions E (4.5), D (2.8) and C (2.0). It is noteworthy, however, that some countries in sub-region C have made some progress in developing EPC.

The EPC in Canada are not mandatory, although an Energuide rating system developed by the federal government is widely used and supported through incentive programs. In addition, Canada, in its new "Build Smart, Canada's Buildings Strategy 2017", sets the goal for federal, provincial, and territorial governments to work together with the aim of requiring labelling of building energy use by as early as 2019.

Most of the countries in sub-regions A and B employ mandatory stringency for EPC while countries in sub-region C currently have a much lower level of EPC implementation. The existence of national registry database for EPC is also more prominent in sub-regions A and B.

Energy Performance Certification in individual countries. Best practice

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Slovakia

In Slovakia, the responsibility of the EPC system and the database falls under the jurisdiction of the Ministry of Transport and Construction. Slovakia established a national database in 2010 which is becoming more and more functional with open content.

The data for newly issued certificates must first be uploaded by the qualified expert to the database in order to be approved and validated. Furthermore, Slovakia has implemented an online system which allows the registered assessors to directly access the database. The mandatory upload allows automatic quality controls at a basic level for all entered data and calculations. In addition to qualified experts, any user can view aggregated statistics by using this online tool. It is possible to view statistics for each year since 2009 for the total number of issued certificates in each of the country's provinces. The database also provides information on the year of EPC issuance, the energy class, building type, its exact address, as well as the name of the qualified assessor.

Energy Performance Certification in individual countries. Best practice

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Russian Federation

Russian Federation adopted the decree 399 in August 2016, which sets the rules for energy efficiency classes of apartment buildings. The energy efficiency class is determined based on comparison of the actual energy use (for existing buildings) and estimated energy use (for new buildings), with the base energy use value set depending on the heating degree-days and the building height. The certification includes nine classes (A++ to G) and requires the building class to be presented in the energy passport and on the building facade.

The A++ class presumes 60 percent energy savings in comparison to the base level. High energy efficiency classes cannot be given to a building that is not equipped with: an individual heat-supply station with automatic indoor temperature regulation, energy-efficient lighting of common areas and energy meters in each apartment.

This certification system is envisioned to be mandatory; however, it is not yet enforced, and measures to stimulate compliance have not been developed yet.

Energy Performance Certification in individual countries. Best practice

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Ireland

The Energy Performance Certificates scheme came into effect in 2009 and became mandatory information for sales and leases. By mid-2014 25 percent of homes had Building Energy Ratings (BERs) and certificates. A one-step increase in BER rating has been valued at a 2.8 percent increase in sale price and 1.4 percent of rent.

Building Energy Codes enforcement standards

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Ireland

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Building Energy Codes enforcement standards

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The results of the gap analysis suggest that sub-regions A, B, and D have developed a number of specific policy packages and incentives that complement or motivate compliance with building energy codes. Such mechanisms include green loan programs, financial schemes and incentives, and public incentives including tax credits. The results for sub-regions C and E present a different picture where specific incentives and enforcement mechanisms are currently not widely used in building energy codes. Ukraine, for example, currently does not have incentives for owners of buildings to make energy audits and get energy performance certificates. However, the work is currently underway to introduce an Energy Efficiency Fund where the state will provide financial support to partially compensate the costs of modernization and implementation of the energy efficiency measures.

Building Energy Codes enforcement standards. Best practice

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Albania

Albania's National Energy Efficiency Action Plan established a target of 9 percent energy use reduction across sectors by 2018. Energy use reduction in the residential building sector is expected to account for 22 percent of the broader target. Albania has taken important steps toward achieving these reductions by requiring 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. Albania is working towards the development and passage of an updated Law on Energy Efficiency, which will build a framework for enforcement and implementation of national energy efficiency priorities that have previously remained unenforced.

Building Energy Codes enforcement standards. Best practice

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Canada

Canada has all three kinds of enforcement mechanisms in both residential and commercial codes. Canada's most advanced building code, which has not been evenly implemented across the country, contains some comprehensive energy efficiency policies, incentives, and disincentives. Onsite inspections throughout the construction process is required throughout Canada. Specifically, the Ontario Building Code's enforcement includes on-site inspection during and after the completion of a building. They also require certification and inspection of boilers and HVAC systems. Enforcement, as with nearly all building codes, is performed by localities, but the Ontario code also requires a third-party inspection and provides training for inspectors.

Building Energy Codes enforcement standards. Best practice

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Belgium

In Flanders, fines are set for the owners (builders, constructors or installers), who fails compliance. These fines are based on the failure in complying on u-values for the surface area. For example, a one family house with non-compliant glazing was fined €2,500

Declaration of Energy Efficiency before the construction

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Portugal and Denmark

In Portugal and Denmark the building's energy efficiency must be declared before the building is constructed. This can be done by the architect or the contractor. After construction, a certificate is to be issued by independent consultants including a review of the self-declaration. If the building fails to comply with the regulations, the occupancy permit needed to use the building can be rejected, until an adequate efficiency level is accomplished.

In Denmark all new buildings are inspected by an independent consultant, who makes calculation based on the self-declaration of the building used for the building permit, and a visual inspection on site which checks the actual insulation, glassing and installed products. Occupancy of the building can only occur once compliance with the building codes is validated

Incentives. Best Practice

France

France is leading the way in supporting measures. They incentivize and reward initiatives beyond the building energy code. They also have robust labeling and certificate schemes that include grants, subsidies, loans, tax incentives, and trading schemes. France provides a successful example of implementing tax incentives for homeowners: due to a tax credit scheme providing tax credits for homeowners adopting measures which improve the energy performance of their dwellings, a 26 percent reduction in energy consumption of residential buildings by 2020 is expected.

Incentives. Best Practice

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United States of America

In the US, tax incentives have been given in the last years to increase the level of insulation and to encourage the constructor and building owners to go further than the minimum requirements. These incentives have probably also helped to increase the compliance with the national codes.

Analysis of energy efficiency materials and products requirements in Building Energy Codes.

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Countries of sub-regions A and B perform consistently across all three criteria. Member States of the sub-region C have shown a lower level of consistency in implementing these requirements compared to the sub-regions A and B, with some countries being more stringent than the others when it comes to materials certification and testing.

A number of countries from sub-regions C and E, e.g. Albania, Georgia, Turkmenistan, Ukraine and the former Yugoslav Republic of Macedonia, showed relatively low level of implementation for this metric, while other countries, e.g. Armenia, Bosnia and Herzegovina, Kazakhstan, Montenegro, Russian Federation, Serbia and Uzbekistan, exhibited greater level of commitment to implement energy efficiency materials and products in their building energy codes.

Analysis of energy efficiency materials and products requirements in Building Energy Codes. Best practice

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Armenia

In Armenia, technical regulation on “ES and EE in residential multi-apartment buildings under construction as well as in objectives constructed (reconstructed, repaired) at the expense of state means” (12.04.2018) was adopted in April 2018. New building code on “Thermal Protection of Buildings” was developed and adopted in July 2016. 17 EU and ISO standards on energy efficiency were developed/adopted and registered: a database of insulation construction materials and lighting equipment produced locally or imported to Armenia (with technical parameters) was prepared in 2013 and 2016, and an Advisory Handbook on Technical Solutions in Insulation was adopted by the resolution of the Minister of Urban Development in 2013. In addition, a full package of replicable design documents for 5 energy-efficient residential houses (published on the web-site of the Ministry of Urban Development) has been available free of charge for use since 2014

Effectiveness of building energy codes by sub-region

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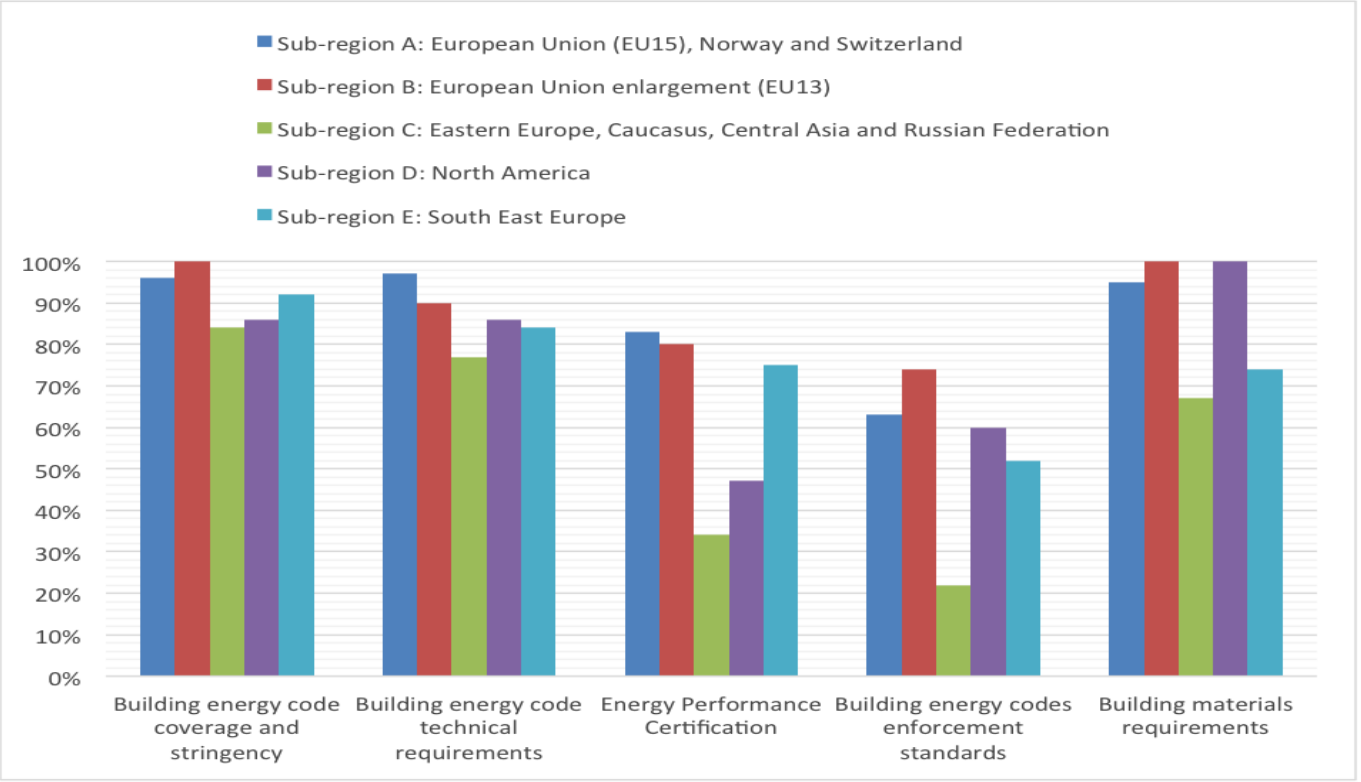
Figure below illustrates the overall effectiveness of the building energy codes by sub-region across all five metrics, where previously calculated average scores were converted into percentages (where 100 percent indicates max amount of points per metric).



Conclusion

In Europe, the Energy Performance of Buildings Directive (EPBD, 2002/91/EC) was a step forward through which sub-regions EU15 and EU13 introduced energy efficiency requirements in buildings. This explains a greater level of consistency across the countries that fall under the EPBD in reporting building energy standards stringency, coverage, technical requirements, energy efficient materials and enforcement measures with just a few exceptions noted in some countries.

Results of the gap analysis revealing that, although the first two metrics (codes stringency and coverage and technical requirements) do not indicate a high level of disparity in their application between sub-regions, metrics concerning requirements for the EPC, incentives, enforcement mechanisms and building materials and products suggest an area of focus for further harmonization and an opportunity for improvement in some countries, particularly for countries in sub-region C.