USAID FROM THE AMERICAN PEOPLE | MUNICIPAL HEATING REFORM IN UKRAINE

MUNICIPAL HEATING REFORM PROJECT (MHR)

Building codes related to Energy Efficiency of Buildings

Spot Gap Analysis between EU and Ukraine

December 2010
This document was produced for review by the United States Agency for International Development (USAID).
It was prepared by ENSI within the USAID Municipal Heating Reform Project in Ukraine.

MUNICIPAL HEATING REFORM PROJECT (MHR)

Building codes related to Energy Efficiency of Buildings

Spot Gap Analysis between EU and Ukraine

ENERGY II IQC, TASK ORDER 9
Contract: EPP-I-00-03-00006-00

December 2010

This document was made possible through support provided by the U.S. Agency for International Development.
The author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government.

List of content

1. Executive summary 4
2. Background 5
   2.1 Main EU Directives related to energy efficiency in buildings 5
   2.2 Main Ukrainian legislation and regulations related to energy efficiency in buildings 7
   2.3 Conclusions 10
3. Review of Building Standards related to energy efficiency 12
   3.1 Requirements to energy use (need) by different types of buildings 20
      3.1.1 Europe 20
      3.1.2 Ukraine 22
      3.1.3 Conclusions 25
   3.2 Requirements to building envelope 26
      3.2.1 Europe 26
      3.2.2 Ukraine 27
      3.2.3 Conclusions 32
   3.3 Requirements to heating systems, heat supply in building 34
      3.3.1 Europe 34
      3.3.2 Ukraine 38
      3.3.3 Conclusions 39
   3.4 Requirements to ventilation systems 39
      3.4.1 Europe 39
      3.4.2 Ukraine 42
      3.4.3 Conclusions 43
   3.5 Requirements to domestic hot water, and hot water supply in buildings 43
      3.5.1 Europe 43
      3.5.2 Ukraine 45
      3.5.3 Conclusions 45
   3.6 Requirements to lighting systems 45
      3.6.1 Europe 45
      3.6.2 Ukraine 47
      3.6.3 Conclusions 47
   3.7 Requirements to Energy Metering and Management 47
      3.7.1 Europe 47
      3.7.2 Ukraine 48
      3.7.3 Conclusions 48
   3.8 Requirements to energy certification of buildings 48
      3.8.1 Europe 48
      3.8.2 Ukraine 54
      3.8.3 Conclusions 54
4. Recommendations 55
   4.1 Immediate 55
   4.2 Medium term 56
   4.3 Long term 58

1. Executive summary

The Spot Gap Analysis of Building Codes related to energy efficiency in buildings is developed within the USAID project Municipal Heating Reform in Ukraine (further MHR Project).

The objective of this Spot Gap Analysis is to identify the main areas of improvement of Ukrainian Building Codes in comparison with the EU norms or requirements of EU directives related to energy efficiency or energy performance of buildings.

The Spot Gap Analysis was developed by ENSI in close cooperation with SRI BC (Ukraine).

The Report presents an overview of the legislation in Europe and Ukraine in Chapter 2, while Chapter 3 gives an overview of the Building Regulations per building service which is influencing energy performance of buildings and of interest for this project. Chapter 3 also provides brief overview of energy certification schemes in Europe and passportization in Ukraine.

In general Ukraine has created legislation basis for implementation of Energy Efficiency policy. There are Law of Ukraine ―About Energy Saving" and number of laws, which support and develop provisions of energy efficiency. Continuously the President of Ukraine and the Government of Ukraine announce decrees about implementation of secondary legislation related to energy efficiency. However Law of Ukraine ―About Energy Saving" is of declarative character and does not contain implementation mechanisms of energy efficiency policy. By the time of development of this Spot Gap Analysis, there were several draft Laws aimed at improvement of Ukrainian legislation in the sector of energy efficiency in buildings. These drafts have a number of weaknesses and need to be revised.

Considering that most of the buildings in Ukraine and their technical systems do not correspond with the required level of energy efficiency, it is important to establish legislation base (including correspondent by-laws, standards, norms) considering requirements of EU Directives 2010/31/EC and 2006/32/EC (on Energy Performance of Buildings and Efficient Energy End Use), as well as supportive EN norms which are developed for each building service.

The recommendations, based on the results of this study, are given in Chapter 4, divided for ―Immediate" implementation, ―Medium term" implementation and ―Long term" implementation.

2. Background

The Spot Gap Analysis of Building Codes related to energy efficiency in buildings is developed within the USAID project Municipal Heating Reform in Ukraine (further MHR Project).

The purpose of the MHR Project is to assist the National Government of Ukraine (GOU) and local governments to create a financially viable and sustainable municipal heating sector able to deliver quality services to the population, public institutions and local industries. Among many other tasks MHR Project is also focusing on development of Energy Efficiency Building Codes.

The objective of this Spot Gap Analysis, developed by ENSI AS in cooperation with SRI BC, is to identify the main areas of improvement of Ukrainian Building Codes in comparison with the EU norms or requirements of EU directives related to energy efficiency or energy performance of buildings.

This analysis is needed due to necessity to provide regulatory and normative basis which is focused on implementation of energy efficient principles during designing, construction and operation of buildings.

The spot GAP analysis is focused mainly on the most important provisions of law and standards for building elements and systems which influence energy performance of the buildings.

Based on this Spot Gap Analysis general recommendations are provided to improve legislation and norms of Ukraine in order to increase energy performance of the buildings.

2.1 Main EU Directives related to energy efficiency in buildings

Buildings have a substantial role to play in the EU's attempts to reduce greenhouse gas emissions, as they represent around 40% of all energy use. To address this problem EU introduced minimum requirements for the energy performance of buildings.

In 2002, the EU adopted the Energy Performance of Buildings Directive (EPBD), which set minimum efficiency standards for both residential and commercial buildings. The Directive on energy performance of buildings (2002/91/EC) was the main legislative instrument at EU level to achieve energy performance in buildings until its recast in 2010. The Directive referred to a common methodology for calculating the energy performance of buildings (EN 832 and ISO 13790:2008) and obliged Member States to draw up minimum standards. According to the Directive of 2002 these should be applied to all new buildings and to existing buildings with a usable floor area above 1 000 m² when they undergo a major renovation. Consequently, the legislation imposed flexible approach to energy performance of buildings, requiring Member States to lay down concrete requirements, while accounting for local climate conditions and building traditions.

The EU took an integrated approach for calculating efficiency standards. This extends beyond insulation to aspects like heating, cooling, heat recovery and lighting installations. In addition, regular inspections of boilers and central air-conditioning systems and assessments of heating installations were made mandatory.

Moreover, according to EBBD Directive of 2002 alternative systems like decentralised energy from renewables, district heating, combined heat and power generation, heat pumps must be considered in new buildings with a floor area above 1 000 m². To promote greater public awareness and debate on energy savings in buildings, the Directive introduced an energy performance certificate, which has to be made available each time a building is built, sold or rented out. The certificate is supposed to help potential buyers or renters to compare the building's energy performance against established national standards and benchmarks, and to consider any cost-effective improvements they could make. The public sector was expected to take the lead by displaying energy certificates in "prominent" places in public buildings.

It should be noted that the implementation of the EPBD Directive in EU Member States encountered problems due to the lack of qualified experts for energy certification and inspections. A shortage of trained

professionals thus delayed its entry into force by three years. In the same time, the Directive of 2002 excluded a big portion of existing building stock (nearly 70 %) from having to comply with Energy Performance standards by imposing the 1 000 m² threshold. According to the expert opinion the adding of energy efficiency elements into building codes was a slow way to bring energy savings to desired level, as only about 3% - 6% of a country's building stock is built new or renovated even in a good economic year.

In order to overcome these shortcomings, the Commission proposed a recast of the 2002 Directive. One of the key changes introduced by the recast was the extension of the scope of the Directive by eliminating the 1 000 m² threshold. At the same time, alternative energy systems would have to be considered for all new buildings.

The Commission acknowledged that the considerable flexibility in the original Directive had led to widely different levels in the minimum requirements laid down by the Member States. The new recast now refers to a methodology to calculate the "cost-optimal" level of standards, against which Member States would have to compare their actual requirements.

Now all new buildings would have to comply with tough energy-performance standards and supply a significant share of their energy requirements from renewables source after 2020. The public sector shall take a lead with introduction of "nearly zero" energy standards by the end of 2018. However, the concept of "nearly zero" was left vague, allowing Member States to define their own standards. Currently, there are wide variations between definitions in different member states, and often they do not include all types of energy use, from space heating to electricity consumption. One of the criticisms of the new recast was also that there were no standards laid down for the energy performance of existing buildings. The new Directive declaratively indicates that major renovations must increase energy-savings if doing so is technically, functionally and economically feasible. The Member States shall develop national plans to encourage owners to take the opportunity to install smart meters, heat pumps and heating and cooling systems using renewables.

It was estimated that additional costs for making energy efficient buildings will be about 10% compared to building according to traditional solutions. However, experiences from Germany and Austria, with a great share of Europe's low-energy buildings, have shown that increased competition in the market reduces the costs closer to those of standard buildings.

Since appropriate funding will be very important for implementation of reinforced legislation, an article was added to the new Directive on financial incentives, at both the national and EU levels. The new legislation will require Member States to list incentives from technical assistance and subsidies to low-interest loans by mid-2011 for the transition to near zero-energy buildings. One way of raising money for energy-efficiency investment is energy performance contracting, which allows the consumer to pay for energy efficiency investments with future savings. In essence, a building owner contracts an energy service company (ESCO) to assess the energy-saving opportunities in the building and to recommend improvements that will pay for themselves through future savings. Energy performance contracting agreements were established in a number of EU countries in the mid-1990s. Germany, the UK and France now have relatively developed markets, however, according to experts, in this sense Europe is far behind the developed market like in the USA (where federal and state governments have adopted performance contracting as the preferred method for making efficiency improvements in large facilities).

To summarise, the EU requirements on energy performance of buildings and building services are mainly covered by the following EU Directives:

- Directive 2010/31/EC
- Directive 2006/32/EC
- Directive 2009/125/EC
- Directive 2010/30/EU

1. Directive 2010/31/EC Energy Performance of Buildings Directive (EPBD) of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (recast) is mainly focuses on the following topics related to this analysis:
    - Requirements to the common methodology for calculating the integrated energy performance of buildings;
    - Requirements to the minimum standards on the energy performance of new buildings considering cost effectiveness of these requirements;
    - Application of minimum requirements to the energy performance for existing buildings, building units, building elements, building envelope parts or technical building systems that are subject to major renovation or replacement;
    - Necessity of National plans for increasing number of nearly zero energy buildings;
    - Requirements to Energy certification of buildings;
    - Necessity of Inspection of heating and air-conditioning systems in buildings;
    - Necessity of independent control systems for energy performance certificate and inspection reports
2. Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services of the European Parliament of the Council of 5 April 2006 is mainly focuses on the following topics related to this analysis:
    - Energy metering
    - Energy audit as a systematic procedure
    - Provision of independent consultants on providing services on energy auditing
3. Directive 2009/125/EC on Establishing a Framework for the Setting of Eco-design Requirements for Energy-related products of the European Parliament and of the Council of 21 October 2009 (recast) is mainly focuses on the following topics related to this analysis:
    - Establishing energy performance requirements for lighting (lamps).
4. Directive 2010/30/EU on the Indication by Labelling and Standard Product Information of the Consumption of Energy and Other Resources by Energy-related Products of the European Parliament and of the Council of 19 May 2010

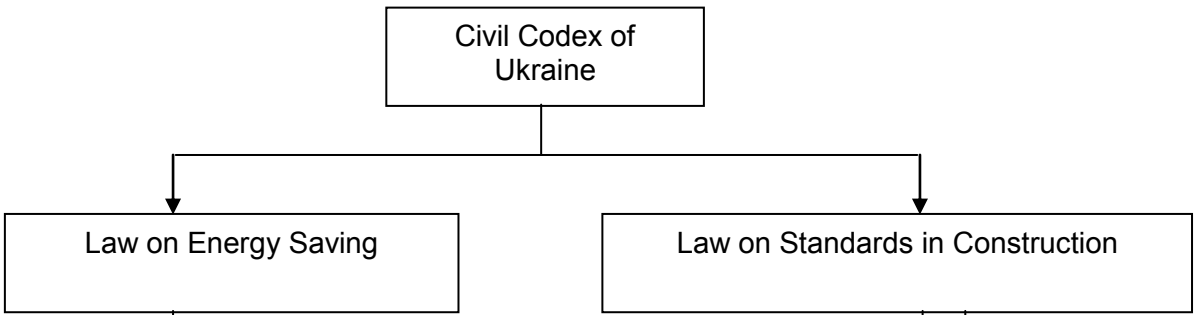
EU Directives lay down certain end results that must be achieved in every Member State. National authorities have to adapt their laws to meet these goals, but are free to decide how to do so. In the same time EU Directives often refer to a number of EU Standards, which provide specifications and methods which should be used providing presumption of conformity to 'Essential Requirements' of the Directives.

2.2 Main Ukrainian legislation and regulations related to energy efficiency in buildings

The structure of legislation base for energy efficiency in buildings in Ukraine is given in the scheme below. The main basis consists of the Law on Energy Saving enforced in 1994 and the Law on Standards in Construction enforced in December 2009.

The main purpose of the Law on Standards in Construction is to define legal and organisational basis for development, endorsement, approval, registration and implementation of construction standards.

It is stated by the Law that the State Construction Standards is valid normative act which include obligatory requirements in construction sector, town-planning and architecture. There are three types of construction standards in Ukraine: State Construction Standards, Branch Construction Standards and Territorial Construction Standards.



Ukrainian legislation in force on energy efficiency

In 1994 Ukraine approved the **Law on Energy Saving**, which defined the strategy of technical development in this sector as well as the main principles of the state policy for energy saving. This Law also introduced the terms of state expertise (approval) on energy saving and energy audit. According to the Law the following objects were subject to the state expertise: energy and technological parts of the feasibility studies and construction projects for the new construction and for expansion (reconstruction, modernization, etc.) of the facilities with the yearly energy consumption equal to 1000 t.c.e or more. In 1998 the Government of Ukraine added the following objects subject to energy saving state expertise: industrial enterprises, residential buildings and agricultural facilities. However it should be underlined that there are still no normative document put in force which would define the order and procedures of such expertise.

It should be noted that this Law has quite declarative character and does not describe solution mechanisms for achieving the goals. In addition, the term ‐energy saving" is not suitable for the building sector, as it was often interpreted in Ukraine as implementation of the most primitive measures reducing energy use for heating often at the cost of indoor comfort. Therefore it would be better to use the term ‐energy efficiency", as it would be defined by specific (or total) energy use of the building at the mandatory level of indoor comfort.

Energy saving policy is also present in tax legislation of Ukraine. Thus, in the **Law on One Custom Tariff**, specifically in amendment dated 16.03.2007, it is stated that the following goods are not subject to custom tax if there are no equivalent of such goods produced in Ukraine: renewable energy equipment, energy saving equipment and materials, metering tools and control tools for energy use, as well as materials for production of renewable installations. The list of such goods is defined by the Government of Ukraine. The

same products are free from VAT according to the **Law on VAT** and free from profit tax in case of sales within territory of Ukraine according to the **Law on Profit Taxation** of enterprises.

It should be noted that adaptation of Ukrainian legislations to EU legislation is a commitment which Ukraine took within the Partnership and Cooperation Agreement signed in 1994. In 2004 adaptation of energy related legislation was defined as priority sector according to the **Law of Ukraine on Legislation Adaptation State Program to EU Legislation.**

Bylaws

During 2006-2010 the President and the Government of Ukraine issued a number of decrees and orders which were addressing energy efficiency in different sectors of economics. Some of them are mentioned below.

In 2006 the Government of Ukraine approved „Energy Strategy of Ukraine up to 2030". The Strategy declared that it is planned to achieve the European level of energy efficiency through technological energy saving, which means modernization of energy intensive technologies, improvement of energy efficiency in industry and communal sector as well as reduction of energy losses. It was planned to make a transition towards market energy prices during 2006 – 2007. Implementation of energy saving measures is planned through transition to modern building standards, first of all in construction and reconstruction of the residential buildings.

In 2008 the President of Ukraine issued the order to include energy efficiency into prioritized topics for adaptation of Ukrainian Legislation to EU legislation; to develop and approve national energy efficiency programs, particularly in standardization and development of the technical regulations for energy efficiency for the period 2009-2010.

In November 2008 the Government of Ukraine approved the Concept of the National Program on energy efficiency for 2010 – 2015. The goal of the program is to reduce GDP energy intensity to the level of the world developed countries. It was planned to achieve this goal through new legislation and economical stimulation for implementation of energy saving measures, adaptation of national energy efficiency to EU legislation, implementation of energy labeling system.

In June 2010 the Government of Ukraine issued a decree about approval of procedures for funds use in 2010 from the State Budget, allocated for implementation of National Energy Efficiency Program 2010 – 2015. The funds shall be used for: development of TOR for technical regulations, reconstruction of public buildings including development of design documentation, implementation of heat-pumps technology and electrical heat accumulation heating.

New Drafted Laws

The following drafted Laws related to energy efficiency in buildings are now in the stage of approval:

Draft Law on Energy Efficiency (Registered in the Parliament on 23.07.2009., № 5016) regulates interrelations related to energy resources use by enterprises, organisations and institutions of all types of ownership. This Draft Law defines first of all the state policy on energy efficiency (priority of energy efficiency, popularization of benefits from energy efficiency measures, obligatory state expertise on energy efficiency and responsibilities for ineffective energy use). This Draft also defines the mandatory national standards in energy efficiency sector and procedures for norms of specific energy use, energy labelling of products and certification of buildings.

According to this Draft Law state, financial support for implementation of energy efficient measures is provided through compensation of interest rates on loans, support to physical persons and stimulation of production of energy efficiency products through the State Energy Efficient Fund.

The weakness of this Draft Law is also related to many declarative statements without definition of implementation mechanisms.

Draft Law on Energy Audit (registration Number № 1036 dated 27.11.2007) was developed to support the Law on Energy Saving. The Draft Law gives basis for organisation and implementation of Energy Audit. The weakness of the Draft Law is that the term -energy audit" is focused on its purpose, while the content of the energy audit is not described. It should be noted that an audit in the energy sector (like in any other sectors) shall be considered as a process of object assessment from the point of view of conformity to certain criteria given in legislation. In this Draft Law these criteria are not defined, neither are the norms, methods, instructions which the energy auditors shall follow when performing energy auditing.

Draft Law on Energy Efficiency (Performance) in Buildings is now registered in the Parliament as developed by the Parliament members (registr. Nr. 6426 dated 25.05.2010). It was developed to improve the legislation base for energy efficiency in residential, office and public buildings, as well as for energy certification of buildings, energy auditing of buildings, etc.

According to this Draft Law minimal requirements to energy performance of buildings shall be revised minimum every 5 years and shall reflect new technologies in construction. In case of reconstruction of existing building with total area more than 1 000 m^2 it is obligatory to implement the energy efficiency measures which will bring the building to the established minimal requirements.

The Draft Law also envisages that the local governance authorities shall provide proposals for development of the state energy efficiency programs, however it is not specifically stated who shall develop these plans.

In August 2010 similar Draft Law **on Energy Efficiency (Performance) in Buildings** was developed by the Ministry of Communal Services. This Draft Law will be considered in parallel with the one proposed by the Parliament members, and it will be voted which one shall be accepted as the basis. The purpose of this Draft Law was to reflect EU Directive 2010/31/EC Energy Performance of Buildings Directive (EPBD).

ENSI comments to this Draft Law were provided in October 2010 and were mainly related to the following:

- discrepancy in determining of norms of energy efficiency of buildings
- there are no mentioning of cost efficiency in relation to minimal requirements and proposed energy efficiency improvements
- not clear division of responsibilities of the authorities in implementation of national policy of energy efficiency
- no requirements for certification of existing public buildings
- energy auditing of buildings, as important mean for efficient energy end-use, is not properly reflected

2.3 Conclusions

Ukraine has established a legislation base for implementation of energy efficiency policy. However, the legislation base has in many aspects declarative character and is lacking the mechanisms of implementation of the declared policy.

Ukraine is lacking the special legislation for energy efficiency in buildings. Considering that most of the buildings in Ukraine and their technical systems do not correspond with required level of energy efficiency, it is important to establish legislation base (including correspondent bylaws, standards, norms) considering requirements of EU Directives 2010/31/EC and 2006/32/EC (on Energy Performance of Buildings and Efficient Energy End Use), as well as positive international and local experience in this field. The drafted laws mentioned above are the first steps to eliminate the gaps in the Ukrainian legislation.

We would like to underline that it is very important to establish legislation base to regulate interrelationships of energy efficiency in buildings, specifically for energy certification of buildings and energy auditing, including specification of necessary procedures, methodologies, requirements, etc.

3. Review of Building Standards related to energy efficiency

Europe

The Energy Performance of Buildings Directive 2010/31/EU (EPBD) is a ‐framework directive" to be differentiated in methodology at national and regional levels with national/regional minimum requirements for the energy performance of buildings and building elements. National authorities have to adapt their laws to meet these goals, but are free to decide how to do so. Furthermore, EU Directives often refer to a number of EU Standards, which provide specifications and methods which should be used providing presumption of conformity to 'Essential Requirements' of the Directives.

One example of such reference in EPBD is EN ISO 13790:2008 ‐Energy Performance of Buildings – Calculation of energy use for space heating and cooling". This Standard provides the means to assess the contribution that building products and services make to energy conservation and to overall energy performance of buildings. It present a set of calculation methods with different levels of detail for the energy use for space heating and cooling of building, and the influence of recoverable thermal losses of technical buildings system. This Standard allows the National Authorities to select which method to use, for instance simplified monthly methods or hourly dynamic calculations and gives some variations in definitions of some of the input parameters (for instance, Bulgaria chose to apply monthly methods, while Norway decided to use hourly dynamical calculations for several building types). The Standard also gives references to a number other EN standards for detailed calculations.

Each country develops its Standards for thermal protection of building envelope and technical installations. They also develop its own procedures related to energy auditing and energy certification of buildings.

To explain the relationship between various European standards and the EPBD, the European Committee for Standardization (CEN) issued a technical report CEN/TR 15615 – Umbrella Document.

The following four main issues are set out in EPBD:

- calculation methodology
- minimum energy performance requirements
- energy performance certificate
- inspection of boilers and air conditioning.

According to CEN/TR 15615, there are a number of EU Standards which are aimed to facilitate the implementation of the Directive in Member States in terms of establishing calculation methodology set out in Annex to EPBD. Many of the standards deal with specific aspects of the calculation (e.g. fabric losses, air changes, energy use for lighting, system performance); these aspects are drawn together in the following standards:

- EN 15603 - Energy use, for space heating, cooling, ventilation, domestic hot water and lighting, inclusive of system losses and auxiliary energy; and definition of energy ratings
- EN 15217 - Ways of expressing energy performance (for the energy certificate) and ways of expressing requirements (for regulations); content and format of energy performance certificate
- EN 15378 - Boiler inspections
- EN 15240 - Air-conditioning inspections
- EN ISO 13790 - Energy needs for healing and cooling (taking account of losses and gains)

According to CEN/TR 15615 the following EN Standards are supporting implementation of EPBD (if to arrange them according to hierarchy):

Section 1 - Standards dealing with calculation of overall energy use in buildings (based on results from standards in section 2)

- EN 15217 - Energy performance of buildings - Methods for expressing energy performance and for energy certification of buildings
- EN 15603 - Energy performance of buildings - Overall energy use and definition of energy ratings
- EN 15459 - Energy performance of buildings - Economic evaluation procedure for energy systems in buildings

Section 2 - Standards dealing with calculation of delivered energy (based where relevant on results from standards in section 3)

- EN 15316-1 - Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 1: General
- EN 15316-2-1 - Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2-1: Space heating emission systems
- EN 15316-4 - Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies.
- EN 15316-2-3 - Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies - Part 2-3: Space heating distribution systems
- EN 15316-3 - Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies-
- EN 15243 - Ventilation for buildings - Calculation of room temperatures and of load and energy for buildings with room conditioning systems
- EN 15377 - Heating systems in buildings - Design of embedded water based surface heating and cooling systems
- EN 15241 - Ventilation for buildings - Calculation methods for energy losses due to ventilation and infiltration in commercial buildings
- EN 15232 - Energy performance of buildings -Impact of building automation, controls and building management
- EN 15193 - Energy performance of buildings - Energy requirements for lighting

Section 3 - Standards dealing with calculation of energy need for heating and cooling

- EN ISO 13790 - Thermal performance of buildings - Calculation of energy use for space heating (ISO 13790:2008)
- EN 15255 - Energy performance of buildings - Sensible room cooling load calculation – General criteria and validation procedures
- EN 15265 - Energy performance of buildings - Calculation of energy needs for space healing and cooling using dynamic methods - General criteria and validation procedures

Section 4A - Standards to support the above - Thermal performance of building components

- EN ISO 13789 - Thermal performance of buildings - Transmission and ventilation heat transfer coefficients - Calculation method (ISO/DIS 13789:2007)

- EN ISO 13786 - Thermal performance of building components - Dynamic thermal characteristics- Calculation methods (ISO 13786:2007)
- EN ISO 6946 - Building components and building elements - Thermal resistance and thermal transmittance - Calculation method (ISO 6946:2007)
- EN ISO 13370 - Thermal performance of buildings- Heat transfer via the ground - Calculation methods (ISO 13370:2007)
- EN 13947 - Thermal performance of curtain walling - Calculation of thermal transmittance
- EN ISO 10077-1 - Thermal performance of windows, doors and shullers - Calculation of thermal transmittance - Part 1: General (ISO 10077-1:2006)
- EN ISO 10077-2 - Thermal performance or windows, doors and shutters - Calculation of thermal transmittance - Part 2: Numerical method for frames (ISO 10077-2:2003)
- EN ISO 10211 - Thermal bridges in building construction - Heat flows and surface temperatures- Detailed calculations (ISO/DIS 10211 :2007)
- EN ISO 14683 - Thermal bridges in building construction - Linear thermal transmittance – Simplified methods and default values (ISO 14683:2007)
- EN ISO 10456 - Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values (ISO/DIS 10456:2007)

Section 4B - Standards to support the above - Ventilation and air infiltration

- EN 13465 - Ventilation for buildings - Calculation methods for the determination of air flow rates in dwellings
- EN 15242 - Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration
- EN 13779 - Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems

Section 4C - Standards to support the above - Overheating and solar protection

- EN ISO 13791 - Thermal performance of buildings - Calculation of internal temperatures of a room in summer without mechanical cooling - General criteria and validation procedures (ISO 13791:2004)
- EN ISO 13792 - Thermal performance of buildings - Calculation of internal temperatures of a room in summer without mechanical cooling - Simplified methods (ISO 13792:2005)
- EN 13363-1+A1 Solar protection devices combined with glazing - Calculation of solar and light transmittance - Part 1: Simplified method
- EN 13363-2 Solar protection devices combined with glazing - Calculation of total solar energy transmittance and light transmittance - Part 2: Detailed calculation method

Section 4D - Standards to support the above -Indoor conditions and external climate

- CR 1752 - Ventilation for buildings - Design criteria for the indoor environment
- EN 15251 - Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics

- EN ISO 15927-1 - Hygrothermal performance of buildings - Calculation and presentation of climatic data- Part 1: Monthly means of single meteorological elements (ISO 15927-1 :2003)
- prEN ISO 15927-2 Part 2: Hygrothermal performance of buildings - Calculation and presentation of climatic data- Hourly data for design cooling load (ISO/OIS 15927-2:2007)
- prEN ISO 15927-3 Part 3: Hygrothermal performance of buildings - Calculation and presentation of climatic data- Calculation of a driving rain index for vertical surfaces from hourly wind and rain data (ISO/DIS 15927-3:2006)
- EN ISO 15927-4 - Hygrothermal performance of buildings - Calculation and presentation of climatic data- Part 4: Hourly data for assessing the annual energy use for heating and cooling (ISO 15927-4:2005)
- EN ISO 15927-5 - Hygrothermal performance of buildings - Calculation and presentation of climatic data- Part 5: Data for design heat load for space heating (ISO 15927-5:2004)
- EN ISO 15927-6 - Hygrothermal performance of buildings - Calculation and presentation of climatic data- Part 6: Accumulated temperature differences (degree days) (ISO 15927-6:2007)

Section 4E - Standards to support the above - Definitions and terminology

- EN ISO 7345 - Thermal insulation - Physical quantities and definitions (ISO 7345:1987)
- EN ISO 9288 - Thermal insulation - Heat transfer by radiation - Physical quantities and definitions (ISO 9288:1989)
- EN ISO 9251 - Thermal insulation - Heat transfer conditions and properties of materials – Vocabulary (ISO 9251:1987)
- EN 12792 - Ventilation for buildings - Symbols, terminology and graphical symbols

Section 5 - Standards concerned with monitoring and verification of energy performance

- EN 12599 - Ventilation for buildings - Test procedures and measuring methods for handing over installed ventilation and air conditioning systems
- EN 13829 - Thermal performance of buildings - Determination of air permeability of buildings – Fan pressurization method (ISO 9972:1996, modified)
- EN ISO 12569 - Thermal insulation in buildings - Determination of air change in buildings - Tracer gas dilution method (ISO 12569:2000)
- EN 13187 - Thermal performance of buildings - Qualitative detection of thermal irregularities in building envelopes - Infrared method (ISO 6781 :1983 modified)
- EN 15378 - Heating systems in buildings -Inspection of boilers and healing systems
- EN 15239 - Ventilation for buildings - Energy performance of buildings - Guidelines for inspection of ventilation systems
- EN 15240 - Ventilation for buildings - Energy performance of buildings - Guidelines for inspection of air-conditioning systems

In many aspects EN Standards propose different methods and approaches allowing certain flexibility for National Authorities to select the most suitable one for their countries. Therefore National Authorities of the Member Stated are to reflect these Standards into their National Building Regulations depending on accepted calculation methods (simplified monthly or seasonal calculations, or simplified hourly calculations, or detailed calculations), accepted way of expression of minimum energy performance requirements and energy performance certificate, as well as accepted procedures for inspection of boilers, heating systems, ventilation and air conditioning.

In addition to the above mentioned standards there are number of EN norms, which specifies different element products for the buildings:

- EN 12524 Building materials and products - Hygrothermal properties -- Tabulated design values (EN 12524:2000)
- EN ISO 14683 Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values (ISO 14683:1999; EN ISO 14683:1999)
- EN ISO 14683/AC Thermal bridges in building construction - Linear thermal transmittance - Simplified methods and default values (ISO 14683:1999; EN ISO 14683:1999/AC:1999)
- A number of standards of series ―Thermal insulation products for buildings" EN 1316… - EN 1317… as well EN 13499 and EN 13 500 regarding different products for thermal insulation of buildings, like factory made mineral wool, factory made products of expanded polystyrene, factory made cellular glass, etc.)

Ukraine

The first step to ensure energy efficiency in buildings in Ukraine was made in 1993 – 1995 when normative thermal requirements to building envelopes were increased significantly, which stimulated transfer to more energy efficient multilayer envelope structures. At that time were also introduced requirements for obligatory energy metering, which reduced significantly energy consumption in public buildings (however, very often at the cost of the indoor comfort).

In 2006-2007 new standards for building envelope were introduced in Ukraine – ДБН В.2.6-31:2006 ―Building Structures Thermal Insulation of the Buildings", which was enforced from 1.04.2007.

After introduction of ДБН В.2.6-31 during 2008-2010, Ukraine started to built up a new set of norms and regulations, which are supporting implementation of energy efficiency provisions. The regulative basis consists of the state building regulation documents, which establish obligatory indicators for energy safety of the buildings as well as methods for determining those indicators through experiments or calculations.

Based on ДБН В.2.6-31:2006, a number of sub-standards were developed (types of ДСТУ and ДСТУ-Н). ДСТУ sub-standards establish the requirements to heat insulation products, structures, and materials, as well as requirements to experimental thermal tests for these products. ДСТУ-Н sub-standards describe the calculation methods for evaluation of relevant thermal characteristics, stipulated in ДБН В.2.6-31.

Also another document ДБН В.1.2-11:2008 ―Main Requirements to the Buildings. Energy Saving" provides the main requirements to energy saving is related to reduction of energy use in buildings during their operation considering climatic conditions, location and type of the building. The document has more declarative character and gives directions for development of further energy saving norms for designing, construction and operation of buildings.

State Building Standards for Thermal Protection of Building Envelope

ДБН В.2.6-31:2006 ―Building Structures Thermal Insulation of the Buildings" was enforced in 2007. Compared to requirements of 1994 the new standard increases requirements for thermal insulation of the building envelope for residential and public buildings with in average 15-40% for external walls, 20-25% for roofs and 20% for windows. Beside this the new standard introduces:

- norms for maximum specific heat use of the building for heating purposes
- principal of designing thermal envelope according to 2 alternatives: according to thermal requirements of the various elements of the building envelope elements and integral specific heat use rates. In case the requirement of integral heat use rates is fulfilled, the thermal characteristics of the building envelope elements can deviate from the thermal indicators.
- increased requirements for thermal indoor comfort

- energy passportisation of buildings for new construction and reconstruction
- requirements to reliability of thermal insulation of the building envelope

Requirements to the thermal characteristics of the building elements are established depending on building types and climatic zones (4 climatic zones in Ukraine). This document also considers the building envelope as one system, allowing variations in building solutions to optimize energy efficient characteristics.

The new regulation introduces new approach to indicators of thermal indoor comfort – as temperature difference between indoor air temperature and adjusted temperature of indoor surface of the envelope. However, with the time when requirements to the thermal conductivity of the building envelope become stronger and stronger, such requirement on temperature difference might not be needed as it will be fulfilled anyway.

Also it introduces assessment of the humid regime based in humid quantity which can be condensed in the body of the structure during the heating season, specifying maximum allowed values of humidity. This principal is used in the designing norms of many European countries. Humidity in the building envelope materials defines durability of the structure and level of heat flows during the heating season.

In general introduction of ДБН В.2.6-31:2006 was intended to reflect the requirements of EU Directive 2002/91/ЄС dated 16.12.2002 and the related development in other countries.

Construction according to these regulations will allow to:

- reduce total heat use by minimum 15-20 % compared to the building designed according to the regulations of 1994, and more than by 50% compared the regulations before 1994.
- improve designing quality during assessment of thermal characteristics of the building envelope
- improve normative sanitary thermal indoor requirements.

Another document ДСТУ Б В.2.2-21-2008 –Buildings and structures. Method for determining specific heat use for heating" specifies a field test method to compare the result with the requirements of ДБН В.2.6-31. This method allows determining total heat transfer factor for the building envelope. The method is based on measurements during time intervals of the heating season.

Besides, there is a document ДСТУ Б В.2.6-37:2008 which specifies a field test method for infiltration of building envelope.

ДСТУ Б В.2.6-100:2010 –Building structures. Method for determining heat capacity of the building envelope." – which is enforced to replace ГОСТ 26253-84 specifying the methods for laboratory and field testing of heat capacity of the envelope of residential and public buildings.

ДСТУ Б В.2.6-101:2010 –Building structures. Method for determining of thermal resistance of the building envelope" – is a standard which in enforced to replace ГОСТ 26254-84, specifying the methods of laboratory and field testing of thermal resistance of the envelope structures. Such testing shall confirm correspondence of actual thermal resistance of the envelope to the requirements of ДБН В 2.6-31 (not for transparent envelope structures). It should be noted that when revising the provisions of ГОСТ 26254-84 the new methodology was introduced which approximated the test results of the thermal resistance of the test samples to calculated humidity conditions of the materials.

ДСТУ Б В.2.7-182:2010 –Construction materials. Methods for determining terms of effective operation and heat transfer of insulation materials under designing and standard conditions" includes methods for determining these characteristics to satisfy the conditions of durability indicated in ДБН В.1.2.-11-2008. For heat insulation materials the effective operation term are assessed based on changes of heat transfer

rate under standard testing conditions. For air-insulation materials the effective operation term is assessed based on changes of vapor transmission rate and air transmission rate of the material.

In addition to the regulatory documents related to energy efficiency in buildings, the following normatives are also referring to this topic:

- ДСТУ 4065-2001 „Energy Saving. Energy Audit. General Technical Requirements" – the standard is applied to the work related to development of energy efficiency measures, analysis of energy balance and energy costs of the enterprises, etc. The standard gives algorithm for energy auditing, procedures for data collection, training of personnel. The standard is applied for energy audit of industrial enterprises.
- ДСТУ 4035-2001 (ГОСТ 25380-2001) „Energy Saving. Buildings. Metering methods for surface heat flow density and heat exchange factors between building envelope and environment" - the standard allows ensuring the united approach on determining heat losses or heat gains thought the building envelope. This standard is additional for testing of thermal characteristics of the building envelope.
- ДСТУ-Н Б А.2.2-5:2007 „Designing. Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction" – from 01.01.2009 the Energy Passport of the building became obligatory document for designing documentation. The standards defines the procedure of energy auditing in buildings, which includes analysis of architectural solutions, metering of thermal characteristics of the building envelope, comparison to normative energy performance rate, determining of energy saving potential, suggestion of feasible energy efficient measures.
- ДСТУ Б А.2.2-8:2010 „Energy Efficiency Section in designing documentation" – this norm stipulates that Energy Efficiency Section shall be included as the last section into the Design Specification and shall include necessary information about energy saving solutions, technologies, materials which are present in each part of the design.

State Building Standards related to Heating, Ventilation and Air Conditioning (HVAC)

Designing of HVAC systems in Ukraine is being done according to СНиП 2.04.05.-91* „Heating, Ventilation and Air Conditioning" with some revisions. The norms are old and need to be revised. The new revision is currently being done. However, having studied the draft document, ENSI can recommend some areas for improvement (see Chapters 3.3 – 3.4).

State Building Standards related to climate data

When designing of heat insulation the designers are using the data provided in СНиП 2.01.01-82, which was developed based on climatic data for the period 1930-1980. For the last 40 years the climatic parameters have changed. Besides, СНиП 2.01.01-82 does not have data needed for development of energy passport (some recommended data are provided in ДБН В.2.6-31:2006, however it is noted that the data are old and can be used until new climatic standard is enforced).

Conclusions

1. Considering the content of the normative basis, it can be said that Ukraine is making some steps to achieve the level of developed European countries in terms of energy efficiency in buildings.
2. In the same time, Ukraine shall gradually start accepting EU standards mentioned above which support implementation of EPBD. These accepted standards shall have correspondent national annexes or specifications.

3. New standards introduce requirements to energy efficiency in buildings, as well as classification of buildings with energy performance rates and procedures for energy passportisation of buildings.
4. New norms are introduced on field testing of parameters influencing energy efficiency of buildings. In terms of methodological content the system of field testing of such parameters is quite modern. Many provisions of these systems are equal or even better than in European countries.
5. The new standards introduce flexible approach of designing thermal protection of building envelope (based on minimal requirements to the building elements or unified maximal specific energy use for heating).
6. Normative requirements with regards to technical systems are old and require revision. Energy efficiency aspects are not reflected there, the methods for evaluation of efficiencies of different technical systems, calculation procedures, benchmarking, etc. are also missing.
7. Ukraine does not have standard for general procedures for energy auditing in buildings, analysis of actual energy performance of buildings, which hinders implementation of justified technical and economical policy in thermal reconstruction of the existing building stock.
8. Climate norms are also outdated and need to be revised.

3.1 Requirements to energy use (need) by different types of buildings

3.1.1 Europe

As supportive standards for implementation of EPBD the European Union issued the following standards:

- EN 15603 Energy performance of buildings – overall energy use and definition of energy ratings
- EN 15217 Energy performance of buildings – Methods for expressing energy performance and for energy certification of buildings
- EN ISO 13790:2008 Energy Performance of Buildings – Calculation of energy use for space heating and cooling

EN ISO 13790 and EN 15603 offer different ways of dealing with interactions between a building and its systems. There are two methods (holistic or simplified), both taking the recoverable thermal losses of the building systems into account. National authorities shall define under which conditions the two methods are to be applied. The choice of method depends on several aspects. First the purpose of the assessment should be considered, as it influences the level of required details. The type and complexity of the building and its technical system are also relevant parameters. More details about 15603 and 15217 are given in Chapter 3.8.1.

According to the standard EN 15217 „Energy performance of buildings – Methods for expressing energy performance and for energy certification of buildings", the energy performance indicators can be expressed by:

- Primary energy
- CO_2 emissions
- Total energy cost
- A weighted sum of the net delivered energy weighted by any other parameter defined by national energy policy.

The energy requirements can be expressed in the following ways:

1) as overall energy performance requirement (which should be lower than limited value defined by National Authorities)
2) as specific requirements based on:

- energy use for specific building services (e.g. heating, domestic hot water, cooling, lighting, ventilation);
- energy need heating, domestic hot water and cooling
- characteristics of the building itself or of its technical building systems considered as a whole (e.g. heat transfer coefficient of the building envelope, heating, domestic hot water or cooling system efficiency);
- characteristics of the building envelope or technical building systems components (e.g. thermal transmittance of walls, efficiency of boilers, insulation of pipes, lighting power density, specific fan power).

To avoid too large tradeoffs between the performance of the building envelope and the performance of the utilities, as well as to prevent components with low technical performance to be put on the market, the overall indicator may be combined with the specific requirements.

Possible specific requirements could be: thermal transmittance of the building envelope components (like walls, roofs, doors, floors, windows, etc.); solar factor of the combined glazing and solar protection device in accordance with EN 410 and EN 14501; max linear thermal transmittance for junctions between

building components; max value of air permeability measured according to EN 13829; max value of energy use for heating as obtained according to EN ISO 13790; max value of energy need for heating as obtained according to EN ISO 13790; minimum efficiency of the heat generation system; minimum insulation of pipes, ducts and tanks; energy use for cooling as obtained according to EN ISO 13790; energy need for cooling as obtained according to EN ISO 13790; efficiency of heat recovery units according to EN 308; specific fan power of ventilation system according to categories specified in EN 13779; energy need for ventilation; artificial lighting according to EN 15193; minimum level of daylight; minimal level of automatic control; minimal level of metering and monitoring, etc.

The National Authorities are free to define which option to use for expression of energy performance requirements and indicators.

It should be underlined that EPBD Directive specifically says that Member State shall not be required to set minimum energy performance requirements which are not cost-effective over the estimated economic lifecycle.

The example below is for Norway, which is not EU Member, however committed to follow EU Directives and norms.

Norway

The Norwegian climate vary from 3000 (Stavanger) to 6600 degree days (Kautokeino). In spite of this, the building codes are unified for the whole country, based on the national average, 4000 degree days (Oslo). All Norwegian energy performance requirements are based on calculations described in NS 3031 (EN ISO 13790).

The requirements for energy performance applies for new buildings and existing buildings undergoing a major renovation (renovating 25% of building surface / value or more).

The requirements on energy performance can be fulfilled in two alternative ways of calculation:

> **Alt. 1: "Energy performance"** (Holistic approach). This alternative specifies the maximum yearly specific energy need (kWh/m^2 · year) allowed for the building (based on calculations as described in NS 3031:2007 (EN ISO 13790)). The energy performance requirements are given for 13 different building categories. In addition, for all categories, the building envelope must comply with some given specific minimum requirements (U-values, air leakages, window specifications).
>
> **Alt. 2: "Minimum requirements"** (Detailed approach). This alternative specifies minimum requirements to the quality of the building envelope and technical building systems. These requirements are the same for all building categories, only with few exemptions.

Requirements for the "Energy performance" method

According to Alt. 1 the Norwegian building codes sets no energy performance requirements for the individual energy budget items, only for the sum (the total energy need for heating, ventilation, domestic hot water, cooling, lighting, fans and pumps, etc.).

The total net energy need for a building shall not exceed the limits given in the following table:

Building category	Total net energy need (kWh/m^2 · year)
Single family house, (and cabin > 150 m^2)	120 + 1 600/m^2 heated area
Block of flats	115
Kindergarten	140
Office building	150
School	120
University / high school	160
Hospital	300 (335)*
Nursing home	215 (250)*
Hotel	220
Sports hall	170
Commercial building	210
Cultural building	165
Light industry / workshop	175 (190)*

*: Number in parentheses applies for areas where heat exchange of ventilation system leads to risk for spreading of contamination.

Multi category buildings must be split in zones for each building category, and the frame requirement applies for each zone.

When calculating total energy need in the ~~"~~energy performance" approach, a reduction in the budget items ~~"li~~ghting" and ~~"v~~entilation" can be accepted if:

- the lighting systems are equipped with daylight and presence sensors (- 20% energy need for lighting)
- the ventilation system has VAV (variable air volume) control based on CO_2 sensors (- 20% ventilation rate during operation hours)

Requirements for the "Minimum requirements" – will be presented in the each correspondent chapter provided below, dedicated to each energy budget line of the building.

3.1.2 Ukraine

General information about energy performance of buildings in Ukraine

Existing residential and public building stock in Ukraine can be divided in the following sections:

1 – multi-storey buildings built up to 1949;

2 – multi-storey buildings built between 1950 – 1995;

3 – multi-storey buildings built between 1996 – 2006;

4 – multi-storey buildings built after 2007;

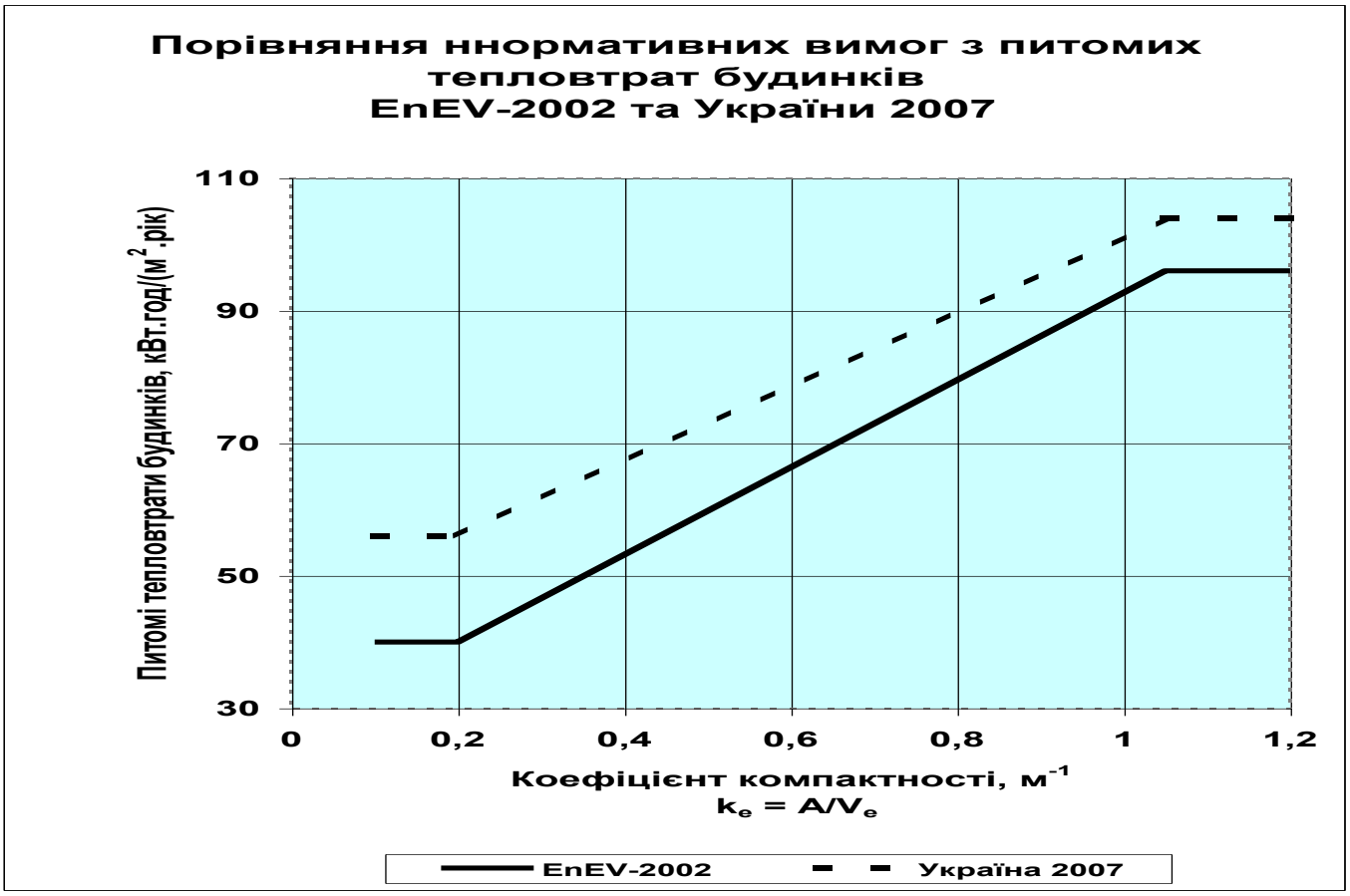
5 – Single family buildings built between1950 – 2005;

6 – Single family buildings built nowadays.

Such division is related to changes in the building regulations and correspondent changes to the requirements to thermal insulation of building envelope. Single family buildings are marked out in separate division as there is no obligatory state control over their thermal properties during construction, therefore

there are no actual data for these types of buildings. During the recent years, due to increase of energy prices, single family houses are being built with quite good level of thermal protection of building envelope, however it is unknown how close this level is to the normative values.

For multi-storey buildings built up to 1996 specific energy use for only heating purposes is about 300 kWh/m^{2}year as the most optimistic value (under the condition that all insulation requirements are fulfilled). It should be noted that most of the residential building stock in Ukraine belong to this class. The reform of normative basis in 1995-1996 aimed at reducing specific heating use in new buildings to 150-200 kWh/m^{2}year. After introduction of new norms ДБН В.2.6-31, the specific heating use are reduced to 100 kWh/m^{2}year.



Specific energy use for heating in German norms is between 40 to 96 kWh/m^{2}year. Energy use for heating according to ДБН В.2.6-31:2006 and recalculated to German climatic conditions are between 56 - 104 kWh/m^{2}year. Allowed energy use for heating in multi-storey residential building in Ukraine is therefore 28% higher than German norms from 2002. To have comparable numbers, all data are recalculated because German data are in primary energy. If to take Nowegian norms, Ukrainian norms are 60% higher (Norwegian norms are for total energy need, not only heating). Compared with Slovakian 2006 norms the allowed energy use in Ukrainian buildings is about 15 % higher than class C in Slovakian buildings.

In current Ukrainian normative base there are two documents which specifically connected to energy efficiency of buildings related to energy performance indicators:

- ДБН В.2.6-31:2006 –Heat Insulation of Buildings”
- ДСТУ-Н Б А.2.2-5:2007 «Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction”

However, it should be noted that they mainly deal with the influence of the building envelope on these indicators and related only to energy for heating and ventilation (fresh air heating) during the heating season.

It should also be noted that even though ДБН В.2.6-31:2006 is connected to ДСТУ-Н Б А.2.2-5:2007, there are no references given to ДСТУ-Н Б А.2.2-5:2007 in this code, even though substantial part of calculation algorithm for determining $q_{буд}$ (calculated or actual specific energy need for heating purposes) is given in ДСТУ-Н Б А.2.2-5:2007.

According to ДБН В.2.6-31:2006 there are two ways of complying with the requirements of this building code:

1. *To comply with the following requirement related to building envelope elements (to external envelope and internal partitions separating zones with Δt > 3 ^{0}C):*
   - $R_{\Sigma\, пр} \geq Rq_{\,min}$ (where $R_{\Sigma\, пр}$ – adjusted thermal resistance of opaque envelope and adjusted thermal resistance of transparent envelope and $R_{q\,min}$ – minimal accepted thermal resistance of building envelope)
   - $\Delta t_{\,пр} \leq \Delta t_{сг}$ (where $\Delta t_{\,пр}$ - temperature difference between indoor air temperature and adjusted temperature of indoor surface of the envelope and $\Delta t_{сг}$ – accepted by sanitary norms temperature difference between indoor air temperature and adjusted temperature of indoor surface of the envelope)
   - $\tau_{\,в\,min} > t_{\,min}$ (where $\tau_{\,в\,min}$ - min temperature of indoor surface of the thermal bridge in the building envelope and $t_{\,min}$ - minimal accepted temperature of indoor surface of the envelope at design indoor and outdoor temperatures.)

   The details of this way are described in Chapter 3.2.

2. *To comply with the requirement*

$$q_{буд} \leq E_{\,max}$$

where:

$q_{буд}$ – calculated or actual specific energy need for heating purposes

$E_{\,max}$ - maximal allowed specific energy need for heating purposes, expressed in kWh/m^2 or kWh/m^3.

Generally, for reconstruction it is allowed to have $R_{\Sigma\, пр}$ as 75% of $R_{q\,min}$ for opaque envelope and 80% of $R_{q\,min}$ for windows when requirement of second approach is fulfilled.

Regarding the second approach: $E_{\,max}$ (which might be considered as equivalent of energy performance indicator) is expressed in kWh/m^2 or kWh/m^3, and provided for 4 climatic zones of Ukraine and divided into the following types of buildings:

- residential buildings and hotels (of different number of floors and heated area)
- public and administrative buildings (of different number of floors)
- medical and children educational buildings (of different number of floors)
- kindergartens
- shops, stores, supermarkets (of different number of floors)

It should be noted that for medical and children educational buildings, kindergartens, shops, stores, supermarkets as well as public and administrative buildings with up to 3-storeys $E_{\,max}$ is expresses only in kWh/m^3, while EU norms expresses energy performance indicator by conditioned area (m^2) and not conditioned volume.

Extracts from the table with $E_{\,max}$ values are presented below:

Building type	***E $_{max}$* expressed in kWh/m^2 [kWh/m^3]**			
	I (>3 501 DD)	**II (3 001… 3 500 DD)**	**III (2 501 … 3000 DD)**	**IV (< 2 500 DD)**

Residential and hotels …..4-5 floors	89 [32]	77 [28]	65 [24]	53 [19]
Public and administrative buildings ….4-5 floors	94 [35]	81 [31]	69 [26]	56 [21]
Medical and children educational buildings ….4-5 floors	[32]	[28]	[24]	[20]
Kindergartens (1-3 floors)	[43]	[37]	[31]	[26]
Shops, stores, supermarkets ….4-5 floors	[21]	[18]	[15]	[12]

Algorithm for calculation of $q_{буд}$ is provided in the ДБН В.2.6-31:2006 ―Heat Insulation of Buildings". The same algorithm, but more detailed is some aspects is provided in ДСТУ-Н Б А.2.2-5:2007 «Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction". In general, the calculation algorithm is based on seasonal method (which, as approach, is allowed by EN ISO 13790), however it does not follow the methodology for such seasonal approach in EN ISO 13790. To the main discrepancies the following can be referred:

- $q_{буд}$ mainly intends to reflect characteristic of the building envelope, therefore might be referred as the term ―energy need" (as mentioned the EN ISO 13790). However the calculation algorithm includes a number of coefficients, which partially reflect influence of automatic controls of heating system and factor which could be considered as close to the term emission efficiency. Such adjustment of calculation with these coefficients does not allow to consider $q_{буд}$ neither as ―energy need", nor as ―energy use" (as it does not include many other factors which influence energy use by heating).
- the algorithm includes heat transfer coefficients for ventilation and infiltration. However, there is no provision to include heat recovery unit for ventilation. A heat recovery unit, if present, is usually an important element in the heat balance of the building zone, strongly influencing utilisation of the heat gains and heating or cooling demand. For that reason the effect of use of heat recovery units shall be taken into account in the calculation of the energy needs for heating and cooling and cannot be dealt via a separately determined correction factor.
- compared to EN ESO 13790, the Ukrainian algorithm simplifies a lot of parameters, including utilisation factor for heat gains. The algorithm also contains a lot of different types of conditioned area (heated area, useful area, apartment area, etc.).
- as mentioned above, the algorithm reflects mainly influence of building envelope on energy needs for heating. For the future perspective Ukraine will need to reflect influence of technical systems, calculation of domestic hot water needs and use, calculation of cooling needs and use, lighting use, etc. Otherwise, implementation of new solutions or technologies for heating, domestic hot water, cooling, lighting utilities will not be possible to reflect in overall energy performance requirements to the buildings, and therefore reducing the pressure on the building developers to impellent such solutions.

3.1.3 Conclusions

1. Current Ukrainian regulation documents have established calculation requirements for assessment of energy performance indicators (specific energy use for heating, including heat for ventilated air). It is based on standard methodology which is close to EU seasonal and some USA degree-days methodologies. It includes to some extent, but not sufficiently, characteristics of building utilities. The energy performance indicators are getting closer to correspondent EU

indicators, but still behind the best available practices, especially after introduction of EPBD recast in 2010, which required revisions of this characteristic.

2. Ukraine has established a system for heat limits for the purpose of heating and heating of ventilated air ventilation in different types of buildings. These limits can be considered as a type of energy performance requirements at designing of new buildings and reconstruction of existing one.
3. In order to harmonise the calculation algorithms for heating needs with EU norms, modernisation in the algorithm needs to be done, as well to reflect influence of buildings utilities on energy use in the building. Improvement of calculation methodology is possible by at least following the monthly method of EN ISO 13790 which will require development of national climate data including solar radiation, buildings thermal capacity data, internal gains data, efficiencies data, etc.
4. For the future perspective Ukraine will need to develop energy performance requirements and correspondent calculation algorithms for energy performance indicators for domestic hot water, cooling, lighting, fans and pumps, etc.
5. To comply with EU requirements Ukrainian authorities will need to determine if ―energy need", ―energy use", ―delivered energy", ―primary energy" shall be accepted in Ukraine as energy performance indicator. Should it be decided to be ―primary energy", Ukraine will have to develop primary energy factors for different types of energy sources. It should also be determined if overall energy performance requirements for buildings will be applied in Ukraine, or if will be limited to heating and heating in ventilation (as it is limited now), or some other budget items will be included into energy performance indicator (as, for instance, domestic hot water, cooling, lighting, etc.).
6. It will be necessary to recalculate minimum energy performance requirements (currently presented in ДБН В.2.6 – 31:2006) in accordance with the new calculation methodology and taking into account modifications to the minimal requirements to the building envelope and technical building systems components, mentioned in ―Immediate" recommendations.
7. To correspond to Annex 1 of EPBD Ukraine shall make more detailed division of building types when specifying limits for building energy rates.

3.2 Requirements to building envelope

3.2.1 Europe

EU Member States and those who are committed to comply with EU norms can, beside energy performance limit values, imply specific requirements in its Buildings codes, like characteristics of the building envelope or technical building systems components (e.g. thermal transmittance of walls, efficiency of boilers, insulation of pipes, lighting power density, specific fan power etc).

Thus, for example, in Norway in addition to the ―Energy performance" values presented in previous chapter, the following requirements for the building envelope must be fulfilled:

a) Building envelope, max. values

Area windows + doors ≤ 20% of floor area	Maximum U-values (W/ $m^2 \cdot K$)				Normalised thermal bridges*	
	Wall	Roof	Floor	Window/door	Single family house	Other build.
	0,18	0,13	0,15	1,2	≤ 0,03 W/($m^2 \cdot K$)	≤ 0,06

*: total heat loss through thermal bridges divided by heated floor area

U-values for glass/windows/doors including frames multiplied with the share of window and doors of the total heated floor area must be less than 0,24. This allows limiting application of big glazing with poor thermal characteristic areas in the buildings.

Total sun factor (the amount of solar radiation that passes screening and glass) for glass/window shall be less than 0,15 for sun exposed facades unless it can be documented that the building does not need cooling.

More comparison of Ukrainian U-values with other European countries is given in the next Chapter 3.2.2.

Other specific requirements, related to buildings utilities are presented in further chapters of this Spot Gap Analysis.

3.2.2 Ukraine

In Ukrainian buildings built up to 1995 the following heat transfer (U-values) are applied: external walls - 1,3 ÷1,7 W/m^{2}K, windows – 2,9 - 3,3 W/m^{2}K, roofs – 0,8 - 1,25 W/m^{2}K. In multi-storey buildings built between 1996 – 2006 the external walls have U-values approximately 0,4 ÷ 0,8 W/m^{2}K , windows 2 -2,5 W/m^{2}K , roofs 0,4-0,5 W/m^{2}K.

In current Ukrainian normative base there are two documents which specifically connected to energy efficiency of buildings related to energy performance indicators:

- ДБН В.2.6-31:2006 „Heat Insulation of Buildings"
- ДСТУ-Н Б А.2.2-5:2007 «Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction"

However, it should be noted that they mainly deal with the influence of the building envelope on these indicators and related only to energy for heating and ventilation (fresh air heating) during the heating season.

It also should be noted that even though ДБН В.2.6-31:2006 is connected to ДСТУ-Н Б А.2.2-5:2007, there are no references given to ДСТУ-Н Б А.2.2-5:2007 in this code, even though substantial part of calculation algorithm for determining $q_{буд}$ (calculated or actual specific energy need for heating purposes) is given in ДСТУ-Н Б А.2.2-5:2007.

As mentioned earlier, one of the ways to comply with current Ukrainian norms related to building envelope (to external envelope and internal partitions separating zones with Δt > 3 ^{0}C) is to follow presented specific requirements given in ДБН В.2.6-31:2006 „Heat Insulation of Buildings" (enforced in 2007):

- $R_{\Sigma\, пр} \geq R_{q\, min}$ (where $R_{\Sigma\, пр}$ – adjusted thermal resistance of opaque envelope and adjusted thermal resistance of transparent envelope and $R_{q\, min}$ – minimal accepted thermal resistance of building envelope
- $\Delta t_{\, пр} \leq \Delta t_{сг}$ (where $\Delta t_{\, пр}$ - temperature difference between indoor air temperature and adjusted temperature of indoor surface of the envelope and $\Delta t_{сг}$ – accepted by sanitary norms temperature difference between indoor air temperature and adjusted temperature of indoor surface of the envelope)
- $\tau_{\, в\, min} > t_{\, min}$ (where $\tau_{\, в\, min}$ - min temperature of indoor surface of the thermal bridge in the building envelope and $t_{\, min}$ - minimal accepted temperature of indoor surface of the envelope at design indoor and outdoor temperatures.)

Thus, the buildings built after 2007 have the following U-values (recalculated as 1/$R_{q\, min}$), the table contains extracts from the ДБН В.2.6-31:2006:

	Type of envelope	U-value for different climate zones, W/m^{2}K			
		I (> 3 501 DD)	II (3 001… 3 500 DD)	III (2 501 … 3000 DD)	IV (< 2 500 DD)

1	External walls	0,36	0,40	0,45	0,50
2a	Roof	0,20	0,22	0,26	0,30
2b*		0,30	0,33	0,38	0,45
3	Slabs over the passages	0,29	0,30	0,33	0,40
4	Slabs over unheated basements, higher than ground level	0,36	0,38	0,45	0.50
5a	Slabs over unheated basements, lower than ground level	0,26	0,29	0,33	0,37
5b*	Slabs over unheated basements, lower than ground level	0,40	0,43	0,50	0,50
6a	Windows	1,67	1,79	2,00	2,22
6b*		2,00	2,00	2,00	2,22
* - for summer houses and buildings up to 4 storeys					

Comparison of the Ukrainian norms related to thermal insulation of buildings with the norms of other countries are given in the table below. It shows that Ukrainian requirements to the thermal protection of building envelope are lower compared to a number of EU countries, and lower than Norwegian requirements which have as a basis Oslo climate (approx. 4 000 DD) .

According to the current norms in Finland, whose climate is very close to Ukrainian climatic zone I, requirements to heat insulation of building envelope is 48% higher, and starting from 2010 Finland is introducing new norms, which will be 40% stronger than the current norms.

Type of envelope	Max. U-value for different climate zones, W/m^{2}K			
	I (> 3 501 DD)	II (3 001… 3 500 DD)	III (2 501 … 3000 DD)	IV (< 2 500 DD)
Ukraine, (Non EU), 2007				
External walls	0,36	0,4	0,45	0,5
Roofs	0,3/0,2	0,3	0,38	0,45
Windows	1,67	1,79	2,0	2,22
Russia (Non EU)				
External walls	0,37	0,4	0,42	0,45
Roofs	0,28	0,29	0,32	0,34
Windows	2,3	2,56	2,78	3,12
Belorussia (Non EU)				
External walls	0,31	-	-	-
Roofs	0,17			
Windows	1,0			
Norway (Non EU), 2008				
External walls	0,18			
Roofs	0,13			
Windows	1,2			
Lithuania (EU)				
External walls	0,2			
Roofs	0,16			
Windows	1,6			
Bulgaria (EU), 2009				
External walls			0,35	
Roofs			0,28	
Windows			1,7/2,0	
Germany (EU) EnEv 2009				
External walls		0,28		
Roofs		0,2		
Windows		1,3		
Czech republic(EU), 2006 for new buildings				
External walls		0,38		
Roofs		0,30		
Windows		1.7		
Slovakia (EU), 2007 for new buildings				
External walls		0,32		
Roofs		0,20		
Windows		1,7		
Finland (EU), 2010				
External walls	0,17			
Roofs	0,09			
Windows	1,0			

Thus, it is necessary to continue improving Ukrainian norms related to thermal insulation of buildings. It should be synchronized with the introduction of modern regulations related to technical systems of the buildings. It should also be taken into consideration that higher thermal insulation of the buildings will cause reduction of needed heating capacities and will influence the cooling demand.

Heat and humidity indoor regimes during the heating season

Scale of the humidity indoor regimes in the residential, public, industrial and agricultural buildings, depending on indoor temperature (see table below).

Humidity regime	Indoor air humidity, $\varphi_в$, %, at indoor temperature $t_в$		
	$t_в \leq 12$ ˚C	$12 < t_в \leq 24$ ˚C	$t_в > 24$ ˚C
Dry	$\varphi_в < 60$	$\varphi_в < 50$	$\varphi_в < 40$
Normal	$60 \leq \varphi_в \leq 75$	$50 \leq \varphi_в \leq 60$	$40 \leq \varphi_в \leq 50$
Humid	$75 < \varphi_в$	$60 < \varphi_в \leq 75$	$50 < \varphi_в \leq 60$
Wet	-	$75 < \varphi_в$	$60 < \varphi_в$

Design indoor temperatures, which are established when determining the energy performance of buildings, as well as accepted humidity levels, which are established when calculation thermal parameters of the envelope structures, are given in the table below:

Building type	Design indoor temperature, $t_в$, ^{0}C	Design relative humidity , $\varphi_в$, %
Residential	20	55
Public and offices	20	50 - 60
Medical and schools	21	50
Kindergartens	22	50

Indoor temperatures and requirements to air exchange in residential buildings according to B.2.2-15-2005 ~~-~~Residential Buildings" are given in the table below (extracts):

Premises	Design temperature, ^{0}C	Air exchange		
		Inlet	Exhaust	
Living room, bedroom	20	1 [1)]	-	
Kitchen	18	-	Minimum, m^3/h:	90 [6)]
Dining room	20	0,8 [1)]		
Bathroom	25 [2)]	-		25
Toilet	25 [2)]	-		50
Swimming pool	25	As of calculations		
Laundry in apartment	18	-	0,5.	
Corridor, staircases	16	-	-	
Elevator machinery room	5 [4)]	-	0,5.	
Garage	5	-	As of calculations	
Power board rooms	5	-	0,5	

[1)] Inlet air shall penetrate through windows. In case windows are hermetic and without wicket, ventilation openings shall be used.

[2)] Indoor temperature in bathrooms and toilets which do not adjacent to building envelope or unheated rooms, is not subject to regulations if they have towel dryers connected to DHW system of electrical.

[4)] During the summer time indoor temperature in elevator machinery room shall not be higher than 35 ^{0}C.

[6)] In kitchens with electrical stoves the exhaust shall be 60 m^3/h.

Note 1. If there is floor (wall or ceiling) heating the indoor temperature can be accepted as 1..2 ^{0}C lower than indicated in the table. At that heat use is calculated considering average radiant indoor temperature.

Note 2. In thermal calculation for the building envelope of residential buildings the relative humidity shall be accepted as 55%.

As mentioned earlier, the temperature regime of the envelope structures according to ДБН В.2.6-31 is regulated by 2 parameters:

- difference between adjusted indoor surface temperature of the envelope structure and indoor temperature at designed outside temperature;

- minimal allowed indoor surface temperature on thermal bridges at design indoor and outdoor air temperatures.

Allowed temperature difference between indoor temperature and adjusted surface temperature of the building envelope structure, Δt_{cr}, ^{0}C, is established for different building types and type of the building envelope structure according to the table below.

Building type	Envelope elements		
	Walls	Roofs	Floors
Residential, schools, kindergartens	4,0	3,0	2,0
Public buildings except mentioned above	5,0	4,0	2,5
Industrial buildings with dry and normal operational regimes	7,0	5,0	
Industrial buildings with humid and wet operational regimes	$t_в$ - $t_р$	0,8($t_в$ – $t_р$)	
Industrial buildings with heat excess (more than 23 W/m^3)	12	12	

If the window factor is more than 0,18, the temperature regime of windows structures shall be accounted when calculating temperature difference. This method allows making regulations to ensure conditions of thermal indoor comfort for modern wall structures, which are based on transparent façade structures.

There is another specific requirement related to EE of buildings in ДБН В.2.6-31, given as recommendation in the Attachment -Calculated compactness ratio".

The compactness ration is determined as:

$$\Lambda_{к\ буд} = F_{\Sigma}/V_h$$

where:

F_{Σ} – total area of indoor surfaces of building envelope, including roof slabs of the upper floor and floor slab of lowest heated space.

V_h – heated volume of the building, which framed by indoor surfaces of building envelope.

It is recommended not to exceed the following $\Lambda_{к\ буд}$ when designing the building:

- 0,25 - for 16-storey buildings and higher
- 0,29 - for buildings of 10 – 15 storey
- 0,32 - for buildings of 6 – 9 storey
- 0,36 - for 5-storey buildings
- 0,43 - for 4-storey buildings
- 0,54 - for 3-storey buildings
- 0,9 - for 2-storey buildings
- 1,1 - for 1-storey building

Indoor climate requirements

Ukraine is behindhand developed EU countries in terms of regulation of indoor climate in buildings. The most complete set of regulated indoor parameter is presented in ISO 7730 Third edition 2005-11-15 Ergonomics of the thermal environment − Analytical determination and interpretation of thermal comfort using calculation of the PMV and PPD indices and local thermal comfort criteria. Analysis of Ukrainian and international norms to indoor climate shows the following:

- Ukrainian norms related to indoor climate do not always correspond to modern level of thermal comfort (thermal discomfort is influence by far more factors, then usually considered in practice during designing. Among them – air turbulence, radiant temperature of heating/cooling surface, asymmetry of radiant temperature);
- Installation of the most modern equipment in the building does not necessarily mean achievement of necessary requirements of thermal comfort.

In EU countries input data for designing in terms of indoor climate are used according to EN 15251:2007 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics. This standard includes provisions of ISO 7730, and adds requirements of air exchange for different types of buildings and premises, explains use of different parameters, etc.

One of the differences from the Ukrainian norms (minimal or optimal indoor microclimate) is that in Europe there are 4 classes of indoor microclimate:

- A (I) − highest class, recommended for premises with diseased people, or people which need special indoor environment – disabled people, children, old people;
- B (II) − normal class, recommended for newly constructed or reconstructed buildings;
- C (III) − accepted class, recommended for existing buildings;
- (IV) − sufficient class, recommended for premises which are used within limited period of time during the year.

For instance, for residential buildings EU norms stipulate values close to Ukrainian norms: air exchange rate for living room and bedroom = 1,44 h^{-1} and norms for air flow in kitchen, bathroom and toilet = 72 m^3/h, 54 m^3/h, 36 m^3/h correspondingly. Air exchange rate for the total apartment area is 0,6. Indicated rates are accepted for the newly constructed buildings or reconstructed buildings. Reducing heat losses through the building envelope (which is aimed by most of the countries, including Ukraine), the energy use for ventilation needs will be increasing.

Regarding requirements to temperature regime of the building envelope, the methodology accepted in Ukraine is updated and corresponds, or sometimes exceeds, EU norms.

3.2.3 Conclusions

1. In spite of lack of special laws about energy efficiency of buildings, Ukraine has established a set of State Building Standards related to energy efficiency indicators.
2. State requirements to thermal protection of buildings of Ukraine are in average 40% lower than correspondent requirements in EU countries. Having in mind there will be a new set of norms after 2010 in EU countries because of the EPBD recast, this gap will increase. Thus, it is necessary to continue improving Ukrainian norms related to thermal insulation of buildings with 30 – 40 % in very near future.
3. To strengthen Ukrainian norms with regard to thermal protection of building envelope, it would be good to introduce a new parameter, rated heat transfer coefficient per conditioned

area H', which gives limitation of heat transfer through the building envelope. If it should be based on the Ukrainian methodology given in ДСТУ-Н Б А.2.2-5:2007 «Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction" the following formula could be used:

$$H' = \frac{k_{\Sigma пр} \cdot F_{\Sigma}}{F_l} = \xi \frac{\left(\frac{F_{нп}}{R_{\Sigma прнп}} + \frac{F_{сп}}{R_{\Sigma прсп}} + \frac{F_{д}}{R_{\Sigma прд}} + \frac{F_{пк}}{R_{\Sigma прпк}} + \frac{F_{ц}}{R_{\Sigma прц}} \right)}{F_l}$$

where:

$k_{\Sigma пр}$ – adjusted U-value of the heat insulation envelope of the building, W/m2K

ξ – factor which counts for additional heat losses connected with envelope orientation, availability of corner rooms, cold air penetration through entrances.

$F_{нп}$, $F_{сп}$, $F_{д}$, $F_{пк}$, $F_{ц}$– area of walls, windows, doors, roof, floor slabs (or floors on the ground)

$R_{\Sigma пр\ нп}$, $R_{\Sigma пр\ сп}$, $R_{\Sigma пр\ д}$, $R_{\Sigma пр\ пк}$, $R_{\Sigma пр\ ц}$– adjusted thermal resistance of walls, windows, doors, roof, floor slabs (or floors on the ground – considering their division into zones)

F_{Σ} – total area of indoor surface of building envelope

F_l – useful area of the building (or heated area, depending on the decision of National Authority)

Such rated heat transfer coefficient (H') could be also specified in more details, giving the limits for each envelope element (walls, windows, roof, floor) or for infiltration.

4. As one additional measure to strengthen requirements to thermal protection of building envelope, additional requirements can be introduced in Ukrainian norms, for instance that the U-values for glass/windows/doors including frames multiplied with the share of window and doors of the total heated floor area must be less than specific values, stipulated by the authorities. Or the requirement could be addressed to the average U-values of the whole building envelope, which should be not more than specific value. This allows limiting application of big glazing with poor thermal characteristic areas in the buildings.

5. Ukraine has introduced basic documents on field testing of energy efficiency indicators. Considering its methodological content this approach is quite modern, is based on deep theoretical and experimental knowledge. Many provisions of this system are equal or exceed the international requirements.

6. Ukraine is behind EU countries in terms of regulation of indoor climate requirements especially in division occupied and non occupied time periods, which is influencing energy use of the building (set back temperatures, ventilation rates, lighting rates, etc during non-occupied periods).

3.3 Requirements to heating systems, heat supply in building

3.3.1 Europe

In 1992 EU endorsed Directive 92/42/EEC on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels, which was continuously updated (the latest update was done in 2008).

Article 5 of this Directive says that such boilers must comply with the following useful efficiency requirements:

- a rated output, i.e. operating at rated output Pn expressed in kW, at an average boiler-water temperature of 70 ^{o}C , and

- a part load, i.e. operating at 30 % part load, at an average boiler water temperature which varies according to the type of the boiler.

The useful efficiency requirements to be complied with are set out in the following table:

Type of boiler	Range of power output	Efficiency at rated output		Efficiency at part load	
	kW	Average boilerwater temperature (^{o}C)	Efficiency requirement (in %)	Average boilerwater temperature (^{o}C)	Efficiency requirement (in %)
Standard boilers	4 to 400	70	≥ 84 + 2 logPn	≥ 50	≥ 80 + 3 logPn
Low temperature boilers (*)	4 to 400	70	≥ 87,5 + 1,5 logPn	40	≥ 87,5 + 1,5 logPn
Gas condensing boilers	4 to 400	70	≥ 91 + 1 logPn	30 (**)	≥ 97 + 1 logPn

(*) Including condensing boilers using liquid fuels.

(**) Temperature of boiler water-supply.

As well the Article states that the harmonized standards relating to the requirements of this Directive shall determine the verification methods valid for production and measurements. Appropriate tolerances must be incorporated in the efficiency levels.

Also EU Directive 2002/91/EC on the Energy Performance of Buildings (and later recast of 2010) requires form the Member States to lay down the necessary measures to establish a regular inspection of accessible parts of systems used for heating buildings, such as the heat generator, control system and circulation pump(s), with boilers of an effective rated output for space heating purposes of more than 20 kW. Boilers of an effective rated output of more than 100 kW shall be inspected at least every 2 years. For gas boilers this period may be extended to 4 years.

The existing buildings and systems have the most important impact on energy consumption. Identifying the weak points of energy consuming systems (screening) and highlighting possible improvements (tailored information) is the first necessary step to improve the energy performance of existing heating systems. These are the main goals of inspection. To support implementation of these requirements of the Directive there was a standard issued: ***EN 15378 –Heating systems in buildings - Inspection of boilers and heating systems"***.

The standard EN 15378 contains a defined basic procedure but allows a high flexibility, too. A lot of practical procedures are given, ready to be assembled according to national inspection classes. This standard has been organized according to the requirements of EPBD, which requires two types and levels of heating system inspections: a "regular" inspection of boilers and a "one-off" inspection of the entire heating system. Regular inspection is meant to be repeated periodically and is restricted to the boiler.

One-off inspection is extended to the entire heating system and includes an assessment of boiler efficiency and sizing. It is explicitly intended to be the basis for advice to the user on possible energy performance improvements.

Accordingly the standard defines two separate procedures for boiler (regular) inspection and heating system (one-off) inspection. This standard is not designed to provide a full energy audit of the heating system. However the methodology of this standard can easily be extended to collect the required on-site information to support an energy audit. The basic procedures to inspect boilers and heating systems are defined in the normative part of this standard.

Due to different background with inspection of boilers and heating systems in different Member States, the standard does not directly give the actual fully detailed procedure but requires that:

- "inspection classes" are identified at national level. Inspection classes may depend on any relevant parameter like size of the heating system, fuel used, individual/collective heating system, etc.
- Inclusion/omission/alternatives of individual detailed procedures (according to boiler or heating system inspection class) are specified according to the inspection class, through tables given in a national annex.

Boiler inspection is defined in clause 5 of EN 15378. Possible objectives of boiler inspection are:

- to verify if the boiler is set, operated and maintained correctly;
- to estimate the actual boiler energy performance;
- to support advice on possible boiler energy performance improvements.

Boiler inspection procedure includes the following steps: define the inspection class; identify the boiler; identify available documents; visual inspection to check for any evidence of wrong and/or dangerous situations ; check if the boiler provides the intended service; check proper setting and functionality of boiler controls; record available data (fuel, time, energy counters) to help create historical data; check if the boiler is regularly maintained; check boiler performance; report to user with optional advice.

The Annexes to the Standard provide procedures for the usual boiler checks that can be made in-situ: flue gas analysis, basic boiler setting check and combustion efficiency measurement as well as example of a complete boiler inspection report.

Heating system inspection is defined in clause 6 of EN 15378. The possible objectives of heating system inspection are:

- verify if the heating system is set, equipped, operated and maintained correctly with regard to energy efficiency;
- estimate actual heating system energy performance;
- support advice on possible heating system energy performance improvements.

The procedure for heating system inspection includes the following steps: define the inspection class; find or assemble required documentation to support inspection; identify the heating system; check if the heating system provides its intended service; check if the heating system is regularly maintained; check proper setting and functionality of heating system sensors, indicators and controls; check energy consumption level (in-use energy performance); inspect emission and control sub-system; inspect distribution sub-system; inspect generation sub-system; inspect DHW production system; check generation sub-system sizing; report to user with optional advice.

The Annexes of EN 15378 include many methodologies to be specified through inspection class tables. For instance Annex F gives methods to assess actual energy consumption for heating. It complements methodologies defined in EN 15603 – Annex B, like the energy signature method. The focus is on criteria

to separate heating and non-heating (DHW and cooking) energy use and on giving references; Annex G is a simple annex dedicated to the emission subsystem - it is limited to criteria to check for overheating in the upper part of rooms with high ceilings; Annex I gives information on space heating distribution sub-system; Annex J deals with domestic hot water (DHW) - the focus is on the cause of the highest losses, like recirculation circuits; Annex L deals with boiler controls setting; Annex N is dedicated to seasonal boiler efficiency assessment; Annex P contains an example of simple tables to assess generation efficiency, either for heating system service or for domestic hot water service, and other Annexes.

The EU Member States reflected methodologies and requirements of EN 15378 in their National Standards.

Beside EN 15378 there are another EU standard directly related to energy efficiency in heating systems of the buildings - ***EN 15316-1 Standard –Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General"***. It defines the efficiency of heating systems or parts of them (subsystems) and introduces the relevant calculation methods. Dividing the general performance of a building, as indicated in EN 15603, makes it possible to identify the strong and the weak points in the total energy performance of a building. EN 15316-1 could also help in the definition and application of specific requirements for heating systems as included in the recast of the Directive 2002/91/EC.

It specifies the structure that should be used for the calculation of energy use in space heating systems and domestic hot water systems in buildings. The calculation methods facilitate the energy analysis of the different sub-systems of the heating system, including control (emission, distribution, storage, generation), through determination of the system energy losses and the system performance factors. This performance analysis permits the comparison between sub-systems and makes it possible to monitor the impact of each sub-system on the energy performance of the building. Calculations of the system energy losses of each sub-system of the heating system are defined in subsequent standards (EN 15316 parts 2-4). The system thermal losses, the recoverable system thermal losses and the auxiliary energy of the sub-systems of the heating system are added together. The system thermal losses of the heating system contribute to the overall energy use in buildings (EN 15603). The energy performance of the generation sub-system is not covered in detail in this European Standard, but is directly taken into account in EN 15603.

Besides the inspection of boilers and heating systems and establishing calculation procedures for system efficiencies, EU Member States introduce, as mentioned in Chapter 3.1, specific requirements in its Buildings codes, like characteristics of the building envelope or technical building systems components (e.g. thermal transmittance of walls, efficiency of boilers, insulation of pipes, lighting power density, specific fan power).

For instance, specific requirements to thermal protection in **Norwegian norms** were presented in previous chapter. The requirements in Norway for heating systems and heat supply in buildings in addition to the —EnergyFrame" value presented in Chapter 3.1, are as follows:

Heat supply

1) It is not allowed to install boiler using oil to cover the base load (60–90% of total energy need) Oil is only allowed to cover peak load.
2) Buildings with more than 500 m^2 heated area must be designed and built so that minimum 60% of net heat need is covered with other energy sources than direct electricity or fossil fuel by the end user.
3) Buildings up to 500 m^2 heated area must be designed and built so that minimum 40% of net heat need is covered with other energy sources than direct electricity or fossil fuel by the end user.
4) Requirements in 2) and 3) are not enforced if it can be documented that environmental conditions make it impossible to reach the requirements in a practical way.
5) Residential buildings that are exempted according to 4) must have chimney and closed fireplace for bio fuel. This, however, is not required for residential units smaller than 50 m^2 heated area or residential buildings that are built as passive houses.
6) In district heating areas with obligatory connection to the grid, all new buildings must be equipped with systems that can utilise district heating for heating, ventilation (heat) and domestic hot water.

Heating and cooling systems

- Heating and cooling systems shall have equipment for adjusting the load to obtain energy efficient operation.
- Water based heating systems connected to district heating or heat pumps must have temperature control possibilities so the system can be adjusted to suit the technical equipment and energy efficient heat production.
- Heat pumps and cooling plants (chillers) must have automatic control and be adjustable to energy efficient operation.
- Piping, equipment and ducts for the heating (and cooling) distribution systems that are emitting unexploitable energy (heating/cooling) must be insulated with energy efficient insulation according to NS-EN 12828 *Heating systems in buildings / Design of water based heating systems*.

Energy Inspection

In addition to energy certificate registering, energy inspection of technical systems must be done by skilled experts in the following cases:

- Boiler for fossil fuel covering > 400 m^2 heated floor area
- Air conditioning system covering > 500 m^2 floor area

The energy inspection must be done at least every 4th year.

If the boiler for fossil fuel covers > 2 000 m^2, the energy inspection must be done every 2nd year.

One time inspection

The owner of boilers older than 15 years must perform a one-time inspection if the boilers are based on fossil fuel and deliver heat to more than 400 m^2. The inspection includes the boiler's efficiency, the heat distribution system efficiency and its capacity compared to the heat demand. The inspection must be performed within one year after the boiler's age passes 15 years.

Reporting

The report from these inspections includes documentation and a list of recommended measures.

Some of the examples of other EU countries are listed below:

Denmark

When replacing an oil-fired boiler, for instance, at least a low-temperature boiler must be installed instead and gas-fired heating boilers must be replaced by condensing boilers. Regular energy inspections of heating boilers and air conditioning systems are also mandatory.

France

Regulations require regular energy inspections of heating boilers and air conditioning systems. At the same time, it makes low-temperature heating boilers the standard in France. Regulation is complemented by comprehensive programs designed to promote technologies for the use of renewable energies as well as energy-efficient heating systems.

Germany

There are minimum requirements on new heating systems, such as low-temperature boilers with time control and controllable outside temperature. An additional law for heat energy efficiency, the EEWärmeG, demands renewable energies are to be used for heating in new buildings to a small percentage. Owners of existing buildings have to replace all boilers with an actual power output of between four and up to 400 kW when they are: using fluid or gas as the fuel and were built up in or before October 1978; they have been improved to run below the exhaust emission limit, or if the burner was changed after October 1996. Exceptions are boilers that are not using common market fuel, only heating water or ranges, and heating appliances also delivering hot water. Uninsulated accessible hot water pipes, as well as fittings in unheated rooms, have to be insulated; the thermal transmission coefficient shall not be above 0.3 W/m^2K.

3.3.2 Ukraine

Regarding heating systems, currently in Ukraine is valid SNiP 2.04.05 – 91 for engineering systems of buildings – heating, ventilation and air conditioning. This norm requires revision, and the new draft of прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" is currently being developed. This draft was submitted to ENSI and the following comments, related to improvement of energy efficiency in heating systems, can be mentioned:

- the new draft is referring to European standards EN 12792 ‐Ventilation for buildings. Symbols, terminology and graphical symbols" and EN 15232 ‐Energy performance of buildings – Impact of Building Automation, Controls and Building Management", which is the first good step to harmonize with the EU norms.
- the new daft requires to connect the heat supply to buildings from the district heating through the automatic heating substation, with automatic control of heat supply depending of outside temperature.
- if the heating substation is serving several buildings, the heat supply could be done according to ‐dependant" scheme through automatic pump units allowing to control heat supply temperature depending on outdoor air temperature.
- the heating units shall be equipped with thermostatic valves, unless it can be proved that it is technically impossible to do so.
- the new draft does not give any efficiency limitations with regards to heat exchangers, individual boilers, ovens and other heat generation sources.
- the new draft requires heat insulation of the pipes, just from the point of view of safety operation. It would be good to strengthen these requirements from the point of view of heat losses.

- regarding decorative covers of heating units which are usually used against burns, there are no requirements given to ensure proper heat emission (convection and radiation).
- the draft contains separate chapter ‑Energy Efficiency". However, the provisions of this chapter have recommendation character without obligatory requirements. Heat recovery is suggested for implementation if justified by feasibility study, rather then vice versa – to justify by feasibility study not to include heat recovery into the design. Besides, some provisions refer to ДБН В.2.6-31 with inclusion of air conditioning, heat and cold supply, which is currently not covered by ДБН В.2.6-31

With regard to inspection of boilers and heating systems Ukraine has regulation mainly for heat suppliers as maintenance and operation rules for heating systems, and address mainly issues related to safety operation , not energy efficiency. Generation efficiency is defined for mainly the centralized heat sources at design phase, while during operation phase checking of efficiency of individual components is desirable but not done at the moment.

Automation of heating systems is currently solely linked to safety provisions (e.g. disconnection in case of overheating). However Heat System Operation Rules now requires automatic weather dependant controls. It would be recommendable to elevate this requirement into an obligatory automatic weather and time control in the level of ДБН. Also temperature setback is currently allowed in Ukraine, however is not prescribed as obligatory (with exceptions in some cases).

Currently there are no requirements of obligatory installation of automatic thermostatic valves on heating units.

The insulation of pipes are now solely focused on safety (avoid burn, so the surface of the insulated pipe should be not more than 40°C). It could be good to introduce into new norms in the Annex a ready-to-use table of thermal conductivity and thickness of insulation for typical diameter of pipes.

3.3.3 Conclusions

1. Weak and outdated Ukrainian building norms related to energy efficiency in current requirements to building utilities require fundamental revision and improvement. The proposed draft прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" is the first step, however it also has space for improvement, like requirements to efficiencies of heat exchangers, individual boilers, automatic controls, heat recovery, etc.)
2. Ukrainian regulations do not have norms for inspection of boilers and heating systems with the focus on energy efficiency (as described above in EU countries according to EN 15378 ‑Heating systems in buildings - Inspection of boilers and heating systems").
3. Ukraine has not introduced calculation method for determining efficiency of heating systems or parts of the systems ((as described above in EU countries according to EN 15316-1 Standard ‑Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General".

3.4 Requirements to ventilation systems

3.4.1 Europe

Energy Performance of Buildings Directive requires the Member States to set energy performance requirements. These requirements: "shall take account of general indoor climate conditions, in order to avoid possible negative effects such as inadequate ventilation, as well as local conditions and the designated function and the age of the building. These requirements shall be reviewed at regular intervals which should not be longer than five years and, if necessary, updated in order to reflect technical progress in the building sector. In view of the large impact of ventilation on the energy consumption of buildings, it

was developed a methodology concerning the inspection of ventilation systems (***EN 15239***), as has been done for air conditioning (as described in EN 15240) and for heating systems (as described in EN 15378), following the requirements of EPBD.

EN 15239 describes how to prepare for an inspection, provides a methodology for the inspection, the requirements for the content of the report and advice for improvements. The methodology addresses mechanical, natural and hybrid ventilation systems in relation to their energy consumption, for both residential and non residential buildings. Inspection may include the following items: the system performance and system conformity to the original design, system operation and building air tightness (however, building air tightness is not really taken into account in the details of the standard itself, which focuses on the ventilation system description and operation).

It is not the intention of the standard to provide a full ventilation system audit and it therefore focuses on an assessment of its functioning and its impact on energy consumption. It includes recommendations on possible system improvements.

The objective of EN 15239 is to provide a methodology that could be applied during inspection, to obtain an assessment of its energy performance and its ability to provide acceptable indoor air quality to the building in which it is installed.

The general methodology as described in the standard is intended to provide the inspector with guidelines that specify the major items that should be inspected, for any building and any associated ventilation system. The inspection protocol is described by means of specific checklists of items to verify. The inspection is mainly based on examination of the existing documentation and visual inspection and on some measurements where available and possible. The difficulty in the inspection is to assess in an easy way such parameters as the duct air tightness, the electrical energy consumption of fans and the implementation of the control strategy (e.g. running during unoccupied periods in an office building). For the actual running of the installations, the assessment of its energy performance must therefore be based mainly on checking that there is good and regular maintenance of the equipment, the correct settings of the controls for the pattern of usage of the building (i.e. duration of occupancy) and the good functioning of all its components.

One of the results of an inspection of a ventilation system should be a list of proposals to improve its energy performance. The report of the inspection should be used as a basis for the proposals.

A large part of the information is provided by the standard in the informative annexes. The Standard also refers to the following EU standards: EN 12599 ~~-~~Ventilation for buildings — Test procedures and measuring methods for handing over installed ventilation and air conditioning systems"; EN 13779 ~~-~~Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems"; EN 15240 ~~-~~Ventilation for buildings - Energy performance of buildings - Guidelines for inspection of air-conditioning systems"; EN 15242 ~~-~~Ventilation for buildings — Calculation methods for the determination of air flow rates in buildings including infiltration"; EN 15378 ~~-~~Heating systems in buildings- Inspection of boilers and heating systems".

One of the other important EU standards related to ventilation is ***EN 13779 –Ventilation for non-residential buildings — Performance requirements for ventilation and room-conditioning systems"***, which applies to the design and implementation of ventilation and room conditioning in non residential buildings intended for human occupancy.

The standard gives the main design criteria and data that must be taken into account in ventilation design. The standard also defines a common language for the characterisation and classification of several data (types of air, air quality, occupancy…). In the annexes, the standard provides some guidelines for good practice, basic information on financial calculations, a checklist and examples. Natural ventilation systems are not covered by this standard.

According to the standard, the ventilation design is based on 3 types of data and parameters:

- The design criteria which regroup the data not directly related to indoor air and ventilation systems; e.g.: The construction data, the use of the room, the systems requirement in term of control and maintenance.
- The classification data which regroup the different classifications and specification of air, the different types of system functions, and data on system functioning and system energy performance, such as pressure conditions, specific fan power or heat recovery.
- The indoor environment which defines the operative temperature, the thermal environment, the main determinants of indoor air quality, the indoor air humidity, the acoustic environment, and the internal loads.

In the Annexes the standard gives guidelines established for mechanical ventilation and air-conditioning systems for buildings intended for human occupancy. It also provide some design values and recommendations – for example for correct consideration of outdoor air quality, selection of air filters and heat recovery - to set up the appropriate ventilation system in the building.

Besides the inspection of ventilation systems, EU Member States introduce, as mentioned in Chapter 3.1, specific requirements in its Buildings codes, like characteristics of the building envelope or technical building systems components (e.g. thermal transmittance of walls, efficiency of boilers, insulation of pipes, lighting power density, specific fan power). The requirements in Norway for ventilation in buildings in addition to the —Energy performance" value presented in Chapter 3.1, are as follows:

Infiltration and ventilation heat losses

It is allowed for have only approx. 0,15 h^{-1} for infiltration (natural ventilation) according to Norwegian norms. It means that norms require that most of the fresh air shall be supplied to the building through mechanical ventilation allowing regulation and heat recovery.

It is obligatory to install heat exchangers in all new ventilation systems. Efficiency requirements:

Leakage number at 50 Pa pressure difference		Annual efficiency for heat exchanger in vent. syst.	
Single family house	Other buildings	Residential houses**	Other buildings
2,5 h^{-1}	≤ 1,5 h^{-1}	≥ 70%	≥ 80%

**: and areas where heat exchangers can lead to spreading of contamination

Ventilation rates

The minimum ventilation rates given below are purely based on people's need for fresh air. Minimum requirements for ventilation rate:

Operation time	**Domestic buildings**	**Buildings for the public and working places***	
		a) Ventilation for human need	**b)** Emission from building parts and furniture
Occupancy /working hours	1,2 $m^3/h \cdot m^2$	26 m^3/h per person with light activity, with higher activity the ventilation rate should be increased	2,5 $m^3/h \cdot m^2$
Non occupancy	0,7 $m^3/h \cdot m^2$	0	0,7 $m^3/h \cdot m^2$

*: Total requirement is the sum of **a)** and **b)**

Calculation: For ventilation systems with VAV (Variable air volume) controlled by CO_2 sensors, the calculation of annual energy need for heating / cooling can be based on 20% reduced air flow during working hours.

Other measures

Specific fan performance (SPF)		Possibility for night and week end temperature setback	Measures are done to avoid need for local space cooling
Residential buildings	Other buildings		
≤ 2,5 $kW/(m^3/s)$	≤ 2,0 $kW/(m^3/s)$		

For residential buildings the requirements can be internally adjusted, as long as the building's heat loss number*** does not increase.

For other buildings the requirements regarding infiltration and ventilation heat losses can be internally adjusted, as long as the building's heat loss number*** does not increase.

***: Heat loss number = H" $(W/(m^2 \cdot K))$

These norms are similar to German NF 2009.

Ducts and piping

Piping, equipment and ducts for the heating and cooling distribution systems that are emitting unexploitable energy (heating/cooling) must be insulated with energy efficient insulation according to NS-EN 12828 *Heating systems in buildings / Design of water based heating systems*.

3.4.2 Ukraine

As already mentioned above, there is currently valid in Ukraine SNiP 2.04.05 – 91 for engineering systems of buildings – heating, ventilation and air conditioning. This norm requires revision, and the new draft of прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" is

currently being developed in Ukraine. This draft was submitted to ENSI and the following comments, related to improvement of energy efficiency in ventilation systems, can be mentioned:

- the new draft is referring to European standards EN 12792 „Ventilation for buildings. Symbols, terminology and graphical symbols" and EN 15232 „Energy performance of buildings – Impact of Building Automation, Controls and Building Management", which is the first good step to harmonize with the EU norms.
- the heating units shall be equipped with the thermostatic valves, unless it can be proved that it is technically impossible to do so.
- the new draft does not require to apply whenever possible mechanical ventilation systems, which allows regulation and heat recover.
- the new draft does no imply specific minimal requirements for heat recovery (like efficiency of the recovery units) in mechanical ventilation systems.
- the new draft does not give any specific requirements for heat insulation of ducts.
- the draft contains separate chapter „Energy Efficiency". However, the provisions of this chapter have recommendation character without obligatory requirements. Heat recovery is suggested for implementation if justified by feasibility study, rather then vice versa – to justify by feasibility study not inclusion of heat recovery into the design. Besides this, some provisions refer to ДБН В.2.6-31 with inclusion of air conditioning, heat and cold supply, which is currently not covered by ДБН В.2.6-31

Currently Ukraine has no requirements for heat recovery in ventilation systems as well. Automatic control requirements in the current norms for ventilation are similar to the ones mentioned in previous chapter for heating systems.

3.4.3 Conclusions

1. Weak and outdated Ukrainian building norms related to energy efficiency in current requirements to building utilities require fundamental revision and improvement. The proposed draft прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" is the first step towards it, however it also has space for improvement, like requirements to heat recovery, automatic controls, insulation of air ducts, etc.)
2. Ukrainian regulations do not have norms for inspection of ventilation and air conditioning systems with the focus on energy efficiency (as described above in EU countries according to EN 15239).

3.5 Requirements to domestic hot water, and hot water supply in buildings

3.5.1 Europe

EU normative base comprise a number of standards related to Domestic Hot water systems and its efficiencies. For instance EN 15316-3-1 „Domestic Hot Water systems - Characterisation of Needs (tapping requirements)", which characterizes hot water needs. It contains explanations of the calculation methods with details of the input and output data and the links with related other EU standards. The standard is the first of a series of three standards for calculation of domestic hot water system energy needs and system efficiencies. The two other standards treat distribution (EN 15316-3-2) and generation systems (EN 15316-3-3).

The correct characterisation of hot water needs is important because the losses of boilers and the distribution system are very sensitive to the couple of frequency and energy content of heat up and cool down at any tapping. Therefore the needs are defined by the energy amount and also by the tapping

patterns. According to EU expert opinion the energy amount of hot water needs could represent about 20 to 25 kWh/m².year in existing residential buildings.

The standard gives four methods for calculation of the energy needs of the delivered domestic hot water. The four methods calculate the energy needs at different levels of detail. The hot water needs in MJ/day or MJ/year is the first important input parameter for the energy calculation. Allowing for distribution and generation losses and auxiliary energy, the final energy consumption can be calculated. In addition to the hot water needs, a detailed tapping pattern may be needed, especially for dwellings and individual hot-water appliances. The performance of individual hot-water appliances depends a lot on the applied tapping pattern. Instantaneous heaters in particular are very sensitive to this since they heat up and cool down at any tapping, causing large start/stop losses. Circulation systems for distribution and hot water generators using storage systems have constant losses and are less sensitive to the tapping pattern. So for non-residential buildings, detailed tapping patterns are generally not required.

Four calculation methods are described: Energy need related to tapping programs; Energy need related to volume needs; Energy need linear with floor area; Energy need from tabulated values for different building types or functions. For all methods a national annex is required. The annexes to the standard provide default values.

Energy need related to tapping programs: This method is characterized by the use of one or more 24-hour cycles that define a number of domestic hot water draw-off needs. Tapping patterns may be given in a National Annex. These must identify the building type(s) for which they can be used. The tapping patterns must include the start time, the energy content of each draw-off, the type of delivery, the corresponding delivery temperature and the minimum temperature required. In addition to these patterns a method is required that gives the energy demand as a function of the building size, generally the floor area.

Energy need related to volume requirements: This method is defined assumes that required volumes and water temperatures are given to enable energy demand to be calculated. The required volume has a linear or non-linear relation with floor area of the building. The input parameters are: floor area of the building in m^2; temperature of the (cold) inlet water in °C; specified temperature of domestic hot water at the tapping point in °C. The factors to describe the relation between floor area and required volume are fixed parameters.

Energy need linear with floor area: This method assumes a linear relation between the floor area and the energy demand. Basically, this method is a linear and straightforward version of the previous method, using a specific domestic hot water demand per day based on a water delivery temperature (e.g. of 60°C) and a cold water supply temperature (e.g. of 10°C). The input parameter is floor area of the building in m^2. The factor to describe the relation between floor area and required energy is a fixed parameter.

Energy need from tabulated values for different building types or functions: This method assumes a (linear) relation between the floor area and the energy demand. Basically, this method is quite similar to the previous methods, but only this method refers to different building types or functions.

The input parameters are: the type of building; the type of activity carried out within the building; the use of a zone within a building where more than one activity is carried out; class of activity, such as the category of a hotel (number of stars) or the class of catering establishment.

Example of the annual specific energy demand for DHW for different building types:

Building function	**Specific energy need MJ/ (m^2year)**	**Specific energy need recalculated to kWh/ (m^2year)**
dwelling	68	18.9
bar	15	4.2
restaurant	10	2.8
prison	15	4.2

hospital	55	15.3
health service	10	2.8
office	5	1.4
hotel	45	12.5
school	5	1.4
sports	45	12.5
shops	5	1.4

In addition to requirements to energy needs for domestic hot water some of EU countries implied requirements for renewable energy to be used for DHW.

For example, in Portugal: the use of solar energy for heating domestic water is obligatory, as in Spain. A solar collector area of at least one square meter per inhabitant of the building is prescribed – up to a maximum of 50 % of the available surface area of the building. In Spain the requirements essentially aim to limit the total energy consumption of a building and make it mandatory to use at least 30 % solar energy to heat the domestic water.

3.5.2 Ukraine

According to the current Ukrainian norms recirculation is obligatory for domestic hot water. The norms also requires installation of water meters in each apartment. Insulation of hot water pipes are required but only from the point of view of safety (not from the point of view of heat losses).

No other requirements related to energy efficiency in DHW systems are introduced in Ukrainian standards. Neither there requirements for application of solar heater (at least in southern regions of Ukraine).

3.5.3 Conclusions

1. In general, Ukrainian normative base does not have a set of regulations related to energy efficiency for DHW systems. To harmonise with EU standards Ukraine will have to reflect EN 15316-3-1, as well as EN 15316-3-2 (for distribution of DHW) and EN 15316-3-3 (for generation of DHW), and select the methodologies proposed in these standards.
2. Ukraine does not require applying renewable energy for preparation of DHW. Future requirements to apply solar energy for preparation of DHW in southern regions could be introduced (this requirement might be softened with the note that such technology may not be applied if it is documented that it is not feasible).

3.6 Requirements to lighting systems

3.6.1 Europe

The EU Directive 2009/125/EC of 21 October 2009 *establishes a framework for the setting of ecodesign requirements for energy-related products (recast)*. It specifies environmental- and energy performance requirements at product level, mainly for household products. It also covers requirements for different types of lamps, but there are no direct references to building codes or specifications on specific energy use (kWh/m^2·year) or installed power (W/m^2) for lighting.

In 2009 the European Commission adopts regulations to progressively remove from the market non-efficient light bulbs. The Commission adopted ecodesign regulations to improve the energy efficiency of household lamps and of office, street and industrial lighting products. Inefficient incandescent light bulbs will be progressively replaced by improved alternatives starting in 2009 and finishing at the end of 2012. The two regulations set energy efficiency, functionality and product information requirements for households lamps (in particular incandescent bulbs, halogen lamps and compact fluorescent lamps), as

well as for lighting products typically used in office, street and industrial lighting (fluorescent lamps, high-intensity discharge lamps and related ballasts and luminaires). Households will still have the choice between long-life compact fluorescent lamps that currently yield the highest energy savings (up to 75% less energy than incandescent lamps), or efficient incandescent lamps (of the halogen type) fully equivalent to conventional bulbs in terms of light quality, providing between 25% and 50% energy savings.

There is another Directive 2000/55/EC of the 18 September 2000 related to lighting - on energy efficiency requirements for ballasts for fluorescent lighting. All fluorescent lamps contain ballasts. The amount of energy dissipated can be reduced considerably by using more efficient ballasts. The Directive applies to electric mains-operated ballasts for fluorescent lighting, which are defined in the annexes. The Member States must take all necessary measures to ensure that ballasts covered by the directive can be placed on the Community market, and put into service only if their power consumption is less than or equal to the maximum allowable power consumption value for their category, calculated in accordance with the procedures defined in the annex. Manufacturers of ballast covered by the directive are responsible for ensuring that each ballast placed on the market complies with the power consumption requirements laid down in the directive.

The maximum input power of ballast-lamp circuits expressed in W is defined by the following table:

Ballasts category	**Lamp Power**		**Max. input power of ballast-lamp circuits**
	50 HZ	**HF**	
1	15 W	13,5 W	23 W
	18 W	16 W	26 W
	30 W	24 W	38 W
	36 W	32 W	43 W
	38 W	32 W	45 W
	58 W	50 W	67 W
	70 W	60 W	80 W
2	18 W	16 W	26 W
	24 W	22 W	32 W
	36 W	32 W	43 W
3	18 W	16 W	26 W
	24 W	22 W	32 W
	36 W	32 W	43 W
4	10 W	9,5 W	16 W
	13 W	12,5 W	19 W
	18 W	16,5 W	26 W
	26 W	24 W	34 W
5	18 W	16 W	26 W
	26 W	24 W	34 W
6	10 W	9 W	16 W
	16 W	14 W	23 W
	21 W	19 W	29 W
	28 W	25 W	36 W
	38 W	34 W	45 W

Other EU regulations which is worth to mention regarding lighting are:

- Regulation (EC) No 244/2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for non-directional household lamps, and later amendments to it.

- Regulation (EC) No 245/2009 as regard to ecodesign requirements for fluorescent lamps without integrated ballast, for high intensity discharge lamps, and for ballasts and luminaires able to operate such lamps, and repealing Directive 2000/55/EC of the European Parliament and of the Council, as well as late amendments to it.

With regards to calculation of energy use for lighting, EU developed Standard 15193: Energy performance of buildings – Energy lighting requirements. In addition to providing the internal loads due to lighting, the method described in the standard can also be understood as a design tool, making it possible to optimise lighting energy requirements in a holistic approach integrating artificial lighting, daylighting and control systems. The EPBD will not only maintain good quality levels of lighting, as described for instance in the standard EN 12464-1/3, but in conjunction with the technical methods and standards within EN 15193 will also promote energy efficient artificial lighting systems and the efficient use of daylight.

Standard EN 15193 specifies the metering and calculation methodology to be used for the evaluation of the amount of energy used for lighting in buildings. The standard can be applied to existing buildings and for the design of new or renovated buildings. It also provides a benchmarking system for different building types, making it possible to rank order the calculated or measured lighting energy demands. It should be, however, noted that the Standard provides a framework outlining general aspects, but still leaving room for national variations and refinements using more detailed sub-models and methods.

3.6.2 Ukraine

The existing Ukrainian norms stipulate requirements for illumination and natural lighting, not requirements are provided for the lighting as whole system and considering the energy efficiency of this system.

Also, as we could see, there is no ordinance about gradual replacement of incandescent lamps with more efficient solutions.

3.6.3 Conclusions

1. In general, Ukrainian normative base has a big gap with EU base with regard to requirements to energy efficiency in lighting. To cover this gap Ukraine will need to introduce gradually a system of norms starting from minimal general requirements to efficiencies to lighting sources, their durability and correspondent labelling and ending with establishing calculation methodologies for energy use for lighting purposes.

3.7 Requirements to Energy Metering and Management

3.7.1 Europe

EU Directive 2006/32 of 5 April 2006 *on energy end-use efficiency and energy services* says in Article 13 pt. 1: ~~M~~Member States shall ensure that, in so far as it is technically possible, financially reasonable and proportionate in relation to the potential energy savings, final customers for electricity, natural gas, district heating and/or cooling and domestic hot water are provided with competitively priced individual meters that accurately reflect the final customer's actual energy consumption and that provide information on actual time of use".

Beside this, EU issued the Standard EN 16001:2009 – Energy Management systems. As it is stated in the standard adoption of EN 16001: 2009 will contribute to the setting up of a continuous improvement process that will lead to more efficient energy use. It will encourage organizations to implement an energy monitoring plan as well as energy analysis.

The example requirements to energy metering, as it is arranged in Norway, is presented below:

- *Heat and DHW:* Norwegian authorities so far have concluded that individual metering of water based heat and domestic hot water for final customers (single flats and rented space)

inside buildings is not mandatory. This applies for district heating and local central heating systems. The normal way of metering the district heating supply is at the utility side of the local heat exchanger. The energy meter then covers the building's total consumption of heat for heating, ventilation (heat) and DHW.

- *Gas:* Very few areas in Norway have grid for gas (natural gas). There are no official regulations for individual metering of gas, but the gas distributor always install meters for each end user.
- *Metering inside the final customer's boundary:* There are no requirements in the building regulations on energy metering inside the final customer's boundary.
- *Energy management.* There are no requirements in the building regulations on energy management. The Norwegian state owned public enterprise, Enova, is responsible for marketing and arranging voluntary programmes for building owners to establish energy management for their buildings. Within their programmes they have requirements on energy management and energy monitoring. At the same time Norway endorsed EN 16001:2009 – Energy Management systems.

3.7.2 Ukraine

The Ukrainian Law on rational use of energy sources requires that the State control over effective use of energy recourses and correspondence to state energy efficiency regulations shall also cover obligatory energy metering. Energy Management for buildings is not introduced and not obligatory for Ukraine.

3.7.3 Conclusions

1. It would be beneficial for Ukraine to take steps in introduction of Energy Management standard for the buildings owners (at least the big building owners, like municipalities, ministries, commercial building, etc.). As a first step could be to develop a methodology for energy management and further define a certain threshold, building energy footprint, etc.

3.8 Requirements to energy certification of buildings

3.8.1 Europe

Briefly EPBD Directive requires the following regarding energy performance certification of buildings:

- Member States shall lay down the necessary measures to establish a system of certification of the energy performance of buildings. The energy performance certificate shall include the energy performance of a building and reference values such as minimum energy performance requirements in order to make it possible for owners or tenants of the building or building unit to compare and assess its energy performance.
- The energy performance certificate shall include recommendations for the cost-optimal or cost-effective improvement of the energy performance of a building or building unit, unless there is no reasonable potential for such improvement. The recommendations included in the energy performance certificate may provide an estimate for the range of payback periods or cost-benefits over its economic lifecycle.
- The evaluation of cost effectiveness shall be based on a set of standard conditions, such as the assessment of energy savings and underlying energy prices and a preliminary cost forecast. In addition, it shall contain information on the steps to be taken to implement the recommendations. Other information on related topics, such as energy audits or incentives of a financial or other nature and financing possibilities may also be provided to the owner or tenant.

- Certification for building units may be based: (a) on a common certification of the whole building; or (b) on the assessment of another representative building unit with the same energy-relevant characteristics in the same building.
- Certification for single-family houses may be based on the assessment of another representative building of similar design and size with a similar actual energy performance quality if such correspondence can be guaranteed by the expert issuing the energy performance certificate.
- The validity of the energy performance certificate shall not exceed 10 years.
- The Commission shall by 2011 adopt a voluntary common European Union certification scheme for the energy performance of non-residential buildings.
- Member States shall ensure that an energy performance certificate is issued for: (a) buildings or building units which are constructed, sold or rented out to a new tenant; and (b) buildings where a total useful floor area over 500 m^2 is occupied by a public authority and frequently visited by the public. On 9 July 2015, this threshold of 500 m^2 shall be lowered to 250 m^2 .
- Member States shall ensure that the energy performance certification of buildings and the inspection of heating systems and air-conditioning systems are carried out in an independent manner by qualified and/or accredited experts, whether operating in a self-employed capacity or employed by public bodies or private enterprises. Experts shall be accredited taking into account their competence.
- Member States shall make available to the public information on training and accreditations. Member States shall ensure that either regularly updated lists of qualified and/or accredited experts or regularly updated lists of accredited companies which offer the services of such experts are made available to the public.
- Member States shall ensure that independent control systems for energy performance certificates.
- Member States shall require the energy performance certificates and the inspection reports referred to in paragraph 1 to be made available to the competent authorities or bodies on request.
- Buildings occupied by public authorities and buildings frequently visited by the public should set an example by showing that environmental and energy considerations are being taken into account and therefore those buildings should be subject to energy certification on a regular basis.

Also Directive 2006/32/EC on energy end-use efficiency and energy services states:

- Certification in accordance with EPBD shall be regarded as equivalent to an energy audit. Furthermore, audits resulting from schemes based on voluntary agreements between organisations of stakeholders and an appointed body, supervised and followed up by the Member State concerned shall likewise be considered as having fulfilled the requirements set in this Directive.

As supportive standards for implementation of EPBD the European Union issued the following standards:

- EN 15603 Energy performance of buildings – overall energy use and definition of energy ratings
- EN 15217 Methods for expressing energy performance and for energy certification of buildings
- EN ISO 13790:2008 –Energy Performance of Buildings – Calculation of energy use for space heating and cooling”

EN ISO 13790 and EN 15603 offer different ways of dealing with interactions between a building and its systems. There are two methods (holistic or simplified), both taking the recoverable thermal losses of the building systems into account. National authorities shall define under which conditions the two methods are to be applied. The choice of method depends on several aspects. First the purpose of the assessment should be considered, as it influences the level of detail required. The type and complexity of the building

and its technical system are also relevant parameters. In general, the holistic approach is applied for complex systems and when a high level of detail is required.

EN 15603 defines the energy services whose energy performance ratings must be determined in planned and existing buildings. Two principal types of energy rating for buildings are proposed in this standard: the calculated energy rating and the measured energy rating. Both methods have their pro's and con's. However, it should be noted that most of the countries chose to follow calculated energy rating, as there are difficulties with establishing benchmarking according to the measured method, which require substantial database for energy consumption for the past 3 years for different types of buildings. Besides, the measured data must be adjusted to standard climatic conditions and standard indoor conditions (to avoid reflection of low energy consumption at the cost of worsen indoor climate), which is, again, will need application of EN ISO 13790. In addition, according to the Standards a measured energy indicator will no longer be valid after a change of building occupant or a change in the pattern of use of the building.

En 15217 provides methods that are required to express the energy performance (EP) of buildings. It stated that the certificate shall contain an easy-to-understand global indicator of the energy consumption of the certified building. As different forms of energy can be delivered to a building: (district heating, gas, electricity, wood, etc), the indicator will be a weighted sum of these delivered energies. Depending of the weight chosen, the indicator can represent either:

- Primary energy
- CO_2 emissions
- Total energy cost
- A weighted sum of the net delivered energy weighted by any other parameter defined by national energy policy.

The National authority shall also define the frame for term –Conditioned area, AC": internal dimensions or external dimensions, or overall internal dimensions.

EN 15217 indicates that the performance scale shall range from A (buildings of highest energy performance) to G (buildings of lowest energy performance) shall be introduce for certification.

As the mentioned standards provides several alternatives for expressing energy performance of buildings in certificates, EU Members States have differences in their certification methods based on the decisions made by their National Authorities.

As an example below is provided information about certification scheme in **Norway**:

A separate regulation on energy certification went into force 01 July 2010. It is based on the Norwegian Energy Act and is harmonised with the EU Directive on energy performance of buildings.

Approach: The following buildings shall have an energy performance certificate (EPC):

- All domestic buildings/flats with a heated floor area > 50 m^2 and non domestic buildings with a heated floor area <1 000 m^2 shall have an EPC when: selling existing, renting out existing or commissioning new building/flat.
- All non domestic buildings with a heated floor area >1 000 m^2 shall have an EPC.

The energy performance certificate consists of an energy performance label showing energy rating (from A to G) and heat rating (from green to red).

The energy rating is based on annual **delivered energy** per m^2 and the heat rating is based on how big part of the **heat need** must be covered with direct electricity or fossil fuel (oil, gas).

In addition, the certificate has a list of proposed measures needed to get a better energy and heat rating. Buildings > 1 000 m^2 must have the energy certificate label exposed in a place used by the building users. The certificate must be renewed at least after 10 years.

Calculation: All calculations for the certification are done according to NS 3031 (EN 13790) by the central calculation system and database of the Norwegian Water Resources and Energy Directorate (NVE). The calculation is based on the registration input done by the building owner or a person/specialist authorised by her.

The certification system has 4 levels of registration.

Domestic buildings at level 1 and 2 can be registered by non skilled personnel. All non domestic buildings must be registered by skilled personnel.

1. *Simple registration.* For domestic single family houses (buildings with up to 4 flats, chained houses) where no changes have been done on building envelope or heating systems since it was built.
2. *Detailed registration.* For domestic buildings where changes have been done, and for small and simple non domestic buildings.
3. *Expert registration.* For complex buildings without air conditioning and/or large glass areas.
4. *Expert registration with external calculation programme.* For complex buildings with air conditioning and/or large glass areas where dynamic (hourly) calculation is needed. The external programme must be based on methods described in NS 3031 (EN 13790) and produce a result file to be uploaded in NVE's certification system.

The calculations done in NVE's system give two indicating values:

The energy rating: The annual delivered energy is input to the table of energy rating:

Building category	**Delivered energy**						
	A	**B**	**C**	**D**	**E**	**F**	**G**
	Lower than (kWh/m^2)						
Single family house	79	118	158	231	305	458	> 458
Block of flats	67	100	134	184	235	353	> 353
Kindergarten	90	135	180	228	276	414	> 414
Office building	84	126	168	215	263	395	> 395
School	79	118	158	208	259	389	> 389
University	95	143	191	240	289	434	> 434
Hospital	179	268	358	416	475	713	> 713
Nursing home	136	203	271	328	384	576	> 576
Hotel	135	202	269	321	373	560	> 560
Sports facility	109	164	218	272	325	488	> 488
Shopping centre	129	194	258	309	360	540	> 540
Cultural building	105	158	210	256	302	453	> 453
Light industry	106	159	212	270	329	494	> 494

The heat rating: is an indicator showing how big part (from 100 to 0%) of the energy need for heat (heating, ventilation (heat) and domestic hot water) must be covered with of direct electricity or fossil fuel. The purpose is to show the possibilities to heat with ~~r~~enewable" energy such as bio, solar, heat pump and district heating.

1: < 30%
2: < 47,5%
3: < 65%
4: < 82,5%
5: < 100%

Another example can be taken from **Slovakia**, where Energy Performance classes are also determined for delivered energy, kWh/m^{2}year:

	A	B	C	D	E	F	G
Family houses	≤ 54	55-110	111-165	166-220	221-275	276-330	> 330
Apartment	≤ 40	41-79	80-119	120-158	159-198	199-237	> 237
Offices	≤ 58	59-115	116-166	167-218	219-272	273-327	> 327
Schools	≤ 42	43-84	85-124	125-163	164-204	205-245	> 245
Hospitals	≤ 101	102-201	202-293	294-385	386-481	482-578	> 578
Hotels and restaurants	≤ 94	95-187	188-275	276-363	364-454	455-545	> 545
Sport halls and facilities	≤ 48	49-95	96-140	141-184	185-230	231-276	> 276
Commercial buildings	≤ 81	82-161	162-237	138-313	314-391	392-469	> 469

In addition the Energy Certificate shall contain information on primary energy and CO_2 emission. For this, the Slovakian authorities developed the following reference values for these parameters:

Energy carrier	Transformation type	Unit	Calorific value GJ/unit	Generation efficiency %	CO2 emission factor kg/kWh	Primary energy factor
	standard boiler - old	1 000 m^3	34,28	83	0,2385	1,1
	standard boiler - new	1 000 m^3	34,28	88	0,2249	1,1
Gas	low-temp. boiler - old	1 000 m^3	34,28	90	0,2199	1,1
	low-temp. boiler - new	1 000 m^3	34,28	93	0,2128	1,1
	condensing boiler - new	1 000 m^3	34,28	98,5	0,2010	1,1
Electricity	electric heating cooling	MWh		99	0,6200	2,8
	electric DHW	MWh		99	0,6200	2,8

3.8.2 Ukraine

Ukraine has introduced energy passport of buildings, which provides information about energy efficiency of the building. This information in many aspects is following EU requirements for certification of buildings. It also includes the following energy classes (new or reconstructed building are requested to have class not less than C):

Energy Efficiency Classes	Difference in % between calculated or actual specific energy use, $q_{буд}$, and maximal allowed E_{max}, $[(q_{буд} - E_{max}) / E_{max}] \cdot 100\%$
A	minus 50 and less
B	from minus 49 to minus 10
C	from minus 9 to plus 5
D	from plus 6 to plus 25
E	from plus 26 to plus 75
F	plus 76 and more

However, as it was mentioned in chapter 3.1, $q_{буд}$ does not follow calculation procedures of EU norms. As well, such expression of energy performance does not allow to reflect application of renewable energy in the building services, while expression of energy performance through Primary energy or CO_2 could help to reflect renewable solutions in the energy passport.

The presentation of energy efficiency classes in the Energy Passport does not meet EU requirements.

3.8.3 Conclusions

1. In general, energy certification procedures are not established in Ukraine. It is necessary to develop correspondent normative documents which establish methodological principles, procedures and legislation basis for energy certification of buildings.
2. For establishing certification scheme the Ukrainian authorities will have to consider the following list of issues, but not limited to:
   - Which energy rating to use for existing buildings - calculated or measured energy rating.
   - Method/requirements for adjustment/verification of measured data, if the measures energy rating is selected.
   - Which calculation methods to use for new buildings and existing buildings if calculated energy rating is selected
   - Energy rating of total energy use only, or also on heating, cooling, domestic hot water, etc.
   - To adjust national reference values according to newly accepted calculation method
   - To define procedures and rules for energy auditing and certification of buildings
   - To define national conversion factors (for primary energy and CO_2 emissions)
   - To define training requirements for certification experts and energy auditors
   - To establish inventory of certified auditors, buildings, benchmarks, progress reporting.

4. Recommendations

4.1 Immediate

1. If still possible, to reflect ENSI comments to the draft Law on Energy Performance of Buildings, provided 8.10.2010.

2. To develop a standard for general procedures for energy auditing in buildings, analysis of actual energy performance of buildings.

3. To update ДБН В.2.6 – 31:2006, introducing stronger requirements of thermal protection of buildings, at least for external walls with 30%.

4. To strengthen Ukrainian norms with regard to thermal protection of building envelope, it would be good to introduce new parameter, rated heat transfer coefficient per conditioned area H', which gives limitation of heat transfer through building envelope. If to base it on Ukrainian methodology given in ДСТУ-Н Б А.2.2-5:2007 «Instructions on Development and Preparation of Energy Certificates (passport) of the Buildings at New Construction and Reconstruction" the following formula could be used:

$$H' = \frac{k_{\Sigma пр} \cdot F_{\Sigma}}{F_l} = \xi \frac{\left(\frac{F_{нп}}{R_{\Sigma прнп}} + \frac{F_{сп}}{R_{\Sigma прсп}} + \frac{F_{д}}{R_{\Sigma прд}} + \frac{F_{пк}}{R_{\Sigma прпк}} + \frac{F_{ц}}{R_{\Sigma прц}} \right)}{F_l}$$

where:
$k_{\Sigma\, пр}$ – adjusted U-value of the heat insulation envelope of the building, W/m2K
ξ – factor which counts for additional heat losses connected with envelope orientation, availability of corner rooms, cold air penetration through entrances.
$F_{нп}$, $F_{сп}$, $F_{д}$, $F_{пк}$, $F_{ц}$– area of walls, windows, doors, roof, floor slabs (or floors on the ground)
$R_{\Sigma пр\, нп}$, $R_{\Sigma пр\, сп}$, $R_{\Sigma пр\, д}$, $R_{\Sigma пр\, пк}$, $R_{\Sigma пр\, ц}$– adjusted thermal resistance of walls, windows, doors, roof, floor slabs (or floors on the ground – considering their division into zones)
F_{Σ}– total area of indoor surface of building envelope
F_l – useful area of the building (or heated area, depending on the decision of National Authority)
Such rated heat transfer coefficient (H') could be also specified in more details, giving the limits for each envelope element (walls, windows, roof, floor) or for infiltration.

5. As one additional measure to strengthen the requirements to thermal protection of the building envelope, additional requirements can be introduced in Ukrainian norms, for instance U-values for glass/windows/doors including frames multiplied with the share of window and doors of the total heated floor area must be less than specific values, stipulated by the authorities. Or the requirement could be addresses to the average U-values of the whole building envelope, which should be not more than specific value. This allows limiting application of big glazing with poor thermal characteristic areas in the buildings.

4. To update weak and outdated Ukrainian building norms related to energy efficiency in current requirements to building utilities. As the first step the draft прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" should take into consideration the following recommendations:

   - to introduce specific requirements to minimum allowed efficiencies of boilers and heat exchangers in new construction and reconstruction of heating systems

- to introduce more specific requirements to automatic controls systems in heating, ventilation and air conditioning, in terms of minimal functionalities of these systems to maintain required indoor climate and temperature set-back.
- to introduce specific requirements for heat insulation of pipes and ducts from the point of view to minimize heat losses. To provide assistance to the designers, adding special Annexes to the прДБН В.2.5-XX-20XX «Engineering Systems of Buildings. Heating Ventilation and Air Conditioning" providing reference information for recommended heat insulation of pipes.
- to introduce limitation of air which can be supplied to building through uncontrolled infiltration
- to introduce obligatory heat recovery for mechanical ventilation, with at least 50% minimal recovery efficiency for the ventilation rate bigger than specified value.
- to introduce requirements given to ensure proper heat emission (convection and radiation) with regards to decorative covers of heating units which are usually used against burns.
- to introduce obligatory application of solar water heaters for domestic hot water in southern regions of Ukraine for new construction and reconstruction, unless it can be documented than such installation is not feasible. It will also require to specify the regions of application of this requirement.
- to introduce obligatory application of heat pumps for new construction and reconstruction in the construction sited where district heat supply is not available, unless it can be documented than such installation is not feasible.

6. To introduce regulations stipulating main input parameters for feasibility assessment of energy efficiency solutions, so there would be established common basis for economical comparison.
7. To update regulation of indoor climate requirements especially in division occupied and non occupied time periods, which is influencing energy use of the building (set back temperatures, ventilation rates, lighting rates, etc during non-occupied periods).
8. To gradually introduce a system of norms starting from minimal general requirements to efficiencies to lighting sources, their durability and correspondent labelling and ending with establishing calculation methodologies for energy use for lighting purposes, introducing into Ukrainian norms the requirements of EU Regulations regarding lighting performance (EC) No 244/2009, (EC) No 245/2009, No 859/2009.

4.2 Medium term

1. To introduce legislation for obligatory inspection of boilers and heating systems with the focus on energy efficiency (as described above in EU countries according to EN 15378 -Heating systems in buildings - Inspection of boilers and heating systems").
2. To develop regulations supporting implementation of obligatory inspection of boilers and heating systems in accordance with EN 15378 -Heating systems in buildings- Inspection of boilers and heating systems".
3. To introduce calculation method for energy need and energy use which follows EU methodologies, like indicated in EN ISO 13790 Energy Performance of Buildings – Calculation of energy use for space heating and cooling" and -EN 15603 -Energy performance of buildings – overall energy use and definition of energy ratings".

   It will also require to introduce gradually respective regulations for determining efficiencies of different systems reflecting the principles of EU norms, like:

- EN 15316-1 Standard ―Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General”,
- EN 15241 ―Calculation methods for energy losses due to ventilation and infiltration”
- EN 15242 ―Ventilation for buildings - Calculation methods for the determination of air flow rates in buildings including infiltration”.
- EN 15316-3-1 ―Domestic Hot Water systems. Characteristics of needs”.
- EN 15316-3-2 ―Domestic Hot Water systems. Distribution”
- EN 15316-3-3 ―Domestic Hot Water systems. Generation”
- EN 15251 ―Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics”
- other supportive EU standards

4. To introduce to the Ukrainian norms the principle of the EN 13779 Standard ―Ventilation for non-residential buildings - Performance requirements for ventilation and room-conditioning systems”.
5. To determine if ―energy need”, ―energy use”, ―delivered energy”, ―primary energy” shall be accepted in Ukraine as energy performance indicator. Should it be decided to be ―primary energy”, Ukraine will have to develop primary energy factors for different types of energy sources.
6. To determine if overall energy performance requirements for buildings will be applied in Ukraine, or if will be limited to heating and heating in ventilation (as it is limited now), or some other budget items will be included into energy performance indicator (as, for instance, domestic hot water, cooling, lighting, etc.).
7. To recalculate minimal energy performance requirements (currently presented in ДБН В.2.6 – 31:2006) in accordance with the new calculation methodology and taking into account modifications to the minimal requirements to the building envelope and technical building systems components, mentioned in ―Immediate” recommendations.
8. To upgrade the climatic standard of Ukraine, which could fit the adopted calculation methodology (if possible, to include data for cooling calculation which shall be considered by Ukraine in the future).
9. For establishing certification scheme the Ukrainian to decide upon the following:
   - energy rating method (calculated or measured), for which types of buildings.
   - method/requirements for adjustment/verification of measured data, if the measures energy rating is selected.
   - calculation methodology
   - To define procedures and rules for energy auditing and certification of buildings
   - To define national conversion factors (for primary energy and CO_2 emissions)
   - To define training requirements for certification experts and energy auditors
   - To establish inventory of certified auditors, buildings, benchmarks, progress reporting.

10. To develop methodology for Energy Management in building stock, which could be used for example by big building owners, like municipalities or commercial buildings owners, establishing certain energy management procedures.
11. To introduce gradual phase out of incandescent lamps from the Ukrainian market thorough legislation acts, for instance Government Decrees, etc.
12. To develop training courses and ensure training possibilities for local designers to be able to reflect the new approaches and requirements in their work
13. To develop training courses and ensure training possibilities for inspection experts for boilers and heating systems.

4.3 Long term

1. To introduce in Ukrainian legislation obligatory inspection of air conditioning and ventilation systems with the focus on energy efficiency (as described above in EU countries according to EN 15239 on inspection of ventilation systems and EN 15240 on inspection of air conditioning systems).
2. To develop regulations supporting implementation of obligatory inspection of air conditioning and ventilation systems in accordance with EN 15239 ‐Inspection of Ventilation Systems" , EN and EN 15240 ‐Ventilation for buildings - Energy performance of buildings - Guidelines for inspection of air-conditioning systems";
3. To develop training courses and ensure training possibilities for inspection experts for ventilation and air conditioning systems.
4. For the future perspective Ukraine will need to develop energy performance requirements and correspondent calculation algorithms for domestic hot water, cooling, lighting, fans and pumps, etc.
5. For lighting energy performance to introduce benchmarking following 15193 in combination with illuminance requirements of 15646-1.
6. To introduce obligatory requirements for application of renewable energy sources application, both for heat generation and power generation, for the new construction or reconstruction, unless it can be documented that such applications are not feasible for specific objects.
7. To revise Ukrainian standard for thermal protection of buildings, aiming to introduce ‐near-zero buildings" as it is currently stipulated in EPBD of 2010 for EU Member States.
8. To develop training courses and ensure training possibilities for local designers to be able to reflect the new approaches and requirements in their work

Bibliography

1. «Звіт про науково-технічну роботу «Реформа міського тепло забезпечення в Україні». Етап 2. Огляд існуючого будівельного законодавства та ідентифікація необхідних рекомендацій, щодо його покращення», виконаний Зав.відділом будівельної фізики та ресурсозбереження, керівником науково-технічного центру з питань енергоефективності у будівництві, доктором техн.наук, с.н.с. Г.Фаренюком, Київ 2010
2. Directive 2010/31/EC Energy Performance of Buildings Directive
3. Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services
4. CEN/TR 15615 ―Explanation of the general relationship between various European standards and the Energy Performance of Buildings Directive (EPBD) - Umbrella Document"
5. ДБН. Б. 2.6 – 31:2006 «Конструкції будинків та споруд. Теплова ізоляція будівель», Міністерство будівництва, архітектури та житлово-комунального господарства України, Київ 2006.
6. ДСТУ-Н Б А А.2.2-5:2007 «Національний стандарт України. Настанова з розроблення на складання енергетичного паспорта будинків при новому будівництві та реконструкції». Міністерство регіонального розвитку та будівництва України, 2008.
7. ДБН. В. 2.2 – 15- 2005 «Будинки і споруди. Житлові будинки. Основні положення», Державний комітет України з будівництва та архітектури, Київ 2005.
8. Зміна №1, ДБН. В. 2.2 – 15- 2005 «Будинки і споруди. Житлові будинки. Основні положення», Міністерство регіонального розвитку та будівництва України, Київ 2009
9. ДБН. В. 2.2 – 9- 2009 «Будинки і споруди. Громадські будинки та споруди. Основні положення», Міністерство регіонального розвитку та будівництва України, Київ 2010
10. Information paper on Energy performance of buildings – Overall energy use and definition of energy ratings – Calculated energy rating EN 15603 (Overall energy use), by Johann Zirngibl CSTB, France, EU Directorate General for Energy Efficiency, 2009.
11. Information paper on EN 15316-1: ―Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General", by Johann Zirngibl CSTB, France, EU Directorate General for Energy Efficiency, 2009
12. Information paper on EN 15378 Heating systems in buildings - Inspection of boilers and heating systems, by Laurent Socal, Edilclima, Italy, EU Directorate General for Energy Efficiency, 2008
13. Information paper. Inspection of ventilation systems - EN 15239 for the application of EPBD, by Jean-Robert Millet, CSTB, France, Directorate General for Energy Efficiency, 2008
14. Information paper ―A vehicle for energy-efficient lighting EN 15193: Energy performance of buildings – Energy lighting requirements", by Jan de Boer Fraunhofer Institute of Building Physics, Germany, EU Directorate General for Energy Efficiency, 2008.