HI-SMART: HIGHER EDUCATION PACKAGE FOR NEARLY ZERO ENERGY AND SMART BUILDING DESIGN

MODULE #6

CHAPTER 1: SUSTAINABILITY

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6.1.1 HISTORICAL DEVELOPMENT

The world-famous Russian writer L. N. Tolstoy in the final part of his novel War and Peace seeks to define modern historiography not as a simple description of the events of life and the search for their causes in the freedom of choice of individuals or nations, which he said is impossible, but as an effort to seek laws of necessity, which led humanity, nations, and individuals to act. He makes an analogy with mathematics when he says that at the moment "*when this most accurate of the sciences reached an infinitesimal quantity, it abandoned the process of fragmentation and embarked on a new process of adding infinitesimal unknowns. The mathematics left the notion of cause and seeks the law, that is, properties common to all unknown, infinitesimal elements*." Tolstoy is of the opinion that historical events are not a product of people's free will, but people's actions are conditioned by external circumstances, e.g. geographical, ethnographic or economic. He says that "*it is true that we do not feel our dependency (note: on external conditions), but if we admit that we are free, we will come to nonsense, but if we admit our dependence on the outside world, on time and causes, we will reach laws.*" The current pandemic caused by the new coronavirus sars-cov-2 seems to confirm this thesis. If we ignore a virus that we do not see and feel and insist on the freedom of assembly, travel, etc., the chances of becoming infected increase significantly. However, if we accept this fact of threat and adapt our actions, i.e. we give up supposed freedoms for a time, the chances increase that we will survive the pandemic unscathed. Our real freedom, therefore, lies in recognizing the fact of the existence of the coronavirus and the need to take preventive measures.

In the history of construction and architecture, it is possible to see a similar sequence of necessities, which led to the current state, when in response to the deteriorating state of the environment we are talking about the need for sustainable architecture and construction.

It is quite clear that immemorially the primary purpose of buildings has been to protect people from the effects of climatic conditions and to create suitable conditions for their life and activity. The climatic conditions are still probably the most important factor that must be respected when designing buildings with permanent residence of people. The answer is the outer envelope of the building protecting from wind, rain, cold or heat. The second important factor is the need to create sufficiently large and healthy indoor spaces to enable the development of human activities. This need rises with the development of humanity and the gradual transfer of its main work activities from the external to the internal environment. Other factors are the economic possibilities of builders, the availability of building materials, population density, etc. It is also important not to forget the often overlooked fact that construction is the main occupational activity of a huge number of people. It is relatively difficult, if not impossible, in history to pinpoint the time at which all these factors, as well as many others, have merged into one huge challenge to provide the widest possible population with high-quality, human-dignified living and working spaces.

Perhaps it's a period of huge economic boom in the United States at the turn of the 19th and 20th Centuries, perhaps Europe in the 1930s between the two world wars. In 1946, P. D. Close published the third edition of his book “Building Insulation” in Chicago, in which he discussed in great detail the principles and possibilities of using thermal and sound insulation in buildings. It deals, among other things, with the basics of heat transfer in building materials, their properties, calculation of heat loss of buildings, economics and efficiency of thermal insulation and their impact on the dimensioning of the heating system, water vapor condensation on interior surfaces, etc. Already at that time, he presents a graph of the effect of the thickness of thermal insulation on the reduction of heat flow, saying that "no thermal insulation with final thickness (or commercial thermal insulation) can have 100% efficiency". We will also find there a graphic solution for the optimal thickness of thermal insulation in terms of reducing the cost of heating the building. This principle was later related by other authors to the heat transmission coefficient (U-value), respectively other relevant independent variables. For example, A. Csík (2014) presents a similar, albeit more complex, numerical solution for optimizing the global costs of renovation and operation of buildings, where the input independent variable is the cost of insulation of the building envelope. In all these cases, the basic precondition is a sufficiently high and stable or, best of all, rising price of oil as the main representative of fossil fuels, to the price movements of which the heat sources gas and coal are linked. Given that, after an initial rise in the late 1940s, the crude oil price has stabilized at a relatively low level between $ 30 -20, with a declining trend that lasted until the first oil crisis, the issue of energy efficiency and building insulation was not a topic. Especially in the USA, the all-night lighting is characteristic of this period in both residential and office buildings. The shock came in 1973 during the Israeli - Arab conflict, also called the Yom Kippur War, and the ensuing oil crisis triggered by a sharp rise in its price due to an embargo on its exports by oil-producing Arab countries. The second crisis occurred in 1979 as a result of the Islamic Revolution in Iran. Both events represent a major milestone in the view of energy supplies and the way they are used. The Western world has realized its existential dependence on oil and gas from oil and gas exporting countries, especially the Middle East and North Africa and, later, Russia. The political response of the United States and, in particular, Western Europe has manifested itself in two main directions - by promoting the saving of energy from fossil fuels and, at the same time, by supporting research aimed at finding new energy sources. The saving of energy from fossil fuels was ensured by both restrictive and motivational means. The first included, and still are, increased fuel taxes and various legislative measures. In the construction industry, these were mainly the increasing requirements for the thermal resistance of the building envelope, and later for the total maximum specific heat loss due to heat conduction and ventilation. The recommended standard values of the thermal resistances of individual parts of the building envelope and of the maximum specific heat loss are becoming legislatively mandatory requirements (e.g. the very first Regulation on thermal protection (of buildings) approved in the Federal Republic of Germany in 1976 titled Wärmeschutzverordnung 1977 (WschVO 77)). It must be said, however, that the mandatory thermal resistances, the heat transmission coefficients (U-values) respectively, of the main components of the building envelope, based on the standards of the time, were very mild in terms of today's perception. However, they gradually tightened. This whole process is accelerated by the discovery of the ozone hole in 1982 as a result of Freon emissions into the atmosphere and the observation of an increase in the earth's surface temperature as a result of greenhouse gas emissions. The world is beginning to perceive a global threat to the environment. Spontaneous communities of environmentalists are emerging, many of which are later transformed into political parties, especially in Western Europe (e.g. the Green Party was formed in 1980 in the Federal Republic of Germany). Their primary agenda was environmental protection, reducing greenhouse gas emissions and energy dependence on fossil fuels, support for renewable energy sources, decommissioning of nuclear power plants, etc. In terms of the thesis that the best energy saved is the one that does not need to be produced at all, they focused on reducing the operational energy demand of buildings, especially with the help of thermal insulation, and the issue of building materials as such, in this case thermal insulation, did not interest them. Finally, the results of scientific research from this period only confirmed them in this, as they argued that good thermal insulation is a basic prerequisite for reducing energy for heating buildings (Close, 1946, Panzhauser et al., 1996). However, the construction industry was not fully prepared for this situation. The ever-higher required thermal resistances became increasingly difficult to achieve and at the same time increased the input costs when procuring the building. Although heat losses through heat conduction have been significantly reduced, heat losses through ventilation, as one of the basic conditions for a healthy life of people in buildings, have remained unchanged. The use of renewable energy sources as an alternative way of heating buildings was in its infancy and was largely unable to cover consumption. In the mid-nineties of the last century comes Dr. W. Feist with the idea of an energetically passive house, based on the recovery of heat from the ventilated air, and thus a significant reduction in heat loss through ventilation. Of course, the low heat transmission coefficients (U-values) of individual parts of the building envelope are a basic prerequisite for the functioning of such a house. A demanding heating system with water as the heat transfer medium in these houses is no longer necessary. If local installations using renewable energy sources, in particular heat pumps and solar collectors or photovoltaic panels respectively, are able to balance the annual energy balance, we start talking about houses with nearly zero energy consumption, i.e. the energy based on burning fossil fuels. The local installations should be located in / on the house or on its building plot, and the house may or may not be connected to the public energy network. If it is not, it is the so-called autarkic, energetically self-sufficient house. It was no longer possible to define such complex buildings by a simple value of the average heat transmission coefficient or specific heat loss. The specific climatic conditions, heat gains from solar radiation, interior equipment and the inhabitants of the buildings themselves, the efficiency of the heating (cooling) and ventilation system, the possibilities of using renewable energy sources, etc. had to be taken into account. A need for a more accurate and methodologically more uniform way of assessing the energy performance of buildings arises. In addition to CEN (Comité Européen de Normalization, European Committee for Standardization), various interest groups, mainly environmental activists, passionate experts and academics, are taking grasp of and promoting the idea of voluntary energy certification of buildings. They are convinced that energy certification will contribute to increasing the value of energy-efficient buildings on the real estate market and will force owners of uneconomical buildings to invest in their improvement. Unfortunately, the market did not accept this idea and continued to consider the location of the building as the most decisive factor. However, the thermal insulation industry, which has traditionally been strongly represented on the relevant CEN standard-setting committees, has taken the chance and is strongly lobbying for standards and legislation to increase the energy performance of buildings. The concept of low-energy, passive (or ultra-low-energy) and nearly zero-energy buildings has finally found application in European legislation. In 2002, the European Parliament approved the first directive on the energy performance of buildings (2002/91/EC), which aimed to promote better energy performance of buildings in the European Community, taking into account external climatic and local conditions as well as indoor temperature and efficiency requirements, laying down requirements in relation to:

(a) a general framework for a methodology for calculating the integrated energy performance of buildings;

(b) the application of minimum requirements on the energy performance of new buildings,

(c) the application of minimum energy performance requirements for large existing buildings that are undergoing major renovation;

(d) energy certification;

and

(e) regular inspections of boilers and air-conditioning systems in buildings and, in addition, to an assessment of heating installations, in which the boilers are more than 15 years old.

The directive therefore leaves the definition of specific calculation procedures, minimum requirements for the energy performance of those buildings, as well as certification scale, on the legislation of each Member State. However, the European Commission also mandates CEN to develop and adopt standards for methodology, calculation of integrated energy performance of buildings and environmental impact assessment in accordance with the adopted directive. To date, more than 200 new or substantially updated standards relating directly or indirectly to the energy performance of buildings have been developed under this mandate.

In order to meet its long-term commitment to keep global temperature increases below 2°C and, also, its commitment to reduce total greenhouse gas emissions by at least 20% below

1990 levels by 2020, in order to comply with the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC), the European Parliament adopted another directive on the energy performance of buildings in 2010 (2010/31 / EU). This Directive already requires Member States, inter alia, to ensure that:

(a) From 31 December 2020, all new buildings are nearly zero energy buildings;
and
(b) After 31 December 2018, all new buildings, in which public authorities are located and/or are owned by them, are nearly zero energy buildings.

While the first directive was, so to speak, the result of joint lobbying of the thermal insulation industry, civic associations, unsuccessfully trying to establish the energy certificates for buildings on a voluntary basis, as well as sincere environmental activists, respectively their political representatives; the second directive is indeed a response to global societal challenges, but in particular to the dangerously increasing overheating of the earth's surface due to the greenhouse gases. The third directive, adopted in 2018 (2018/844/EU), aims, in addition to supplementing and clarifying the previous 2010 Directive, to promote and use digitization to increase the energy performance of buildings.

The states of Central and Eastern Europe, mostly in the position of satellites of the former Soviet Union, operated until almost the mid-1990s on cheap Siberian and Central Asian oil, or their own coal reserves. Especially the eighties are characterized by overheated apartment buildings built in the form of prefabricated concrete panels with low thermal resistance. Following the fall of the Iron Curtain and realizing the real energy prices, the required thermal resistance and energy criteria have been gradually tightening since the second half of the 1990s. Even before 1989 (the fall of the Iron Curtain), Czechoslovakia had a revised system of standards ensuring the thermal-technical and hygienic quality of buildings. These standards had the character of regulations and in its successor states were until the end of 1996 (Czech Republic), respectively 2000 (Slovakia) legally binding. Following these milestones, the necessary technical specifications were required by references in the relevant laws, e.g. also in relation to national standards resulting from the European Commission's and Parliament's directives on the energy performance of buildings. Despite the fact that in the countries of Central and Eastern Europe there were enthusiasts of low-energy and environmentally oriented architecture even before the beginning of the new millennium, only accession negotiations and accession to the European Union meant the adoption of the concept of passive and nearly zero energy buildings in full scope, not only officially, but also in terms of societal acceptance.

The described development of improving the energy efficiency of buildings focused almost exclusively on reducing energy consumption from the combustion of fossil fuels and related greenhouse gas emissions, especially carbon dioxide, during the operation of buildings. Although the result has been unprecedented technological progress in the field of construction, in particular renewable energy installations, ventilation systems and, also, building materials and components (windows, building envelope); the energy consumption issues and related greenhouse gas emissions from production of building materials and components, their transport and assembly on the construction site, as well as the dismantling of buildings and the removal of unnecessary building materials (collectively the creation of the so-called gray or bound energy) remain not yet taken into account. As in the case of efforts for voluntary energy certification, at the beginning of this millennium one can see attempts to create databases of ecological properties of building materials and products by both civic associations and private or state organizations (see https://www.oekobaudat.de/) with a probable goal of gray / bound energy assessment. It must also be said that the process of improving the energy performance of buildings had its winner, which was the industry producing thermal insulation, and the loser, which was the industry producing ceramic products, in particular bricks and ceramic blocks. Fired bricks, later ceramic blocks, traditional building materials in Europe, were unable to compete with thermal insulation in the face of tighter thermal resistance requirements, without giving up some of their important properties, e.g. load capacity. It is therefore possible that in the near future there will be a similar alliance in promoting the assessment of gray / bound energy as in the promotion of energy certification in the 1990s, but this time between environmental activists and the ceramics industry.

The package of tools for energy performance assessment of Buildings concludes with an energy audit, which focuses on assessing the energy performance of large companies, including their properties, with more than 250 employees. Its aim is to obtain sufficient information on the current state and characteristics of energy consumption needed to identify and design cost-effective energy saving options in the company, including its existing building or group of buildings. Theoretically, it should be possible to derive the energy certificate of the building from the energy audit of the building. All these instruments focus exclusively on reducing energy consumption from fossil fuels and related greenhouse gas emissions. They do not take into account the impact of buildings on the surrounding environment in terms of impact on flora, fauna, air or water quality, etc. They also do not address the quality of the indoor environment of buildings, although the required calculations should take into account legislative, if any, and standard requirements for thermal and light comfort as well as adequate air exchange.

With a growing awareness of the need to protect the environment, environmental impact assessments (EIAs) have taken hold in decision-making processes in the 1960s, especially in North America and Western Europe. Its aim is not to meet some predetermined criteria, but to estimate the impact on the environment - especially the direct impact on the immediate surroundings, which is often the subject of criticism of this process. A great deal of uncertainty arises when setting the limits of assessment. EIA is used not only in construction, but also in various other areas of human activity, e.g. in industry, agriculture, forestry, transport, etc. In the European Union, it is required of Member States by

Regulation 2011/92 / EU of December 2011, which is the third amendment to the original 1985 Regulation.

In the growing environmental concerns, which began in the second half of the last century, has its roots also the idea of sustainable development, articulated in particular in the 1987 report of the United Nations Commission on Environment and Development (also known as the Brundtland Commission Report). "*Sustainable development is an organizational principle to meet human development goals while maintaining the ability of natural systems to provide the natural resources and ecosystem services on which the economy and society depend. The desired result is a state of society, in which living conditions and resources are used to meet human needs, without compromising the integrity and stability of the natural system. Sustainable development can be defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs."* Further development of the principle of sustainability has led to differentiation and a focus on sustainable economic and social development and environmental protection for future generations. It has been suggested and, more or less, established that "*the notion of "sustainability" should be considered as a target state of human-ecosystem balance, while the notion of "sustainable development" should refer to a holistic approach and temporary processes, which lead us to the goal of sustainability.*" Following the idea of sustainable development of the society, initiatives are being developed in the field of architecture and construction for the formalized assessment of the sustainability of buildings as an auxiliary decision-making tool in building planning. These have resulted in European standards (EN 15643 Part 1 - 5) describing a methodology for assessing the economic, social and environmental sustainability of buildings. These three aspects are also called the pillars for assessing the sustainability of buildings. The aim of the assessment is not the certification of buildings in terms of their sustainability, but to influence the planning processes and necessary decisions so that they are in the intentions of sustainable development. Assessing the sustainability of buildings is not yet mandatory. Sustainability assessment systems for buildings, developed not only by private companies or non-profit organizations, but also by academic institutions, and also showing certain features of certification, are non-binding and often commercial. Misunderstood, they can lead to misunderstandings or even be counterproductive to the goals of sustainable development.

The Great Recession from 2008 to 2015, caused by the global financial crisis at the turn of 2007/08, as well as the migration crisis in 2015, temporarily pushed the issue of deteriorating environment to the sidelines. There is also felt a certain stagnation in the field of construction and architecture in promoting the principles of sustainable construction. The relatively established concept of passive and nearly zero energy houses is becoming a maximum effort. The environmental protection is gaining new momentum and accelerating after a series of school strikes initiated by a young Swedish activist, Greta Thunberg, in 2018/19. The 2019 newly elected European Commission and the parliament reflect on this movement and declare the so-called European Green Deal, i.e. a plan to reduce the

greenhouse gas burden on the environment by increasing the use of renewable energy sources instead of fossil fuels. The aim is to slow down, preferably stop, the process of climate change caused by the greenhouse effect and the consequent overheating of the atmosphere. In the field of construction and architecture, the plan focuses mainly on the very *"process of building new and renovating existing buildings due to the unsustainable methods that currently prevail in it, as it still uses a lot of non-renewable resources. The plan therefore aims to promote the use of methods leading to energy-efficient buildings, such as designing climate-resistant buildings, increasing digitization and tightening enforcement of energy efficiency rules for buildings. One of the ambitions of the plan is to support the renovation of social housing in order to reduce the cost of energy bills for those, who are less able to finance these costs. The plan is also to triple the rate of renovation of all buildings in order to reduce pollution caused by the operation of these building."* (https://en.wikipedia.org/wiki/European_Green_Deal#Building_and_Renovation).
However, despite these ambitions, one cannot avoid the feeling that the Commission does not have a clear idea of which direction the construction and architecture should take in terms of sustainable development, and what exactly deserves priority support. This follows, somewhat, from the questionnaires intended for the professional, especially academic, public, the purpose of which is probably to generate ideas, even though certain directions of development are already indicated. One of the problems is also that environmentalist goals are often contradictory.

According to a report by the Swedish Ornithological Society from 2012, one wind turbine in Europe or North America kills an average of 2.3 birds and 2.9 bats per year. In the case of wind farms, these are often high numbers of birds killed, often protected species. According to that report, the solution is to place wind farms correctly outside the migration trails and habitats of these birds, which, of course, is not always quite possible. Therefore, there are occasional disputes between environmentalists and wind farm owners. Both parties are in principle trying to protect the environment - the first party the local, the second the global environment, although the word "local" must be enclosed in quotation marks, as the protection of endangered species of fauna is in the interest of the entire planet. In the case of construction and architecture, it is also possible in some cases to observe the conflict between the objectives of sustainable economic and social development on the one hand and environmental protection on the other. It is clear from the previous text that there are quite a number of well-meaning decision-making and evaluation tools that can be used to design new and evaluate existing buildings. Nevertheless, the result may not always bring the desired effect, respectively it is often accompanied by undesirable phenomena. The application of the principles of passive and nearly zero energy houses also brings about problems, both in terms of construction practice and environmental character.

The following overview of "lessons", which does not claim to be complete, is based mainly on experience gained within programs to reduce the energy intensity of houses and residential buildings, especially with the help of additional thermal insulation, in Central

Europe - Czech Republic (governmental program "Green to the Savings" since 2009), Austria (housing support linked to the energy efficiency of buildings - varies by federal state, e.g. in the federal state of Salzburg since 1993) and in Slovakia (governmental building insulation program since 2009).

6.1.2 ENERGY PRICE

One of the most common arguments of proponents of the building insulation is that the insulation contributes to reducing the heating costs and thus to financial savings. That is true, but at the cost of investment, which, at fossil fuel prices, especially gas, will almost never pay off, or only after a very long time. Fossil fuel energy prices are linked to the price of oil, which has a relatively high volatility, which is advantageous from an investment point of view - if timed correctly. The problem is that even if the investment timing would fit in terms of oil price developments on world markets, most countries regulate fossil fuel energy prices in order to mitigate the impact of oil price volatility on world markets so that energy prices match the domestic purchasing power and do not reduce industrial competitiveness. This is happening mainly through the creation of reserve stocks in "better times", long-term contracts, etc. The energy prices thus remain relatively stable, but also not very motivating in terms of investment in building insulation. The state support for thermal insulation, more efficient heating systems and renewable energy sources is therefore essential. This support can also be seen as an investment in a "green" economy, which also puts downward pressure on fossil fuel energy prices, e.g. due to the increasing use of energy from renewable sources. If states, especially industrial ones, did not do so and the world continued to depend only on fossil fuels with limited supplies, the fossil fuel energy prices would most likely rise. The above statement that the building insulation contributes to the reduction of heating costs and thus to financial savings is therefore true rather from a macroeconomic point of view. It does not apply to small investors without state support.

6.1.3 THERMAL INSULATION

Today's standard requirements for very low values of heat transmission coefficients (U-values) lead to large thicknesses of conventional thermal insulation and do not allow for much discussion about their optimization. Polystyrene-based materials are also relatively cheap, so it is generally recommended not to save them. However, as already mentioned by P.D.Close in 1946, no thermal insulation with a final thickness can be 100% effective. The point is, in particular, that the relationship between the thickness of the thermal insulation and the heat transmission coefficient (U-value) is not linear but exponential. At very low values of the heat transmission coefficient (U-value), the curve of their mutual relation approaches the limit at infinity, while increasing the thickness of the thermal insulation no longer means any significant reduction of the heat transmission coefficient (U-value) (Fig. 1). At present, the standard values of the heat transmission coefficient required for the individual components of the building envelope are probably at the edge or even beyond the optimum limit of conventional constructions. This then has its consequences, both in terms of practical application and in terms of the environment.

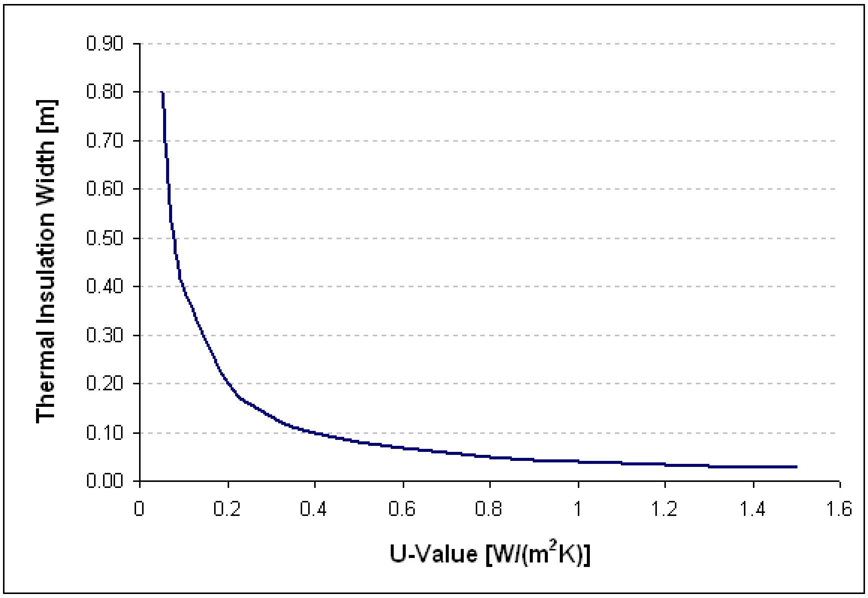

Figure 6.1.1 - The course of function U = λ/d for λ = 0.04 W/(m.K) and d = thermal insulation width as variable (source: author)

Very thick thermal insulation does not allow overheating and drying of the perimeter walls up to the outer surface, which creates favorable conditions for the formation of algae and mold on shaded facades, especially during transitional periods (spring, autumn). The outer surface of the shaded façade remains cool even with rising outdoor air temperatures, with a constant normal temperature of around 20 ° C inside. With repeated fluctuations in the temperature of the outside air, moisture can form on such external surfaces, which is a breeding ground for fungal and algal spores. Fungi and algae, in turn, create an environment for aerial plants and the presence of small insects. The result of their activity is small cracks, which are gradually increased by the rain and wind. The ingress water and overall moisture reduce the effectiveness of thermal insulation. In order to avoid deterioration of insulated facades, not only technically, but also visually, it is necessary to regularly maintain them by cleaning or even new coatings with antifungal additives at intervals of 10-15 years. The problem is also that fungi and algae washed away by rain or cleaning get into groundwater and thus into the water cycle. By removing oxygen from the water, they worsen the environment for aquatic animals, which, at excessive concentrations of algae, either die or migrate away from such waters.

A specific problem of thermal insulation based on polystyrene is its high flammability. Gabi Greiner, an ORF journalist, writes in her 2014 article; loosely quoting; that *"until about the end of the first decade of this millennium, this problem was addressed by adding non-flammability enhancers, often based on hexabromocyclododecane (HBCD). This substance was recognized by the European Chemicals Agency as very worrying in 2008. Hexabromocyclododecane is a persistent and bio-accumulative toxin in the environment, so it remains permanently in nature and accumulates in organisms. It also reportedly reduces the reproductive capacity of organisms. In 2013, the use of HBCD was banned. Due to the long-term use of HBCD products, while their ban also allowed for various long transitional periods, polystyrene-based thermal insulation impregnated with HBCD represents a recycling problem. Today, commercially available thermal insulation systems have an average life of 30 to 40 years. Then it will be necessary to replace a huge amount of polystyrene. Its recycling won't be possible enough due to flame retardants and it will have to be disposed of as problematic waste. Greenpeace therefore demands from the chemical industry flame retardants that can be used in an environmentally friendly way."*

The optimization of the thickness of thermal insulation, always tailored to the specific building, is therefore justified, although the current legislation, based on low, standardly required values of heat transmission coefficients, does not require it. Legislatively required is the fulfillment of energy efficiency criteria of buildings such as the need for thermal energy for heating and hot water, energy for cooling, ventilation and lighting, or the need for primary energy for the operation of the building. The values of the heat transmission coefficients are recommended, but without reaching them it is not usually possible to meet the required energy efficiency criteria, i.e. by a commonly used standard calculation. Small builders, especially owners of family or smaller apartment buildings, who cannot afford more expensive calculations based on computer simulations of the future behavior of buildings, prefer simplified standard calculations, although the standards do not exclude simulations. This often results in very thick thermal insulation and the size of windows, which is barely meeting the required minimum dimensions. Windows are the weakest link in the building envelope. In an effort to reduce the heat transmission coefficient, the light transmission of windows also decreases with the number of glazing panes (lower U-values), which leads, together with the minimum dimensions, to a deterioration in daylight and, counterproductively, to an increase in energy need due to the artificial lighting of indoor space.

6.1.4 GLOBAL ENVIRONMENT

Climate change is currently one of the most important topics shaping society-wide debate. It is raised in particular by scientists, vulnerable communities, non-governmental and non-profit organizations, sensitive communities and individuals, who see the impending global threat from man-made artificial greenhouse gas emissions. This is a classic bottom-up pressure to which the people's representatives, i.e. politicians and governments, tend to react slowly and often without knowing the matter. However, the urgent nature of the negative effects of climate change on society is forcing concrete action. Politicians have basically two types of tools at their disposal - restrictive (legislation) and motivational (tax relief, investment resources from taxes). The legislative measures are generally effective, but politicians often lose voter support. The tax relief, the subsidies, etc., are more popular, but these financial resources may then be lacking in other sectors of the state. A good strategy is a combination of both instruments, especially, if they are properly structured, have a clear informative value, lead to competitiveness, have a longer-term character (i.e. do not require an immediate one-off change) and the individual's financial gains outweigh losses, respectively they are at least balanced. A good example of such an instrument is the mandatory energy certificate of buildings, which can be suitably combined with subsidy instruments. Its disadvantage is that it is primarily aimed at reducing the consumption of fossil fuels and the resulting CO2 emissions during the operation of the building. EPDB has the potential to suitably supplement or replace the energy certificate, as it also takes into account the pre-operational phase of the building's life, i.e. its production and manufacture, or other factors such as transport of components and materials to the construction site, waste disposal, etc. Theoretically, the whole life cycle of a building could also be taken into account, but the description of the phase after the end of the building's operation would probably be really theoretical. The preparation of EPDs is dealt with not only by renowned research institutes, but also by the European Commission, so the question is not whether the EPDB will come or not, but, rather, in what form. EPDB must not necessarily focus only on the issue of built-in / gray energy, but can also take into account the potential of ozone layer depletion (ODP), oxygenation or eutrophication (see fungi and algae from building facades) in terms of EN 15643. However, the most pragmatic approach represents the narrowing the assessment to only the total primary energy demand (PEI) from fossil fuels, i.e. from non-renewable sources, and the global warming potential (GWP), i.e. equivalent CO2 emissions as a proxy indicator of greenhouse gas emissions. Several studies show that the low average values of the heat transmission coefficient of buildings result in a longer time to reach the point, where the equivalent CO2 emissions due to the built-in/grey energy are balanced with the emissions due to the operation of the building. The use of heat recovery underlines this fact. Although this situation is desirable, it should not be achieved at the expense of greenhouse gas emissions due to the built-in energy. Thus, one option of the assessment within EPDB could be some form of comparison of greenhouse gas emissions due to built-in/grey and operational energy (Fig. 2). However, the administrative complexity of the process of such an assessment would probably be very high. It would therefore be ideal, if the production of building materials and products entering the market would already met strict environmental criteria and architects and building designers did not have to deal with the assessment of PEI and GWP at all. They could thus focus on what is the essence of architecture - the organization of the space, the quality of the indoor environment, the aesthetic expression and the design of the building. One of the ways to contribute to this aim could also be a support for emission exchange in

Leipzig, Germany, and enhancing the emission trading by the European states on the one hand and the EU Commission and Parliament on the other. This would ensure a reduction in greenhouse gas emissions from the very beginning of the construction process, while the role of the designers would remain to optimize the quality of the building envelope and the operation of building from an energy point of view.

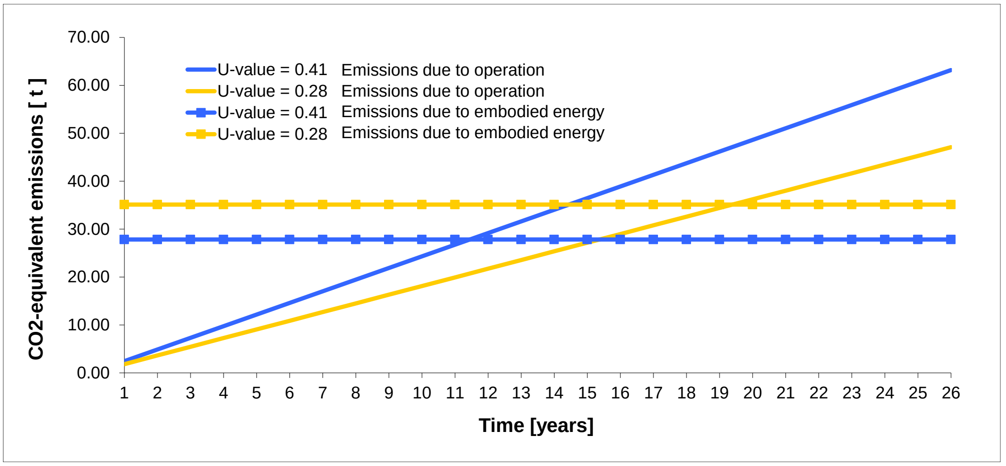

Figure 6.1.2 - Time needed to achieve the "break-even point" equalizing the CO2-equivalent emissions due to the embodied energy with CO2 emissions due to the building operation in dependence on the mean U-values of a brick-based house (Rabenseifer, R. & Jamnický, M., 2020). The CO2-equivalent emissions due to the embodied energy are expressed by constant lines and the CO2-equivalent emissions due to the building's operation are represented by ascending lines.

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