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REASONS FOR THE GROWING POPULARITY OF ENERGY EFFICIENT BUILDINGS IN POLAND

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Abstract

Recently the so called "green", ecological or sustainable architecture is becoming more and more popular. Energy efficiency of buildings is one of the aspects of this kind of architecture. In our country, the main reason for the growing popularity of the energy efficient buildings is the new buildings' legislation. The new buildings' regulations set up much higher standards for energy performance of buildings than the previous ones. Poland, like all other EU member states, was forced to introduce new energy standards for buildings, by the implementation of the Directive 2010/31/EU. The prospective standards for all new buildings in Poland are on the level of today's low energy buildings. The purpose of introducing such high standards is to reduce the amount of energy used by the building industry in Europe.

According to EEA report one of the results of climate change in our region would be longer and more severe heat periods, and some adaptation action should be taken. Probably, according to the new legislation, too little emphasis was put on the overheating risk of the buildings.

At present, in Poland, other reasons for constructing energy efficient buildings are of minor meaning. Especially the financial encouragements for small investors are not effective enough. The situation looks better in the area of public buildings. Institutional investors have more possibilities for obtaining financial support, which is encouraging enough. Also, the obligation to inform the public about the results of the energy performance certificate

is not respected fully. This obligation could help to increase the environmental conscience of investors. So there is still much room for improvement.

Keywords: energy efficiency of buildings, energy performance of buildings, climate change, energy standards, Directive 2010/31/EU.

INTRODUCTION

In relatively rich countries energy efficiency of buildings is now being rediscovered, in very poor areas it was never forgotten. Till 20th century, the issue was obvious for every building constructor all over the world. Everybody knew that the energy was not for nothing and that buildings had to be adapted to the local climate to be able to achieve thermal comfort in their interiors. This attitude changed when it became possible to achieve it with technical equipment only, disregarding conditions of the surrounding environment. The question was only how much energy had to be put into the system. But the energy was relatively cheap, so it was possible to construct the same types of buildings all over the world. Today we are rediscovering the energy efficiency of buildings. At the same time we are expecting the same, high level of thermal comfort, which we are used to, and which is probably higher, than the comfort of the historical buildings. So, why do we want to have energy efficient buildings again? And why do we want them also in Poland? And what it is an "energy efficient building"?

CLIMATE CHANGE

"Climate change is a reality around the world, and the extent and speed of change is becoming ever more evident. This means that every part of the economy, including households, needs to adapt as well as reduce emissions," said Jacqueline McGlade, EEA Executive Director (EEA 2012). In 2012 EEA published a report: "*Climate change, impacts and vulnerability in Europe 2012"*. This is an indicator-based report. The key messages from this report are (EEA 2012):

- "Climate change (increases in temperature, changes in precipitation and decreases in ice and snow) is occurring globally and in Europe; some of the observed changes have established records in recent years.
- Observed climate change has already led to a wide range of impacts on environmental systems and society; further climate change impacts are projected for the future.
- Climate change can increase existing vulnerabilities and deepen socio−economic imbalances in Europe.

- Damage costs from natural disasters have increased; the contribution of climate change to these costs is projected to increase in the future.
- The combined impacts of projected climate change and socio−economic development can lead to high damage costs; these costs can be reduced significantly by mitigation and adaptation actions.
- The causes of the most costly climate impacts are projected to differ strongly across Europe.
- On-going and planned monitoring and research at national and EU level can improve assessments of past and projected impacts of climate change, thereby enhancing the knowledge base for adaptation."

Below are some of the main findings of the report regarding the results of the climate change, which can have an impact on the building industry in Europe (EEA 2012):

- global rise in the sea levels – impact on the coastal areas,
- temperature extremes, river floods and reduced summer precipitation are projected to be the key impact of climate change in *central and eastern Europe*,
- temperature increase and the very likely increase in length, frequency and intensity of heat-waves will result in reduced energy demand for heating, but higher energy demand for cooling,
- soil erosion: increase in rainfall intensity and pattern are expected to make soils more vulnerable to water and wind erosion,
- air pollution by ozone and health: although the connection between the observed changes in ozone level and climate change is difficult to be found, the fact is, that excessive exposure to ground-level ozone is a reason for about 20 000 premature deaths annually in Europe and the ozone concentrations is projected to increase, unless the emissions are reduced.

The key issues from this report are as follows (EEA 2012):

- the climate is changing,
- the changes are mostly unfavourable for people,
- there is a need to adapt each area of economy to the climate change,
- there is a common belief that the reason for most of the climate changes is human activity, especially for the greenhouse gas emissions,
- therefore, if people emit fewer greenhouse gases, the climate will change slower.

In order to prevent the most severe impacts of climate change, the United Nations Framework Convention on Climate Change (UNFCoCC 1994) has agreed to take actions, which are believed to maintain global temperature rise below 2K. However, current global actions to constrain the temperature increase

are insufficient and global warming will be probably above 2K by 2100. But even if the 2K limit was kept, impacts of the climate change would occur anyway. Therefore, actions should be taken in two directions: to reduce the emissions and to adapt to the changes. The capacity for adaptation to the changes could depend on the economic, technical and institutional situation of each region. Therefore, it could lead to the deepening of already existing imbalances. So, for counties like Poland, which belong to the less economically and socially developed areas in the EU, it is especially important that the necessary actions do not cause additional costs or that the cost are as small as possible.

LEGISLATION

As the majority of scientists believe; that human activity and especially the emission of greenhouse gases is the main reason for global warming, the European Union established climate and energy targets for 2020 (Climate strategies 2007). The targets, known as 20-20-20, set three aims for 2020:

- a 20% reduction in EU greenhouse gas emissions from 1990 levels,
- a 20% raise in the share of EU energy consumption produced from renewable resources,
- a 20% in energy consumption.

Because the construction sector represents 40% of the total energy consumption in European Union and it is still expanding, reduction of energy consumption by this sector is one of the key issues to achieve the above mentioned aims. Therefore, the European Parliament and the Council released several Directives on the energy performance of buildings. The last Directive 2010/31/EU, which superseded the previous ones, was issued on 19th May 2010. The Directive aims to promote energy efficient performance of buildings and building units (Directive 2010). Energy performance of a building is the calculated or measured amount of energy needed to meet the energy demand associated with a typical use of the building, which includes energy used for heating, cooling, ventilation, hot water and lighting. Among other things, the Directive sets minimum requirements for energy performance of new buildings and buildings which are undergoing major renovations. By 31 December 2020, all new buildings should be nearly zero-energy consumption buildings. New buildings occupied and owned by public authorities shall comply with zero-energy criteria by 31 December 2018 (Directive 2010). Member States shall also adopt the methodology for calculating the energy performance and implement a system for energy performance certification of buildings. In case of offering for sale or rent, the certificate should be included in advertisements in commercial media, shown to the new tenant or prospective buyer and handed over to the buyer or new tenant. The EU Member States are responsible for implementation of the Directive

into National Building Regulations and related Technical Guidance Documents. European Commission issued Regulation (2012) supplementing the Directive 2010/31/EU. The Regulation established a methodology framework for calculating cost-optimal levels of minimum energy performance requirements for building and building elements. In Poland the Directive's guidelines were implemented, among the other legislations acts, by updating Technical Guidance for buildings and their location issued on 13 August 2013 (Regulation 2013) and Regulation on the methodology for calculating the energy performance of buildings and buildings' units and for energy performance certificates, issued on 18 March 2015 (Regulation 2015).

The Directive 2010/31/EU and its implementation by the national law, have a crucial impact on the development of energy efficient building sector. Firstly, they established very high standards for energy performance of new buildings and buildings undergoing major renovations. Secondly, they introduced the obligation for calculating the energy performance of a building and to inform the public about the results by showing the energy performance certificate. Currently in Poland the obligation regarding handing over the energy performance certificates is not respected fully, but this will probably change with time. Should the regulations be implemented fully, they could have a very big impact on the property prices and also on the whole building industry in Poland. The new Technical Guidance Regulation set up U values for the main building's components, which required bigger thickness of the insulation than before.

STANDARDS

There is no one international standard to calculate energy efficiency of buildings. Even in one country different systems could be used, as it is the case in Germany. However, there are some indicators saying about energy efficiency of a building. For its evaluation most systems use: the maximum values for primary energy demand, space heat demand, cooling demand and U values for main building's components. As it has already been said, according the Directive (2010) all new buildings in EU completed after 2018/2020 should achieve a very low energy consumption standard, they should be zero-energy or almost zero-energy buildings. The term zero-energy is misleading, because it suggests that buildings do not need any energy, which is never the case. It means only that the amount of the energy needed from the greed is balanced by the amount of renewable energy generated on site, mostly using the photovoltaic modules. Equally misleading can be the value for primary energy demand. Primary energy is the final energy multiplied by renewable energy factor. Most systems are taking into account the energy needed for heating, cooling, ventilation, hot water, in some cases artificial lighting and auxiliary energy. Some systems are also

taking into account the energy needed for all other electrical appliances used in a building. The renewable energy factor varies depending on the kind of energy e.g. for gas and oil is 1,1; for electricity from grid 3 (in Poland) but for energy generated by photovoltaic modules 0 (Regulation 2015). However even for the same kind of energy, the renewable energy factor could be different, depending on a country's energy policy or even on the system used for calculation, e.g. the indicator for electricity from grid in Poland is 3 (Regulation 2015) but in Germany 2,6 (Auer and Sauerbruch 2011). According to Auer and Sauerbruch (2011) this could lead to completely different values of primary energy used by one building. In case of KfW-Westarkade, the primary energy values differs from 82 kWh$(m^2a)^{-1}$ (according to SolarBau standard) to 141,2 kWh$(m^2a)^{-1}$ (according to German Regulation EnEV 2007).

Therefore, end values needed for heat, ventilation, cooling and artificial lighting demand would be more reliable for giving information about the real energy efficiency of a building. However, it should be pointed out that they take into account also the auxiliary energy needed by technical equipment, so the amount of the final energy needed by the building depends also on the energy efficiency of the technical systems used.

Another misleading term is a "passive house". It is suggesting that the energy needed at least for heating, is provided by passive methods only, mostly by big windows facing south. In reality, the Passive House standard is a package of energy values established by the Passive House Institute. The standards are quite high and influential, e.g. they are mentioned in the publications provided by the International Energy Agency and since 2007 all new public buildings in the Federal State of Lower Austria have to meet Passive House standards. Therefore, it is worth to compare them with the requirements of Polish Technical Guidance Regulations (Regulation 2013) to find out where we actually are with our energy efficiency. For the below comparison I use values for: primary energy demand, airtightness of building's envelope and U values for main building's components, given by Gonzalo and Vallentin (2014) and Polish Technical Guidance Regulations (Regulation 2013). For the estimated thermal insulation thickness, a two layers building components were taken into account, loadbearing and insulation, and a typical insulation material with the λ value of 0,038 W $(mK)^{-1}$.

To be able to compare the two systems, I took into account the primary energy demand for the same services: heating, ventilation, cooling and production of domestic hot water. According to Polish Technical Guidance, the maximum allowed amount of the energy for cooling depends on the relation between heated and cooled areas. The calculations for the below comparison are based on the assumption that the heated area and the cooled area of the building are equal. Therefore, the estimated values for cooling for residential buildings are

10kWh $(m^2a)^{-1}$ at present and 5kWh $(m^2a)^{-1}$ perspective, and the value for public buildings is 25kWh $(m^2a)^{-1}$ at present and perspective.

The maximum primary energy demand according to Passive House standards, cannot exceed 120 kWh $(m^2a)^{-1}$, but this demand includes the energy needed for heating, ventilation, cooling and production of domestic hot water, auxiliary energy for the above services, energy for lighting and the energy needed for all others electrical appliances (e.g. computers, printers, household appliances). On the contrary, according to Polish Technical Guidance, primary energy demand for residential buildings does not take into account energy used for lighting and energy needed for all other electrical appliances. According to Gonzalo and Vallentin (2014), at present this amount in Germany is approx. 70-80 kWh $(m2a)^{-1}$, so for the correct comparison, this energy amount was subtracted from 120 kWh $(m^2a)^{-1}$, and the corrected value for Passive House standards is 50 kWh $(m2a)^{-1}$.

Additional explanation requires also the airtightness of the building's envelope. According to Polish Technical Guidance, airtightness of the building's envelope should not be bigger than $n_{50} \leq 3{,}0\ h^{-1}$ in case of natural or hybrid ventilation, and $n_{50} \leq 1{,}5\ h^{-1}$ in case of mechanical ventilation. However, this is not an obligation but only advise. On the contrary, passive houses are always equipped with mechanical ventilation with heat recovery and a blow test for checking the airtightness is an obligation.

Table 1. Comparison of standards for residential buildings according to Passive House Standards and Polish Technical Guidance

No	Component	Unit	Passive House	Polish Technical Guidance – present	Polish Technical Guidance – after 1 January 2021 (after 1 January 2019 for buildings for public authorities)
1.	Exterior wall insulation	cm	24-40	13	18
2.	Roof insulation	cm	30-50	18	25
3.	Windows U value	$W(m^2K)^{-1}$	0,8	1,3	0,9
4.	Airtightness	h^{-1}	$n_{50} \leq 0{,}6$	$n_{50} \leq 3{,}0$ $n_{50} \leq 1{,}5$	$n_{50} \leq 3{,}0$ $n_{50} \leq 1{,}5$
5.	Primary energy demand excluded average amount of electricity used by electrical devices	kWh $(m^2a)^{-1}$	≤ 50	≤ 130 – single family houses ≤ 115 – multifamily houses	≤ 75 – single family houses ≤ 70 – multifamily houses

Table 2. Comparison of primary energy standards for public buildings, excluded buildings for health, according to Passive House standards and Polish Technical Guidance

No	Component	Unit	Passive House	Polish Technical Guidance – present	Polish Technical Guidance – after 1 January 2021 (after 1 January 2019 for buildings for public authorities)
1.	Primary energy demand excluded average amount of electricity used by electrical devices	kWh $(m^2a)^{-1}$	≤ 50	≤ 90	≤ 70

In both standards the U values for the buildings' components are the same, regardless the use of buildings. According to Passive House Standards, the primary energy demand is also the same independently of the kind of buildings. Polish Technical Guidance makes differences for the maximum allowed energy demand for different types of buildings. Another criterion of Passive House in a criterion regarding summer thermal comfort: $h_{(\geq 25°C)} \leq 10\%$. This means that the number of hours in which the room temperature rises above 25°C should not extend 10% of the year. This is a very important criterion, because as it was said in the chapter on Climate, it is very probable the heat waves in summer, in our climate, will be longer and more severe than before. Both comparisons above show that the standards regarding the maximum allowed primary energy amount and the thickness of the thermal insulation, according to the Polish Law, should be by 2021, only approx. 40% higher than Passive House standards. Primary energy demand on the level of approx. 100 kWh $(m^2a)^{-1}$ for heating and domestic hot water (without cooling and household electricity) is currently typical for so called "Low Energy Buildings". It means that all new buildings built in Poland after 2021, and buildings being used by public authorities already after 2018, should meet today's Low Energy standards.

Contrary to the Passive House regulations, Polish Law does not directly define the criterion for summer comfort. The requirements are only put on the amount and quality of glass used in the buildings' envelopes.

THERMAL COMFORT

One of the main reasons why buildings are designed and constructed is to provide the thermal comfort for their users. According to Passe U. and Battaglia F. (2015) "thermal comfort is the condition of mind that expresses satisfaction

with the thermal environment, and is assessed by subjective evaluation". In Poland thermal comfort considerations are regulated by ISO standard PN-EN ISO 7730. The assessment methods, however, are primary intended as an aid for designing HVAC installations (Hegger M. 2008). The adaptive comfort model for naturally ventilated buildings has been recently included in an American ASHRAE standard 55-2013, but the standard is not very well known and used in Poland.

The level of thermal comfort in a building is essentially determined by few factors: temperature, indoor air humidity and air movements. A person well-being depends on the interior air temperature, the average enclosing surfaces temperature and the difference between them. The energy efficient buildings are usually very well isolated, so in winter the internal air temperature can be very comfortable and the temperature of the external surfaces is close to temperature of the air. The speed of air movement depends, among the other things, also on the difference between air temperature and the temperature of the internal side of building's envelope. This is the reason why good isolated and airtight buildings envelope could be on advantage considering the thermal comfort. Another issue is the building's overheating risk in summer. The energy efficient buildings should be planned so as not to require an active cooling system in summer. This is not always possible especially in case of non-residential buildings and the thermal comfort shouldn't be compromising by the energy efficiency. However, for natural ventilated buildings less strict adaptive comfort model should be taken into account.

FINANCIAL REASONS

Since 1999, energy prices in Poland have been increasing on average 4,5-8,0% annually. It was more than the inflation rate (Anam 2007). For half a year, we have had deflation in Poland (Inflacja 2015), however, according to the prognoses, energy prices should be rising, anyway. At the same time, an average household is spending 46% of all energy expenses on heating (Anam 2007). If not commonly used, relatively cheap coal heating, this part could be even bigger. But coal heating is environmentally unfriendly, not only because of its impact on climate change but on air quality, as well. So, it could be that Poland would be forced to change its energy policy. However, at the moment it seems that the relation between energy prices and additional expenses needed for achieving better energy performance of buildings is not encouraging enough.

More effective could be financial support for the construction of energy efficient buildings. There are some financial programs supporting this kind of buildings, but their analysis is beyond the scope of this article. However, especially for the construction of new residential buildings, they are not common and

insufficient. They work better in the area of modernisation of existing buildings and construction of public buildings.

OTHER REASONS

To other reasons for energy efficiency of buildings in Poland belong:

- marketing,
- fashion,
- increasing environmental conscience of investors.

Especially in the time of recession, energy efficiency of buildings could be their added value, which makes them easier to be sold. But green-marketing is unfortunately often connected with the so called "green – washing". Greenwashing (Greenwashing 2014) or "green sheen" is a form of spin in which green PR or green marketing is deceptively used to promote the perception that an organization's products, aims or policies are environmentally friendly". It based on little environmental knowledge of potential buyers. More educational environmental actions could be helpful.

In Poland very often, high environmental standards for public buildings, are set by international investors. They found that it is worth to construct environmental and user friendly buildings, and all buildings they construct have to achieve a high environmental friendly level proved by one of the most popular certificates (BREEAM, LEED, DGNB). To be able to compete, smaller companies would probably have to try to achieve also some kind of environmental certificates. Recently also the local authorities try to introduce high environmental standards. The good example is the new City Council in Krakow, which has to achieve the BREEAM gold certificate. It is much needed that the public buildings for the local authorities set such high standards. "Green buildings" are very often better places to work than conventional buildings. Through the creation of a higher quality internal environment, they have positive impact on employee productivity. Many investors realise also that today's conventional building could be below the standards tomorrow. Because every building is a disadvantage for the environment, so probably an ecological building does not exist at all. But some buildings are more environmental friendly than others. And whatever are the reasons for that, more and more investors want to believe that their buildings do not contribute to the further destruction of our planet.

CONCLUSION

At present we are rediscovering energy efficiency of buildings. But at the same time we don't want to resign of the high level of comfort which we got

accustomed to. Recently, in Poland, we are being forced to design and construct the buildings which consume much less energy than before. In nearest future all new buildings constructed in Poland will have to reach today's standards of low energy buildings. At the moment it seems that the changing legislation is the main reason for improving the energy performance of buildings in our country. However, the legislation in the case of the duty to show to the public the energy performance certifications is not fully respected. It is a pity, because this could help to promote the low energy standards. Poland, as all other EU Member States, was obliged to introduce the new Technical Guidance and energy performance certificates by the implementation of the Directive (2010). The reason for this Directive was the belief that climate change is caused by human activity, especially the greenhouse gas emissions, and by reduction of these emissions people are able to stop and slow the changes. But whatever the reason for the legislation for our, very energy consuming building industry, they are advantageous. Even if we do not reduce the temperature growing, we can at least reduce the level of air pollution caused by coal heating.

On the other hand, EEA (2012) issued a report on the climate change which recommended two kinds of actions: reducing greenhouse gas emission, to stop or slow the changes, and at the same time to adapt to the changes. For our region, longer and more severe waves of very high temperature were foreseen. The new Polish legislation probably does not put enough emphasises on overheating risk of the buildings. Another finding of the document is that climate change could deepen imbalances between the regions in Europe. Therefore especially for less economically developed countries, like Poland, adaptation steps shouldn't be connected with high expenses. The answer could be the passive methods for achieving thermal comfort.

Other reasons for constructing energy efficient buildings in Poland are of minor importance. Especially financial support for small investors is not encouraging enough. High environmental standards are set up by big international companies, which do not want to have in their portfolio buildings below the standards. Smaller Polish companies are financially not able to follow the examples, or do not see any reason for following it. Some improvement is in the fact that local authorities started to introduce high environmental standards for their new buildings. This is sometimes connected with the possibility of financial support. The system of financial support for promotion of the energy efficient buildings works better in the case of public buildings, than in the case of residential buildings.

Summing up, although recently in Poland much was done to improve energy performance of buildings, there is still much room for improvement.

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