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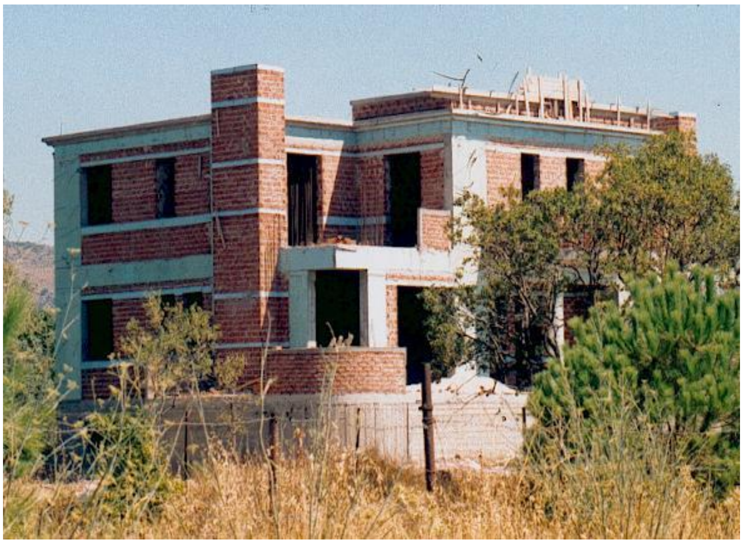
State of the art in thermal insulation of buildings in Europe and a proposal for the Albanian energy regulation for buildings



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1. Introduction: Energy performance of buildings in Europe

The regulation concerning the energy behavior of buildings should, in principle, be characterized by the effort to meet three complementary goals:

1. The primary policy still remains the reduction of energy demand, by means of reducing heating and cooling loads in winter and summer respectively. This implies enhanced thermal protection of the building's envelope and also, for the summer, sun-protection.
2. The second policy, in terms of ranking, is to strive and cover the, now reduced but still inevitable demand, in the most efficient way. This implies to heating, ventilation and air-conditioning systems, to lighting and to automation and controls.
3. Finally, the aims lies in attempting to utilize renewable energy sources to the greatest possible extent, but always within the limits set by a sound feasibility analysis.

This hierarchy is mirrored in the development that are taking place in national European, but also in international EU legislative frameworks, since the mid 1990's.

The majority of regulations in Europe have already gone beyond the determination of specific thermal transmissivity values for the buildings' elements (km or U values), as this step is being taken for granted since the 1980's. In that sense, there are no strict limits for the thermal transmissivity of each façade or elevation, but there are limits for the overall coefficient of the building's envelope.

Most regulations are now concerned with the buildings' energy behavior as a whole, in the sense of monitoring the Energy Performance (EP) by means of either standardisation and/or regulation. These new regulations are already valid in several countries, while in several others they are under preparation.

The principle of an Energy Performance regulation defines the regulation through a formula like:

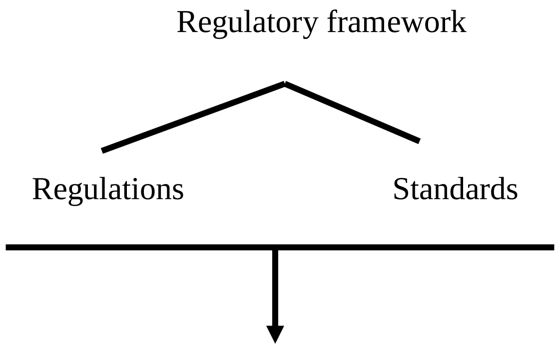
$$\mathbf{EP \leq EP_{max}}$$

where, EP is an indicator which represents the calculated energy consumption, or in some cases even CO_2 emission, of the building and EPmax is the maximum consumption or CO_2 emission not to be exceeded by the building respectively.

The energy performance index EP is calculated through a procedure which takes into account characteristics of the building and of its technical installations, defining the calculation procedure is a technical issue. EP_{max} is defined in the regulation through a formula which can be simple or very complex, defining EPmax is a political and economical issue.

The EP regulations differ from regulations, where requirements are specified for energy performance of individual components, and focus on the overall energy performance of the building. In practice, however, global EP regulations and regulations dealing with components are not contradictory. Many countries have both an EP regulation for the building as well as specific requirements for components or systems, in order to ensure the maximum energy conservation by means of a well insulated building envelope.

The two pillars on which every regulatory framework is founded are the regulations and the standards. The implementation of those effects directly to the construction of more efficient buildings and the production of more efficient products and techniques.



- More energy efficient buildings
- More energy efficient products, elements and techniques

Figure 1. The role of regulations and standards

In fact, the impact of building regulations on the growth of sustainable products and techniques is essentially important. It is noted that as the cumulated experience has proven the introduction of a new regulation is the most important mechanism of transforming the building market.

In principle, there are four phases involved in the building construction and operation that are affected by building regulations: the design process, the construction of the building, the delivery of the building and finally, the operation of the building.

In the European Union there are two types of legal procedures followed by the national building regulations concerning the design phase of a building.

According to the first procedure followed by all countries except of France and Belgium, the designer or the responsible engineer has to prepare a document that should satisfy the specific requirements of the regulation. This may involve energy calculations or specific estimations, (like U values, shading values, etc). The document has to be submitted to an official authority in order to obtain the permission to build. Calculations may be checked or not. During the construction or later the authority may check or not the compliance with the regulation.

In the second procedure, followed by France and Belgium, the responsible designer or the building owner has to certify that the building regulations will be respected. A control by the authorities is possible when the building is finalised.

These two procedures are presented schematically in Figure 2.

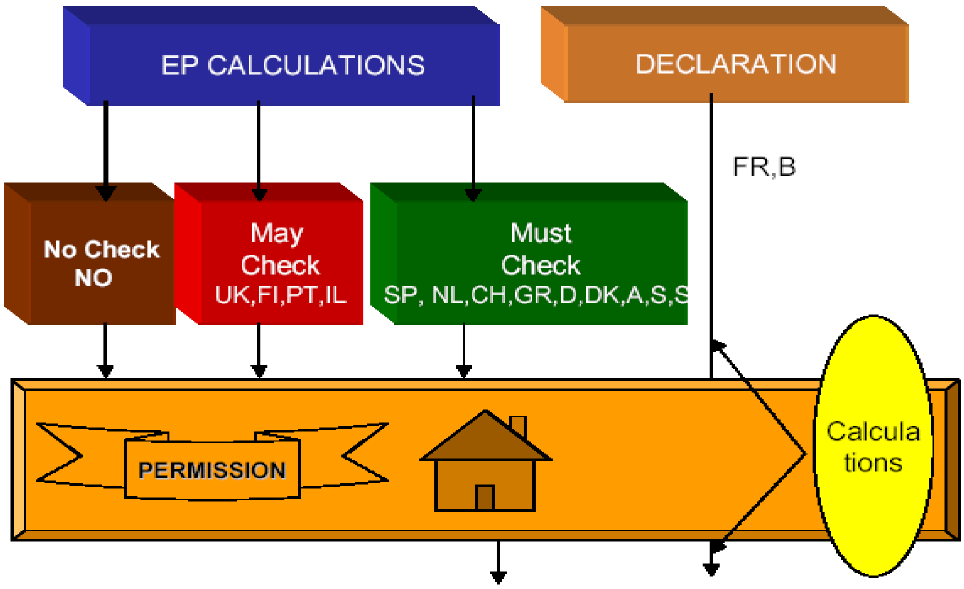


Figure 2. Legal procedures in EU concerning the design phase of a building.

The degree to which each national regulation attempts to manage the issue depends on two main parameters:

- The climatic conditions, which prescribe the necessity to tighten the standards and
- The standard of development of the building sector, which makes such an attempt feasible.

It is evident that the approach in regulations today has as basic idea a correct assessment of the energy efficiency of a building for an agreed level of indoor climate conditions, whereby particular attention is given to thermal comfort in summer, indoor air quality and visual comfort (figure 5). It implies that a meaningful approach presupposes a procedure that aims to limit the (normalised) energy use, but cannot be limited only to that. Table 1 presents the four scaled levels of calculation procedures foreseen by the EP regulations.

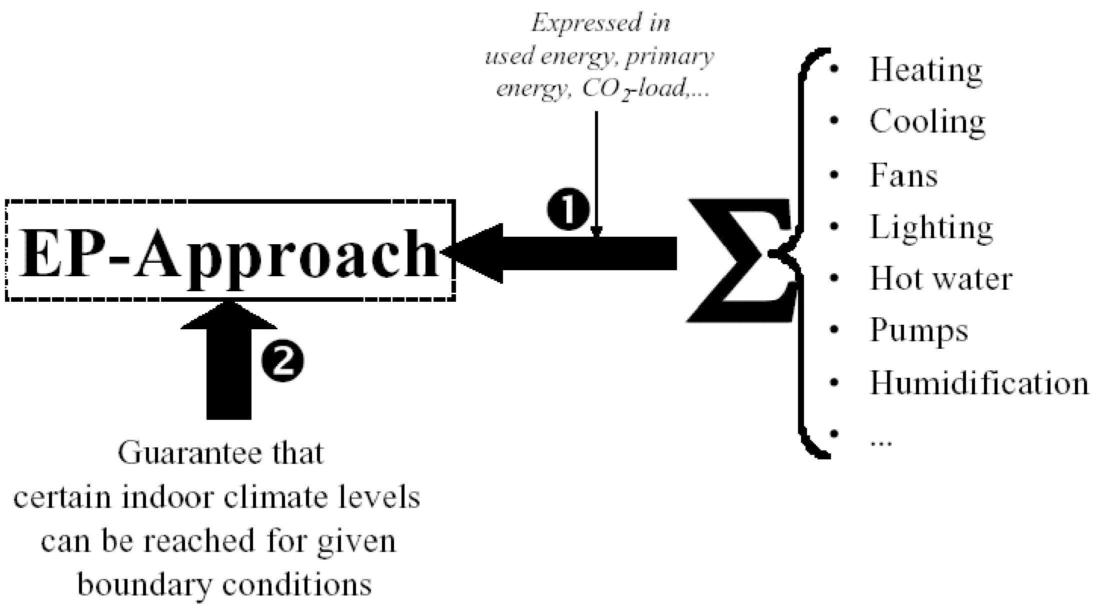
Table 1. Levels of complication for the EP regulations

1. Unit approach	U-value component 1 U-value component 2 U-value component 3 U-value component 4	min R_c=2,5 m²/K U < 0,37 w/m²K	
2. Transmission loss calculation	Insulation floor, roof , facade		
3. Heat demand calculation	Insulation floor, roof , facade	Ventilation, internal heat production and passive solar energy	
4. Energy use calculation	Insulation floor, roof , facade	Ventilation, internal heat production and passive solar energy	Efficiency of installations, hot water, heating and ventilations

The holistic approach of the integrated EP system is depicted in Figure 3. In Table 2 are presented the countries which are satisfying several demands which are met in EP regulations already valid, or already approved to be applied, in Europe.

Table 2. Satisfaction of demands met in EP regulations in several European countries

country	**AT**	**BE**	**DK**	**FI**	**FR**	**GR**	**IR**	**NO**	**SP**	**SW**	**UK**
Temperature limits	no	no	no	**yes**	**yes**	no	no	no	**yes**	**yes**	**yes**
Thermostatic control	no	no	no	**yes**	no	**yes**	**yes**	no	no	no	no
Heating bills	**yes**	no	**yes**	no	**yes**	no	no	no	no	no	no
Boiler inspection	**yes**	**yes**	**yes**	no	**yes**	**yes**	no	no	**yes**	no	no
HVAC inspection	no	no	no	no	no	**yes**	no	no	**yes**	no	no
Heating system control	no	no	no	no	**yes**	**yes**	**yes**	no	**yes**	no	no
Hot water	no	no	no	**yes**	no	**yes**	**yes**	no	no	no	no
Boiler replacement/renovation	no	no	no	no	no	no	no	no	no	no	no
Efficient lighting	no	no	no	no	no	**yes**	no	no	no	no	**yes**
Energy audits	no	no	**yes**	no	no	**yes**	no	no	no	no	no
Buildings’ energy labeling	no	no	**yes**	no	**yes**	**yes**	no	no	no	no	no



Notes:

(1) refers to a specific building. It should be accompanied by appropriate procedures that guarantee that acceptable indoor climate conditions
(2) this can be achieved for given boundary conditions, such as climate, occupancy, etc.

Figure 3. The EP level of a building includes all building related energy consumption (under normalised conditions) and assumes appropriate indoor climate conditions

2. The impact of EP regulations on the thermal insulation of European buildings

The several levels of EP regulations evolution in Europe are easily visible through the decades. Particularly in the seventies due to the oil crises, there was a strong interest in energy conservation which resulted in increased tightening limits for thermal insulation and efficient boilers. This led to a new approach in regulations concerning:

- The minimum requirements with respect to thermal insulation
- The minimum requirements for efficiency of boilers

Respectively, in the eighties, several regulations included the so-called passive solar performances of buildings (use of free solar gains in winter time) whereby minimum requirements concerning the net heating demand were imposed;

Due to the increased importance of summer comfort and cooling, the potential contribution of renewable energy sources, the relative and sometimes absolute increase in the energy use due to ventilation, there is since the beginning of the nineties, a strong tendency for setting up requirements whereby attention is paid to the total energy use of buildings. Still, if one considers the currently valid thermal transmissivity values which are presented in Table 3, as they appear in a series of European countries, they are by far stricter than they were 10 years ago.

Table 3. State of the art for typical k_m-values in the building envelope of presently built residential buildings in various European countries.

	Roofs	Outer walls	Groundfloors	Windows
Austria	0.2 – 0.3	0.3 – 0.4	0.4 – 0.5	1 – 1.5
Flanders-Belgium	0.4 – 0.5	0.5 – 0.6	0.6 – 0.6	1.5 – 2.5
Denmark	0.1 – 0.2	0.2 – 0.3	0.1 – 0.2	1.5 – 2.5
Finland	0.1 – 0.2	0.2 – 0.3	0.2 – 0.3	1.5 – 2.0
France	0.2 – 0.3	0.4 – 0.5	0.3 – 0.4	1.5 – 2.5
Germany	0.2 – 0.3	0.5 – 0.6	0.4 – 0.5	1 – 1.5
Greece	0,4 – 0,5	0,5 – 0,7	0,7 – 1,9	2,5 – 3,5
Ireland	0.1 – 0.2	0.2 – 0.3	0.2 – 0.3	1.5 – 2.5
Italy	0.3 – 0.4	0.4 – 0.5	0.4 – 0.5	2.5 – 3.5
Lithuania	0.1 – 0.2	0.2 – 0.3	0.2 – 0.3	1.5 – 2.5
Norway	0.1 – 0.2	0.2 – 0.3	0.1 – 0.2	1 – 1.5
Portugal	0.6 – 0.6	0.6 – 0.6	0.6 – 0.6	2 – 3
Russian Federation	0.1 – 0.4	0.1 – 0.2	0.1 – 0.4	1.5 – 3.5
Spain	0.6 – 0.6	0.6 – 0.6	0.6 – 0.6	2.5 – 3.5
Sweden	0.1 – 0.2	0.1 – 0.2	0.1 – 0.2	1 – 1.5
Switzerland	0.3 – 0.4	0.3 – 0.4	0.6 – 0.6	1 – 1.5
UK	0.1 – 0.2	0.3 – 0.4	0.2 – 0.3	1.5 – 2.5
Netherlands	0.2 – 0.3	0.2 – 0.4	0.2 – 0.3	1.5 – 2.5

In addition, it is very interesting to mention, that the regulations' evolution and their increasing severity, had a profound impact on the constructive solutions that were adopted in order to fulfill the boundaries set by the aforementioned regulations. A sound paradigm is the evolution of insulation thickness to the envelope and the roof of buildings which is presented in the following Figures 4 and 5, for the walls and roofs respectively. The values indicated in the figures are based on the assumption that organic foamy or inorganic fibrous insulation materials are used, with thermal conductivity values λ of 0,032 W/mK.

It is easy to deduce, that the minimum thickness to be met anywhere in Europe is 50 mm, and this is the case for the capital cities of Mediterranean and Southern European countries like Greece, Turkey and Italy. Still, if one would consider more mountainous regions of these countries, like Northern Greece, North-eastern Turkey and the Alpine region of Italy, thicknesses of up to 100 mm are necessary to fulfil the national regulations.

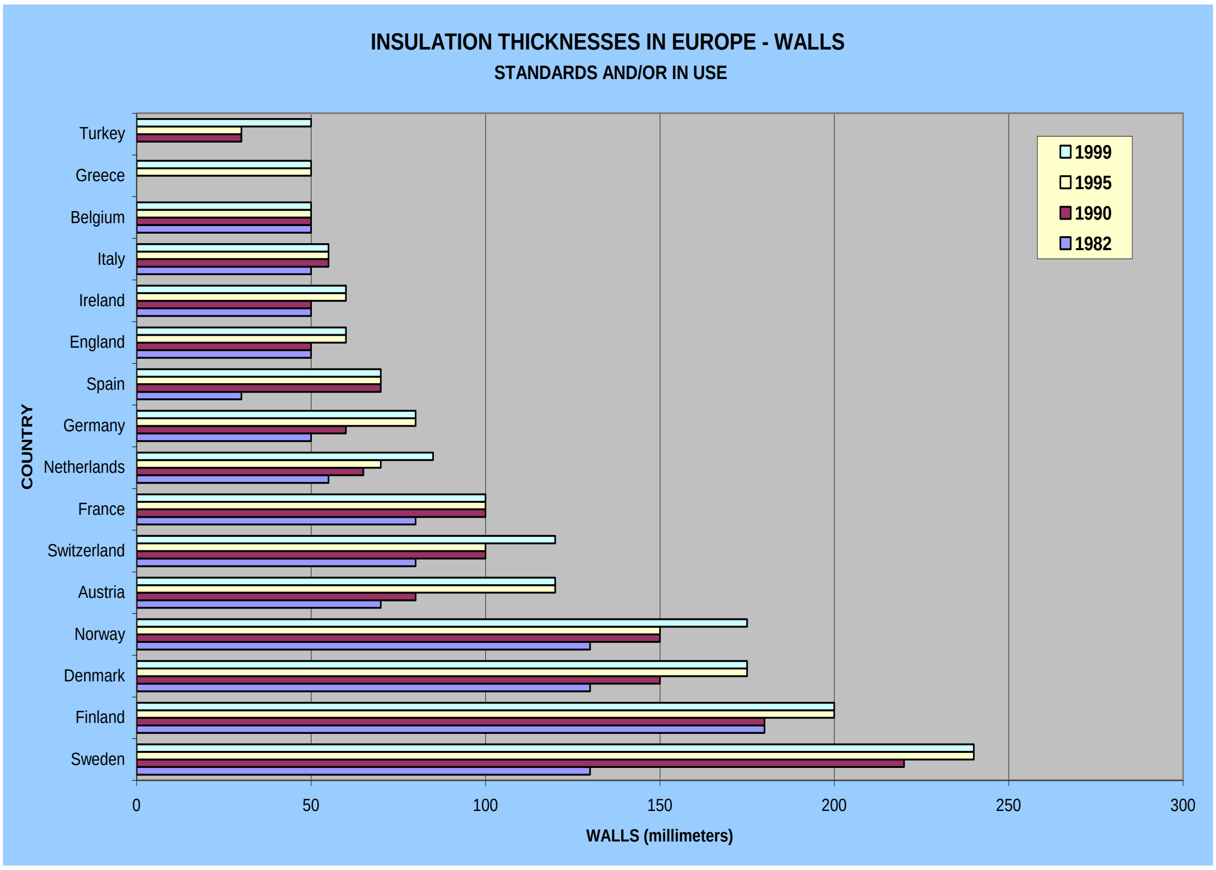


Figure 4. Evolution of insulation thickness in walls in Europe

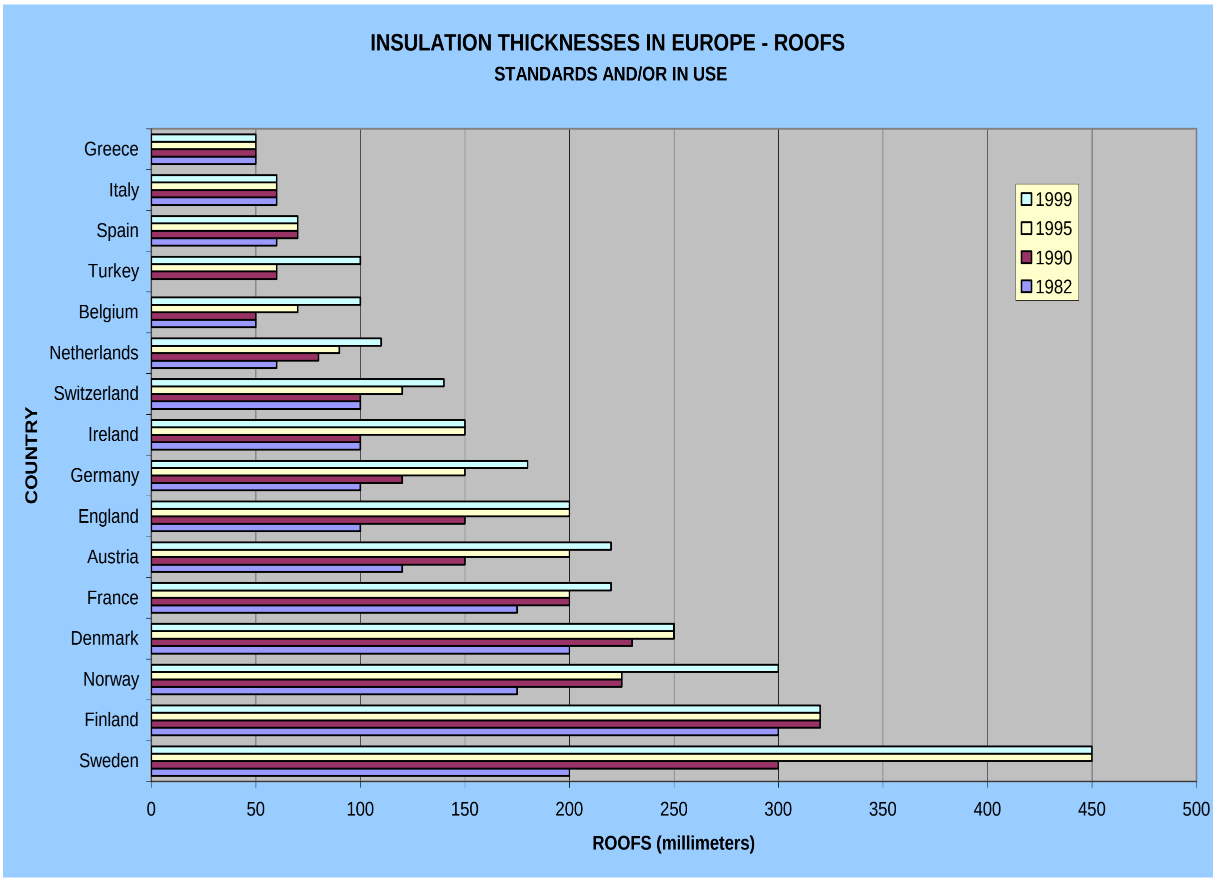


Figure 5. Evolution of insulation thickness in roofs in Europe

It becomes therefore evident, that any contemporary energy regulation is based on an efficient limitation of thermal losses through the buildings' envelope. This is ensured by setting up tight levels for the transmissivity losses, and this can only be achieved by enhanced thermal insulation and high quality of windows.

In any case, insulation of thicknesses of at least 50 mm (5 cm) are foreseen, while even in Southern European countries these limits are up to 100 mm in climatic unfavourable regions.

3. A proposal for the new Albanian energy regulation of buildings

The principle of the Albanian regulation, as proposed in the published draft legislative act **Vendim IKM Nr.38/16-1-03, is beyond any doubt correct**. Aim of the contemporary regulation should be to ensure the maximum achievable energy savings, but not to impose an unbearable financial burden on the building constructors and prospective buyers.

In order to achieve such an aim, the idea of introducing an energy loss coefficient, like the Gv, that will depend on the climatic zones of the country's regions, and that will determine a building thermal losses in terms of conductivity and ventilation is definitely the right one.

In that sense, considering the climatic conditions and the prevailing energy use patterns of Albania, a consumption of some **50 to 100 kWh/m2 and year** can be considered as feasible, with respect to the development monitored in neighboring countries, like Greece, Yugoslavia and FYROM, as these are depicted in Figure 6.

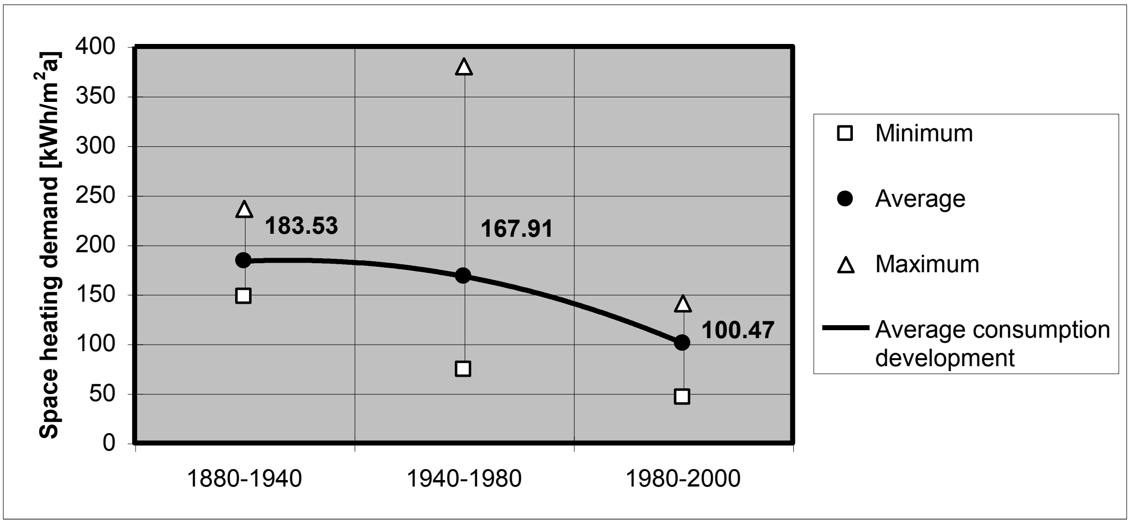


Figure 6. Development in energy consumption in three Southeastern European countries

It can also be regarded as achievable and feasible with respect to the three climatic zones, in which Albania is subdivided, and also he buildings surface to volume ratio. The former are depicted in Figure 7 the latter is appearing in the tables to follow.

This figure, else known as the annual specific energy demand which refers to the square meter of a building's heated surface, is comparable to those of other Southern

European countries. Both as a physical property and as numerical value it inscribes very well with the new European directive for the EP of buildings.

It can be achieved with a reasonable quality and quantity of thermal insulation, with reasonable double glazed windows and doors and with a minimum of ventilation guaranteeing good levels of indoor air quality and also thermal comfort. At the same time, it complies with the minimum temperature and ventilation rates foreseen in the Albanian Vendim IKM Nr.38/16-1-03.

Figure 7. Climatic zones of Albania

3.1. Determination of the energy loss coefficient Gv

In terms of a regulation, this performance measurement can be described by the energy loss coefficient Gv_o (Gv overall), as foreseen in the Vendim IKM Nr.38/16-1-03. In order now to be able to achieve the energy performance needed, the new regulation will have to foresee certain limits for both components, of which Gv consists, namely:

$\mathbf{Gv_t = (F/V) \cdot k_m}$, for transmissivity and

$\mathbf{Gv_v}$ for ventilation

In that sense the statement should be

$\mathbf{Gv_o = Gv_t + Gv_v}$

And there shall be valid that

$\mathbf{Gv_o \leq Gv_o}$ **max,**

and in order to ensure this there will have to be established that

$\mathbf{Gv_t \leq Gv_t}$ **max**

given the fact that in buildings with natural ventilation it is impossible to ensure that

$\mathbf{Gv_v \leq Gv_v}$ **max**

And one can therefore only consider a certain constant $\mathbf{Gv_v}$ for reasons of comparison. In that sense, and given the fact that ventilation is by far the most difficult component of energy losses to control, it is of particular significance that both partial Gv 's shall by subject to a limit, in order to be in practice fairly sure of achieving a satisfactory behavior.

3.2. Determination of the transmissivity losses coefficient Gvt

A series of research projects carried out during the last decade all over Europe have proven, that ventilation losses account in insulated buildings for at least 40% of the overall energy consumption.

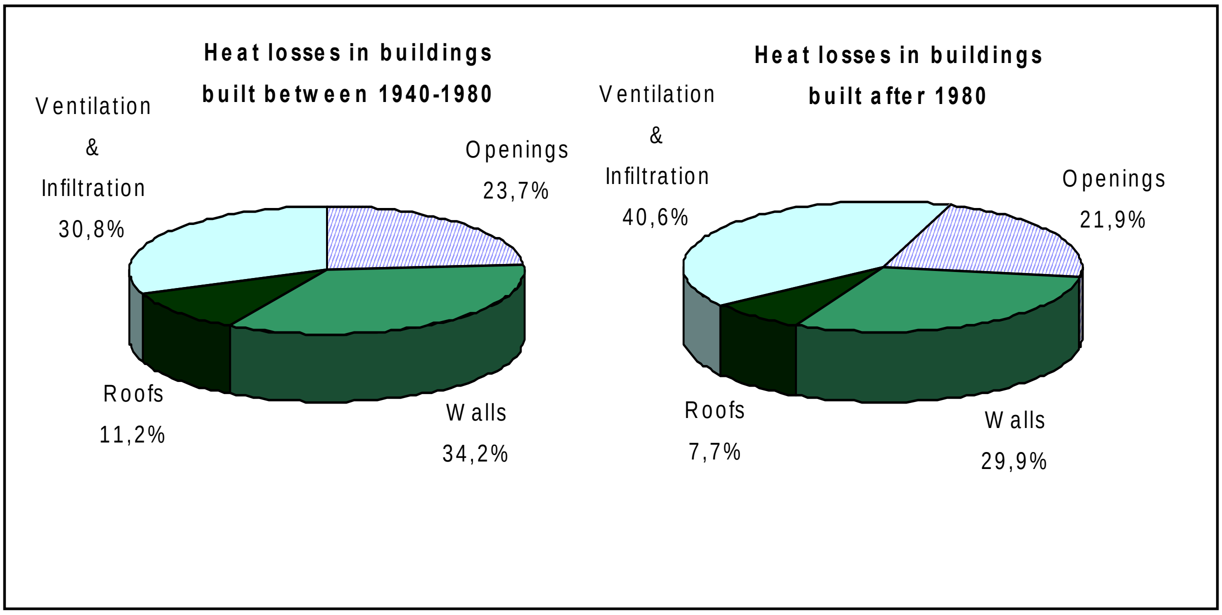


Figure 8: Heat losses with respect to the buildings' age and insulation status

(Left pie chart uninsulated buildings, right pie chart insulated buildings according to the regulations valid in the 1970's and 1980's)

In has to be noted, that in the buildings constructed after 1998, that is after the introduction of the 4th generation of energy regulations, ventilation accounts for as much as 50 to 60% of the total energy consumption.

It is thus obvious, that the transmissivity loss coefficient Gvt foreseen by the new regulation shall be able to ensure the respective energy consumption. With respect to the data published in the Vendim IKM Nr.38/16-1-03, concerning the climate, the indoor temperatures and the building materials and techniques, the **proposed values for the transmissivity loss coefficient Gv**t would have to be the ones presented in the following **Table 4**.

Table 4. Transmissivity loss coefficient Gvt

	A		B		C	
S/V	900	1500	1500	2500	2500	3000
0,2	0,213	0,183	0,183	0,167	0,167	0,147
0,3	0,319	0,275	0,275	0,250	0,250	0,221
0,4	0,407	0,356	0,356	0,333	0,333	0,294
0,5	0,509	0,431	0,431	0,408	0,408	0,361
0,6	0,583	0,517	0,517	0,490	0,490	0,433
0,7	0,681	0,603	0,603	0,560	0,560	0,506
0,8	0,741	0,689	0,689	0,627	0,627	0,567
0,9	0,833	0,750	0,750	0,705	0,705	0,638
1	0,926	0,833	0,833	0,783	0,783	0,694

The implementation of these coefficient will result in **an average energy consumption due to transmissivity losses** that is presented in **Table 5**.

Table 5. Specific energy consumption due to transmissivity losses

	A		B		C	
	900	1500	1500	2500	2500	3000
0,2	12	17	17	26	26	28
0,3	18	26	26	39	39	41
0,4	23	33	33	52	52	55
0,5	29	40	40	64	64	68
0,6	33	48	48	76	76	81
0,7	38	56	56	87	87	95
0,8	42	64	64	98	98	106
0,9	47	70	70	110	110	119
1,0	52	78	78	122	122	130

It has to be noted that these are typical values, as they demand on a series of constructive details, but they demonstrate the huge energy saving potential achievable.

If one would add the losses due to ventilation, according to the formulae and the data presented in the Vendim IKM Nr.38/16-1-03, then the following figures would result, as they are presented in Table 6.

Table 6. Specific energy consumption due to ventilation losses

	A		B		C	
	900	**1500**	**1500**	**2500**	**2500**	**3000**
0,2	19	31	31	52	52	62
0,3	19	31	31	52	52	62
0,4	19	31	31	52	52	62
0,5	19	31	31	52	52	62
0,6	19	31	31	52	52	62
0,7	19	31	31	52	52	62
0,8	19	31	31	52	52	62
0,9	19	31	31	52	52	62
1,0	19	31	31	52	52	62

The **total specific annual energy consumption** would thus result to be the one presented in **Table 7**.

Table 7. Total specific energy consumption

	A		B		C	
	900	**1500**	**1500**	**2500**	**2500**	**3000**
0,2	31	48	48	78	78	90
0,3	37	57	57	91	91	104
0,4	42	64	64	104	104	118
0,5	47	72	72	116	116	130
0,6	51	80	80	128	128	144
0,7	57	88	88	139	139	157
0,8	60	96	96	150	150	168
0,9	66	101	101	162	162	182
1,0	71	109	109	174	174	192

The energy losses for the respective features are calculated based on the following formulae, based on the constant Degree Days method and according to Hitchin:

Transmissivity losses

$$Q_{tr} = DD * G_{vt} * 24 * V/(1000 * S) \qquad [kWh/m^2a]$$

Where:

DD: Number of Degree Days

Gvt: as given before

V: Heated volume

S: Exposed surface

Ventilation losses

$$Q_{vent} = DD * n * 24 / 1000 * \rho * c_p * V / (3600 * S) \quad [kWh/m^2a]$$

Where:

n : Number of air changes per hour

ρ : density of air

cp : specific thermal storage capacity of air

and hence

Total losses

$$Q_{tot} = Q_{trans} + Q_{vent} \quad [kWh/m^2a]$$

If one compares these values, with the one that would result from the Vendim IKM Nr.38/16-1-03, then one would make the following remarks:

A) If the coefficient Gvo in the full legislation text refers **only to transmissivity losses**, then the limits set are **not strict enough**, and a significant reduction is achieved by the herewith proposed values, based on the reduction of transmissivity losses.

This difference, for each climatic zone, in terms of Degree Days, of Albania, is presented in the following Figure 9. **This difference represents the energy saving potential that is exploitable.** The overall consumption shown in this figure is based on the assumption that the ventilation losses are in both cases the same and refer to 1 air change per hour over the whole 24hrs period.

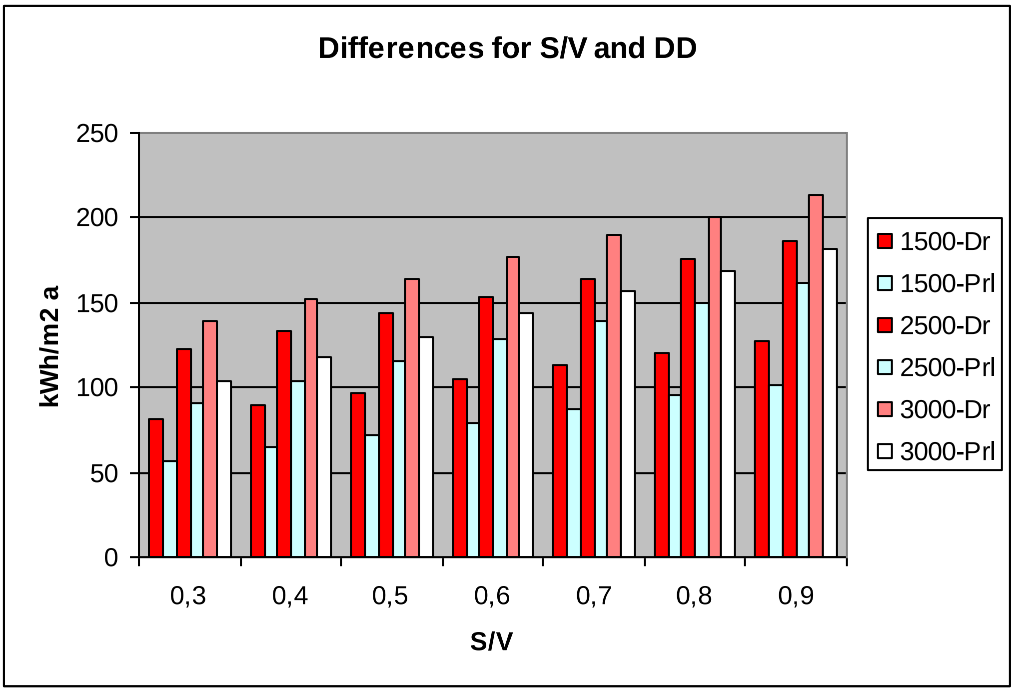


Figure 9. Comparison of total specific energy consumption between the Vendim IKM Nr.38/16-1-03 and this proposal, indicating the possible energy savings if Gvo refers only to transmissivity

B) If the Gvo coefficient proposed in the amendment, or even in the full draft, refers to transmissivity and ventilation losses, then it leads to a very strict limit, which would incorporate for climatic zone C more than 80 cm of insulation to achieve it.

Furthermore, if one would add the ventilation losses for each case, as they were

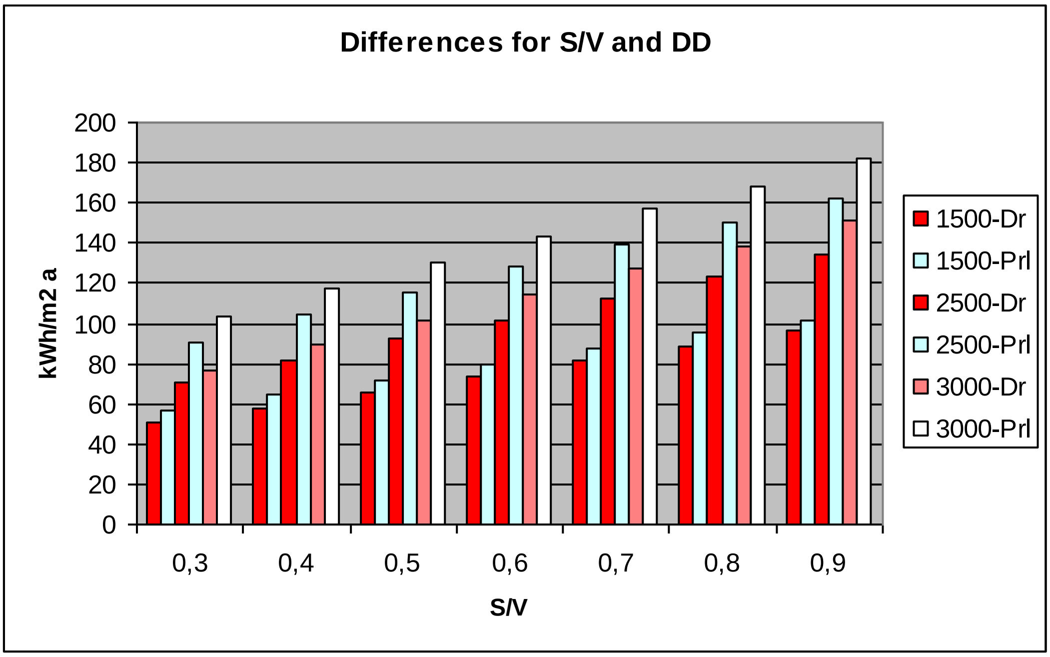


Figure 10. Comparison of total specific energy consumption between the Vendim IKM Nr.38/16-1-03 and this proposal, indicating the possible energy savings if Gvo refers to transmissivity and ventilation

It has to be noted that even in the vas majority of building, i.e. those with S/V ratios of up to 0,8, the consumption values due to transmissivity, according to our proposal remain below 100 kWh/m^2 a, whilst in the more moderate cases they are between 30 and 60 kWh/m^2 . In that sense they are fully harmonized with the current European trends.

The comparison of the impact of the three cases of coefficients (proposal, Vendim IKM Nr.38/16-1-03 Gvo without ventilation and Gvo with ventilation) on the insulation needed to achieve the limits at typical buildings, is presented in the following tables.

Table 8. Total specific energy consumption values for the three cases

Proposal **Insulation thickness [cm]**

	A		B		C	
S/V	900	1500	1500	2500	2500	3000
0,2	3	5	5	6	6	9
0,3	3	5	5	6	6	9
0,4	3	5	5	6	6	9
0,5	4	5	5	6	6	9
0,6	4	5	5	6	6	9
0,7	4	5	5	7	7	9
0,8	4	5	5	7	7	10
0,9	4	5	5	7	7	10
1	4	5	5	7	7	11

Draft without ventilation **Insulation thickness [cm]**

	A		B		C	
	900	1500	1500	2500	2500	3000
0,2						
0,3	1	1	1	1	1	2
0,4	1	1	2	2	2	2
0,5	1	2	2	2	2	3
0,6	1	2	2	3	3	4
0,7	1	2	2	3	3	4
0,8	2	2	2	4	4	4
0,9	2	3	3	5	5	5

Draft with ventilation **Insulation thickness [cm]**

	A		B		C	
	900	1500	1500	2500	2500	3000
0,2						
0,3	3	11	11	N.P.	N.P.	N.P.
0,4	3	9	9	N.P.	N.P.	N.P.
0,5	3	9	9	70	70	N.P.
0,6	3	8	8	49	49	N.P.
0,7	3	8	8	33	33	N.P.
0,8	3	7	7	23	23	N.P.
0,9	3	7	7	22	22	N.P.
1						

N.P. : Not possible, more than 80 cm needed

4. A brief example of applying the proposed regulation

In order to analyze the feasibility of the proposed regulation, two typical buildings were examined. The first one (Building 1) is a small two-storied single or double family house, like it can be seen throughout the suburb and rural areas of Southeastern Europe. Its main features are presented in Table 9, whilst the constructive data for all the building's elements were adopted according to the Vendim IKM Nr.38/16-1-03. It is a good example for an unfavorable surface to volume ratio.

Table 9. Features of building 1

Features of building 1	
Building element	**m^2**
External surface S	450,60
Heated volume V	559,00
Double brick wall (normal bricks)	111,20
Double brick wall (decorating bricks)	22,40
Concrete pillars	33,36
Concrete beams	11,12
Windows and doors	40,00
Roof surface	99,00
Floor surface	99,00
Ratio SV	0,806

The second one (Building 2) is a fairly big six-storied multi-family residential building, like it can be met throughout the cities of Southeastern Europe. Its main features are presented in Table 10 and it is a good example for a building with favorable surface to volume ratio.

Table 10. Features of building 2

Features of building 2	
Building element	**m^2**
External surface S	1924,66
Heated volume V	5834,00
Double brick wall (normal bricks)	660,00
Double brick wall (decorating bricks)	71,16
Concrete pillars	303,12
Concrete beams	83,28
Windows and doors	354,60
Roof surface	374,00
Floor surface	374,92
Ratio SV	0,381

For each of the two buildings, a series of calculations was carried out to determine the **k_m** and **Gv_t** coefficients. These were compared to the **Gv_t max** foreseen by our proposed regulation, in order to determine the **minimum insulation thickness** needed to achieve the foreseen coefficient.

The resulting insulation thickness, for a thermal conductivity value λ that varies between 0,32 and 0,35 W/mK according to the building element that is to be insulated, were calculated for these buildings with respect to the climatic data of all the zones.

These values are presented in Tables 11 and 12.

Table 11. Insulation thickness needed to achieve the Gv_t max foreseen by our proposed regulation

	Climatic zone and degree days					
Insulation thickness	A		B		C	
	900	1500	1500	2500	2500	3000
Building 1	4	5	5	7	7	10
Building 2	3	5	5	6	6	9

Table 12. Gv_t coefficient of the buildings according to the applied insulation thickness

	Insulation thickness							
Gvt coefficient	3	4	5	6	7	8	9	10
Building 1	0,741	0,659	0,602	0,559	0,526	0,502	0,479	0,462
Building 2	0,408	0,37	0,343	0,323	0,308	0,296	0,286	0,278

These calculations were carried out for all three climatic zones and the respective pairs of Degree Days values. The results, that refer to the **minimum insulation thickness required for all cases of buildings, are presented in Table 13**.

It has to be pointed out, that these are **typical values**, as they depend in each specific building on its constructive features, like the size and quality of openings, the type of walls, the architectural characteristics that determine thermal bridges etc.

Still, the calculated thicknesses are concerning moderate, average building characteristics, and can therefore be considered as representative for the large majority of the building stock. In that sense they can be considered as feasible.

Table 13. Insulation thickness needed to achieve the Gv_t max foreseen by our proposed regulation

	A		B		C	
S/V	900	1500	1500	2500	2500	3000
0,2	3	5	5	6	6	9
0,3	3	5	5	6	6	9
0,4	3	5	5	6	6	9
0,5	4	5	5	6	6	9
0,6	4	5	5	6	6	9
0,7	4	5	5	7	7	9
0,8	4	5	5	7	7	10
0,9	4	5	5	7	7	10
1	4	5	5	7	7	11

A final note has to be made with respect to the distinction between buildings with small and big surface to volume ratio. As it can be seen from all the previous tables, the proposed regulation is stricter for buildings with small S-V ratio than with big one, with respect to the final energy consumption. The main idea behind this choice is to have a better energy performance for the typical multi-storied, rectangular residential buildings, which form the large majority of urban buildings.

Small, one or two family buildings, which typically have a bigger S-V ratio, are treated in a less strict way for two reasons: If they are high quality, sub-urban residential buildings, like the villas met in expensive residential areas, then it is most probable that the architect and engineer will already see for an efficient thermal insulation, whilst the owner will be willing to cover the additional cost. If they are low-cost, rural or urban dwellings, as often constructed by people with smaller income, than it would make no sense to burden them with a very tight regulation, which they would most improbably meet. Still, a minimum of fairly tight limits is also needed, to ensure an acceptable energy performance.

As it has been proven by the evaluation of the European regulations valid over the last 25 years, **the major challenge for a new legislation, lies in utilizing sufficiently the energy conservation potential, which is by and large in the big, urban residential buildings.**

5. The European Directive 2002/91

A brief presentation of the new European directive on the energy performance of buildings is considered by the authors as necessary, as it will be the legal framework for all developments, not only in the EU, for the next 15 to 20 years.

The Directive was first proposed by the European Commission on early 2001 while it was finally published in Official Journal on January 4, 2003. The major objective of the Directive was to enforce the emissions by the building sector in order to allow the EU and Member States to meet their Kyoto protocol obligations.

Buildings are mostly inefficient, consisting a major energy saving potential, and can be substantially improved in terms of energy performance. In addition, there is a wide variation in Member States requirements for the building sector, and the Commission wished to see a certain degree of convergence

It is expected that the new Directive will help to harmonize and homogenize the legal frame concerning the energy consumption of buildings.

Particularly, the main requirements of the Directive are:

- to harmonize calculation methods for integrated building energy performance, through a common general framework for the calculation
- to force Member States to establish minimum requirements for new buildings and for major renovations
- to establish Mandatory energy certification of buildings
- to require regular audits of heating and cooling systems

According to the Directive the methodology of calculation of Energy Performances of buildings shall include at least the following aspects:

a) Thermal characteristics of the building (shell and internal partitions, etc.). These characteristics may also include air-tightness.
b) Heating installation and hot water supply, including their insulation characteristics
c) Air-conditioning installation
d) Ventilation
e) Built-in lighting installation (mainly the non-residential sector)
f) Position and orientation of buildings, including outdoor climate
g) Passive solar systems and solar protection
h) Natural ventilation
i) Indoor climatic conditions, including the designed indoor climate

The positive influence of the following aspects shall in this calculation be taken into account:

a) Active solar systems and other heating and electricity systems based on renewable energy sources

b) Electricity produced by CHP

c) District or block heating and cooling systems

d) Natural lighting

For the purpose of this calculation buildings should be adequately classified into categories such as:

a. Single-family houses of different types

b. Apartment blocks

c. Offices

d. Education buildings

e. Hospitals

f. Hotels and restaurants

g. Sports facilities

h. Wholesale and retail trade services buildings

i. Other types of energy-consuming buildings.

The relationship between the Kyoto protocol with the Directive and the European society is presented to the following Figure 11.

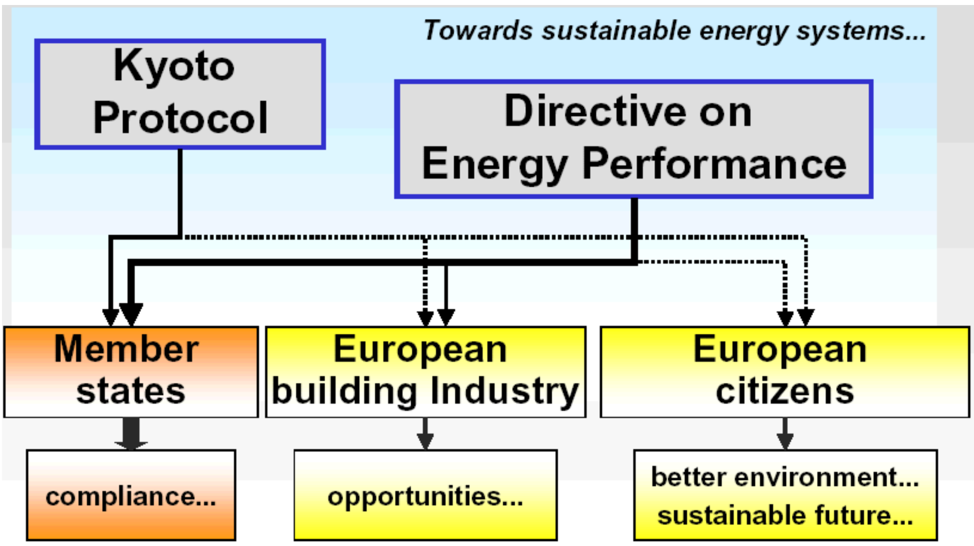


Figure 11. Relationship between the Kyoto protocol with the Directive and the European society

6. Impact of the European Directive on the building branch

An interesting side-effect of all energy regulations is the impact they have on the building branch. Throughout the last 25 years, this has been a positive one, as it stirred the national industries in producing better and more efficient materials and systems. The data from Germany are quite characteristic.

The German buildings improved dramatically over the last 30 years or so: Their specific energy consumption was reduced to 1/6th of what it was and the average thermal transmissivity value was reduced to 1/7th of the original one, as it can be seen in Figure 12.

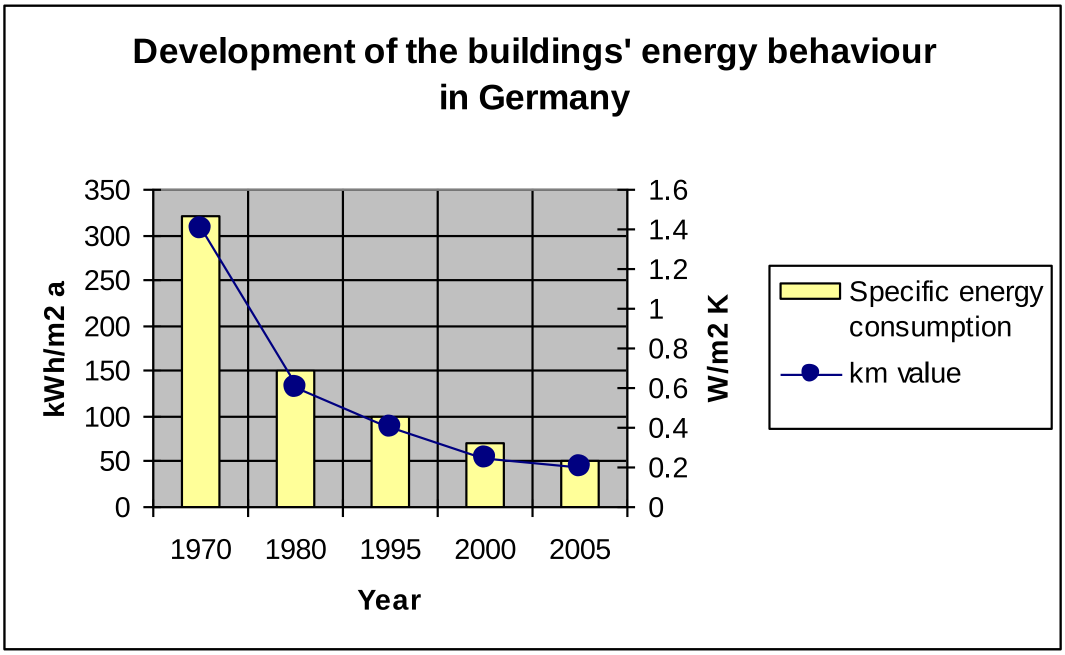


Figure 11. Evolution of the specific energy consumption and the thermal transmissivity value in Germany.

These achievements were possible only due to the extended and expanded use of high quality insulation materials and glazings, a development that boosted the related industrial branches. As a result, the German production of insulation materials increased from 24 to 31,5 millions m^3 annually over the last decade. The current distribution of the insulation materials on the market are shown in Figure 12. At the same time, a similar increase was monitored in the market for low emissivity glass and glazings. This is depicted in Figure 13, and bears clearly the marks of the effect of the new building regulation.

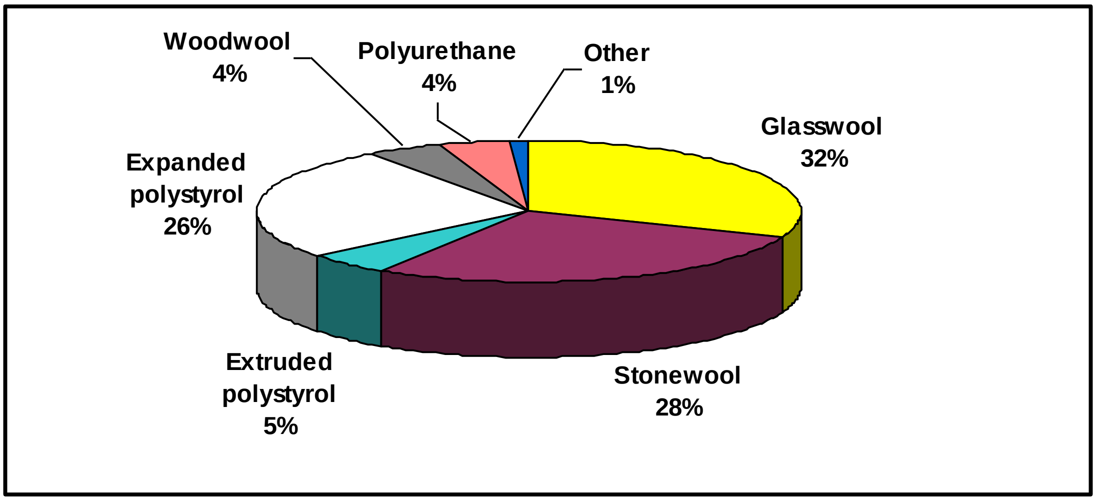


Figure 12. The German market for thermal insulation materials in 2002

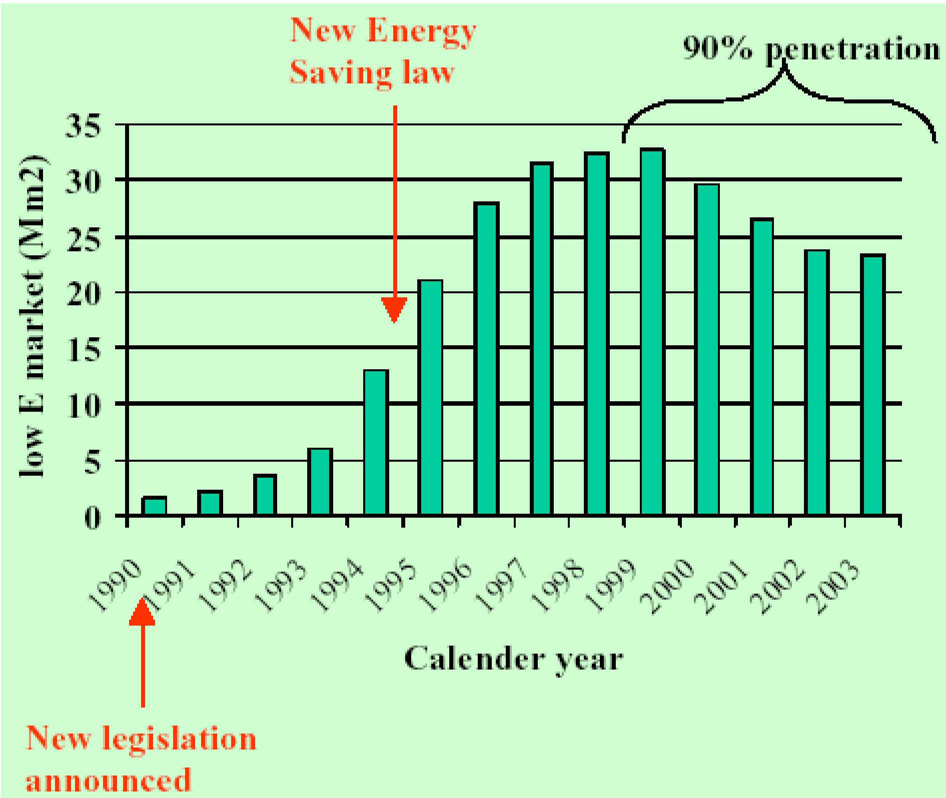


Figure 13. The German market for low emissivity glazing

7. Concluding remarks

The issue of energy regulations, as measures to conserve energy, is both important and complex. The energy saving potential is significant, but so are the financial and regulatory problems to be overcome. The way in which cities were built in the ‘60s and ‘70s led to a situation whereby effective energy conservation measures are often leading to forbidding costs and unacceptable economic results, or at least so it seemed over the last decade. Still, the latest increase in energy prices, and the always present problems of electricity generation shortages due to the increasing demand, are very good reminders of how short-sighted a policy of neglecting thermal protection of a building can be.

Enhanced thermal protection is and will remain the most cost-effective way to build houses with a reasonable energy consumption, satisfactory thermal comfort conditions and low operational costs. This conclusion has been incorporated in the new European energy regulation, which considers a high standard of thermal protection as granted, in order to advance to more sophisticated energy saving measures and to more strict energy performance limits.

The official Vendim IKM Nr.38/16-1-03 of the proposed Albanian energy regulation is certainly moving in the correct direction. Still, a set of stricter transmissivity losses coefficients, like the ones proposed in this study, are needed, in order to ensure that the buildings constructed under the new regulation, will comply with contemporary European performance indices.

The application of the proposed values will by no means lead to a significantly higher initial cost of building, whilst it will contribute to a far better and energy efficient built environment for the coming decades.

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