

Is it suitable a tool for the energy certification in Chile?

An analytical point of view in the context of worldwide building regulations.

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ABSTRACT: Energy efficiency standards for buildings are procedures and regulations that prescribe the energy performance of buildings by setting a maximum level of energy consumption. Standards are sometimes used in conjunction with energy efficiency labels, which features the building's energy performance and should encourage the house buyer to take the aspect of energy-efficiency into respect. This situation appears especially on the middle and high end of the market, where owners and tenants are interested in energy issues and where property suppliers tend to compete and differentiate using a broader range of building performance characteristics. Here the certification can help in directing both demand and supply from the standard performance levels towards buildings with better energy performance. If the Spanish normative scheme seems to be an appropriate choice to incorporate the following stages of the Chilean regulation norm - in terms of a dynamic-state certification software - the establishment of a energy labeling and the improvement of the compulsory requirements seems to be the next step to really establishes a national-broad energy code that answers to the challenges of the contemporary construction.

Keywords: energy regulations norms, standards on energy consumption, energy efficiency labels, certification software

1. INTRODUCTION

Energy efficiency standards for buildings are procedures and regulations that prescribe the energy performance of buildings by setting a maximum level of energy consumption, or a minimum efficiency level compared to a standard building. They are established to decrease the energy consumption that is required for heating and mechanical cooling, service water heating, and lighting and electrical power requirements. Standards are sometimes used in conjunction with energy

efficiency labels, which features the building's energy performance and should encourage the house buyer to take the aspect of energy-efficiency into respect. Generally speaking, a mandatory standard might be more adequate to be incorporated in societies that yet had not established certain consciousness on energy-saving topics. Non mandatory standards (like the "Passivhaus" in Germany for instance) are favorable to be implemented in societies that already developed this consciousness.

By checking the current thermal regulations for building (especially housing)

in different countries, one could distinguish first in countries that do have elaborated mandatory codes for heating and cooling, second in countries that do only offer voluntary standards (sometimes mixed with mandatory minimal requirements) and third and at last, in countries that up to now not had set any standards or requirements on thermal behavior yet. The first group includes most member states of the European Community and some of the mayor global players of today like China, Japan, Switzerland, Norway, New Zealand, just to name some of them. Chile with the recently implemented regulation norm on housing do compile to that category. The second group of countries that only defines voluntary standards combined with minimum mandatory requirements is leaded by Canada, Russia, the US, South Africa and Australia, while in the third group of countries with no requirements at all you will find most South-American, African and Asian countries like Mexico, Egypt, India, for example [1].

2. HOW TO SET STANDARDS ON ENERGY CONSUMPTION?

There are two main approaches in how to set certain standards on energy consumption:

The “prescriptive approach”; this means setting minimum requirement for each building component to satisfy the standard (for instance maximum thermal transmission coefficient of exterior walls or minimum equipment efficiencies).

The “performance-based approach”; in this method a maximum acceptable energy consumption level is been giving, but no methods are specified how to achieve the requested level. For instance, in Germany with the new EnEV there exists no clear limitation on the U-value of building members like in the previous codes. So it is possible, for instance, to compensate weak

U-values by increasing the potentials to gather extra solar gains in a building.

In general four different categories for regulating or limiting the energy consumption of houses you will find. The first category, the “Unit Approach”, mark the simplest existing method by requiring only standards regarding thermal insulation for construction elements. In a second, more complex category, the “Heat Loss Calculation”, the calculation is based on a more holistic view of the insulating properties of the construction. Here the average insulation level of all envelope parts will identify the transmission loss of the building. The third category of “Heat demand calculation”, is also been based on measuring heat loss, but also taking transmission and ventilation losses and heat gain through passive solar effects and through persons and equipment into consideration. The fourth and most complex category of “Energy Use Calculation” will quantify the heat demand and combine that with energy supply features, for instance the efficiency of the installed heating and hot water system. The result is a most adequate assumption on an estimate actual energy use of a building.

The Chilean regulation norm [2] was established from the unit approach, particularly for the envelope components: roof, walls and (ventilated) floors in terms of maximum U-values for each one of the seven climatic zones. Additionally, it exists a requirement for windows, that establishes a maximum glazing percentage. The big advantage of this reduced model is its easy handling that normally does not requires the use of software for calculation and also does not acquire a specialist or in general distinctive knowledge to precede the process. The mayor disadvantage of this schematic model lies in the less precise way of calculation heat losses and demands and in the fact that it mostly ignores at least one mayor aspect of energy performance of building. This scenario could produce the doubt about the need to have a certification

software, such as it is established in the third part of the Chilean regulation.

In general it could be said that the more multifaceted fourth method, besides all problems of increasing complexity in handling, could be recommended. Taking for instance in account even the demands of energy for ventilation, lighting into a more holistic model might avoid unbalanced solutions where “good” results in the field of heat-losses will be opposed to high demand in other energy-consumptive sectors in building (for instance cooling, ventilation, artificial lighting).

The EU Directive on the energy performance of buildings (Directive 2002/91/EC), which all Member States need to incorporate into national legislation by January 2006, sets standards on minimizing energy consumption. As part of this new implementation, an interesting study in this area is been endorsed, which derives following conclusion regarding a “good practice” to measure the energy performance of building (see Table I) as base of national regulations.

3. DIFFERENT SYSTEMS, DIFFERENT STANDARDS

Because of the incomparable settings of parameters in each national regulation, the only clear base on how to evaluate the different systems is according to the performance set for the components of the building. In this context, the Table II compares the required U-values for external walls in eight different countries (six of them are European and two are developing countries, including Chile). Important is to understand that these U-values are not set and required strictly by all these norms since it is possible to compensate “weak” U-values by strengthen other parameters, i.e. increasing solar gains, compactness etc. Anyway, the figures do reflect in a certain ratio the required qualities on the building envelope. In absolute terms, the U-values required in the Chilean Case are much higher than that of buildings in developed countries. For an exterior wall, for example, the U-value for a Chilean building in the most populated climatic zones (zones 3-5) is between 4.5 - 5.4 times higher than a comparable value in the UK or Switzerland.

Table I: Bad / good practices to measure the energy performance of buildings [3]

Bad practice	Good practice
Performance including limited aspects	Performance including heating, DHW, ventilation, lighting, envelope and equipment
Final energy load or consumption	Primary energy consumption (e.g. IEA equivalence factor: 1 KWh electricity = 3 KWh primary energy), accounting for the quality of energy. Energy cost could be an alternative, using a similar ratio (the cost of 1 KWh electricity is generally around 3 times higher than 1 KWh heat)
Thresholds vary according to the shape of the building (compactness)	Fixed threshold, helping to promote low energy architectural design
Different thresholds in different climates	Same threshold (e.g. more insulation is needed in cold climates to reach the same level), possible adaptation according to a local economic optimization
National formats	Same format in Europe : A to G classes, already known for domestic appliances, depending on the ratio (KWh/m ² /y), + indication of the primary energy consumption (KWh/y)

Table II: Required Heat Transfer Coefficient [W/m²K] to exterior walls by country [4]

Country	Zone/region	Heat Transfer Coefficient [W/m²K]																		
		Exterior Wall																		
		0.15	0.25	0.35	0.45	0.55	0.65	0.75	0.85	0.95	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	
UK																				
Germany																				
Switzerland																				
France																				
Belgium																				
Spain	E1																			
	D1, D2, D3																			
	C1, C2, C3, C4																			
	B3, B4																			
	A3, A4																			
China	severe cold zone																			
	cold zone																			
	hot summer / cold winter zone																			
	hot summer / warm winter zone																			
	warm zone																			
Chile	7																			
	6																			
	5																			
	4																			
	3																			

Despite that the Directive 2002/91/EC could represent an example to follow for less developed countries in terms of building regulations, it shows some clear lack on concrection on the following issues:

(a) No clear setting of minimum requirement in energy performance. Therefore all national codes and standards do vary strongly in the setting of minimum values.

(b) No common main indicators for building energy performance. Even though most of the member states had introduced the yearly-balanced energy-performance indicator KWh/m²/y, this is not set obligatorily in the EU-regulation. It should be clear that the implementation of minimum U-values as main indicator is rather poor for judging the performance in a holistic way. Nevertheless some countries allow U-value based calculation as one alternative to comply with the norms. Due to all of this it is quite impossible to compare the results of different national models.

(c) No clear setting for the calculation method that should be used to perform the calculation. For instance the Directive not explicitly promotes the use of dynamic simulation software which could help to point problems of overheating. Especially the summer case could turn into the mayor problem in a lot of climates that could only be detected when simulating according to inside temperatures in a dynamic model. Stating advisories for Chile this has to be considered seriously.

(d) No norms or standards for existing building. The existing building stock incorporates a very high potential in energy saving in building. Also the updating of existing building to better performance levels shows very attractive cost-effect-ratio. Some countries like Germany for example put mayor emphasis on this by setting strict energy standards in the case of mayor refurbishment of old buildings.

(e) No specification on minimum comfort conditions. For instance the problem of overheating, the question on thermal mass or surface temperature, and

the issue of air quality are important aspects besides the pure physical aspects of the envelope.

4. ENERGY STANDARDS AS A MARKET TRANSFORMATION TOOL

Due to this significant lack of concretion in the Directive 2002/91/EC, together with a certain disinterest of the building sectors in some member countries, resulted in a very unequal implementations of requirements in the different states. On the one side we find countries like Denmark or Germany with long established energy regulations and strict and rather complete codes, and on the other side countries like Spain with lower regulative requirements (see Table II) and national-wide very recently established certification. Probably, these two conditions make the Spanish case very interesting from the Chilean perspective, since the software for the energy certification (under construction) is based on the calculation engine of LIDER, the Spanish simulation tool. In fact, LIDER software is one of the few cases of official tools in the European context that it is an dynamic simulation software. Also it is a freeware.

However, the Spanish regulation has the building energy labeling as added value (which is one of the main goals of the Directive 2002/91/EC) in comparison to the Chilean code. The market of new housing is divided in five labels or classes, which are assigned according to the heating demand by means of a normalized scale. The model allows a U-value based calculation (prescriptive approach) as alternative to comply with the norm, but exclusively limited to the minimum standard (classes D and E). Therefore, to reach a better standard (classes A, B or C) it is necessary to use the certification tool (LIDER software).

The criteria to assign the different classes to a specific range of heating load are based on the following assumptions (it is not a directly proportional relationship) [5]:

(a) The average value of the regulation will be in the bound between classes C and D. Within C and D will be the 85 % of the buildings that fulfill strictly the regulations, 10 % in class B and 5% in class E.

(b) Class B should be reachable by buildings initially placed in class C when optimized in a cost-benefit context without recurs to renewable energies.

(c) The effort to move from class B to class must be equivalent to the effort to move from class C to class B

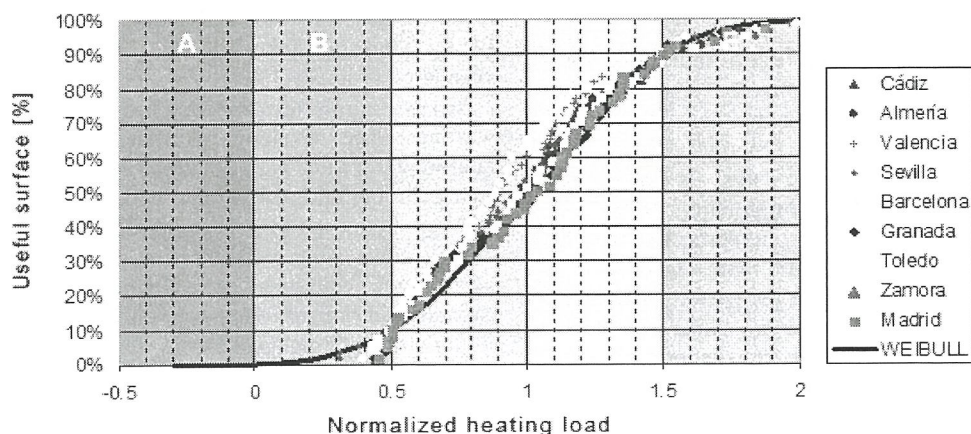


Figure 1: Accumulated frequency distribution of heating demand per labels (A-E) in terms of useful surface percentage in Spain. [5]

On the contrary, the Chinese energy code is based on a more complex prescriptive approach per region (where the required U-value depends on the shape coefficient and the glazing surface) and a performance-based approach for special cases. However, this last system does not correspond to a digital tool; it is just a steady state thermal performance calculation, applied by means of complex equations. The high complexity of the whole system represents an important barrier to its massive application; by the end of 2000 the total floor area of residential buildings designed according to energy-efficiency standards was only 180 million m², which represents only 8% of the total area of residential buildings in cities in China's cold zones [6]. This experience demonstrates that sometimes the prescriptive approach is not always the most applied solution, since the own limitations of the system forces to include very difficult ways to comply with the norm.

5. CONCLUSIONS

The comparative nature of building certification (enabling decision-makers to distinguish between "good" and "bad" buildings") implies that its potential impact is highest on the middle and high end of the market (between classes A and C in the Spanish context). This is the segment where individuals and organizations are already interested in energy issues and where property suppliers tend to compete and differentiate using a broader range of building performance characteristics. Here the certification related to the higher classes can help in directing both demand and supply from the (minimum) standard performance levels towards buildings with better energy performance [7].

If the Spanish formula seems to be the appropriate choice to incorporate the new stage of the Chilean regulation norm, in terms of a dynamic-state certification

software (which considers overheating phenomena), the establishment of a energy labeling in a similar way than the EU and the improvement of the requirements (in absolute terms) seems to be the next compulsory step to really have a building energy code that can answer to the challenges of contemporary construction.

6. REFERENCES

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