Energy Efficiency Standards for Buildings in Mexico: Lessons Learned from a Technical and Political Process

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ABSTRACT

The development and implementation of standards is a technical as well as political process. The process is particularly complex with regard to energy efficiency standards for buildings, since each building is a unique product. . In the case of Mexico, a lack of information and limited modeling capabilities represented a serious burden in both the design and the consensus building protocols. More than five years after the process began, and after one failed attempt to make it mandatory, an energy efficiency building standard will be published by beginning of the year 2000.

This paper reviews both the technical and political processes that led to the final publication standard, and suggests some recommendations for the development of this type of policy instrument in a context where information and skills are limited.

Introduction

A primary benefit of energy efficiency standards is that once they are implemented, all that are effected by them will save energy.

The process to implement standards is long and difficult because the people involved in the process can sometimes have differing points of view. Although the standards are issued and imposed by the government, there must be consensus among all the stakeholders involved: manufacturers, authorities, designers, consumers.

Figure 1 is a flow diagram of the process of standards development and implementation, starting with identification of an opportunity and ending with the product being on the market. The activities in this process are grouped into four stages: justification, consensus, publication and implementation.

The first stage involves technical and economic justification of the standard through the use of feasibility studies. The possible energy efficiency is determined as well as the manufacturing costs involved in the final product and the impact in the price of the product in the market.

The goal of the second group of activities is to reach consensus of the stakeholders in the development of the standard. Participants will revise the proposed energy efficiency values, assess the feasibility of achieving them and determine the costs of implementation. Next, they make an agreement about the test method that will be used to verify the standard. Finally an economic evaluation is made in order to justify the standard. This review is made for the government office that will approve and publish the standard.

The third stage deals with the legal procedures. Once the procedures are fulfilled, the standards is published in the official journal. During the subsequent months comments from the public are received and responses are prepared for each comment. Each response is supported by both technical and economic analysis. After that the comment period is over, the government publishes it as a mandatory standard.

The fourth and last stage is related to monitoring the fulfillment of the standard, since the elaboration of the documentation, until the monitoring of the laboratories that will certify the fulfillment of the standard. [I am not sure what is meant in this sentence and am therefore not able to edit it properly. Additionally, it is necessary to establish a database of the monitoring process. The database assists in simplifying future revisions of the standard.

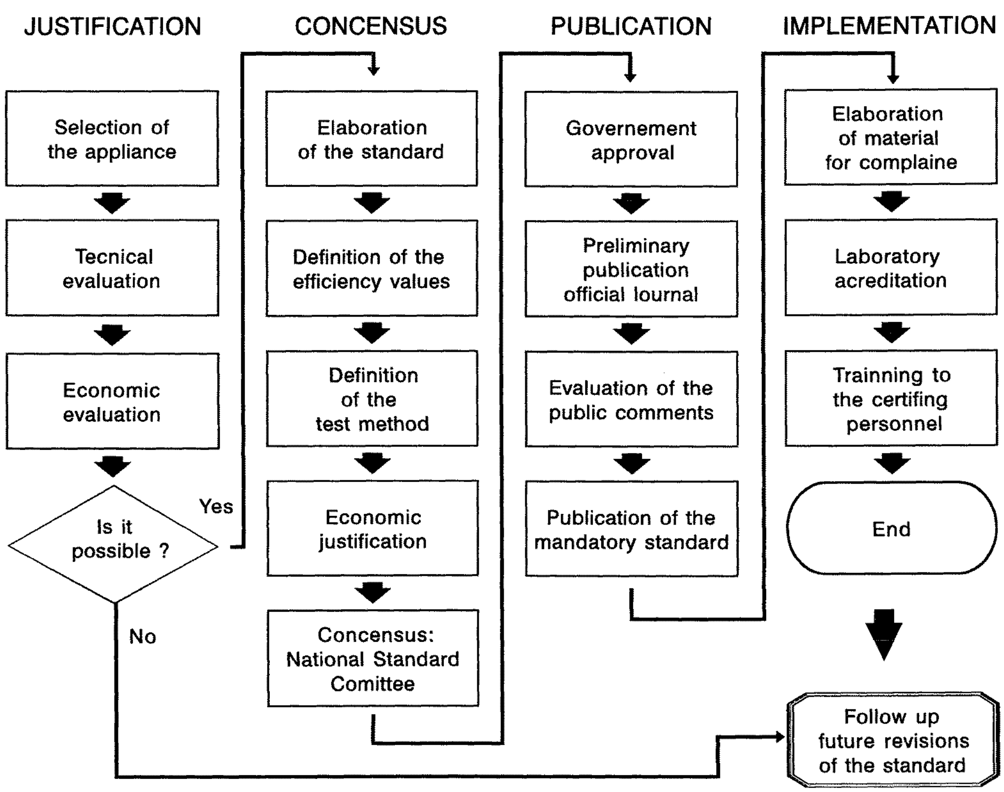

Figure 1 Flow diagram of the implementation process for a standard.

From an operational point of view, stages one, three and four are the easiest to implement. Indeed, the first stage includes cabinet activities, the third stage involves follow-up of the administrative procedures and the fourth activity is the verification of the fulfillment of the standard specifications.

On the other hand, the second stage, building stakeholder consensus, is the most difficult. All the people involved -entrepreneurs, manufacturers, verifiers, and government officials- need to agree on the terms of the standard. And, it is natural that in this process each party will defend his/her own interest. However, the consensus that is required is that a product complies with the energy efficiency specifications while being manufactured in a way that is economical and acceptable to consumers.

Implementing a standard will raise different problems during its development and implementation depending on what the standard is for.

For example, when consensus is sought for appliance standards, the stakeholders are few since there are not many manufacturers. In this case the problems are centered on how to achieve a lower cost product with the desired energy efficiency.

On the other hand, when the energy standards are for buildings, the number of stakeholders and issues involved increases enormously. In fact those responsible for building construction tend to be people with differing backgrounds (architects, engineers, company builders, etc.), and their objectives and points of view vary.

For example, architects think that their creativity would be restricted by a standard since their work is more often of and artistic nature rather than a technical one. If the standard is observed from the financial point of view, investors will focus o n lowering the costs of construction so as to more easily facilitate a sale or lease of the building. They do not concern themselves with the operational cost of the building. Perhaps too, some of the building equipment suppliers will suffer reduced sales, since the requirements in capacity for air-conditioning equipment would be smaller in a more energy efficient building. The suppliers of construction materials allege that they will be displaced from the market, since the efficient materials are costly while they are not of general use, or their production is still difficult.

However, on the other side of the "production chain" one finds a customer that will have to absorb the consequences of bad construction. Indeed, it will be very costly to operate the building during winter and summer, because the building does not adequately meet the needs dictated by the weather conditions: it will seem like a freezer in winter and a heater in the summer. In this paper we comment on some experiences and actions taken to reach stakeholder consensus for the energy efficiency building standard in Mexico.

Fulfillment of the Standard (CONAE, 1996)

The fulfillment of the standard is based on the following idea: The projected building must be specified so that the heat gain (φ_p) through the walls and the roof will be smaller or equal to the heat gain through the reference building (φ_r).

The reference building is a building that has the same direction, the same boundary conditions and the same dimensions of the projected building. It is used to determine a maximum energy budget. The following assumptions and characteristics are used in the reference building: i) the walls are sixty percent opaque (masonry) and forty percent transparent (crystal); ii) the transparent wall uses 3mm glass; and iii) the opaque part is equivalent to polystyrene that has a resistivity as a function of a benefit/cost relationship; the net present value was used as the indicative variable; the investment is the cost of the insulating material; the savings are in electrical energy consumption and in the reduction in capacity of the air-conditioning equipment; the period of analysis is ten years.

The heat gain calculation of both the projected and reference buildings, is known as energy budget (EB).

Consensus of the Standard

In Mexico, people have begun to think seriously about energy savings. Unfortunately, the economic problems over the last twenty years have limited the ability of buildings to comply with comfortable living conditions. However, architects, engineers and construction companies agree that the buildings should be made more comfortable without increasing the costs of operating the building.

To achieve the needed consensus for the energy efficiency standard in commercial buildings, the stakeholders carried out a series of meetings. The consensus took five years. The principal obstacles to obtaining the consensus of the standard are as follows:

- Cultural,
- Technical,
- Methodological,
- Technological, and
- Legal.

Below the most relevant details of the first four of these obstacles are discussed. The summaries reflect the views of the varying groups' representatives. An example is presented in each case

Cultural

Opaque and transparent surface portion. The architects and building designers suggest that their work should be more artistic than technical. For example, nowadays it is very common to build buildings with walls of glass. For the geographical location of the country, the radiation has a very important impact in the thermal load. For that reason, the reference building is calculated considering sixty percent opaque surface and forty percent transparent, because in this proportion, the thermal load by radiation is about 25 percent of the total thermal load. The restriction 60-40 is solely for the calculation of the thermal load of the reference building, since the projected building can be made of all glass, Characteristics of an all glass building include a very low shading coefficient. After several discussions and simulations of the radiation impact due to the wall of glass, the architects and engineers accepted the proposal standard. They were convinced by the fact that the projected building will consider the indivual design and engineering aspects of the proyect.

People participation. An important cultural aspect in Mexico is that the people like to participate in events. Indeed, in the last few years there has been a great increase in citizen participation in all types of forums. Mexican society wants to participate in events, where their comments or suggestions will be considered.

Consequently, in a case where their opinion or recommendation is not considered, they will let the leaders know that the forum is not an appropriate one in which they can explain their points of view. To satisfy Mexican society it is necessary to respond to their inquiries and recommendations with clear answers, explaining the areas of agreement or the differences in opinions.

There are two examples in the case of building standards development. First, architects and engineers proposed to include correction factors, to improve thermal load reduction by using partesoles or eaves. Since the proposal is correct, there were additional studies resulting in correction factors for each different direction (north, east, west and south), from different latitudes and for various types of flaps. A second example is a proposal to use reflective paintin the calculation. In this case, since the painthas a short life and it cannot be assured that it will be replaced periodically when damaged, the proposal was rejected and the reasons were explained in detail.

Legal aspects. Usually, when people hear about regulations they are opposed to them. There are several reasons for this. They fear increased costs or, increased government control. In this sense it was agreed with the engineer and architect associations that their members could carry out the certification fulfillment of the standard.

Technical

Equivalent temperature. Another problem encountered during the development of the standard was the broad variety of climatic conditions of the country. Mexico, by its geographical location and size, possesses almost all climatic possibilities at some place in the country during some time in each season. Data for this variation of conditions was not available. Consequently, it was necessary to find a simple classification procedure that includes all the possibilities. The Equivalent Temperature (ET) concept was devised (Joe Huang, 1994). The ET consists of defining, for all the cities and all the directions (north, south, east and west, roof and inferior surface), an average temperature for the surface (opaque and transparent), during the winter month (five months). It was necessary to explain in detail, the concept of ET to engineers and architects with no expertise in thermodynamics. The lack of meteorological information in the country required the implementation of the Equivalent Temperature concept.

Calculation procedure. The calculation procedure of the final version of the standard, was called the Energy Budget [EB], and is quite different from the first version. The technical differences are few but from the application point of view the EB is a simplified procedure. A key objection to the first version was that it was difficult to calculate the compliance with the standard for two reasons: there were too many variables and too many equations. The decision was made to reduce the number of variables, eliminating those that do not have much impact on the heat gain, and substituting for them a constant value. Also the calculation procedure was further simplified using a kind of checklist with very simple equations.

Information that makes sense. Commonly, people that accomplish the architectural design of a building have no expertise in thermodynamics. For that reason, the results obtained in the EB must make sense. For example, when the heat gain is calculated, it must be easy to observe the effect of the thermal resistance in a material. For this kind of analysis, a worksheet in Microsoft Excel was developed where the user could change different variables and observe their impact.

Promotion of the standard. During the first promotion meetings, people asked about examples of standard fulfillment. They assumed that there were many equations, and an abundance of variablesthat did not make sense; also, they explained that it was very difficult to comprehend the heat gain calculation as a whole. To resolve these concerns, we developed materials for a one day workshop, which combined both the theory and practice of standard fulfillment. The workshop presentation dealt with real cases in which the participants could change variables such as: the masonry materials, the location (by city), etc. At this meeting, there were explanations of the impact a wrong design in the building construction, of the impact on electrical consumption as a result of various air-conditioning equipment, etc. At the end of the workshop the participants agreed that it was easy to calculate the energy budget and that the variables made sense.

Methodological.

Traditional. A difficult aspect of implementation is to break old habits. Many people consider what has been the norm to be the right way and thus, see no reason to change it. This attitude is more common in older people. The strategies used to overcome this obstacle were both to contact prominent persons who agreed with the standard or to convince persons with recognized prestige that the standard was a favorable policy tool and, after they were convinced, invite them to participate as champion and promoters of the standard

Resistance to the innovation. The technological advances in the last years have impacted the way things are achieved. Therefore, traditional design methods have been exceeded sometimes and the procedures or considerations are now quite different. This obstacle was overcome by holding a series of workshops. The workshops concluded that the proposed energy budget procedure is a simple one and that the technology used (computer) was an adequate one.

Technological

As mentioned above, the technological solution was the use of the computer. One of the principal disagreements in the process of getting the standard accepted was its fulfillment evaluation. Remember that as was stated earlier, most of the Mexican population agrees with energy conservation.

As was mentioned before, at the beginning of the standard promotion process, people that attended the meetings criticized the difficulty of having a great number of variables and the difficulty in evaluating the heat gain. In this case, thesolution was to develop a user-friendly computer system that would easily deliver the fulfillment of the energy budget.

The principal advantages of this system are:

- A minimum data requirement: the data were the house dimensions and insulating material values provided by the manufacturer,
- On-line help: by pressing F1 the user can access a help menu,

- User-friendly menus, and
- Presentation of the information in a manner that makes sense: the system was not designed for the building thermal behavior calculation, but when the user changed variables, it is very easy to evaluate its impact.

Conclusions

The second stage of the building standard process, reaching stakeholder consensus, was attained after several years.

The best experience is that we learned to achieve consensus with people with a wide range of opinions and approaches among them.

Technically we were able to consider the important experience each stakeholder had to share and to find a way to indicate technical limitations to some of their suggestions.

The outcome of the workshop, attended by five hundred professionals was favorable, resulting in the implementation of the standard. The workshop was carried out in different cities throughout Mexico.

The Mexican experience indicates that five principal factors were necessary to achieve the desired consensus for implementation of the standard. They are :

- Modification of the original standard proposal as a result of comments received resulting in an improved energy building evaluation.
- Clear explanation as to why some of the changes suggested during the comment period were not considered.
- Development of a simple evaluation procedure.
- Involvement of individuals of recognized prestige in the standard promotion process.
- Achievement of a user-friendly analytical tool for calculating the energy budget

References

Anteproyecto de Norma de Eficiencia Energética NOM-008-ENER; CONAE, 1999.

Joe Hunag; Equivalent Temperature development; presentation to the mexican working group: building energy efficiency standard; Mexico, 1994.