Proposition of a Procedure of Diagnosis of Energy Performance in Morocco

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***Abstract*—In our time, controlling energy consumption is a very important issue for the preservation of terrestrial natural resources. To face these dangers, the states are committed to reduce their consumption by encouraging, in particular, the renewal of their housing stock.**
Morocco is highly dependent on imported energy. Over 91% of energy supplied comes from abroad [1]. However, renewable energy in this country may represent significant deposits as an Alternative energy.
Morocco has set the goal of introducing new methods of sustainable construction and positioning as a leader in this field in the African continent [2]. Efforts are therefore focused on developing an energy efficiency policy for better use of energy in all areas of activity, particularly in the building sector, in order to streamline and improve energy consumption face to the growing energy needs.
In our thesis project, we propose a procedure for the diagnosis of energy performance in the building in Morocco, to be integrated into the building permit circuit. We will define the new actors to involve in this procedure and their roles, as well as the utility of energy labels for the building. The final objective of this proposed procedure is to reduce the primary energy consumption of buildings and gradually introduce energy efficiency techniques for a rational use of energy in Morocco.

***Index Terms*—energy diagnosis, energy efficiency, energy labels, energy performance**

I. Introduction

Since the Kyoto Protocol, the alarm was drawn to the problems of climate and environmental changes, emissions of CO2 and greenhouse gas and also the risk of depletion of natural resources that become increasingly rare, this scenario darkens when we learn that the housing sector represents a consumption of more than 40% of these energies and the equivalent of 30% of emissions of greenhouse gases [3].

Morocco is a country whose energy dependence reached 97% in 2008. It is highly dependent on imported energy. Over 91% of energy supplied from abroad: coal, oil and oil products from world markets; gas from Algeria; and imported electricity [1]. This is a significant burden on the balance of payments, and, insofar as some energy supplies are subsidized, a drain on the budget [1]. However, renewable energy in Morocco can represent significant deposits as an alternative energy. By 2040 Morocco aims to derive more than 40% of its electrical capacity from these sources, strengthening both energy security and sustainability [1]. It also intends to achieve primary energy savings of around 12% to 15% by 2020 through the implementation of an energy efficiency plan in the various economic sectors [2].

Among these sectors, the building is the largest consumer of energy with a share of 36% of the total energy consumption of the country, of which 29% reserved for residential and the rest for the tertiary sector [3]. This energy consumption is expected to increase rapidly in the coming years for two reasons [4]:

The significant evolution of the building stock due to major announced programs: program of 150,000 housing units a year, Strategic plans launched by the Kingdom of Morocco in key sectors of development, (2020 strategy of Tourism with the creation of seaside resorts and the construction of hotel units, the Green Morocco Plan with the creation of agropoles, the Industrial Acceleration plan with the creation of industrial and technological platforms, the National Strategy for the Development of Logistics Competitiveness (logistics platforms) as well as the project of creations of more than 16 new cities.

The noticeable increase in household appliances consumption rate, as a result of the improved standard of living and lower prices for these appliances: (heating, air conditioning, water heating, refrigeration, etc.)

The thermal regulation of new buildings is one of the major instruments for the transformation of the construction market towards a model of more efficient consumption of energy. However, no procedure has been developed in the building sector in Morocco for the introduction and popularization of thermal regulation in buildings. The procedure of the diagnosis of the energy performance of the building which we propose, will make it possible to remedy this delay, and will contribute to the energy saving and the reduction of greenhouse gases in Morocco.

A The Consumption of Energy in the Building Sector

1) In the world.

The building sector is the largest consumer of energy in the world with a share of 34% followed by industry (28%) and transport (27%) (Table I). It is also responsible for a third of the emissions of greenhouse gases. Indeed, man spends today 90% of his time in buildings [1]. However it is a prime target for energy efficiency policies, rendered indispensable for all economies within the

Manuscript received September 1, 2018; revised April 20, 2019.

doi: 10.18178/ijscer.8.3.259-264

constraints related to the security of energy supply and climate change. The distribution of final consumption between sectors was as follows:

TABLE I. THE DISTRIBUTION OF FINAL CONSUMPTION BETWEEN SECTORS IN THE WORLD (IEA, 2013)

	Share of final Consumption in 2012	World Consumption in 2012 (Mtoe)
Final consumption	100%	8 979
Industry	28,3%	2 541
Transport	27,9%	2 507
Residential, agriculture and other sectors	34,8%	3 122
Excluding energy use	9,0%	809

2) In Morocco.

The Moroccan government has launched a program to achieve primary energy savings of about 12% to 15% in 2020 and nearly 25% in 2030 through the implementation of an efficiency plan in different economic sectors [2]. Among these sectors, the construction sector represents about 36% of total energy consumption in the country, with 29% reserved for the residential sector and 7% for the tertiary sector of the total energy in Morocco (a major consumer of energy fields were industry, transport and the tertiary sector) (Fig. 1) [3]. This will be achieved in buildings of all kinds, incorporating all energy efficiency features such as: orientation, insulation, solar water heater and imposing for users to rationalize the use of energy. However, in Morocco, no procedure for integrating energy performance into the building has been adopted or even discussed until today. Hence the interest and purpose of our scientific article.

B Diagnosis of Energy Performance of Buildings

"Building energy performance" is defined as "the amount of energy actually consumed or estimated in order to respond to the different needs associated with a standardized use of the building, which may include among others heating, hot water, cooling system, ventilation and lighting "[5].

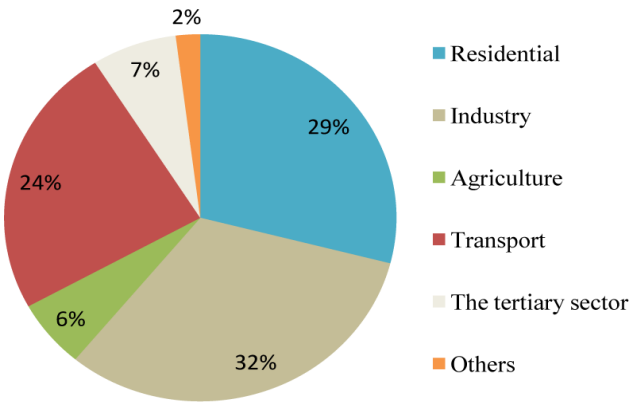

Figure 1. Structure of energy consumption by sector in Morocco. [2]

The question that arises after the definition of the energy performance of the building is as follows: what is a diagnosis? The definition given by [AFNOR, 1994] of the term diagnosis is as follows: "The diagnosis is the identification of the probable cause of the failure(s) using a logical reasoning based on a set information from an inspection, control or test "[6].

In the determination of the cause of the failure occurs a logical reasoning, but also the knowledge that one has of the studied system. This knowledge of the system, in our case "the Building", is obtained by the modeling or the identification, which makes possible to obtain a model of the system from the measurements collected on the building [7].

Evaluating the energy performance of an existing building can be done through one or all of these three approaches [8]:

1. Calculation approach based on data collected from an energy audit.
2. Approach based on tracking energy consumption bills.
3. Approach based on "in situ" measures.

The first two approaches are the most used because they are less expensive than the measurement-based approach. The latter, which is the most reliable, is based on the observation of the real behavior of the building and not on its modeling.

In some countries, the building energy performance diagnosis provides information on the energy performance of a building, as well as its impact in terms of greenhouse gas emissions. We will limit ourselves in our case concerning Morocco on the first part. Thus, the *dep* aims in particular to inform the future owner or the future tenant on The annual quantity of energy consumed or estimated (in primary energy), for heating, domestic hot water production and cooling, related to the surface of the building or part of the building. The measurement index is kWhEP / m ²year;

The main purpose of the diagnosis of the energy performance of buildings is to reduce the primary energy consumption of buildings. However, this objective should not be at the expense of occupant comfort.

The *dep* describes the building or housing (surface, orientation, walls, windows, materials, etc.), as well as its heating, domestic hot water, cooling and ventilation equipment. It indicates the energy consumption estimated for a standardized use of the building or dwelling.

We propose that the content and the modalities for the establishment of the *dep* should be regulated.

C Acts of the Diagnosis of Energy Performance

1) Dep commitment

The commitment of the *dep* is the document by which the applicant and the diagnostician declare on their honor to have taken knowledge of the requirements of the diagnosis of the energy performance of the building and the sanctions applicable in case of non-compliance with them.

2) Initial diagnosis

The initial diagnosis of the energy performance describes the measures to be implemented to reach the requirements of the energy performance and includes the

expected result of the edp calculation, it contains the following elements:

A description of the measures to be implemented demonstrating that the project can meet the requirements of the edp;

An estimate of the expected result of the calculation of the *dep*;

The choice of techniques and devices envisaged, as well as the possibility of recourse to alternative systems of production and use of energy.

The initial diagnosis is made by an authorized diagnostician, designated by the applicant using specialized *dep* software, recognized by the Moroccan state. The diagnostician encodes the technical data of the project, namely the subdivision of the building into energy units and the characteristics of the envelope and alternative systems.

The *dep* software provides the calculation of the performance level obtained for each *dep* unit as well as for the entire building.

The diagnosis also includes recommendations that enable the purchaser, landlord or tenant to know the most effective measures to save energy: it is advice of good use and good management of the building and its equipment as well as recommendations for work. We propose that the recommended works are not mandatory: the aim of the *dep* is to encourage improvement of the energy performance of the building, not to force work to be done.

The actual consumption of buildings depends very directly on the conditions of use and the actual heating temperature [9]; the estimated consumption cannot be a contractual guarantee, but it would allow an objective comparison of the quality of housing and buildings offered for sale or rented.

3) Final diagnosis

The final diagnosis of energy performance describes the measures actually implemented to meet the requirements of energy performance and includes the outcome of the *dep*. the diagnostician encodes the technical data of the building as it was realized.

The final diagnosis contains:

A description of the measures implemented in order to attain the requirements of energy performance;

The choice of techniques, devices and alternative systems put in place;

The result of the diagnosis of the energy performance of the building.

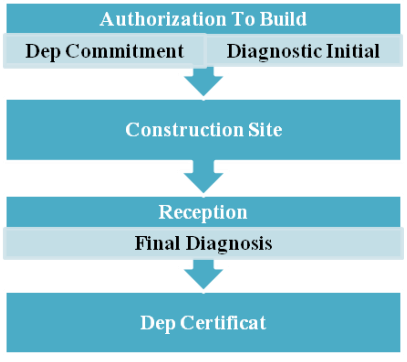

Figure 2. Acts of the diagnosis of energy performance

II. Certificate and Energy Label

The certificate of the energy performance diagnosis is established on the basis of the data of the final diagnosis of the energy performance, accompanied by an energy label of the building and its supporting documents, after verification by the administration.

We propose that the reading of the *dep* be facilitated by a label with 7 classes from a to g (a corresponding to the best performance, g to the worst), in the manner of countries that have adopted this energy label process, also in order to unify the reading of the energy consumption of buildings. It turns out, that in these countries, the class displayed by the *dep* will directly influence the selling price of the property, its value can vary greatly depending on its energy performance [9].

The interest of improving the insulation, the ventilation as well as the heating system is to improve the energy class of a dwelling. A well-insulated and well-rated home will sell better, more expensive and faster than a building that needs renovations, so this note whose display is mandatory will probably influence its price, based on the experiences of other countries especially France [9].

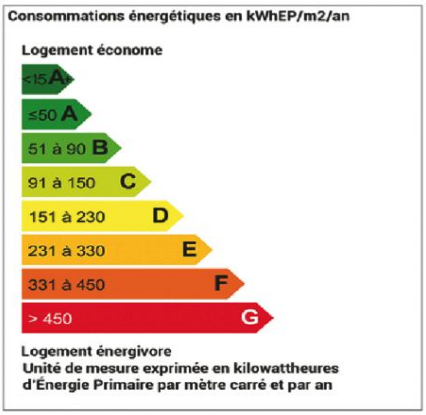

Figure 3. Energy consumption in kWhEP/m2/year [9].

A. Actors of the Diagnosis of the Energy

1) Performance of buildings

The actors we propose for the *dep* procedure circuit are:

Applicant

Diagnostician

Administration

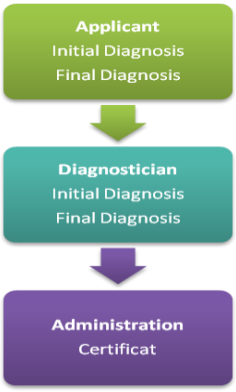

Figure 4. Actors of the diagnosis of the energy performance and their intervention acts

2) Applicant

It is the natural or legal person required to comply with the requirements of the *dep* in other words the owner of the building who expect to have an authorization to construct. The applicant of the *dep* intervenes when applying for the building permit. Indeed, the applicant is required to use the services of an energy performance diagnostician with whom he signs the initial and final energy performance diagnosis.

3) Diagnostician

The energy performance diagnostician is a natural or legal person approved by the administration, who has undergone training and passed an examination whose content is to be specified by the administration.

The energy performance diagnostician is designated by the *dep* applicant. Its main mission is to design and describe the measures to be implemented in order to attain the requirements of the energy performance as well as to control the execution of the works related to the *dep*. The energy performance diagnosis must be established by a professional independent of the owner and the project manager, whose skills are certified.

4) Administration

It is the public entity responsible for establishing and producing the requirements for the diagnosis of the energy performance of the building as well as the allocation of energy certificates for the building.

This entity is responsible for setting up and regulating the procedure for diagnosing the energy performance of the building, as well as the establishment of the examination and the internship in order to obtain the title of diagnostician.

B Dep Obligation for New Buildings

It is proposed that the energy performance diagnosis be mandatory gradually for buildings. Starting with the new public buildings, and after the buildings of individuals, and this in a time schedule that takes into consideration, the provision of elements necessary for its application by the Moroccan administration, especially those related to the development and importation of new technology, the implementation of a legal arsenal regulating the procedure and finally the allocation of human resources well managed to achieve this mission.

Based on the synthesis of a thermal study (initial diagnosis) accompanied by a visual verification in situ of coherence between the elements of this synthesis and the building actually built, this diagnosis makes it possible to evaluate the conventional consumptions of energy, and the annual energy costs of the building.

The energy performance diagnosis is given to the owner at the latest on receipt of the building in the form of a certificate indicating the corresponding energy class.

C Deperditions and Thermal Contributions and Recommendations

For each energy balance item, specific actions contribute to the energy performance of the building. This must be evaluated using indicators to be specified by the administration. And for each *dep* indicator, requirements are to be set according to morocco's climate zoning. They aim to achieve a minimum level of energy performance of buildings for all types of buildings.

These *dep* requirements must not conflict with other essential requirements, such as accessibility, security and building use. In case of renovation, they cannot be incompatible with the function, the quality or the character given to the building.

A good indicator must be understood by the greatest number and especially by the actors concerned by the field of measurement. Therefore, the simplest modes of characterizing the performance of a process should be favored. The annual final energy consumption is generally reduced to an indicator of energy consumption expressed as primary energy kwhep/m2/year, the area considered is the living space in housing or the tertiary floor space.

III. CONCLUSION

The economic and social challenge of applying the diagnosis of energy performance in morocco is great. The non-energy-efficient building is only in its infancy and offers great prospects. Projects and funding around energy management in buildings are growing both in private companies and in research laboratories in Europe, which is not the case in morocco yet, something that must challenge the public authorities to catch up, especially as morocco has set itself the goal of introducing these new methods of sustainable construction and positioning itself as a leader in the field in the African continent.

This device that we propose will be a part of a set of measures aimed at both limiting the impact of rising energy costs on the wallet of Moroccans and also to preserve the environment.

The energetic label will be a great progress in the information of the users: it allows in particular every Moroccan household which buys or rents a property to have an evaluation of its energy bill.

It is reasonable to think that as the energy and ecological transition develops, the difference in value between equivalents buildings, but with different energy performance, will continue to increase, with a double effect of devaluing poorly performing buildings and revaluation of efficient ones.

The main challenge is to limit energy consumption (heating, hot water, lighting, ventilation and air conditioning) in both private and public buildings. the general objective is to better integrate this new approach in the procedures to build in morocco and therefore, to encourage thermal renovation work and reduce greenhouse gas emissions. It is, today more than ever, become indispensable.

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