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About the regulatory framework for improving the energy efficiency of buildings: An overview of the Algerian Context

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Abstract:
Algeria is initiating a green energy dynamic by launching an ambitious program to support the renewable energy sector and energy efficiency. This support program named "*Taka Nadhifa*" is part of the strategic partnership on energy between the European Union and Algeria. The intermediate results of the program have led to the introduction of regulatory energy efficiency measures in the design and renovation of buildings. This paper reviews the inputs of the new thermal regulation related to the building sector through the examination of the produced proposals. This new vision aims on the one hand to alleviate the difficulties of implementation of the existing thermal regulation and on the other hand to integrate the attributes of the energy performance. Examples will also be presented illustrating the interest in the proposals for this new building's thermal regulation. Finally, the expected results of this new regulation will be the verification of the thermal conformity of the buildings with a first attempt to establish energy labeling.
Keywords: Energy efficiency, Building, Thermal Regulation, Energy labeling, Algeria

I. Introduction

General context

Today, the global energy sector is clearly facing severe issues that are getting more acute((Amen, 2021, Aziz Amen, 2022, Amen et al., 2023). thus, current energy trends create huge concerns about the "Three E's" of environment, energy security, and economic development. Globally, buildings consume around 32% of total electrical energy and are responsible for approximately 30% of CO2 emissions (Pinzon, Vergara, Da Silva, & Rider, 2018). For example, in the United States, buildings consume approximately 40% of the energy and 70% of the electricity (Tadokoro et al., 2014). In addition, the construction industry accounts for almost 40% of total energy use in the European Union. According to "EC Research," by improving energy efficiency, carbon emissions from buildings might be reduced by 22%. This will assist the European Union in meeting its climate change goals as part of the Kyoto Protocol commitments, as well as improving the energy performance of new and existing buildings (Li & Yao, 2009, Amen & Nia, 2020). Furthermore, the Chinese building sector now accounts for 30% of total energy consumption in China, illustrating the magnitude of new development undertaken in Chinese cities between 1991 and 2006.

According to the report "Energy Comprehensive Development Strategy and Policy in China" by the Council of State's Center for Research on Development, energy efficiency strategies should focus on the continuation of industrial energy economy promotion and, in particular, energy efficiency promotion in buildings and transportation in order to establish a prosperous society in the next 20 years (Li & Yao, 2009).

Since the global impact of building energy consumption, eco-friendly and long-lasting buildings are becoming a priority since they contribute considerably to global energy consumption and environmental problems. Furthermore, rules, regulations, and policies that define minimum requirements for energy performance and impose specific obligations on building owners and operators are often an important legal arsenal for increasing a facility's energy efficiency. These laws, rules, and policies may help to reduce energy consumption.

The relationship between thermal regulation and energy efficiency of buildings

Thermal regulation (RT) is a set of norms and policies designed to reduce energy use and greenhouse gas emissions in new and rebuilt buildings. it outlines the thermal and energy requirements for buildings, such as insulation, ventilation, heating, climatization, lighting, and so on. Thermal regulation's purpose is to increase building energy efficiency, or structures' ability to give the same level of comfort while consuming less energy. This reduces energy costs for residents and property owners while also reducing greenhouse gas emissions related to energy generation.

The regulatory framework for improving building energy efficiency is frequently comprised of laws, rules, and policies that create energy performance criteria and compel building owners and operators to take specific

activities to improve efficiency. The following are some frequent components of a regulatory framework for building energy efficiency:

- Energy codes and standards: These are the minimal requirements for both new and existing structures' energy efficiency. Insulation, windows, lighting, and heating, ventilation, and air conditioning (HVAC) systems are just a few examples of the many building components that are normally covered by energy codes and regulations.

- The energy labelling and certification of buildings enables building owners and occupants to obtain information about their energy performance. This data makes it possible to compare the energy efficiency of different buildings and identify opportunities for improvement. Energy certification and labelling of buildings may be compulsory or voluntary.

- Energy audits and retrofits for buildings: Energy audits are evaluations of a building's energy use and areas for improvement. Retrofits are improvements to a building's energy systems and components that improve energy efficiency. Building regulatory frameworks may be needed.

Objectif

Algeria, a North African country rich in natural and energy resources, delayed implementing its energy policy. Algeria has taken significant initiatives in recent years to increase building energy efficiency and reduce environmental impact. In the following sections, we focus on Algeria's efforts in terms of thermal regulation of buildings and the incorporation of the energy component in recent years.

This paper examines the produced proposals in order to analyze the contributions of the new Algerian thermal regulation as it relates to the building industry. One goal of this new vision is to make it easier to apply the current thermal regulation, and another is to incorporate the characteristics of energy performance.
Last but not least, the certification of the thermal conformance of the structures with a preliminary attempt to establish an energy labeling will be the anticipated outcomes of this new legislation.

2.Material and methods

Collection of relevant information

In order to conduct an analysis of the regulatory framework for improving the energy efficiency of buildings in the Algerian context, it is essential to collect relevant information. This involves gathering data and documents related to the existing regulations, policies, and measures that are in place to promote energy efficiency in buildings in Algeria. The information can be obtained from various sources such as government publications, academic research, industry reports, and relevant legal documents.
This step should focus on understanding the current state of energy efficiency regulations in Algeria, including the specific laws, codes, and standards that govern the construction, renovation, and operation of buildings. This may include information on building codes, energy performance certificates, labeling schemes, and any other regulatory instruments that aim to improve the energy efficiency of buildings.

Classification and grouping of identified policies and measures

Once the relevant information has been collected, the next step is to classify and group the identified policies and measures. This involves categorizing the regulations and initiatives based on their objectives, target sectors, and specific provisions. For example, policies related to building insulation, HVAC systems, lighting, renewable energy integration, and financial incentives can be classified separately to gain a comprehensive understanding of the different aspects of the regulatory framework.
By grouping the policies and measures, it becomes easier to analyze their individual effectiveness and identify any overlaps or gaps in the existing regulatory framework. This classification allows for a systematic evaluation of the different components of the regulatory framework and provides a structured approach to understanding the overall energy efficiency landscape in the building sector.

Evaluation of the scope and effectiveness of regulations

The scope of the regulations can be assessed by analyzing their coverage in terms of the types of buildings and energy end-uses to which they apply. This analysis helps to determine whether the regulations are sufficiently comprehensive to address energy efficiency in the different building sectors, such as residential, commercial and public buildings.
However, for the purposes of this article, we are going to analyze the effectiveness of these regulations by determining the impact of the new measures introduced by the regulation on energy savings and the overall improvement in the energy performance.

3. Results

Review of national legislation and regulations

Due to strong urbanization and the growth of the Algerian housing stock, energy consumption in this sector has increased considerably. To this end, the National Agency for the Promotion and Rationalisation of Energy Use (APRUE), which is a public establishment of an industrial and commercial nature, was created by presidential decree in 1985, under the supervision of the Ministry of Energy Transition and Renewable Energies (MTEER). Its main mission is to implement the national energy management policy, which is governed by a body of legislation, through the promotion of energy efficiency (APRUE, 2021). Algeria, a country that produces energy and has significant hydrocarbon reserves (including natural gas), has felt the need to regulate energy use only since the end of the 1990s. In Algeria, a thermal code for residential units was established in 1997 to minimize heating energy use by 25%.(El Hassar et al., 2002)

In August 1999, a legislation on energy management (Loi, 1999) was passed, establishing all of the measures and activities to be implemented for the rational use of energy and introducing the concept of energy efficiency. This law is accompanied by an implementation decree (Decree, 2000) which governs the thermal regulation of new buildings. The law on energy management complements the current thermal regulation of buildings. This rule is based on two regulatory technical documents (DTR), the first of which addresses the winter problem (Technical Commission, 1997) and the second solves the summer problem (Technical Commission, 1998). These two texts were initially developed in a broader context of national technique development. (Imessad et al., 2017).

In 2016 The Algerian Ministry of Housing and Urbanization develops a new version of the Algerian building thermal regulation.

The implementation of this thermal regulation must unavoidably lead to the thermal insulation of new buildings in order to reduce energy consumption associated with heating and air conditioning.

Rt 2016 was a revised version of the previous regulations, with the following main changes

- Combining the two sets of regulations into a single document
- Strengthening of the requirements;
- Definition of a new zoning.
- The Algerian thermal regulation currently in place is the DTR C3.2/4[4], the verification of the compliance of a building with this new regulation must be done for the winter period and for the summer period separately.

Analysis of government policies and measures

However, RT 2016 does not adequately address the issue of energy performance in buildings. While it sets certain criteria and requirements, it falls short in providing a profound and effective solution to improve energy efficiency.

One of the limitations of RT 2016 is that it focuses primarily on technical aspects such as thermal insulation and heating systems. While these are important factors in energy performance, they do not encompass the full range of considerations necessary to achieve optimal energy efficiency. Other key aspects such as lighting, appliances, renewable energy integration, and occupant behavior are not given sufficient attention in the regulation.

Moreover, the requirements set by RT 2016 may not be stringent enough to drive significant energy savings. The standards and thresholds established for energy performance may be relatively low, allowing for buildings that are technically compliant but still have a considerable energy demand. This can hinder the progress towards achieving sustainable and energy-efficient buildings.

Additionally, RT 2016 lacks a comprehensive framework for monitoring and enforcement. Without a robust system in place to ensure compliance and ongoing performance evaluation, there is a risk that buildings may not meet the intended energy efficiency targets. Monitoring and enforcement mechanisms are essential for verifying the actual energy performance of buildings and promoting accountability.

To address these limitations, it is crucial to consider revising and updating RT 2016 to include more comprehensive and stringent energy performance criteria. This can involve incorporating additional parameters such as energy-efficient lighting systems, advanced building automation technologies, and stricter requirements for renewable energy integration. Furthermore, raising awareness and providing incentives for building owners and occupants to adopt energy-efficient practices can also contribute to improving energy performance.

By enhancing the regulatory framework with a deeper focus on energy performance and implementing effective monitoring and enforcement measures, it is possible to overcome the shortcomings of RT 2016 and foster a more sustainable and energy-efficient building sector. This would contribute to achieving national energy goals, reducing carbon emissions, and ensuring a greener future for Algeria.

Recognizing the urgency of addressing this issue, Algeria has embarked on an energy transition process aimed at mitigating the risks and ensuring a sustainable future. This transition is being implemented through a series of comprehensive programs that have been designated as national priorities from now until 2030. The energy transition in Algeria includes a focus on the building sector, aiming to improve energy efficiency and reduce reliance on traditional fossil fuels. By enhancing the regulatory framework and implementing effective measures, Algeria seeks to achieve its energy goals, decrease carbon emissions, and secure a sustainable future for the country.

Study of financial support and incentive programs

To support the implementation of Energy-efficient practices, Algeria has prioritized the development of financial incentive programs and subsidies. These initiatives aim to encourage building owners and operators to invest in energy efficiency measures by providing financial support and reducing the upfront costs of implementation. Additionally, capacity-building programs and training initiatives have been introduced to raise awareness about energy-efficient building practices and equip professionals with the necessary skills to implement them effectively.

To this end, Algeria has launched an ambitious program of support for the renewable energy (RE) sector, mainly electricity, and energy efficiency (EE) called *'Taka nadifa'*, which is part of the strategic partnership on energy that the European Union and Algeria have undertaken since 2015. This is a sector that occupies a very important place in relations between the EU and Algeria. The aim of the program is to support the implementation of two Algerian government program, namely the National Renewable Energy Program 2015-2030 (PNDER) and the Algerian Energy Efficiency Program 2015-2030 (PNEE). New proposals have been put forward by the experts of the Taka nadhifa program as part of RT+. [1]

In what follows, a comparative analysis between the thermal regulations (RT 2016) currently applied and the proposals of the Taka Nadia programme will provide an overview of the specific features of the Algerian regulations:

Specific policies and measures: insights from *Taka nadhifa* project

Within "*Taka nadifa*" project, the "Energy Efficiency Regulations for New Buildings and Thermal Insulation of Existing Buildings" working group has carried out an in-depth analysis of the construction sector and the Algerian Thermal Building Regulations. (Document Thermique Réglementaire C3.2/4, known as RTB or DTR).

Initially, the experts from the working group and the technical assistance team from *"Taka nadifa*" carried out an in-depth analysis of the existing Thermal Building Regulations (RTB) described in regulatory technical document no. C3/2-4 drawn up by the CNERIB.[2]

- Contribution to current regulations

Five proposals were then drawn up to overcome the difficulties of implementing the existing RTB and to incorporate the energy performance of the building. The result is RTB+ (table 1).

Table 1: Technical Assistance's proposals for RTB+ compared with RTB (2016)

RTB (2016)	RTB+
Thermal compliance is compulsory for all new buildings, but compliance checks are carried out at the request of the project owner.	Thermal compliance is a condition for obtaining planning permission and a "Thermal File" must be submitted during the design phase
The RTB introduces winter and summer thermal performance requirements for new buildings. Verification of compliance with the regulations involves checking that these requirements are being met.	Compliance checks have been extended to existing buildings undergoing "major" renovation, representing at least 50% of the total envelope surface area.

[1] https://paeree.dz/
[2] *ibid*

The overall heat losses of the buildings are assessed and compared with the reference overall heat losses.	Verification of heat loss requirements "by component" (safeguards) is introduced when an envelope component is replaced (by more than 25% of its surface area).
RTB compliance (with code) is limited to the building envelope. The RTB does not introduce minimum efficiencies for technical systems, but defines how heating and air-conditioning systems should be sized.	Simplified methodology for estimating the overall energy performance of heating, air-conditioning and DHW [1] DHW: stands for Domestic Hot Water systems has been introduced for residential buildings.
There are no energy labelling systems for buildings in Algeria	An energy labelling system for new residential buildings in Algeria has been proposed, called "APPE": Attestation de Performance Energétique Potentielle (Certificate of Potential Energy Performance)

Source: Khoualed Z., 2023

Certificate of Potential Energy Performance (APPE) :*RTB+ labelling scheme*

- *Energy label:* The energy classification of the building with an annual consumption of primary energy for heating, DHW and air conditioning. Seven energy classes are defined from class A++ to E (from very energy-efficient building to energy-intensive building). These energy labels can be summarised as follows (table 2-3)

Table 2: Climate label, Classification of a building's climate from class A to class E. without renewable energies

Climate class	Annual primary energy consumption for heating, DHW and air conditioning
A	≤161 kwh/m².an
B	230 kwh/m².an
C	246 kwh/m².an
D	249 kwh/m².an
E	≥ 323 kwh/m².an

(Source: Progam Taka nadhifa,2021)

Table 3: Algerian energy labelling of annual primary energy consumption with renewable energies

Climate class	Annual primary energy consumption for heating, DHW and air conditioning
A++	≤ 110 kwh/m².an
A+	132 kwh/m².an
A	154 kwh/m².an
B	198 kwh/m².an

C	246 kwh/m².an
D	272 kwh/m².an
E	≥ 275 kwh/m².an

(Source: Progam Taka nadhifa,2021)

- *Climat Label :* The climate classification of a building (without renewable energy) ranges from class A to class E, and with optimization (with PV) we distinguish A+ A++ categories.(table 5-6)

Table 5: Algerian energy labeling of annual primary energy consumption without photovoltaic panels

Climate class	**CO2 Emissions**
A	≤ 35 kg CO2/m².y
B	36-45 kg CO2/m².y
C	46-49 kg CO2/m².y
D	50-55 kg CO2/m².y
E	≥ 66 kg CO2/m².y

(Source: Progam Taka nadhifa,2021)

Table 1: Algerian energy labelling of annual primary energy consumption with photovoltaic panels

Climate class	**CO2 Emissions**
A++	≤ 25 kg CO_2/m².an
A+	29 kg CO_2/m².an
A	34 kg CO_2/m².an
B	44 kg CO_2/m².an
C	50 kg CO_2/m².an
D	57 kg CO_2/m².an
E	≥ 66 kg CO_2/m².an

(Source: Progam Taka nadhifa,2021)

- General results of the program *Taka nadhifa:*

The Taka nadifa program has achieved a number of tangible results, including
- The design of eight effective sectoral action program facilitating the penetration of renewable energy sources and the promotion of energy efficiency in several sectors, namely construction, industry, local authorities and regional planning, electricity distribution, transport, fisheries and fish production, water resources, the production of electricity from renewable sources off the electricity grid and for low power connected to the grid;
- Energy labeling of buildings;
- Supply of software and associated training;
- A study of financing mechanisms for energy efficiency;
- Examining the opportunities and challenges presented by the massive integration of renewable energies into Algerian electricity systems;
- The development of recommendations for improving the thermal regulation of buildings (RTB) through new and innovative measures, in particular support for manufacturers of high-performance products and equipment, and product and company certification. A guide to the existing RTB, enhanced by an "Attestation de Performance

Potentielle Energétique" [APPE] for new residential buildings, aimed at professionals in the building sector, to verify the compliance of the thermal performance of the building envelope.
- Diagnosis of the legal and regulatory framework for energy labelling and the conformity assessment system in force in Algeria.
- Numerous capacity-building initiatives, including training, coaching and experience-sharing workshops with European Union member states, which have helped to identify best practices.

4. Discussion

-**The first proposal** aims to strengthen the implementation of the RTB by making it compulsory to check thermal compliance before obtaining planning permission. In fact, in the procedure for obtaining planning permission for collective public buildings, there is no obligation for the developer (project manager or delegated project manager in the case of social housing) to submit a "thermal compliance report".
The report can be produced using the CTBAT online tool[3] (to guide calculations and avoid tedious manual calculations) or in some other way. The proposal is to integrate this report into the usual file (including the civil engineering, architectural and administrative files, etc.) to be submitted for approval by the Supervisory Body (OdC) in charge.
The process of obtaining planning permission is not affected in terms of time. Once approved, nothing else changes in the process, and the application is subject to the other necessary checks until planning permission is granted. Making the granting of planning permission conditional on the successful completion of the thermal compliance checks means guaranteeing wider implementation of the RTB and therefore indirectly ensuring that all new buildings are built in a "compliant" manner.
-The second proposal is to extend the thermal requirements introduced by the RTB to existing buildings that are subject to a "major" renovation of at least 50% of the total surface area of the envelope. This means that any building benefiting from a major renovation must be treated as a new building in terms of thermal regulations. This measure will gradually improve the energy efficiency of existing buildings that are in a state of disrepair, starting with buildings where renovation has been decided or deemed necessary.
- The third proposal is to introduce regulatory limits (safeguards) on envelope components in cases where more than 25% of their surface area is replaced. At present, thermal checks are carried out on the envelope as a whole: high-performance components can compensate for less high-performance components, provided that the total value of losses is less than 1.05 times the reference heat loss and heat gain. According to this proposal, if a component of the envelope needs to be modified (for example, a roof that no longer guarantees watertightness) for more than 25% of its surface area, it will be necessary to replace it with a component with the minimum thermal requirements set out in the following table (taken from Table 2.1 on p. 32 of the DTR)

- **The fourth proposal** is to propose a simplified methodology for estimating the overall energy performance of heating, air-conditioning and DHW systems in residential buildings. This does not involve a detailed calculation to quantify actual energy consumption exactly, but rather an estimate based on the basic characteristics of the dwelling and its location, as well as the efficiency of the technical systems used.
The estimate is based on the results of the sizing of heating and air-conditioning systems introduced in the RTB. The aim of this measure is to provide information on the energy consequences of using one set of technical systems for heating, air conditioning and DHW production rather than another: in fact, two equal dwellings can have very different energy consumptions depending on the technical systems installed. This methodology provides the theoretical basis for the fifth proposal.
-The fifth proposal is to introduce an energy labeling system for new residential buildings in Algeria, known as the "APPE" (Attestation de Performance Energétique Potentielle). The APPE gives an indication of primary energy consumption due to heating, air conditioning and DHW production, depending on the climatic zone, the characteristics of the dwelling and the technical solutions to be installed. The APPE approach involves a choice - from a range of reference technologies - of the technical system of the dwelling, for which "standard" efficiencies have been established on the basis of market availability. The energy performance of the building is in fact potential, as it depends on the voluntary and informed choice made by citizens regarding the technical systems. The aim of this measure would be to help raise awareness of energy efficiency issues and the management savings that would result from the most efficient choices. The APPE can be calculated using a spreadsheet (cAPPE) developed and made available as part of the Taka nadifa project.

[3] an online calculation tool offered by the *Taka nadhifa* program

5. Conclusions

Through its energy transition programs, Algeria envisions achieving significant reductions in energy consumption, lowering greenhouse gas emissions, and enhancing its overall energy security. The government's commitment to making energy transition a national priority demonstrates a proactive approach to addressing the challenges of rising energy demand and ensuring a sustainable future. During its four years of implementation (2019/2023), Taka nadifa has enabled interactive exchanges between the various players active in the field of renewable energies and energy efficiency, with a view to facilitating and stimulating national and foreign private investment and strengthening the technical and management capacities of institutions in these fields.

With regard to renewable energies, the work focused in particular on the specific regulatory, legal and contractual framework favouring major investments in electricity production, and on mastering the tools and methods for integrating renewable energies into the electricity grid.

In order to support the efforts made by the national partner institutions, *Taka nadifa* has set up regular dialogue with the member countries of the European Union and the international organisations through the establishment of a coordination mechanism between the national institutions and the international technical and financial partners.

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Conflict of Interests

The authors declare no conflict of interest.

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