ISSN: 0369-8963

The High Energy Performance Requalification of a Social Housing Unit in the New Urban Housing Zone – West Plain – ANNABA

***Dr. Iynes Laouni[1], Dr. Sara Khelil[2] , Dr. Adel Sekhri [3]**
[1, 2, 3] Mohamed Kheider University, Faculty of Technology, Department of Architecture, Biskra, Algeria
E-mail [1] : ines.laouni@univ-biskra.dz, E-mail [2] : sara.khelil@univ-biskra.dz E-mail [3] : a.sekhri@univ-biskra.dz

Abstract

The buildings of the NUHZ (New Urban Housing Zone) in Algeria have an alarming energy situation, considering that poor thermal design leads to energy overconsumption. This research has highlighted the factors affecting thermal comfort in this type of housing. In this regard, the solutions for the requalification and energy renovation of NUHZ building housing have become immediate and urgent in order to reduce energy consumption and achieve high-energy performance buildings. Therefore, improving the existing framework is essential to restore quality to this housing stock and ensure its energy performance. The requalification of the buildings stands out as a key operation in the overall response to this issue. The main objective is to reduce energy consumption in existing social housing while ensuring its thermal comfort. Our research enabled us to conduct an analytical and comparative study between the energy balance of social housing before and after its energy requalification.

Keywords*: high-energy performance, energy requalification, thermal comfort, the NUHZ.*

Introduction

Energy is a crucial factor for the survival of societies and essential for meeting daily needs as well as for economic and social development. However, this energy primarily relies on non-renewable fossil fuels (gas, oil, and coal), which are expected to deplete in the medium term [1]. In 1973, the first global oil crisis marked the beginning of a global energy and environmental crisis for the building sector and the introduction of the first thermal regulation in France: the RT 1974[2]. Global energy consumption increased by 42% between 1990 and 2008, from 354 quadrillion Btu (British Thermal Units) to 505 quadrillion Btu. This consumption is projected to increase by 53% between 2008 and 2035, from 505 quadrillion Btu in 2008 to 770 quadrillion Btu in 2035.

A significant portion of the growth in energy consumption occurs in non-OECD countries (Organization for Economic Cooperation and Development), driven by economic growth.

 https://doi.org/10.37896/pd92.5/9256

Energy use in non-OECD countries is expected to increase by 85%, compared to an 18% increase in OECD economies [3].

BP's "New Momentum" scenario envisions a rise in global final energy consumption until around 2040, before stabilizing (with global demand in 2050 expected to be 10% higher than the 2019 level) (Fig 01). In its two other "accelerated transition" scenarios, BP estimates that global final energy consumption in 2050 should be 15 to 30% lower than the 2019 level, thanks to rapid progress in energy efficiency. It is important to note that all three of BP's scenarios anticipate a roughly 75% increase in global electricity consumption by 2050.

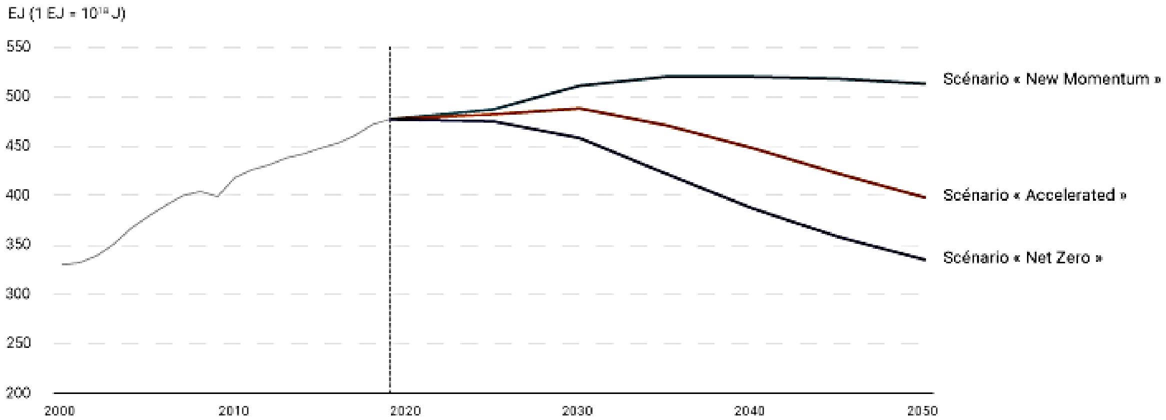


Figure 1- évolution de la consommation finale d'énergie dans les différents scénarios du BP Energy Outlook 2023. (BP Energie Outlook. (2023))

 https://doi.org/10.37896/pd92.5/9256

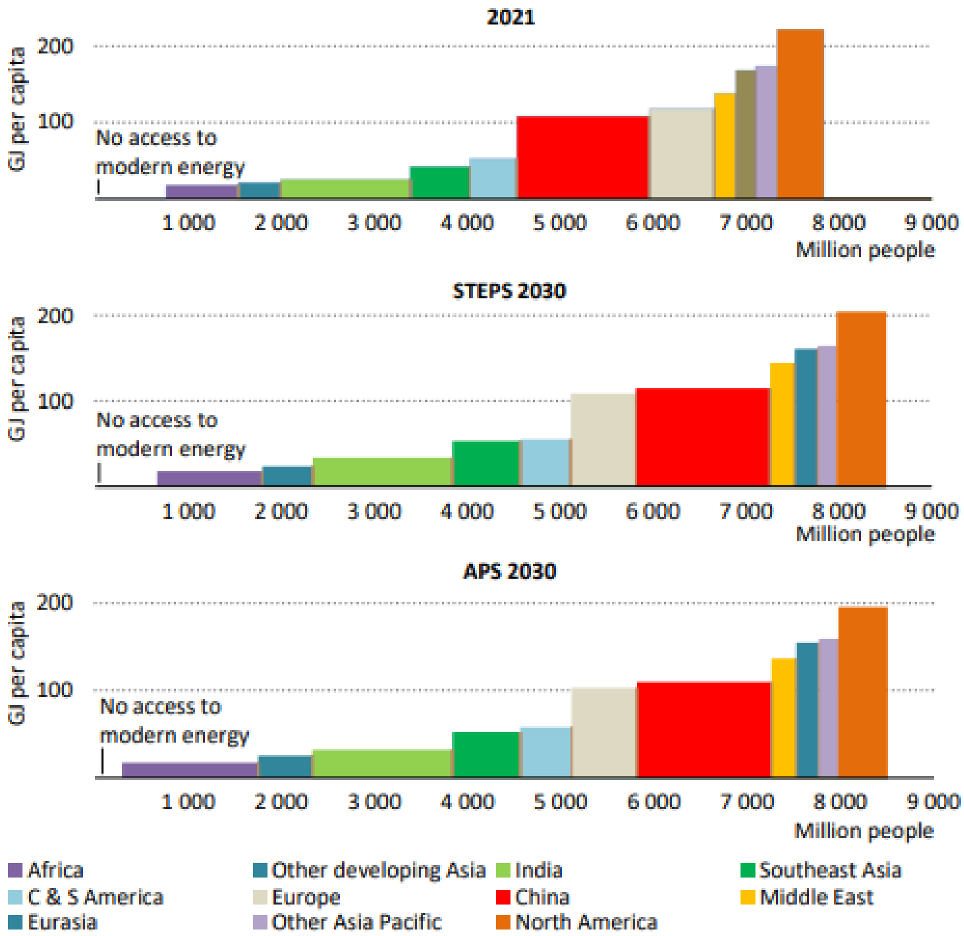


Figure 2.Total moderne energie supply per caapita by region in the STEPS and APS, 2021and 2030. (BP Energie Outlook. (2023))

In recent years, per capita energy demand has been on the rise. This is why the exploration of approaches that promote the development of thermal regulations (including RT2012) and environmental regulations (RE2020) is necessary to support ecological and energy transition. The High Energy Performance (HPE) and the 1983 solar label serve to enhance the performance requirements of future thermal regulations: ... In 2008, the requalification towards high performance. This is why numerous laws have been enacted, plans have been implemented, and commitments have been made to reduce energy consumption in the housing sector [4].

Certainly, in recent years, the proliferation of experimental building performance certification protocols has led to the strengthening of requirements for thermal and environmental regulations. Paradoxically, the proliferation of normative guarantees often appears as an obstacle to ecological solutions in architecture [2].

For instance, the European Union committed to the 2020 energy-climate package in 2008, which consists of a set of directives aiming for a 20% reduction in greenhouse gas emissions

ISSN: 0369-8963

compared to 1990 levels, achieving 20% renewable energy in final consumption, and increasing energy efficiency by 20%, particularly in the building sector. In 2014, new targets were set for 2030, notably pushing for a 40% reduction in GHGs compared to 1990 (Climate Challenge of Cities, 2018). This framework was further revised in 2018 to include 32% renewables as opposed to 27%, and at least 32.5% energy efficiency actions compared to 27%. Thus, "European states are required to adopt integrated national energy and climate plans (NECPs) for the period 2021-2030 and to develop long-term national strategies, ensuring coherence between their long-term strategies and the NECPs."

Energy-related issues are becoming increasingly important in both society and public policies, both at national and local levels. Housing, being a highly energy-consuming sector, places energy-related questions at the forefront [5]. The global issue of the sustainability of fossil fuels underlies the development of energy efficiency policies on an international scale.

Related works

Algeria, being one of the producers and exporters of fossil fuels, is no exception. In 1990, the country launched a national program aimed at energy management, which encompassed various sectors, notably the residential sector. This sector, considered today as the most energy-intensive, saw the initiation of a program involving 600 high energy performance (HPE) housing units. The project's objective is twofold: firstly, to reduce household energy consumption, and secondly, to ensure a 40% thermal comfort for these residences, in accordance with local requirements [6].

Legislatively and regulatory-wise, Algeria has a significant legal framework for rationalizing energy use, though these measures remain largely unenforced on-site due to a lack of oversight in this domain:

- Law No. 99-09 of July 28, 1999, relating to energy management.
- Executive Decree No. 2000-90 of April 24, 2000: It establishes thermal regulations for new residential buildings.
- Law 04-09 of August 14, 2004, regarding the promotion of renewable energies in the context of sustainable development.
- Executive Decree 04-149 of May 19, 2004, outlining the modalities for developing the national energy management program.
- Executive Decree No. 05-16 of January 11, 2005, setting specific energy efficiency rules for devices operating on electricity, gas, and petroleum products.

 https://doi.org/10.37896/pd92.5/9256

- Interministerial Order of November 29, 2008, defining the energy efficiency classification of household appliances.

The National Agency for the Promotion and Rationalization of Energy Use also oversees energy management and covers all measures and actions implemented in terms of rational energy use and renewable energy development. It addresses the concerns of the Ministry of Energy and Mines through the following instruments [7]:

1. The Sectoral Committee for Energy Management (CIME in French)
2. The National Fund for Energy Management (FNME in French)
3. The National Energy Management Program (PNME in French): This includes
    - The framework and perspectives of energy management.
    - The evaluation of potentials and definition of energy management objectives.
    - The existing and to-be-implemented means of action to achieve long-term objectives.
    - A five-year action program.

This latter program includes the following:

1. Top-Industry Program
2. Prop-Air Program
3. Eco-Light Program
4. Alsol Program
5. Eco-Build Program

The objective is to carry out a demonstrative action that proves the feasibility of introducing energy efficiency in Algeria, contribute to the widespread adoption of best practices in architectural design for housing, and ultimately promote compliance with regulatory standards. Unlike the complementary role of most previous programs, the Eco-Build program appears significant because it focuses on designing energy-efficient buildings. Thus, the residential sector emerges as a top priority for energy management due to its high consumption levels.

In Algeria, the thermal regulation is governed by Executive Decree No. 2000-90, which is included in Law No. 99-90 relating to energy management in the building sector. This regulation aims to introduce energy efficiency in new residential and other buildings. Its implementation is expected to achieve more than 40% energy savings for heating and air conditioning needs. Through this regulation, the National Center for Studies and Research in

 https://doi.org/10.37896/pd92.5/9256

the Building Industry (CNERIB in French) has prepared three technical regulatory documents for building professionals:

- DTR.C 3-2, which establishes rules for calculating winter heat losses for residential buildings.
- DTR.C 3-4, which deals with rules for calculating summer heat gains for buildings.
- DTR.C 3-31, which addresses natural ventilation for residential premises.

This regulation enhances the overall energy performance of buildings, providing ample opportunities for designers and developers to choose between overall thermal performance of the building, including the choice of materials and building framework design. The Algerian regulation draws significant inspiration from French regulations, particularly in the aspect of thermal insulation. The concern, however, lies in the fact that there are regulations for new constructions, but not for existing ones. A large portion of the Algerian population has been living in HLM (public housing) and multi-apartment buildings since independence, as the primary concern at that time was to provide housing for as many Algerians as possible, with standardized plans for both the north and the south, neglecting considerations for thermal comfort.

Labels serve as indicators of comfort, energy performance, and environmental compliance, aiming to create buildings with low energy consumption. They rely on reference frameworks and are subject to audit and evaluation procedures. The main labels, particularly European ones, include PASSIVHAUSS (Germany), MINERGIE® (Switzerland), MINERGIE® standard, MINERGIE-P® (passive), MINERGIE-Eco (ecological), MINERGIE P-Eco (passive and ecological), and ZERO ENERGY BUILDING (USA). French labels include EFFINERGIE, which corresponds to the Low Consumption Building label. Additionally:

- HPE 2005 (High Energy Performance): Associated with the 2005 thermal regulation, but more demanding. This label has two performance levels.
- THPE 2005 (Very High Energy Performance): Concerns buildings with at least 20% lower conventional energy consumption than the reference consumption in the 2005 thermal regulation.
- HPE EnR 2005 (High Energy Performance Renewable Energies 2005): In addition to meeting HPE requirements, this label requires the use of renewable energies, with at

 https://doi.org/10.37896/pd92.5/9256

least 50% of the energy used for heating coming from a biomass installation or a district heating network using over 60% renewable energies.

- THPE EnR 2005 (Very High Energy Performance Renewable Energies): Pertains to buildings with at least 30% lower conventional energy consumption than the reference consumption in the 2005 thermal regulation. These constructions must also use renewable energies such as biomass, solar thermal or photovoltaic, and highly efficient heat pumps.
- BBC 2005 (Low Consumption Building) or EFFINERGIE: Requires that the energy consumption of residential buildings be at most 50 kWh/m².year depending on the climatic zone and altitude. For non-residential buildings, the conventional energy consumption must be at least 50% lower than the reference consumption according to the 2005 thermal regulation.

In summary, energy labels can be classified based on their energy consumption requirements into three categories: **efficient** (Minergie, Minergie-Eco), **very efficient** (Minergie-P, Passivhaus, and Effinergie), and **zero energy or positive energy**. Labels for energy performance generally operate on the same principle, namely, reducing energy needs and supplementing them with efficient systems using various energy sources, including renewables.

Heating needs are reduced through improved thermal insulation, the reduction of thermal bridges, and good air tightness. Summer comfort is addressed through passive solutions, sometimes combined with efficient cooling systems. Comprehensive labels and global approaches consider the interaction of the building with its environment from a broader perspective, where energy efficiency is just one aspect of these interactions. Examples include LEED (Leadership in Energy and Environmental Design) in the USA, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, BREEAM (Building Research Establishment Environmental Assessment Method) in Great Britain, and HQE (High Environmental Quality) in France. These methods assess the environmental impact of different types of buildings (office buildings, residential buildings, commercial spaces, and industrial buildings). They integrate energy performance as an environmental requirement to be met, without setting specific performance targets.

These building concepts are defined by a set of objectives (desired performance level) and technical solutions intended to guide the designer. The designer, using various design aids,

 https://doi.org/10.37896/pd92.5/9256

ISSN: 0369-8963

combines techniques, materials, structures, and equipment to best achieve the set objectives. High-energy performance is a recent concept that has already been integrated into French regulations. It refers to the reduction of energy consumption through appropriate architectural design to enhance thermal comfort. Energy performance is defined according to the "total cost," energy balance, and maintenance and renewal cycles. The definition of an energetically efficient building is a comprehensive concept that encompasses architecture, climate, building envelope, and equipment.

The energy management of existing buildings starts with understanding the construction and its consumption patterns, with the organization of various relevant services and human resources. This involves gathering administrative data regarding the building's situation (contracts, invoices, floor area, types of activities, etc.) and technical data including plans, technical diagnostics, and energy and fluid consumption. Next, a strategy and action plan with medium- and long-term objectives must be defined, taking into account the state of the assets and available resources. Finally, monitoring the implemented actions is necessary to ensure planned objectives are met.

In the spirit of requalification, several experiences have been undertaken worldwide, although not in Algeria. Examples include the requalification of a 106-unit social housing building 'Moulin Lambert,' the renovation of 176 housing units... through thermal regulations and various other initiatives. Additionally, buildings constructed within the framework of the requalification of the former RN305, designed according to thermal regulations with a 20% reduction, ultimately achieved HPE level. The Grenelle project, which aims to reduce energy consumption and greenhouse gas emissions from buildings, is a top priority of the Environmental Grenelle. Its implementation in the existing housing stock is particularly important given the size of the stock: 32 million housing units, including nearly 8.5 million in co-ownership and 17 million individual houses. The objective of the Environmental Grenelle is to reduce energy consumption in the existing building stock by at least 38% by 2020. The multi-year investment program (PPI) has defined the need to undertake major renovations of 400,000 housing units per year between 2013 and 2020, and by 2020, intermediate renovations for 9 million housing units.

As part of the National Energy Management Program (PNME), Algeria has launched a project to develop high energy performance housing nationwide. The Eco-Bat program involves the construction of 600 high energy performance housing units, covering various

 https://doi.org/10.37896/pd92.5/9256

climate zones in the country. This program aims to introduce energy efficiency in buildings and aims to achieve a 40% energy savings for heating and cooling.

Economic profitability is another concept used in the building sector to measure its performance. It represents the ratio between the initial investment of a construction and the gains that can be generated in the long term. The profitability of energy management actions is not exclusively economic. It involves several other aspects: energy, thermal comfort, well-being, and more

Case study :

Annaba, a city in northeastern Algeria (figure 3) , is considered one of the highest energy-consuming cities due to the presence of a significant residential housing stock, particularly the New Urban Housing Zones (NUHZ) which play a significant role. The residential sector accounts for 35% of final energy consumption in Algeria. The prospects for expanding the housing stock will lead to an exponential increase in this energy consumption. In this context, the design and construction of energetically efficient housing become a necessity for controlling energy consumption in this sector [19].

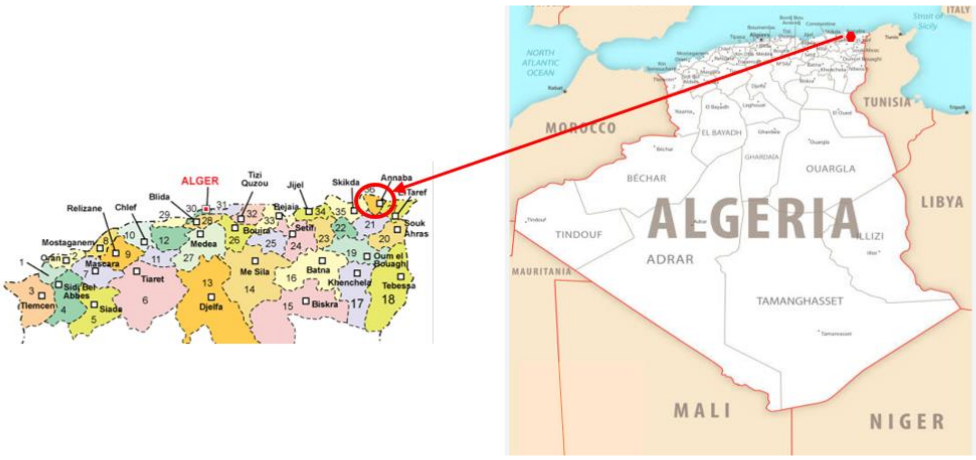


Figure 3 Location of ANNABA city. (source; Estockphoto.2023)

The chosen site is the New Urban Housing Zone (NUHZ) in the western plain for the following reasons:

- The western plain NUHZ is the first NUHZ implemented in the city of Annaba.
- *According to the urban planning department, a large number of* NUHZs *are located in the western plain. The western plain I has 3,209 housing units, and the western plain II*

 https://doi.org/10.37896/pd92.5/9256

ISSN: 0369-8963

has 3,350 housing units (table 1). Energy consumption in sector 3 is higher compared to other sectors (table 2).

Table 1 Operations of the New Urban Housing Zones (ZHUN) in the western plain of the city of Annaba (1976-1987). (Source : Rouaibia, 2012).

Opérations	Superficy ha	Théorical Capacity (house)	Density houses/ha	Housing completed
West-plain I	110	3688	33,52	3209
Est plain II	194	5200	26,80	3350

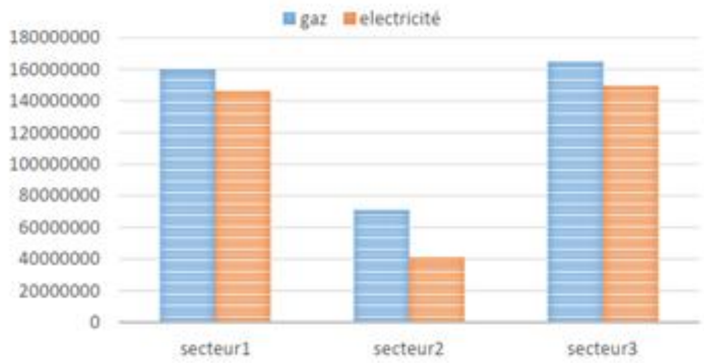


Figure 4 Gas and electricity consumption in the 3 sectors of the city of Annaba. (Source Sonalgaz2020)

The land is circled on the following map (figure 4) and which belongs to the NUHZ II district which is located in the northwest part of the West Plain district.

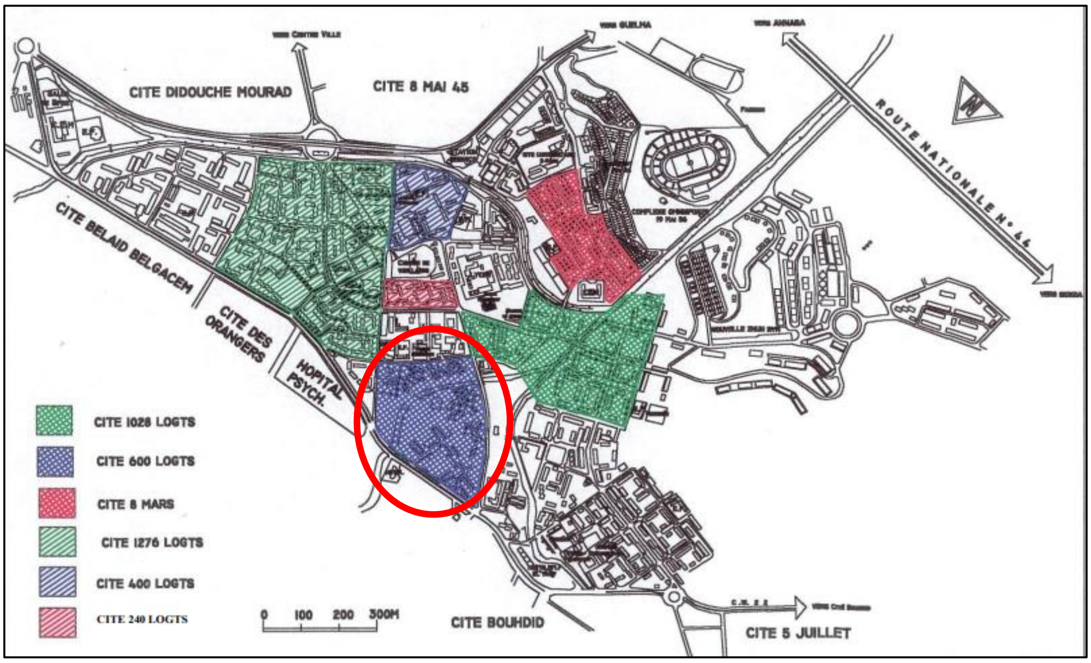


Figure 5 the NUHZ II district

 https://doi.org/10.37896/pd92.5/9256

The land belongs to the NUHZ II district, which is located in the northwestern part of the western plain district. The building (figure 6-7) is situated in the southwestern end of the district (figure5- 6).

- District: 600 housing units
- Total Land Area (ha): 10.57
- Net Land Area (%) : 9.53
- Net Density (housing units/ha): 62.95
- Net Floor Area Ratio (CES): 0.22

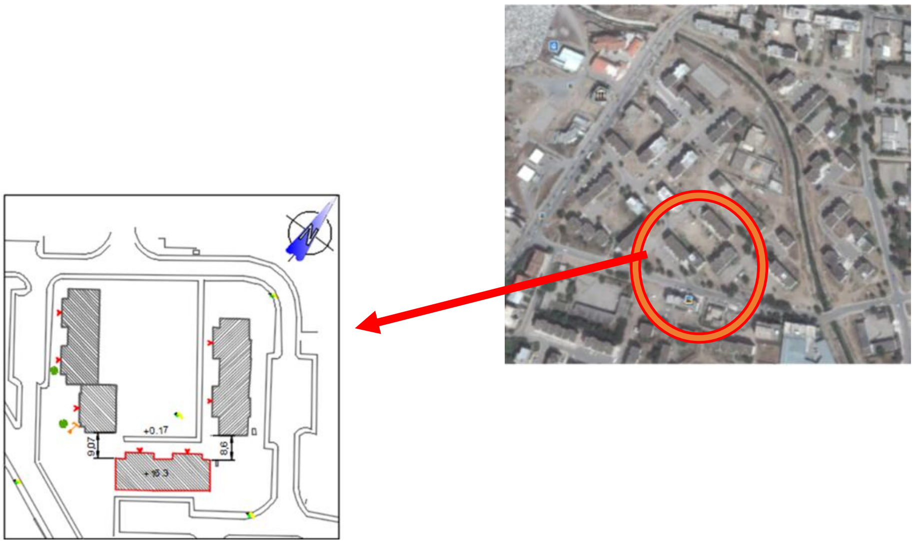
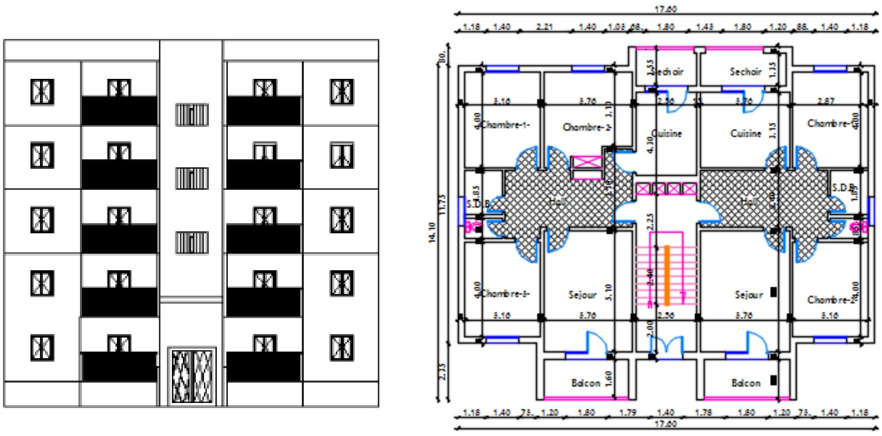


Figure 6: Satellite photo of the studied neighborhood taken by Google Earth.



F3 – F4

ESPACE	F3	F4
Sejour	19.17m²	19.17m²
Cuisine	11.84m²	09.00m²
Chambre1-	12.64m²	12.64m²
Chambre2-	12.64m²	12.64m²
Chambre-3	—	13.28m²
Degagement	13.54m²	14.13m²
S.D.B	02.96m²	02.96m²
W-C	01.36m²	01.36m²
Surface habitable	74.15m²	85.18 m²
Balcon	05.76m²	05.76m²
séchoir	05.36m²	03.94m²
TOTAL	85.27m²	94.88m²

TABLEAU DES SURFACES

Figure 7 floor plan and characteristics of the study building.

https://doi.org/10.37896/pd92.5/9256

ISSN: 0369-8963

Results and discussion :

Climatic analysis :

The climate in Annaba is mild, rainy in winter, and hot and subhumid in summer with an average maximum temperature of 32°C in August and an average minimum of 6.58°C in January. Humidity levels are high both in winter and summer, with a maximum average of 93% in December and a minimum average of 46.4% in July. Sunshine is considerable in summer with a maximum of 356 hours in July and a minimum of 98.9 hours in December. Precipitation is rare in summer and significant in winter, with a maximum of 136.16 mm in December and a minimum of 4.22 mm in July.

Annaba enjoys a Mediterranean climate. It is known for its long, hot, and dry summers. Winters are mild and humid, with rare snowy days. Rainfall can be abundant and even torrential. It is generally hot, especially from mid-July to mid-August.

The layout of the site plan creates a courtyard where the spacing between buildings is small. This affects the sunlight exposure (L = 8m), limiting the penetration of solar rays for lower floors (L = (2.7n-a)/tan h with H: sun height; n: number of levels; A: height of the sill; L: width).

- Maximum exposure on southwest-facing facades, while northeast-facing facades have no solar protection, whether natural like trees or artificial like sunshades, causing overheating of rooms due to intense summer heat.
- The arrangement of the buildings in a U shape causes gusts within the courtyards, and the absence of vegetation barriers increases the speed of cold winds.
- Cross-ventilation of the building and the absence of protections against cold winds allow the penetration of winter drafts, creating uncomfortable internal air currents.
- Walls: Prefabricated elements in reinforced concrete of sandwich type with insufficient insulation made of (polystyrene and cork) λ=1.75. Very low performance.
- Glazing: Wooden window openings with Ug = 0.23 W/m2. Single glazing: clear 3mm glass installed with putty. Very poor performance = 4.15.
- Insulation materials (polystyrene and cork) are used in facade panels and for the 3cm thick roof (insufficient to guarantee comfort in winter and summer).
- The study unit is equipped with auxiliary heating with a capacity of 1900 to 11,000 Kcal/h, located in the entrance hall, which proves to be insufficient in thermal terms on

https://doi.org/10.37896/pd92.5/9256

the coldest days of the year. The cooling device is a window air conditioner with an efficiency of:

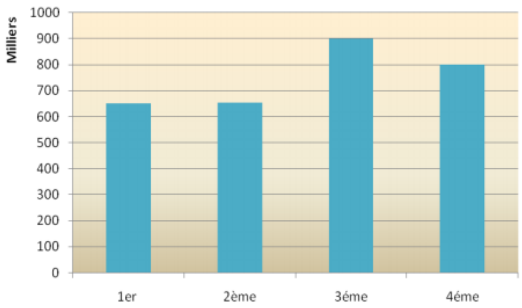


Figure 8 The Gas Consumption of the Housing (Therms)

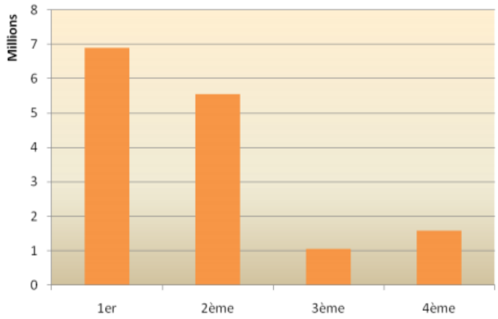


Figure 9 The electricity consumption of the housing KW/h

The increase in electricity consumption occurs in the 3rd quarter of the year (figure 8-9), due to the use of air conditioners in the summer season. As for gas consumption, the most significant increase occurs in the 1st quarter of the year, which encompasses the coldest months.

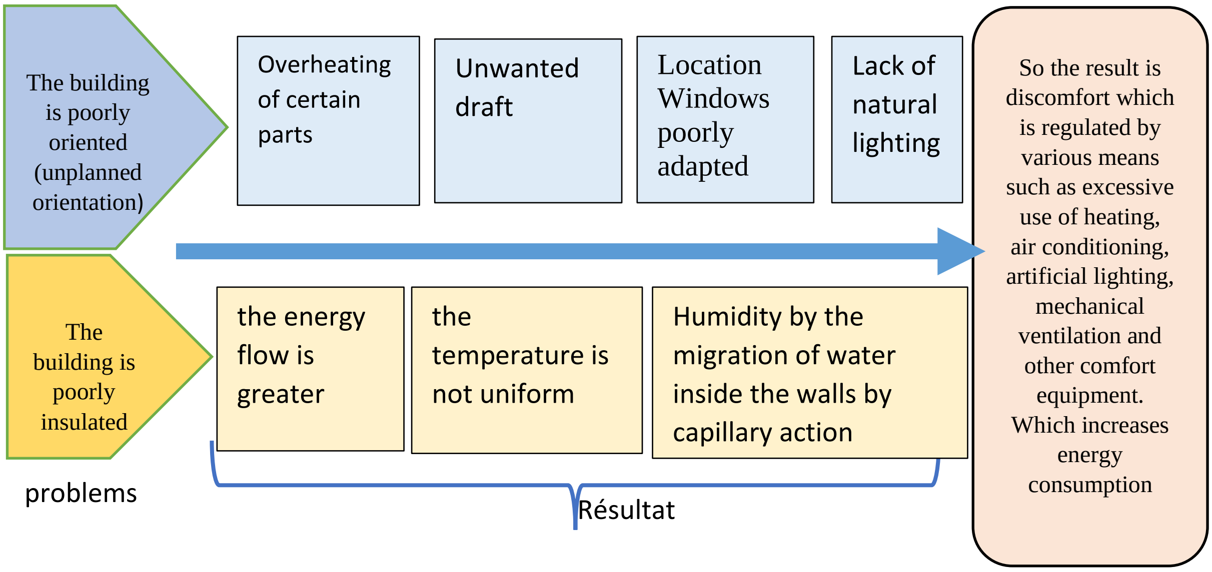


Figure 10 problems linked to insulation and poor orientation of the case study building.

Result of Mahoney Tables Analysis

Through the application of the Mahoney method (table2), we arrive at a number of recommendations necessary for achieving hygrothermal comfort in a building designed for the city of Annaba. Following this analysis, the following recommendations are outlined; (section 1-2-3-4):

 https://doi.org/10.37896/pd92.5/9256

Table 2 : Application of the Mahoney table (section 1-2-3-4) on the case study

Localisation	ANNABA	**Données climatiques**
Longitude	7 - 45 est	
Latitude	36.54 nord	
Altitude	Min. 3 m	

Section 1 :

Temperature de l'air.°C :	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**		Tmax	AMT
Temp moy max	15	16	17	19	22	26	29	30	28	24	20	16		30	18.5
Temp moy min	7	7	8	10	13	16	19	20	18	15	11	8		7	23
Average monthly value	8	9	9	9	9	10	10	10	10	9	9	8		Tmin	AMR

Monthly average value = Max temp – Min temp
AMT = T max + T min /2 (Annual average temperature)
AMR = T max – T min (Annual average value)

Relative humidity.%	J	F	M	A	M	J	J	A	S	O	N	D
Average	77%	78%	74%	73%	75%	71%	70%	73%	73%	74%	76%	75%
humidity group	4	4	4	4	4	4	4	4	4	4	4	4

Précipitation	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**	Total 630
Précip mm	100	70	70	40	30	10	0	10	30	70	60	100	

		AMT>	AMT 15-20°C	AMT <
Comfort limits		**Day/ Night**	**Day/ Night**	**Day/ Night**
humidity group	1	26-34 17-25	23-32 14-23	21-30 12-21
	2	25-31 17-24	22-30 14-22	20-27 12-20
	3	23-29 17-23	21-28 14-21	19-26 12-19
	4	22-27 17-21	20-25 14-20	18-24 12-18

Section 2 : Diagnostics : °C

	J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**		
Avg max temp	15	16	17	19	22	26	29	30	28	24	20	16		18.5
Daytime comfort: superior	25	25	25	25	25	25	25	25	25	25	25	25		AMT
lower	20	20	20	20	20	20	20	20	20	20	20	20		

 https://doi.org/10.37896/pd92.5/9256

Temp avrege /min	7	7	8	10	13	16	19	20	18	15	11	8		
Night comfort: superior	20	20	20	20	20	20	20	20	20	20	20	20		
lower	14	14	14	14	14	14	14	14	14	14	14	14		
Thermal comfort: day	C	C	C	C	O	H	H	H	H	O	O	C		
nuit	C	C	C	C	C	O	O	O	O	O	C	C		

<u>Section 3: Thermal comfort :</u>

O: Comfort, C: Cold, H: Warm

Indicateurs :

Humide: H1						×	×	×	×					4
H2					×					×	×			3
H3														0
Aride: A1														0
A2														0
6	×	×	×	×								×		5

Applicable when	Indicator	Thermal comfort Jour / Nuit	Précip.	Humidity group	Monthly average value
Essential air movement	**H1**	H		**4**	
		H		**2,3**	≤
Desirable air movement	**H2**	O		**4**	
Rain protection	**H3**		**+200mm**		
Capacity Thermique necessaries	**A1**			**1,2,3**	**≥10°**
Sleeping outside desirable	**A2**		H	**1,2**	**≥10°**
		H	O	**1,2**	**≥10°**
Protection from the cold	**A3**				

Section 4 : Specific recommendations Totals of indicators induced in table 3

H1	H2	H3	A1	A2	A3
4	3	0	0	0	3

mass plan

0-10	1	North and South orientation (along the East-West axis)
11,12	5-12	
0-4	2	Compact ground plan with interior courtyard

Spacing between buildings

11,12	3	Large spacing allowing breeze penetration
2-10	4	As previous but with protection against hot and cold wind

Mouvementd'air

 https://doi.org/10.37896/pd92.5/9256

3-12	6	Individual rooms, permanent air supply
1,2	0-5	
6-12	7	Double rooms, temporary air supply
0	2-12	
0,1	8	Air movement not recommended
OPENINGS		

0,1	0	9	Large: 40-80%		Large: 40-80%
11,1 2	0,1	10	Very small: 10-20%		Trés petites: 10-20%
No other condition		11	Average : 20-40%		

Walls		
0-2	12	Light walls, short phase shift time
3-12	13	Thick exterior and interior walls
Roofs		
0-5	14	Light roofs
6-12	15	Thick roofs, longer phase shift times from 8 a.m.
Outdoor spaces **Rain protection**		
3-12	17	Necessary protection against rain

Detail recommendations: :

Totals of indicators induced in table 3					
H1	H2	H3	A1	A2	A3
4	3	0	0	0	5

Dimensions of openings

0,1	0	1	Wide: 40-80%
1-12	2	average: 25-40%	
2-5			
6-10	3	Small : 15-25%	
11,12	0-3	4	Very small: 10-20%
4-12	5	average: 25-40%	

Location of openings

3-12	6	North and south of the wall facing the wind
1-2	0-5	
6-12	7	Ouvertures hautes dans les murs intérieurs
0	2-12	

Protection of openings

0-2	8	Exclude direct solar radiation
2-12	9	Provide protection against the rain

Walls and floors

0-2	10	Lightweight (low thermal capacity)
3-12	11	Thick (phase shift time more than 8 hours)

Roofs

10-12	0-2	12	Light (reflective surface, cavity)
3-12	13	Lightweight with insulation	
0,9	0-5		

 https://doi.org/10.37896/pd92.5/9256

ISSN: 0369-8963

6-12	14	Massive (phase shift time more than 8 hours)	
Exterior elements			
1-12	15	Space to sleep at night outdoors	
1-12	16	Adequate rainwater drainage	

Application of Recommendations to the Case Study:

Table 3 Application of Recommandations to the Case Study

Recommandations	Conditions	Vérifications	Justifications	Règlement	Recommandations
Plan de masse	Orientation Nord et Sud (le long de l'axe Est-Ouest)	Non vérifier ✗	L'organisation du Plan de masse crée une cour d'ilot ou l'espacement entre les bâtiments est petit : ainsi que le prospect d'ensoleillement L = 8m ce qui délimite la pénétration des rayons solaire pour les étage inferieurs L= (2.7n-a)/tan h avec H : hauteur du soleil ; n : nombre de niveaux A : hauteur de l'allège ; L : la largeur		
Espacements entre bâtiments	Comme précédent mais avec protection contre vent chaud et froid	✗	L'espacements entre bâtiments est assuré Protection contre vent chaud et froid n'est pas assuré (l'absence de végétation contre les vents) .	L= (2.7n-a)/tan h avec H : hauteur du soleil ; n : nombre de niveaux A : hauteur de l'allège ; L : la largeur	Plantation des arbres a feuille caduc dans les coté des vents dominant
Mouvements d'air	Chambres individuelles, provision permanente de l'air	✓	La plupart des ouvertures des chambres exposé au vent dominants .		
Ouvertures	Large: 40-80%		21% c'est le pourcentage calculé		Agrandir la surface des ouvertures
Mur	Murs légers, temps de déphasage court	✗	Les murs sont en béton armé		
Toitures	Toitures légères	✗	La toiture est plate en Béton armé		

Site Plan and Solar Mask Study

The arrangement of the buildings in a U-shape leads to gusts in the inner courtyards, and the absence of vegetation barriers increases the speed of cold winds.

https://doi.org/10.37896/pd92.5/9256

Table 4 Sunlight exposure

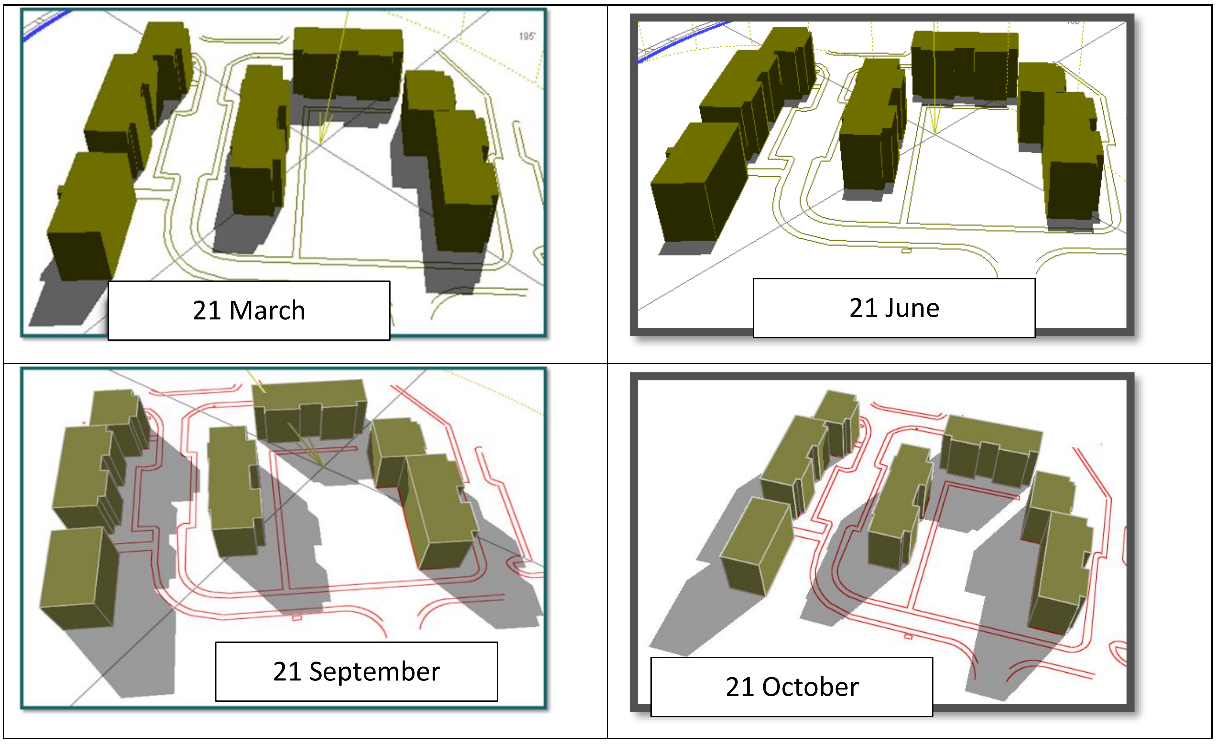
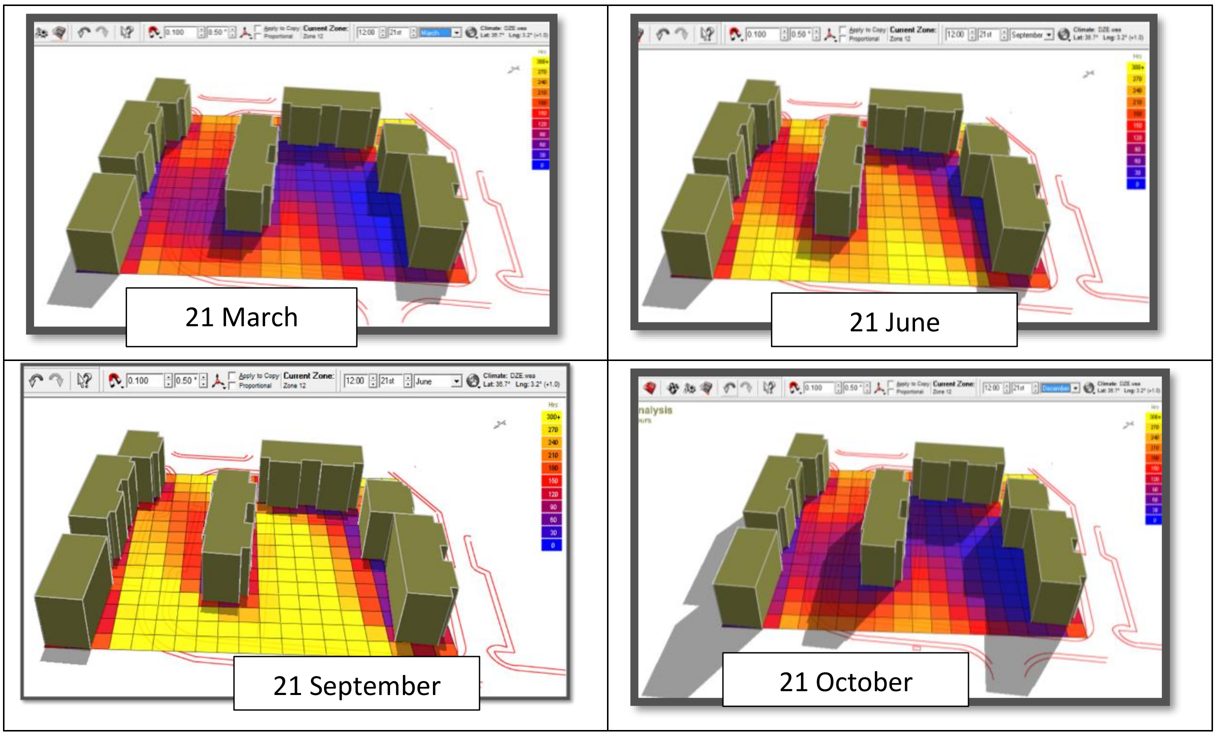


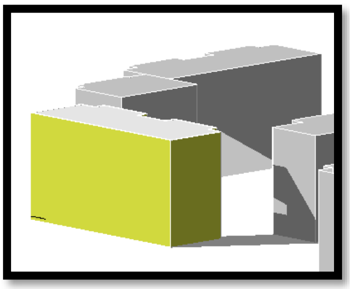
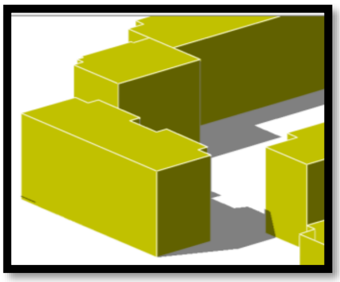
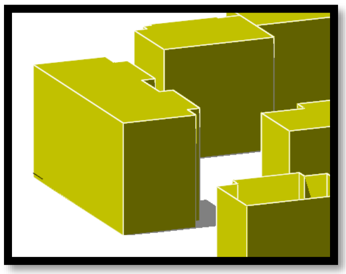
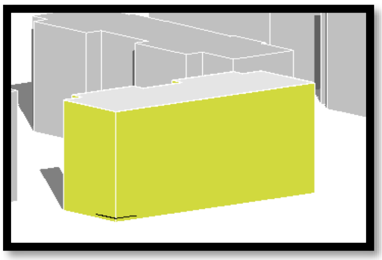
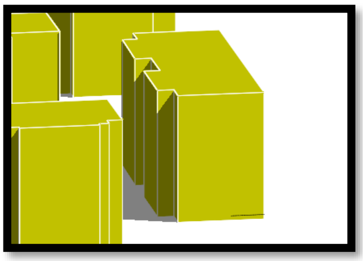
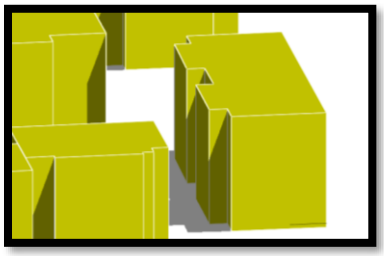
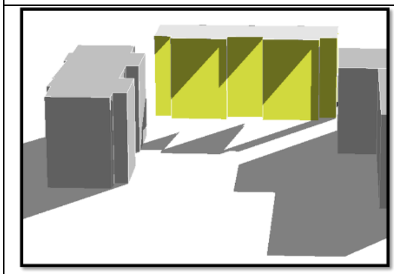
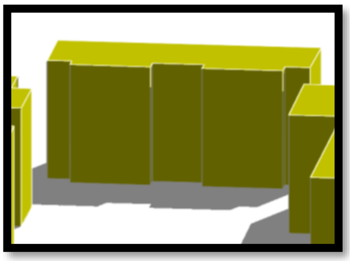
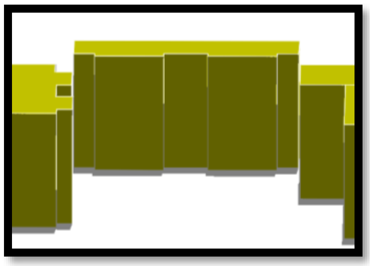
Table 5 solar radiation



The central part is less exposed to the sun and almost entirely shaded, receiving over 900 hours of sunlight (table 5).

ISSN: 0369-8963

Table 6 solar exposure on facades

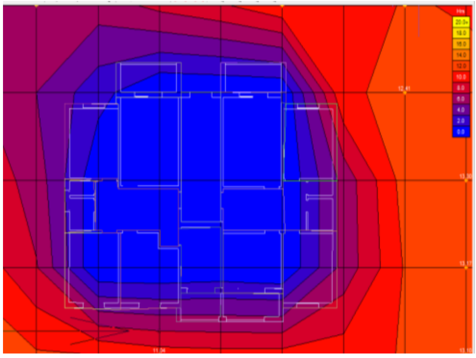
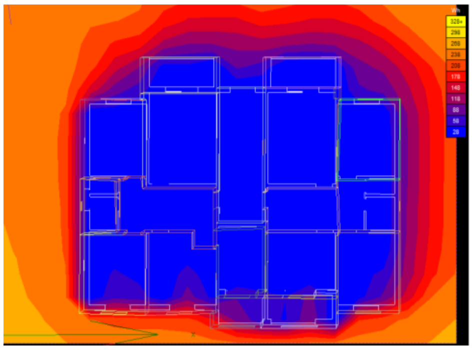
		
December (south west facade)	mars (south west facade)	June (south west facade)
		
December (west facade)	mars (west facade)	South (west facade)
		
December (north est facade)	Mars (north est facade)	South (north est facade)

Sunlight exposure is low on the northeast facade, with some areas receiving less than 1 hour of sunlight per day regardless of the time of year (table 4-5). Natural light is very limited on the main northeast facade. The facade (table 6) is coated with an off-white or beige paint. To combat heat, reflective paints, typically in white, are used. Designed for outdoor applications, they ideally reflect a large portion of solar radiation, reducing the heating of buildings exposed to the sun. Solar radiation inside buildings (table 7) is desirable in winter but remains undesirable in summer.

There is little sunshine on the North-East Facade where certain parts receive less than 1 hour of sunshine per day whatever the time of year, the availability of natural light is very limited in the main north-east façade.

 https://doi.org/10.37896/pd92.5/9256

Table 7 Solar radiation inside buildings in summer and winter

	
summer	**Winter**

The sunlight is insufficient in the unit due to:

• The inadequate orientation of the building (Northeast).

• The size of the openings, which affects both thermal and visual comfort in winter.

Solar radiation inside buildings is desirable in winter, but remains undesirable in summer

The solar rays are insufficient in the cell because of:

Inadequate building orientation (North-East).

The size of the openings, which influences thermal and visual comfort in winter.

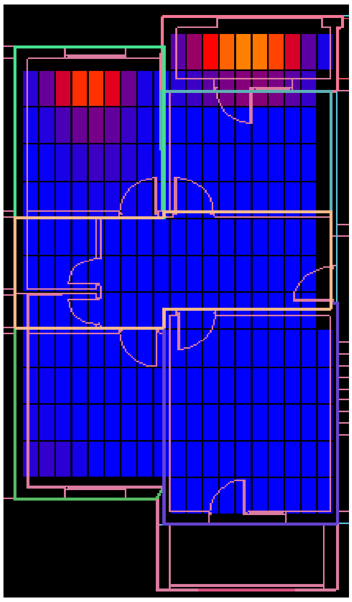
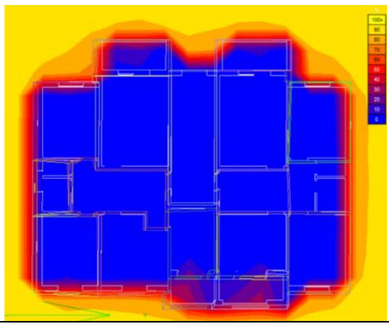
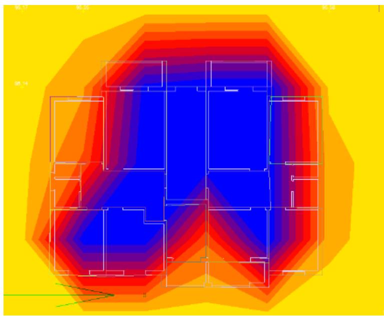


Figure 11 Solar radiation inside buildings

The lighting of the rooms:

The dwelling is characterized by insufficient light intensity during winter, where the penetration of solar radiation is limited for the north-facing rooms (bedroom) (figure in table 8).

Table 8 the lighting of the rooms

	
summer	Winter

 https://doi.org/10.37896/pd92.5/9256

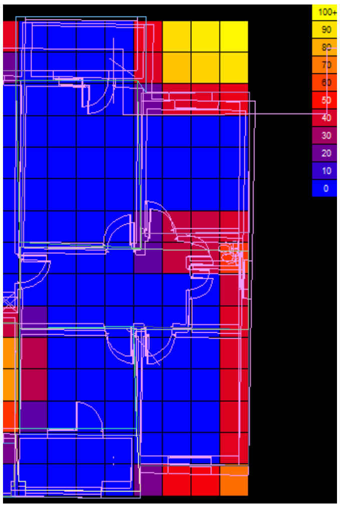


Figure 12 light intensity during winter

The house is characterized by insufficient light intensity during winter where the penetration of solar radiation is limited for north-facing rooms (bedroom) (figure13).

Ventilation Losses Qv

The orientation of the building towards the prevailing wind, along with the absence of protection against cold winds, leads to the penetration of winter breezes and the creation of inconvenient internal drafts. The use of materials with low thermal performance:

The walls are of a prefabricated tunnel system made of concrete with a performance value of ʎ=1.75, and the windows have poor performance with a value of 4.15. This results in a shorter thermal lag time, leading to overheating of internal spaces and poor thermal insulation.

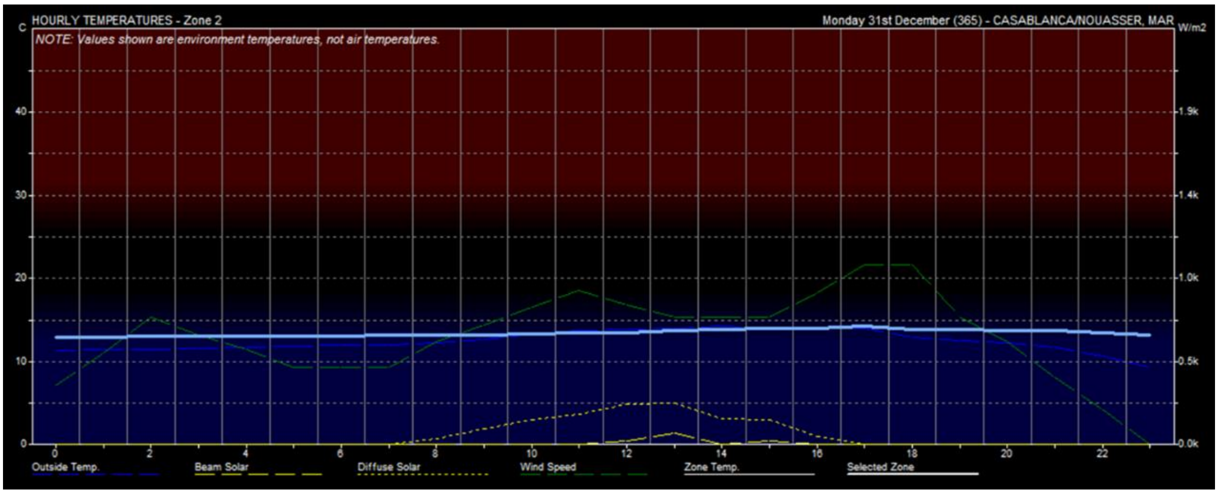


Figure 13 Ventilation Losses Qv of internal spaces.

Recommendations

- **On the scale of the envelope**
  • Reinforce the insulation of the roof (green roof)
  • Work the angles to reduce the mask effect
  • Favor light colors for shaded facades
  • Installation of vegetation in the heart of the island to reduce the effect of gusts
- **At the cell level**
  • Add protection on the exposed side (southwest)
  • Reinforce exterior insulation
  • Rearrange spaces (day space towards the south)
  • Rework the balconies

 https://doi.org/10.37896/pd92.5/9256

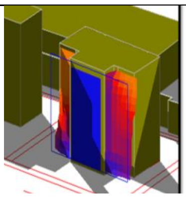
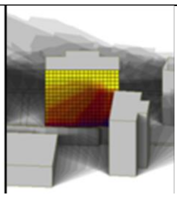
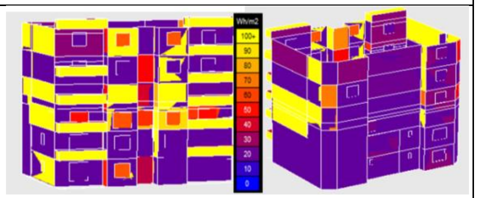
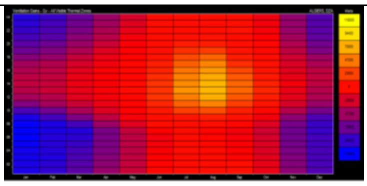
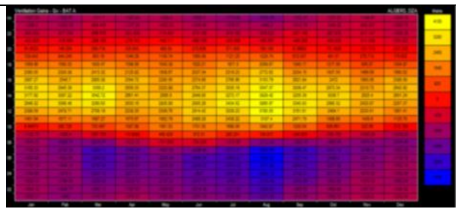
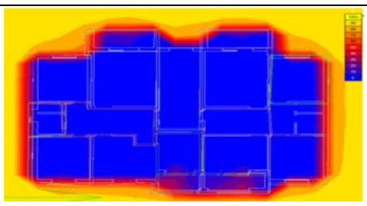
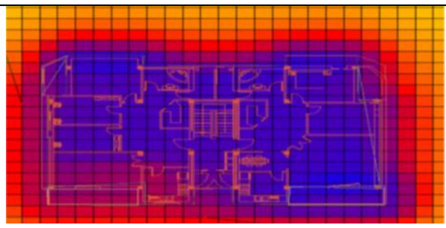
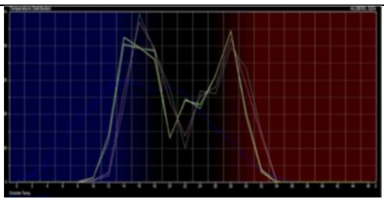
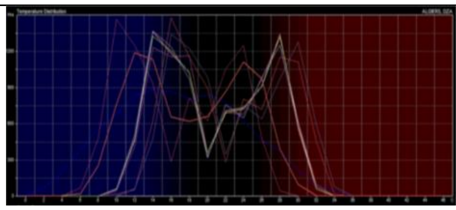
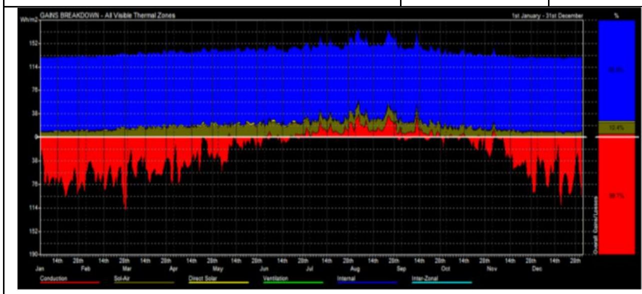
the active and passive actions undertaken on the house in the case study to improve its performance (table 9).

Table 9 active and passive actions

	actions	**Effect on environmental quality interior**
Passive measures	• Ensure good • orientation of the parts. • Use vegetation as an element of protection against excess heat or annoying winds	• Improve thermal comfort • Control the temperature inside the home Improves air quality • Less drafts Reduce the use of heating and air conditioning Promote natural lighting.
	• Improved insulation • walls (insulation by • exterior or interior or both if necessary). • glazing (the technique of • double glazing). • Use of materials • efficient premises • Use of green roofs	• Improve thermal comfort and reduce the use of air conditioning and heating • Reduce heat loss through the walls
Active measures	Using panels photovoltaic	For the domestic water heater, to reduce the use of gas
	The use of LBC lamps	Reduce the amount used for energy lighting
	Use of solar breezes	Protection against unwanted solar rays

 https://doi.org/10.37896/pd92.5/9256

Table 10 comparison between initial state of housing and final state after requalification

	Initial state	**Used technique**	**Final state**
insolation	 	The use of sunshades on the south facades to reduce direct sunlight.	
ventilation		The arrangement of windows ensures cross-ventilation for natural airflow.	
lighting		The glazed area should represent 1/8 of the habitable area.	
température	 In comfort 290 hrs 39%	Use of thermally efficient materials such as reinforced concrete and double-glazed windows with insulation.	 In comfort 4500 hrs 60%
			

GAINS BREAKDOWN FROM: 1st January to 31st December

CATEGORY	LOSSES	GAINS
FABRIC	99.7%	2.7%
SOL-AIR	0.0%	10.4%
SOLAR	0.0%	1.2%
VENTILATION	0.3%	0.0%
INTERNAL	0.0%	85.8%
INTER-ZONAL	0.0%	0.0%

The implementation of high-performance materials such as reinforced concrete and double-glazed windows with insulation, along with the addition of sunshades, ensures a consistent ambient temperature throughout the year.

https://doi.org/10.37896/pd92.5/9256

	total consumption after requalification: **for electricity 100 KWh** **for gas283,4 KWh**

Conclusion

In terms of well-being, HPE housing has also proven to be profitable. The requalification of buildings has ensured thermal comfort. The evaluation of the overall cost of high-energy performance construction compared to its initial state (in our case, Public Rental Housing) has demonstrated that all benefits in the short, medium, and long term result from the good spatial configuration and orientation of the housing. Architectural solutions for sun protection, technical insulation details, and all means directly or indirectly ensure thermal comfort in the housing. Ensuring the thermal comfort of existing housing requires thoughtful energy requalification through renovation or well-considered rehabilitation.

Our research has shown that through this type of requalification, gains can be made in both energy and economic aspects. This experience will have positive impacts on the environment and climate change through the reduction of energy consumption.

Efficiency is achieved through the application of passive and active improvement solutions at the level of the envelope and internal space, as well as by strengthening the envelope through wall and floor insulation, double glazing, and the use of green roofs, which contribute to reducing thermal losses in combination with natural ventilation. Applying high-energy performance standards to existing buildings to minimize energy consumption in the residential sector is a necessity.

Passive measures involve architectural and construction interventions. This includes working on volumes, the orientation of the building, the placement of openings that determine natural lighting and ventilation, thermal insulation, etc. Active measures include, for example, local or central heating, mechanical ventilation and cooling, artificial lighting, etc., which aim to compensate for building deficiencies or complement passive measures.

Reference

[1] *I. Laouni and S. Mazouz, "Towards a Sustainable Building Material in Hot Arid Environments: Compressed and Stabilized Earth Brick (CSEB) Prototype", International Journal of Sustainable Development and Planning. 16(7): **(2021)**, p. 1195-1208. 10.18280/ijsdp.160701*

[2] *H. D. Montero, "Institutionnalisation ou désobéissance des normes environnementales en architecture?", Encyclo. Revue de l'école doctorale Sciences des Sociétés ED 624. (12): **(2022)**, p. 41-59.*

[3] *EIA, "(Energy Information Administration),World energy demand and economic outlook", The International Energy Outlook 2011 (IEO 2011). Energy Information Administration (EIA),Washington: **(2011)**, p. 292.*

[4] A. Giancaterina (2015). L'amélioration énergétique sur le parc privé de logement: Quelle politique publique mise en œuvre par Grenoble-Alpes Métropole? , PACT Isère, 34 ter avenue Marie Reynoard, 38100 Grenoble

[5] R. Akkouche, G. Guerassimoff, S. Selosse (2021). Quels freins à l'amélioration énergétique des bâtiments publics en France.

[6] *N. E. H. B. SLIMANE, "Rafraîchissement urbain, adapter Alger au futur climat,Rentabilité économique des actions de maitrise d'énergie dans le secteur résidentiel en Algérie : 80 logements HPE (Ain Romana) et 300 logements LPL (Chiffa), Blida.", DANS TOUS SES ETATS.Newsletter VUDD. N°2.: **(Mars 2016)**, p. 30.*

[7] *APRUE, " (Agence nationale pour la Promotion et la Rationalisation del'Utilisation de l'Energie) Maitrise d'énergie. ses principaux acteurs et instruments ", La Lettre de l'Aprue, Bulletin trimestriel, APRUE, Alger. n° 08 Mai 2005: **(2005)**, p.*

[8] *P. Maes, "Labels d'efficacité énergétique", France, Bâtiment. 2030: **(2010)**, p.*

[9] F. Chlela (2008). Développement d'une méthodologie de conception de bâtiments à basse consommation d'énergie. Université de La Rochelle

[10] *A. Galderisi, G. Mazzeo, F. Pinto, "Cities dealing with energy issues and climate-related Impacts: Approaches, strategies and tools for a sustainable urban development", Smart Energy in the Smart City: Urban Planning for a Sustainable Future. **(2016)**, p. 199-217.*

[11] *O. Tounsi and M. Moudjari, "Concevoir un projet habitat à haute performance énergétique": **(2017)**, p.*

[12] N. Mehat, L. Mimeche, S. Naili, R. E. Bouraoui (2018). La haute performance énergétique (HPE) dans l'éco-conception de l'habitat en Algérie. Université de Jijel

[13] *C. MEHIRA, "Influence de l'Enveloppe architecturale sur la Performance Énergétique des bâtiments": **(2021)**, p.*

[14] *S. Chadli and C. Kedissa, "Pour un logement à haute performance énergétique": **(2021)**, p.*

[15] *P. GARCIA, "La qualité environnementale", Profession architecte, Paris, Eyrolles. **(2020)**, p. 370-372.*

[16] G. Molina, M. Musy, M. Lefranc (2018). Les professionnels du bâtiment face aux défis énergétiques et environnementaux: compétences et pratiques en transition: ISTE Group

[17] *P. Pelletier and P. B. Grenelle, "Pour une meilleure efficacité des aides à la performance énergétique des logements privés", Paris, Plan Bâtiment Grenelle. **(2011)**, p.*

[18] *S. Sami-Mécheri, D. Semmar, A. Hamid, "Efficacité énergétique des logements à haute performance énergétique,'HPE': Application au site de Béchar", Journal of Renewable Energies. 15(2): **(2012)**, p. 357-364.*

[19] *S. Semahi and B. Djebri, "La conception des logements à haute performance énergétique (HPE) en Algérie-Proposition d'un outil d'aide à la conception dans les zones arides et semi-arides", Revue des Energies Renouvelables. 16(3): **(2013)**, p. 551-568.*

 https://doi.org/10.37896/pd92.5/9256