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Preserving the past, powering the future, energetic rehabilitation of a historical building in Blida – Douirette

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THANKS

بسم الله الرحمن الرحيم ان الحمد لله نحمده ونستعين به

In the name of God, the Most Gracious, the Most Merciful.

Praise be to God, we praise Him and seek His help,

First and foremost, I am honored to present this work, which is the fruit of my six years of hard work and dedication in my institution, which is why I would like to thank all the people who helped me and trusted me throughout my journey:

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LILYA RASELMA

DEDICATION

I am more than honored and happy to dedicate my work to the people that I love:

For both my parents, **Djahida AMROUCHE and Ahmed RASELMA** after God, your blessing is the reason for my success.

- This is for you, my mother **Djahida**. I hope that I made you proud. I will always be grateful for all the sacrifices that you have made for me. You are my source of happiness, my pillar that I rely on, and my role model. You have always shown me your love, support, and willingness to help me every step of the way. I pray that one day I will be able to repay you. to my father for pushing me to be the best version of myself. Thank you for all your hard work.

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Abstract

Algeria is a country with a rich past and a wide range of cultural influences, which are evident in its distinctive architectural styles. Despite being a significant oil and gas producer, it faces substantial energy efficiency challenges, particularly in its built environment. This may be seen in Blida Douirette's historic urban fabric, which is notable for its architectural and historical value. Despite their visual attractiveness, the historic homes in the region are inefficient in using energy, which results in high energy consumption and decreased comfort for the occupants.

The main goal is to increase the energy efficiency of the homes in this area, which will reduce energy use, cut carbon emissions, and improve occupant comfort, and also seek to maintain the local architectural legacy by making sure that any suggested changes blend well with the area's rich historical legacy.

To achieve these objectives, the research begins with a detailed analysis of the present surroundings and the local climate to identify the factors impacting the energy efficiency of the houses as of right now. employing a variety of tools including the dynamic thermal simulation and the graphical Givoni diagram, to suggest an efficient intervention for energy efficiency and occupant comfort while respecting and preserving the local heritage.

Keywords: Energetic rehabilitation, Energy Efficiency, Historical preservation, Sustainable Living Spaces, thermal comfort.

ملخص:

الجزائر هي دولة ذات ماضٍ غني ومجموعة واسعة من التأثيرات الثقافية، والتي تظهر في أنماطها المعمارية المميزة. على الرغم من كونها منتج كبير للنفط والغاز، إلا أنها تواجه تحديات كبيرة في كفاءة الطاقة، خاصة في بيئتها المبنية. يمكن رؤية هذا في النسيج الحضري التاريخي لبليدا دوايريت، الذي يتميز بقيمته المعمارية والتاريخية. على الرغم من جاذبيتها البصرية، فإن المنازل التاريخية في المنطقة غير فعالة في استخدام الطاقة، مما يؤدي إلى استهلاك عالي للطاقة وانخفاض في راحة السكان.

الهدف الرئيسي هو زيادة كفاءة الطاقة في المنازل في هذه المنطقة، والتي ستقلل من استخدام الطاقة، وتقليل الانبعاثات الكربونية، وتحسين راحة السكان، وكذلك السعي للحفاظ على التراث المعماري المحلي من خلال التأكد من أن أي تغييرات مقترحة تتماشى جيدًا مع التراث التاريخي الغني للمنطقة.

لتحقيق هذه الأهداف، نبدأ البحث بتحليل مفصل للمحيط الحالي والمناخ المحلي لتحديد العوامل التي تؤثر على كفاءة الطاقة في المنازل حاليا. تستخدم مجموعة متنوعة من الأدوات بما في ذلك المحاكاة الحرارية الديناميكية والرسم البياني، لاقتراح تدخل فعال لكفاءة الطاقة وراحة السكان مع احترام والحفاظ على التراث المحلي.

<u>الكلمات المفتاحية</u>: التأهيل الطاقوي، كفاءة الطاقة، الحفاظ على التاريخ، المساكن المستدامة، الراحة الحرارية.

RESUME :

L'Algérie est un pays avec un riche passé et une grande diversité d'influences culturelles, ce qui se manifeste dans ses styles architecturaux distinctifs. Bien qu'elle soit un producteur important de pétrole et de gaz, elle fait face à des défis substantiels en matière d'efficacité énergétique, notamment dans son environnement bâti. Cela peut être observé dans le tissu urbain historique de Blida Douirette, notable pour sa valeur architecturale et historique. Malgré leur attrait visuel, les maisons historiques de la région sont inefficaces en termes d'utilisation d'énergie, ce qui entraîne une consommation énergétique élevée et un confort réduit pour les occupants.

L'objectif principal est d'améliorer l'efficacité énergétique des maisons de cette région, ce qui réduira la consommation d'énergie, diminuera les émissions de carbone et améliorera le confort des occupants, tout en cherchant à préserver l'héritage architectural local en s'assurant que les modifications proposées s'intègrent bien dans le riche patrimoine historique de la région.

Pour atteindre ces objectifs, la recherche commence par une analyse détaillée de l'environnement actuel et du climat local afin d'identifier les facteurs influençant l'efficacité énergétique des maisons à l'heure actuelle. En utilisant une variété d'outils, y compris la simulation thermique dynamique et le diagramme graphique de Givoni, pour proposer une intervention efficace pour l'efficacité énergétique et le confort des occupants tout en respectant et en préservant le patrimoine local.

Mots-clés : Réhabilitation énergétique, Efficacité énergétique, Préservation historique, Espaces de vie durables, Confort thermique.

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CHAPTER I : INTRODUCTION

1-INTRODUCTION GENERALE :

Dans un monde de plus en plus conscient de l'impact environnemental de ses activités, l'architecture occupe une position centrale dans la quête d'un développement durable. L'option architecture, environnement et technologie vise à répondre aux défis contemporains en intégrant des pratiques respectueuses de l'environnement tout en assurant un niveau de confort élevé répondant aux nouveaux standards. Le secteur de la construction est responsable d'une part significative des émissions de gaz à effet de serre, de la consommation d'énergie et de l'exploitation des ressources naturelles. Il est donc impératif d'adopter des approches innovantes et durables dans la conception et la construction des bâtiments.

L'atelier E-Cow Built est une initiative pédagogique intégrée dans le cadre du Master 2 visant à fournir aux étudiants des compétences pratiques et théoriques dans le domaine de l'architecture durable, de la construction écologique et des technologies de pointe. Cet atelier est conçu pour combiner les aspects théoriques avec des expériences pratiques, tout en mettant un accent particulier sur l'innovation et la durabilité.

Cet atelier se concentre sur deux aspects ayant pour objectif l'optimisation de l'efficacité énergétique, et ne se limitant pas seulement à la construction de nouveaux bâtiments. La réhabilitation énergétique des bâtiments existants est tout aussi cruciale, car elle implique la rénovation des structures pour améliorer leur performance thermique et énergétique. Cela peut comprendre l'isolation des murs, des toits et des planchers, le remplacement des fenêtres par des modèles à haute performance énergétique, et l'installation de systèmes de chauffage, de ventilation et de climatisation plus efficaces. C'est pour cette raison que certaines thématiques traitent de la modernisation des bâtiments anciens, permettant non seulement de prolonger leur durée de vie, mais aussi d'améliorer le confort des occupants et de réduire les coûts énergétiques.

Les thématiques traitées par les différents étudiants se focalisent sur le confort des occupants, qui est un aspect indissociable de cette démarche, d'autres se concentrent sur les certifications LEED (Leadership in Energy and Environmental Design) ou BREEAM (Building Research Establishment Environmental Assessment Method), mettant l'accent sur la qualité de vie à l'intérieur des bâtiments. Cela inclut le contrôle de la température, de la qualité de l'air, de l'acoustique et de l'éclairage naturel. Des technologies avancées permettent de réguler ces paramètres de manière intelligente, créant ainsi des environnements de vie et de travail agréables tout en réduisant la consommation énergétique.

Les différents objectifs de cet atelier visent l'intégration dès la conception les principes de durabilité et de haute performance énergétique, et ainsi choisir dès le départ des matériaux à faible impact environnemental, concevoir des structures optimisées pour l'efficacité énergétique et intégrer des systèmes de gestion de l'énergie. Sensibiliser les étudiants sur les stratégies passives tels que l'orientation des bâtiments, leur forme et l'utilisation de technologies comme les panneaux solaires ou les pompes à chaleur jouant un rôle crucial dans la réduction de l'empreinte écologique. De plus, la construction modulaire et les techniques de préfabrication peuvent réduire les déchets de construction et améliorer l'efficacité du processus.

L'atelier se concentre également sur l'utilisation des outils numériques, tels que la modélisation des informations du bâtiment (BIM) et la simulation des performances énergétiques des bâtiments, afin d'optimiser leur conception pour maximiser l'efficacité énergétique et évaluer l'impact environnemental à travers ces différents outils.

Cette démarche permet d'anticiper et de réduire les impacts environnementaux dès les phases de conception et de construction, car ces technologies offrent une vision globale du projet et facilitent la prise de décisions éclairées en matière de durabilité.

L'option architecture, environnement et technologie ne se limite pas à l'adoption de nouvelles techniques de construction ou à la réhabilitation énergétique. Elle inclut également une réflexion plus large sur l'urbanisme et la planification territoriale. Les éco-quartiers et les villes intelligentes émergent comme des réponses intégrées aux défis du développement durable, s'évertuant à optimiser l'utilisation des ressources, à réduire les déplacements en voiture grâce à une mixité fonctionnelle et à favoriser les modes de transport doux.

En conclusion, l'intégration de l'architecture, de l'environnement et de la technologie représente une réponse nécessaire et ambitieuse aux défis du changement climatique et de la transition énergétique. Elle exige une approche holistique, combinant la construction neuve et la réhabilitation des bâtiments existants, pour créer des environnements bâtis qui sont à la fois durables, confortables et résilients.

Dr.BENCHEKROUN Marwa

2- GENERAL THEMATIC:

By the end of the twentieth century, the world witnessed radical changes on various fronts due to the impact of globalization, technological progress, and increased oil exploration. These changes have also affected the construction industry, as construction is constantly evolving. The latest is driven by innovations in materials and construction technic and new technologies that can reduce energy consumption highlight the energy efficiency and durability of new buildings.

As a result, environmental awareness has been filled with new buildings and renovations that have left old buildings ruined and abandoned, so heritage is under threat. As the world progresses, we face increasing concerns about climate change and resource depletion, so the world needs to reduce the energy footprint of new buildings and move towards old buildings by improving energy performance structures while respecting their historical significance.

Consequently, the world is increasingly concerned about sustainable urban development and the preservation of cultural heritage, there have been global talks about implementing two major environmental sustainability initiatives: The Energy Union and the Conference of the Parties (COP)[1]. These initiatives have several objectives, including enhancing energy efficiency, decreasing reliance on energy imports, reducing emissions, creating job opportunities, and promoting economic growth. They also aim to decarbonize the economy and transition towards a low-carbon economy.

The history of a place is depicted through various layers, encompassing not just physical monuments and artifacts, but also the traditions, customs, and practices that have been handed down through generations. These elements serve as a reflection of our history and identity, highlighting the significance of cultural heritage as a tangible representation of our collective past.

As for the preservation of cultural heritage, there was a formulation of international rehabilitation strategies such as the United Nations Educational, Scientific and Cultural Organization (UNESCO)[2]'s World Heritage Guidelines[3] that implies specific criteria for

[1] Conference of the Parties to the United Nations ;Sharm el-Sheikh Climate Change Conference - November 2022

[2] The Operational Guidelines for the Implementation of the World Heritage Convention

[3]World Heritage Guidelines: for the identification, protection, conservation, presentation, and sustainable management of cultural and natural heritage sites around the world. UNESCO administers the World ²Heritage program, which aims to recognize and preserve places of outstanding cultural or natural significance

including sites on the World Heritage List and for allocating international aid through the World Heritage Fund.

Their guidelines are detailed in a document titled: "*Operational Guidelines for the Implementation of the World Heritage Convention*." The Committee periodically updates this document to incorporate new ideas, insights, or lessons learned. There is also LEED CERTIFICATION[4] used for both new and old construction, as an ecological certification.

For a better future that answers to both human and environmental requests; sustainable development meets those expectations; it's a model of progress that seeks to fulfill humanity's basic needs while efficiently managing resources and safeguarding environmental quality.

In this context, efficiency refers to energy efficiency 'the goal of achieving the same quality of output while utilizing less energy'. This is not only beneficial for the economy but also reduces social and ecological costs, such as energy and carbon footprint.

And for the sustainable development, the Urban planning plays a significant role in achieving energy efficiency. However, for cities to thrive in the future, they must also learn from their past. Each city is special for its unique urban fabric that gives its character, whether it's simple or complex.

For example, the traditional urban fabric is intricately woven through its narrow alleys, narrating the ways of living that not only respect the culture and religion but also adapt to the harsh and challenging environment which makes it complex, like Pr Ben Hamouche said: "*The urban fabric is the keystone in this complexity*. *This metaphorical term, which is etymologically borrowed from living organisms, considers the built environment in the city as a collection of biological cells. A building, whether it's a house or a mosque, is often attached to other structures on all sides, thus defining its external envelope [Ben-Hamouche Mustapha, 2017/2018; page 49]*". Thus, inserting the operation of energy rehabilitation in a traditional urban fabric presents a challenge for the duality between tradition and technology.

Heritage is not just a collection of old buildings; it's a testament to our past, a reflection of our culture, and a part of our identity the distribution of buildings, and the use of space can

[4] LEED CERTIFICATION: Leadership in Energy and Environmental Design (LEED) is a rating system in more than 132 countries. It's a certification program that promotes environmentally responsible and sustainable building practices. It covers various aspects and the Projects can earn different levels of certification, ranging from Certified to Platinum.

all provide clues about the past as a result it is important to understand the significance of individual heritage buildings and guide their preservation.

This means that this operation requires preserving the inherent cultural significance of architectural treasures while improving their energy efficiency, for example, an old building consumes an average of 240 kWh/ (m² per year), primarily for heating while a new building built to passive standards consumes less than 15 kWh/ (m² per year). Besides financial or fiscal incentives, the quality of energy retrofitting for housing is crucial to achieve the ambitious objective [Hélène Peskine, 2018].

The energetic rehabilitation of old buildings within traditional urban fabrics is a process that touches the building on multiple aspects including energy efficiency, and durability all while maintaining its heritage and historical aspect [Hélène Peskine, 2018].

This initiative, known as "*energetic rehabilitation*" encompasses the process of introducing new energy-related processes to older or historic buildings, all while meticulously preserving their architectural and historical significance. This holistic approach represents a multifaceted challenge, as it demands a delicate equilibrium where energy-related modifications must seamlessly merge with the building's original design, combining modern energy-efficient technologies and strategies with the timeless essence of historical and architectural value.

3- GENERAL PROBLEM STATEMENT:

Nowadays, the world's focus is shifting towards taking action to combat the urgent changes happening globally and to create a more sustainable and efficient environment. This includes reducing CO2 emissions and decreasing the consumption of fuels.

Algeria, a country rich in fossil energy sources like oil and natural gas, has seen a rise in energy consumption due to population growth and economic development. In 2022, the total energy consumption increased by 3% and it has been steadily growing at a rate of 5% per year. However, in recent years, Algeria has taken steps towards developing its renewable energy sector and aims to increase the share of renewables in its energy mix to 27% by 2030.

Algeria has taken a significant step by participating in the COP27 conference as an initiator. One of the topics they covered was the impact of climate change on Cultural and Natural Heritage (CCICH).The goal of this initiative is to bridge scientific knowledge and climate adaptation tools to facilitate the protection of cultural and natural heritage from the effects of climate change. This coordinated effort is taking place at both global and local levels. Currently, the common practice is energetic rehabilitation.

Although energetic rehabilitation is spreading throughout the world; unfortunately, in Algeria, there are few interventions and strategies in this field being done; there are few studies about rehabilitation and thermal performance like: "*Rehabilitation of a Traditional house in SIDI OUZEN "TLEMCEN"*; '*"Test to improve the thermal performance of the "Riwak" Gallery in a traditional house in Patio'*.

In Algeria, restoration is a more frequent operation in historical sites. However, restoration is not as energy-efficient as energetic rehabilitation, even though both aim to preserve the historical and heritage value of a building. Energetic rehabilitation, on the other hand, takes into account the comfort of the occupants in an energy-efficient way and has less impact on the environment.

As mentioned earlier, the infrequency of this operation is destroying historical buildings or their total reconstruction using modern methods in areas with traditional fabric. Therefore, the local identity is slowly fading, and this greatly impacts our environment and ultimately the world.

What methods and approaches can be employed to implement energy-efficient rehabilitation of Algeria's urban and architectural heritage?

4- SPECIFIC PROBLEM STATEMENT:

With its green landscapes and ideal grounds for cultivating various crops, the city is famously known as the city of roses, owing to its topography and position. Blida offers picturesque landscapes and a unique blend of traditions in the northern part of Algeria. The place is renowned for its breathtakingly natural beauty, thriving agricultural prominence, and deeply ingrained historical and cultural heritage that traces back to the ancient era of small tribes.

The urban fabric of the city has undergone various changes, from random and complex implantation to structured and planned modifications, which serve as a witness to all its past transformations.

The City of Roses enjoys a pleasant Mediterranean climate, characterized by mild winters and warm summers. However, in recent years, the weather has undergone drastic changes, becoming unrecognizable due to climate change caused by both human activities and natural disasters. One of the main reasons behind this transformation is the ever-increasing energy consumption in residential, commercial, and industrial buildings. Not only is energy consumption rising every year, but our architectural heritage is also fading away due to globalization and economic changes.

There are only a few areas in Blida that are still the same and haven’t changed that much preserving its history; one of those few areas is Douirette or Casbah of Blida whether through the traditional urban fabric or the historical buildings its rich in history; Cultural values and architecture.

Unfortunately, it faces so many problems among them we can spot from POS B18: The lack of accessibility due to the limited number of roads has made Douirette a closed-off community. The buildings are arranged in a linear fashion, similar to medinas, resulting in a traditional complex urban fabric.

Although the town has managed to maintain its authenticity, the population has been steadily increasing and the state of its buildings varies greatly. Some houses have undergone modern renovations with multiple levels to accommodate a large number of families, while others have managed to preserve their traditional construction methods and legacy, though they may be slightly deteriorated.

The city of Blida is committed to upholding sustainable practices and ensuring responsible resource management. The position of this entity offers a wide range of energy strategies and resources. These strategies encompass a range of sectors, from traditional fossil fuels to renewable energy sources such as solar and wind power. although Blida has great potential, it is still too late to apply the new strategies and this move impacts not only the environment but also the buildings, especially the old buildings in Blida.

Unfortunately, there are also many ruined buildings due to conflicts over inheritance. However, both the historical and ruined buildings are no longer suitable for comfortable and energy-efficient living. This leads us to-ask the following questions:

- **What strategies, whether active or passive, can be employed to enhance thermal comfort and reduce energy consumption in historical Douirette of Blida?**

5- HYPOTHESIS:

Taking into consideration the challenges faced in promoting a better future for Douirette, specifically regarding the comfort of old houses, we propose the following hypothesis:

- Efficient envelope may improve the building's energy performance.
- To enhance thermal comfort in Douirette and their energetic behaviour, passive strategies may offer an optimal solution.
- Active strategies in ventilation and cooling may be the answer to the internal gain in traditional houses in Douirette.

6- OBJECTIVES :

The objective of this thesis articulates on these main points that are:

- ✓ Making an example of responsible energetically old houses in Douirette.
- ✓ Insert rehabilitation strategies in historical buildings to improve the comfort of its occupants.
- ✓ Extend the life spent in old buildings through technological intervention, as a result: preserving the heritage.
- ✓ Study old houses' energetic performance, to make them sustainable.
- ✓ Designing an energy-efficient model suitable for old houses.
- ✓ Upgrading the envelope of the house with low consummation.

7- METHODOLOGICAL APPROACH:

Concerning this part, to approach our research and to address the problem of the hypothesis in question, the work will be divided into four parts:

1. **Theoretical part:**

1.1 Research Bibliography:

- Understanding the concepts and techniques of rehabilitation energetic work, including the definition of rehabilitation the history of Blida and Douirette, and how historical buildings function.

- Reading books related to the traditional urban fabric and thesis on rehabilitation and energy efficiency that are relevant to our theme.

- Studying the strategies and organizations that are working towards rehabilitation energy all over the world, including Algeria (UNISCO; LEED; COP 27; ENERGY UNION).

1.2Collect data and analysis:

Data collection is essential to our work. It was done in two stages:

- The first is primary data: to gather extensive information on the concept of identity, vernacular architecture, and information related to various energy rehabilitation and searching for examples all over the world that used rehabilitation energy in old and historical buildings. An exploratory investigation involves observing the site and gathering information from the citizens.
- The second is secondary data: consisting of contacting the local administration (URBAB, DUCH) and stakeholders in the city of Blida to obtain the PDAU of Blida and the POS 18 of Douirette. Concerned by the chosen projects (the study cases) and even the teachers and architects (Pr. FOUFA, Dr. Kebaili) who worked or have information on Douirette.

2. **Analytical part:**
    - After researching global examples of energy rehabilitation, we analyzed both passive and active strategies that can be applied in our case.
    - It's important to conduct a thorough analysis of a site, taking into account both its physical and historical aspects.

2. 1Operational part:

2 .1. A. Investigation:

one of the methods qualitative is *Observation*, a technique to investigate in Douirette; we visited four houses to evaluate their condition and the comfort of their occupants. During the visit, we took pictures to document the state of the buildings.

During our research to gather information about Douirette, we conducted interviews with residents, including senior citizens and other inhabitants. To begin with, we conducted a free-flowing interview with a baker, allowing him to express his emotions and share all his knowledge about the area. This was followed by a mix of structured and unstructured interviews, depending on the person we were interviewing.

To obtain more specific information, we created both closed and open-ended questionnaires to identify discomfort in participants' homes.

We selected two houses in Douirette for a house survey, which included pictures; measurements, and information on the house's history if available. This selection was based on the state of the house and its precedence in that area.

2. 1. B. Conceptual part:

We conducted an investigation and selected two houses in Douirette to analyze their energy consumption. One of them represents a typical building in the area, while the other is in a ruined state. Our objective is to identify the best intervention to improve the energy performance of the latter and optimize the comfort of its occupants, all while reducing energy consumption. To achieve this, we established a simulation to compare the residents' perception of architectural and ambient quality in both cases and conclude the best rehabilitation strategies for Douirette.

8- METHODOLOGICAL FRAMEWORK:

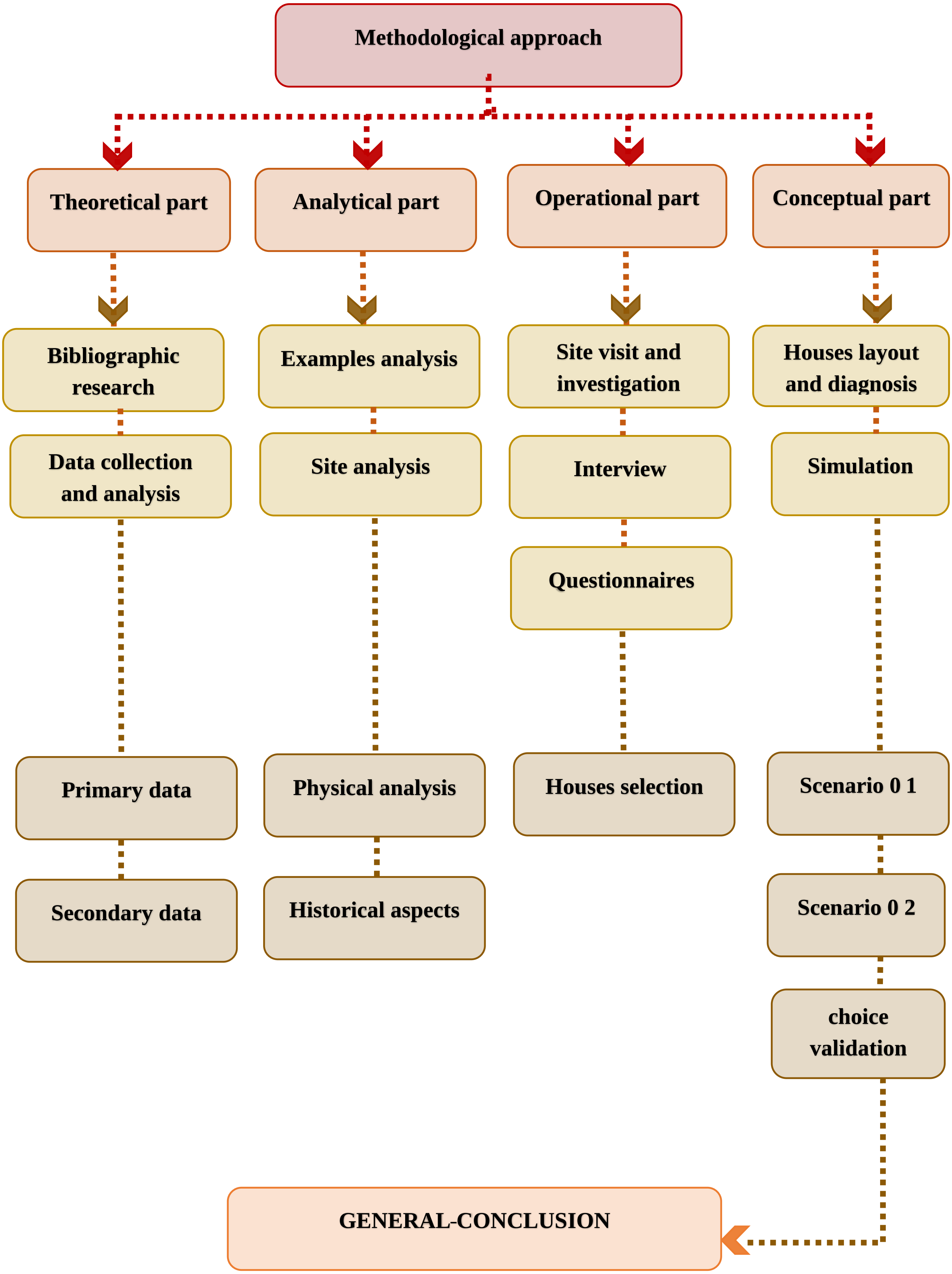


diagram 1 Methodological Framework , by author.

9.THESIS STRUCTURE:

There are four chapters in our thesis:

Chapter I:

This chapter contains the problem statement, the work's aims and hypotheses, the technique used, and the thesis's structure.

Chapter II:

Definitions of terms and ideas about the themes—namely, heritage architecture, energy rehabilitation, and thermal comfort—are provided in the second chapter. Examples are also analyzed in this chapter. It will enable us to build a strong body of information that will improve our comprehension of how energy rehabilitation works.

Chapter III:

The case study is the focus of the third chapter, which is broken up into three sections. We shall give the city's urban and climatic study in the first section. The case study's historical analysis is covered in the second section, while urban interventions and the case study's energy analysis are covered in the last section.

Chapter IV:

The last chapter includes simulations of the selected case's energy usage and thermal comfort together with diagnostics of the study corpus.

General Conclusion: We will summarize our results and synthesis of all the research we conducted in this general conclusion to our thesis.

CHAPTER II: STATE OF ART

▪ Introduction

Historical buildings act as reminders of earlier architectural styles, and old buildings are a substantial structural constituent of the urban fabric of our cities. But these buildings were built during a time when energy was not a primary concern, and so often they do not have the energy-saving qualities that are common in modern construction. This poses its own special set of problems as these buildings are so much a part of our cultural fabric and the prospect of simply replacing them with new, energy-efficient buildings is neither possible nor the right thing to do. In this context, the issue faced by this thesis is the energy rehabilitation of these heritage buildings.

The idea is to use the proper measurements and strategies to make them more energy-efficient and more durable while leaving architectural details untouched.

I. The concept of identity in architecture:

I.1. What is identity?

According to the definition of James D, identity is: “The sameness of a person or thing at all times or in all circumstances; the condition or fact that a person or thing is itself and not something else; individuality, personality.” [James D. Fearon,1999, page 7]. So, identity is the unique characteristics that define each person or thing from someone or something else and that is maintained through the years.

The concept of identity is connected to the distinctive attributes that define a person or a collective, encompassing a broad range of social, cultural, historical, personal, and other factors that contribute to their sense of identity [Saurav Koirala,2021]. It is a dynamic and evolving construct that shifts alongside changing opinions and circumstances. Every city and urban area possesses unique identity elements that promote a sense of belonging and establish a link between individuals and their constructed surroundings.

Therefore, identity is an important aspect to consider when it comes to architectural design to build a sense of belonging in the people and their environment.

I.2. The factors influencing identity in architecture:

Architecture always adheres to certain rules and regulations, and it has a strong connection to society's identity. Architectural form is not only a reflection of society but it is also shaped and influenced by three crucial factors that are:

I.2. 1. Cultural factor:

The design and layout of buildings and spaces can represent the culture and way of life of its inhabitants. It is certain that architecture, both inside and outside of buildings, is one of the ways civilization and culture are expressed in a community. The physical characteristics of architecture, such as shape, size, decorations, and construction style, are influenced by the cultural practices of a society [Olena REMIZOVA, 2020].

I.2.2 Memorial factor:

Memory is the backbone of the architectural profession [Olena REMIZOVA, 2020]. It's the key to holding onto all the information and skills needed to excel in this field. It performs a crucial role in both the creation and preservation of cultural expressions through buildings and houses so ancient buildings can become iconic images and identities of a region or culture, Unfortunately, the identity of this memorial is under threat due to the gradual degradation of surrounding buildings and the rapid passage of time. However, actions are being taken to preserve and maintain these buildings to safeguard their identity.

I.2.3 Political factor:

As time passes, population growth leads to an increased demand for housing. Unfortunately, this demand can lead to pressure to build quickly and in large quantities, often at the expense of quality. Economic factors also play a significant role in shaping a region's architectural identity. Decisions about architectural design can be expensive and have long-lasting effects on a society's economic, social, and cultural well-being [Sveriges Arkitekter, 2010–2015].

As a result, economic considerations can impact architectural styles, urban planning, and the expansion of architectural development, for example, the construction of buildings is heavily influenced by economics. Those with higher incomes tend to build luxurious homes, while those with lower incomes build lower-quality dwellings. This dynamic has a direct impact on the city's architectural identity.

I.3. Architectural identity :

The relationship between architecture and identity is summarised [Salma.S. El – Essawy, 2018] in:

Diagram 2: The relationship between architecture and identity 2, source author

Every community's architecture contributes to establishing its identity because it conveys the message, idea, and distinctive characteristics associated with the community in which it originated, this can include elements such as the building's form, materials, details, façades, history, and cultural references. That reflects the cultural basis of identity.

Architects and urban planners have the unique responsibility to alter and build physical symbols that contribute to a complex set of phenomena that compose the identities of people and communities.

I.3. 1 Urban architecture:

In urban architecture, a building's shape, location, and function are influenced by its environment and neighboring structures. The Medina is a good example of this. Its architecture reflects the city's urbanity, especially in the pre-industrial era. The Medina's compact and complex urban geometry has been formed over time by its inhabitants' actions.

Decisions on building or modifying homes are influenced by factors such as privacy, accessibility, sunlight, and ventilation, creating a chain of constraints and solutions that inform future development. As a city ages, its urban plan becomes increasingly intricate, reflecting the unique history of its growth and development [Mustapha Ben Hamouche. 2022].

I.3.2 Vernacular architecture:

Vernacular buildings are architectural structures that appeared in response to the needs of societies before the industrial era. These buildings were designed to fit the region, climate, and locally available materials.

Vernacular buildings, whether on their own or as part of a larger settlement, demonstrate a remarkable balance between human behavior, construction, and the natural environment. They hold invaluable knowledge about how to maximize energy efficiency while keeping costs low, using materials found nearby. Furthermore, they represent centuries of refinement in creating comfortable dwellings that suit local climates and employ available materials and building methods [Parinaz Motealleh,2016].

It is a type of construction that evolves within communities, adapting to their unique social, climatic, and technological conditions over time. It is consistent with their values, economy, lifestyle, and cultural roots, it's explained in:

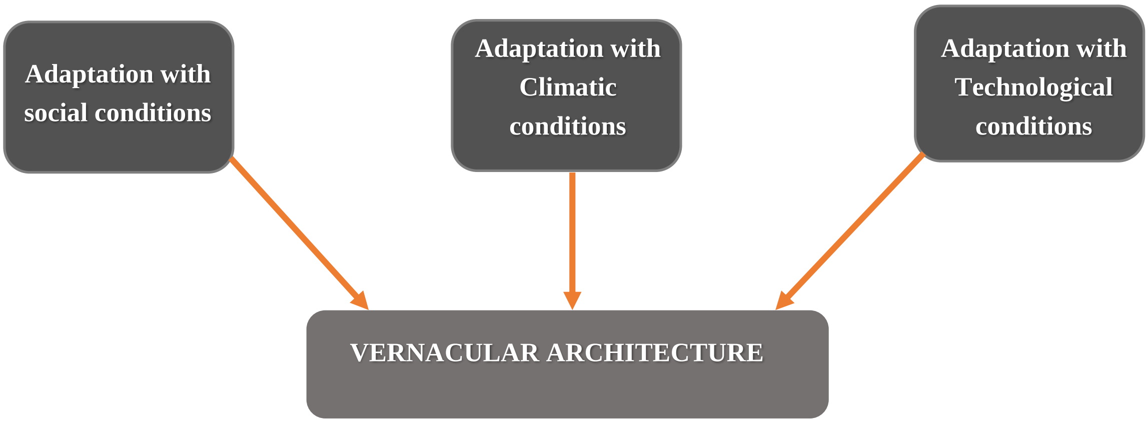


Diagram 3 : The influence on the Vernacular architecture, source author

The ability to create vernacular architecture is believed to stem from innate human talents and intelligence, rather than simply a need for environmental control. Architects strive for a harmonious balance between their designs and nature [T. Hubka,2012].

I. 3.3. The influence of localization:

3.3.1. Localized culture:

Culture plays a pivotal role in shaping the design of vernacular constructions. Within the realm of architecture, "culture" encompasses the unique way of life, beliefs, customs, and habits of a particular community.

Consequently, vernacular constructions are heavily influenced by the lifestyle of their inhabitants, taking into account factors such as occupancy, spatial usage and dynamics, meal preparation, and religious practices. A holistic approach is taken to integrate all of these elements into the design process. Additionally, cultural perspectives of the region also impact the physical environment, dictating the ornamentation and appearance of these structures [Krisanne gonsalves, 2020].

3.3.2. Localized resources:

Vernacular architecture embodies the rich heritage and traditions of local communities through its building practices. It prioritizes the expertise and techniques of skilled local builders over the involvement of qualified architects.

This approach also emphasizes the use of locally sourced and eco-friendly materials, rather than industrial resources. By utilizing indigenous materials, vernacular architecture creates distinct characteristics that are specific to a particular region, fostering regional diversity and promoting socio-economic growth.

I.3.4 Spirit of place:

A 'place' is more than just a spot on a map - it's a fundamental aspect of our existence. A place and its components are shaped by the habits, actions, and beliefs of those who interact with it. Through this interaction, a place takes on its own unique identity, responding to the identities of those who make use of it [Norberg-Schulz, Christian. 1980].

Even basic human activities like sleeping, eating, and gathering can vary greatly depending on cultural, environmental, traditional, and climatic factors, resulting in diverse demands and characteristics of different places.

A space becomes a "place" when it develops its distinct character that can convey meaning, serve its users, and communicate with its surroundings. However, if a place's relationship with its surroundings and users is compromised, it can lose its identity.

I. 4. The question of architectural heritage:

Architectural heritage refers to the cultural and civilizational achievements that have been passed down from our ancestors. It has a qualitative value that has proven its importance and originality in resisting the forces of change and is becoming a visual reference.

Unfortunately, the architectural heritage has been exposed to natural and human factors that have caused significant damage. Therefore, it is crucial to address these factors at every level through joint action, which includes maintaining and protecting heritage buildings.

The process of preserving the heritage value of old buildings can involve introducing new roles that cater to the needs of the new structure. These new roles can add political, historical, or social value to the building. In other words, preserving the permanent architectural heritage can be achieved while also accommodating new functions and values.

I. 4. 1 The approach to the conservation process:

Over time, buildings are subject to deterioration due to a variety of factors, including aging, weathering, and usage. The level of wear and tear that occurs depends on factors such as materials, construction, and maintenance.

Consequently, the methods used to repair buildings can vary depending on the culture and technology involved in their construction. However, the primary goal of heritage building restoration and conservation is universal in its importance: to safeguard the original work of the builder for both present and future generations.

I.4.2 The methods to preserve the architectural heritage:

To maintain the integrity of the old built environment that is prone to degradation, various interventions are carried out. These interventions include conserving historic buildings, preserving their original architecture, modernizing them to suit contemporary needs, and perpetuating their existence to safeguard heritage sites within the region.

All these efforts are geared towards ensuring that the rich cultural and historical significance of these buildings is protected and passed on to future generations.

- These are the interventions that can safeguard the old historical buildings:

4.2. 1 Preservation:

Heritage resource preservation is a systematic approach that involves a series of activities aimed at retaining the current condition of a cultural or natural resource. The primary objective is to slow down the rate of deterioration and prolong the lifespan of the resource. This process typically involves a careful assessment of the resource's condition, the identification of potential threats to its longevity, and the development of strategies to mitigate those threats. Heritage resource preservation may also involve the use of various interventions and treatments to restore and maintain the resource's integrity and value [Khaled El-Daghar, 2020].

4.2.2 Conservation:

Conservation protects old buildings and areas. It involves repairing damages, removing erosion signs, and establishing protection standards [Kabila Faris Hmood, 2019] This preserves heritage while maintaining modern urban fabric.

4.2.3 Restoration:

The restoration technique aims to return a heritage resource to its original state without making assumptions or adding new materials. Attention to detail is key, as the restoration process uses only existing materials to preserve the authenticity and significance of the resource. This approach ensures that important heritage resources' original character and beauty are maintained and appreciated for generations to come.

4.2.4 Renovation:

Renovation is a widely adopted practice that involves repairing structures that have been degraded over time. This process may necessitate either partial or complete demolition of the existing structure to make way for a new and improved one. The primary objective of renovation is to restore a heritage resource to its original state with precision and accuracy, without introducing any new materials to the existing framework [Nicholas Jacob ,2017].

4.2.5 Rehabilitation:

Rehabilitation refers to the precise process of enhancing an already existing building or structure, intending to restore it to a functional and visually appealing condition. This practice typically entails repairing and upgrading various elements of the building, including its structural integrity, utilities, indoor areas, and exterior facade, all while preserving its historical, cultural, or architectural significance. The ultimate objective of rehabilitation is to prolong a building's useful lifespan. It may be required to comply with contemporary building codes and safety regulations while still honoring its original design and unique character. It has different levels depending on the level of damage due to malfunctions for example: climatic hazards, an earthquake, etc.

Distinguishing several levels of rehabilitation:

4.2.5.a. Light rehabilitation:

It is concerned with under-equipped structures whose load-bearing construction exhibits no special vulnerability. It consists of reorganizing spaces or improving thermal comfort and acoustics. It involves painting, cleaning, and carpentry replacement.

4.2.5.b. Medium rehabilitation:

This applies to buildings that need to improve comfort, strengthen load-bearing structures, and upgrade equipment that are:

- Repair of electricity and plasters;
- Improved acoustic comfort;
- Improvement of thermal consumption;
- Installation of water or elevator parts.

4.2.5.c. Heavy rehabilitation:

Heavy rehabilitation is consenting on the redistribution of rooms, repair of roofs, waterproofing, and work on major works.

4.2.5.d. Exceptional rehabilitation:

It applies to buildings whose load-bearing structure has been severely damaged and is in advanced stages of wear. In this scenario, the question is whether to strengthen or replace the structure. This type of work should be saved for structures with unique characteristics or in an extraordinary urban area.

- ➢ There is also an alternative kind of rehabilitation that integrates and combines technology and historical elements while taking into account a building's energy efficiency and legacy which is energetic rehabilitation.

Rehabilitation			
Light rehabilitation	Medium rehabilitation	Heavy rehabilitation	Exceptional rehabilitation
under-equipped structures.	Consists of improved comfort.	Redistribution of spaces, change or repair the roof.	severely damaged structure.

I.5.Energetic Rehabilitation:

It’s a concept that combines elements of both energy efficiency improvements and wider building rehabilitation efforts. It involves making energy-related upgrades to an older or historic building while preserving its architectural and historical value. This can be a complex balancing act because energy-related changes must often be integrated seamlessly with the building's original design; it aims to achieve a balance between reducing energy consumption and environmental impact while maintaining or enhancing the building's unique characteristics.

I.5. 1. The different forms of energy rehabilitation:

There are two forms of rehabilitation: the first produces intention, and the second guarantees its realization, these two forms are summarized as follows:

5.1.1. The first form of energetic rehabilitation “Subjective rehabilitation”:

Subjective rehabilitation is a cultural-focused approach that prioritizes the preservation of moral values and ancestral traditions. This method excludes physical structures and instead focuses on the people and their collective conviction to uphold cultural heritage. By reusing and reinterpreting ancestral values within a thoughtful framework, subjective rehabilitation aims to prevent the loss of culture and ensure the continuity of local traditions [NAIT Nadia, 2011].

5. 1.2. The second form of energetic rehabilitation “objective rehabilitation”:

Objective rehabilitation is a crucial aspect of improving the built environment, particularly when it comes to cultural properties. This type of rehabilitation requires architects with a deep understanding of historic buildings and their authentic values.

It involves the combination of "building rehabilitation" and "cultural rehabilitation" to achieve successful outcomes. By respecting and preserving the cultural significance of the property, objective rehabilitation ensures that the intervention is carried out effectively.

Energetic rehabilitation	
Subjective rehabilitation	objective rehabilitation
a cultural-focused approach that prioritizes the preservation of moral values and ancestral traditions.	Approach the focus on improving the built environment.

5.2 The different approaches to energetic rehabilitation:

Reducing energy usage is not the only goal of retrofitting a heritage building. In contrast, it needs to stay true to a worldwide strategy founded on:

5.2. 1. diagnosis of a given existing condition:

A thorough diagnosis of the current building must be completed to make sensible choices about potential actions to enhance energy performance. This preliminary evaluation consists of General building information, including its present and prospective uses, a general description of the structure and its context, etc.

5.2.2. Choice of measures justified by a multi-criteria assessment:

A selection of actions supported by a multi-criteria evaluation based on three specific aspects, aside from the financial and societal risks associated with any energetic rehabilitation project:

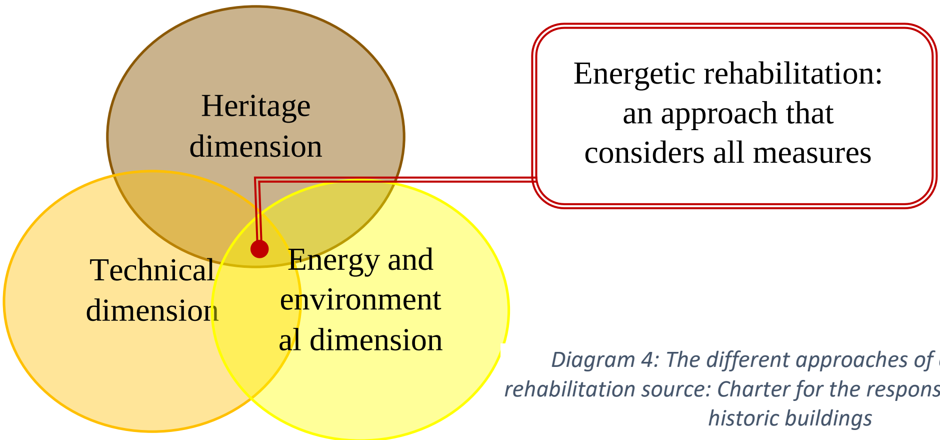


Diagram 4: The different approaches of energetic rehabilitation source: Charter for the responsible retrofit of historic buildings

• The energy and environmental dimension (lowering environmental impact and energy use)

influence of the structure, improving comfort within).

• Technical dimension (building hygienic quality and component durability)

• Heritage dimension (maintaining the building's architectural and heritage values)

The three diagnosis dimensions		
5.2. 1. A. historical diagnosis:	*5.2. 1.B. Technical diagnosis:*	*5.2. 1. C. Environmental, energy diagnostics:*
-Historical and evolutionary background of the building and its components. - Information about the technological systems within the building, including the initial design, evolution of usage, and development of interior and exterior forms. - Explanation of the building's historical significance, unique characteristics, and susceptibility to alteration. - Priorities and specifications for conservation and retrofitting. - Potential to enhance heritage value by reinstating or uncovering hidden or lost elements. - Evaluation of the building's technical state and related environmental variables. - Assessment of the building's initial environmental and energy performance.	- An overall description of the type of construction. - A brief description of each component of the building envelope, including its constituent materials, finishes, as well as any prior interventions, along with an evaluation of its state. - A brief description together with an evaluation of the building's technological systems' state. - Details on the local environment, the plot's topography and climate, and the physical interactions with the nearby buildings.	- The building's actual energy consumption and related CO_2 emissions, - The building's total heat loss as well as how it is distributed across its many parts (walls, windows, floors, etc.). - How well energy systems operate. - The guidelines for building use and management. - The degree of comfort within, contingent on the season.

I.5.3. What to consider in energy rehabilitation?

It is crucial to adhere to the basic principles of consideration for user comfort and health, energy sobriety with energy efficiency, and the use of renewable energy sources, so in energy rehabilitation we have to consider:

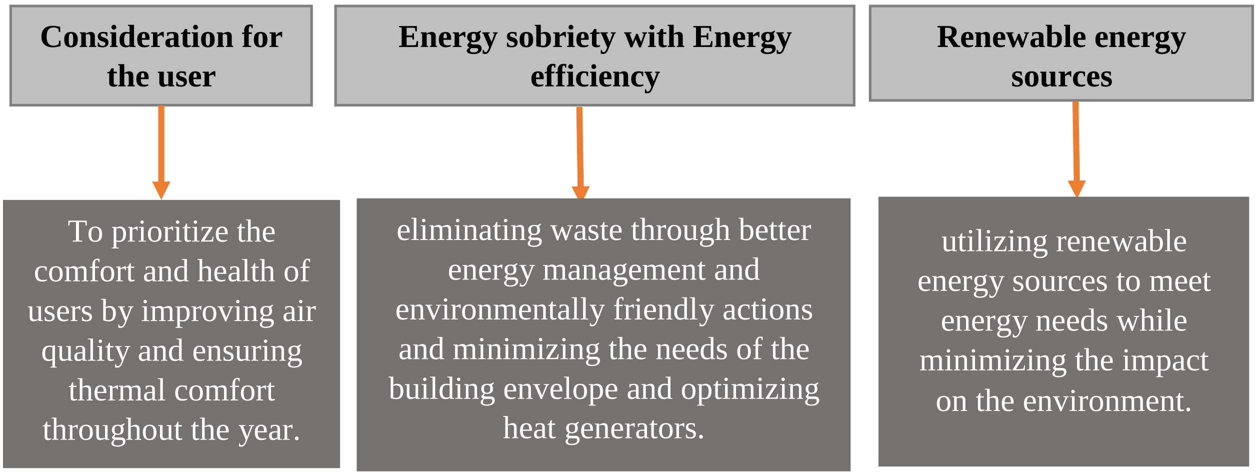


diagram 5: the basic principles to consider in energetic rehabilitation

II. Energetic rehabilitation and thermal comfort:

Thermal comfort is a crucial aspect that must be considered when creating a building. It is essential for the functionality of the building and justifies the need for heating, ventilation, and air conditioning systems.

The definition of thermal comfort holds great importance in ensuring that the building meets its objectives. Providing the necessary answers to thermal comfort can ensure that the building is conducive to its occupants and meets their needs. Therefore, understanding and addressing thermal comfort is essential in the design and construction of any building or the rehabilitation of old buildings.

The thermal comfort is to be considered in three essential points: the first is in two seasons: SUMMER and WINTER, the second is Thermal inertia, and the third is airtightness and thermal bridges.

II. 1. The thermal comfort in historical buildings:

II.1. 1. Winter comfort:

In terms of winter comfort, improving building energy efficiency encourages the use of free solar input and maximizes solar radiation penetration. This method substantially contributes to boosting visual comfort during the season, especially when natural light is scarcer and more sought after than in the summer. It also ensures that a building consumes as little energy as possible to keep warm and cozy during the winter. This is a critical component of sustainable architecture that incorporates both active and passive strategies for instance, proper insulation in walls, roofs, and floors can prevent heat loss and that is exactly what happens in historical building due to their life expand and sense the intervention was not done from the start its essential to consider different measures like local climate etc. to make the proper type of intervention. (see figure 1).

II. 1.2. Summer comfort:

To ensure summer comfort, the focus will be on protecting the home from overheating and maintaining its cool temperature indoor by enhancing its insulation, improving the quality of its glazing and solar protection, as well as optimizing ventilation and air renewal in the rooms all while minimizing the energy use. These measures will contribute to creating a more comfortable living environment during the warmer months, this entails conducting a detailed examination of the building's existing features, the local environment, and the tenants' needs and habits. This allows for the creation of a comfortable, energy-efficient space that is in agreement with its surroundings while also respecting its architectural heritage (see figure 2).

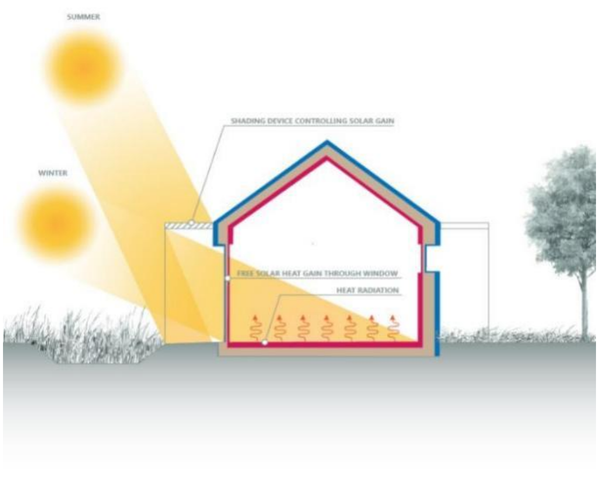


Figure 1: winter comfort, free solar input in winter and summer, source:architecture-bynature.com

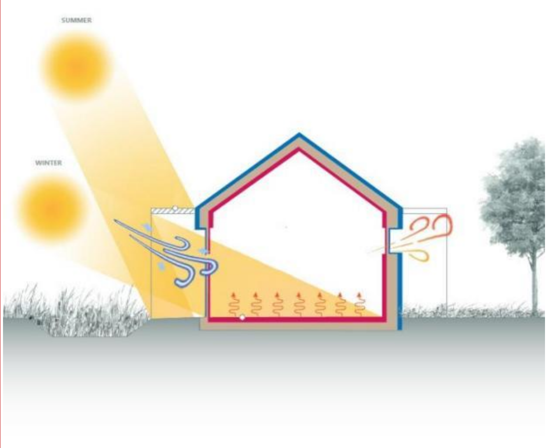


Figure 2: Summer comfort, free solar input, and natural ventilation, source: architecture-bynature.com

1.3. Thermal inertia:

The concept of thermal inertia in building energy rehabilitation involves maintaining or enhancing a building's ability to store and release heat regardless of the season. It's defined by the rate at which the building heats or cools down, which is contingent upon the external temperature [Amaryllis Audenaert, 2018]. Thermal inertia served as the foundation for vernacular construction during times of limited energy resources.

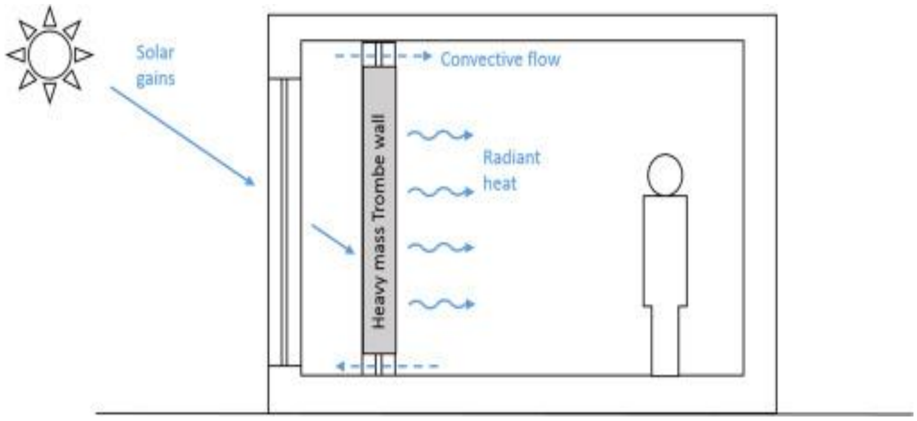


Figure 3: the reaction of the building to a thermal inertia, source: sciencedirect.com

1.4. Airtightness and thermal bridges:

Airtightness and thermal bridges are critical considerations in building design and construction. Proper attention to these factors not only enhances energy efficiency but also contributes to a healthier and more comfortable indoor environment.

- Airtightness plays an essential role in ensuring controlled air movement within a building. Poor sealing can lead to increased energy consumption and reduced indoor air quality. Therefore, it is imperative to address airtightness before installing ventilation systems or efficient double glazing to maximize their effectiveness (see figure 4).
- thermal bridges, characterized by linear heat losses, can contribute to substantial energy inefficiencies. As the level of thermal insulation increases, the impact of thermal bridges becomes more pronounced, leading to potential condensation problems and reduced thermal comfort within the building.

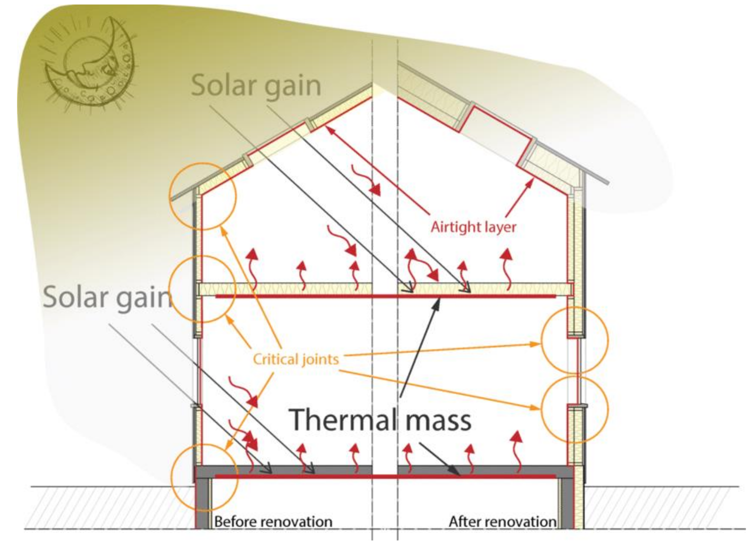


Figure4 : Typical critical joints for thermal bridges in a residential building, source: researchgate.net

2.The main technical solutions for energy rehabilitation:

There are passive and active techniques available to optimize energy consumption in thermal and energy rehabilitation. These techniques involve enhancing the building envelope, improving lighting, heating, cooling, ventilation, domestic hot water systems, and harnessing solar energy.

2. 1. Passive Intervention Solutions:

Passive Intervention Solutions improve the building's original architectural design. Which improves the efficiency of existing constructive systems, they also increase the comfort levels of users.

This group of interventions is essential for heritage architecture rehabilitation and helps improve building efficiency [Lauren Etxepare,2020]. It classified the active intervention solutions to reduce demand into 4 large groups:

2.1. 1. The first group:

The first group is the group of application technologies; it's in an opaque envelope for facades. These were divided into three types:

- The first type was solutions on the outside (see figure 5):

To choose the exterior insulation system, we need a synthetic or mineral coating. The coating must have these characteristics:

- ✓ Waterproof.
- ✓ Permeable to water vapor for drying of the masonry behind the insulation.

- ✓ Good mechanical resistance and a certain aesthetic appearance.
  - The second type was solutions on the inside (see figure 6):

When the exterior renovation is in good condition, to solidify the house´s insolation and ensure insulation from the inside, it is essential to consider:

- ✓ The exterior facing wall must be in good condition and capable of withstanding bad weather since there is no longer the influence of the internal climate.
- ✓ The interior load-bearing wall is dry and protected from infiltration.
- ✓ Sufficient inertia.
  - The third type is technologies to improve opaque envelopes through their air chamber (see figure7):

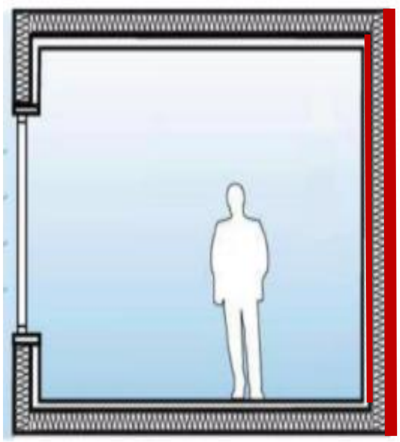


Figure 5 An opaque envelope from the outside source: green-building-envelopes-101, edited by the author

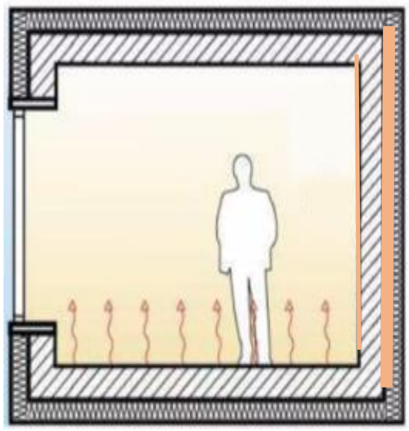


Figure 6: An opaque envelope from the inside source: green-building-envelopes-101, edited by the author

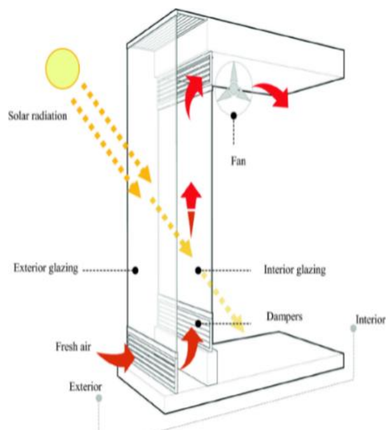


Figure 7: improve opaque envelopes through their air chamber, source: springer.com

2.1. 2. The second group:

The second one was the application technologies group. They used opaque envelopes for roofs. There are two insulation solutions: one on the outside (see figure 8) and one on the inside of the flat roof (see figure 9). Insulating the floors reduces energy consumption by 5-10%. By insulating the ceilings or floors of cellars, you can save 5-10% of total energy.

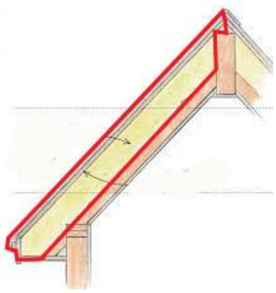
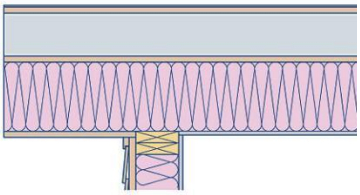
	

Figure 8: insulation solutions: one on the outside ,edited by author , source : gstatic.com	*Figure 9: Flat roof insulation: one on the outside, Source: finehomebuilding.com*	*Figure 10: Floor insulation between levels, source:rockwool.com*

- Roof insulation saves a lot of money because it significantly reduces energy use. The roof is responsible for up to 2/3 of the heat that enters a building, but reflective and insulated roofs can prevent this heat from getting inside.

- insulating the decks between stories and insulating partitions between non-heated areas and dwellings.to determine the insulation choice for a floor, we assess its thermal quality based on several criteria. These criteria include:

- the construction of the floor,
- the connections between the floor and adjacent vertical walls, and
- the presence and nature of any air volume under the floor.

When renovating a home, insulating the floor can be challenging. However, if there is a crawl space or a cellar, it is possible to install insulation below the slab [see figure 10].

2.1. 2. The third group:

This group is the group of application technologies in glazed envelopes that affect windows: carpentries, the different glass solutions, and shading elements that prevent the heat but let the light through the windows (see figure11).

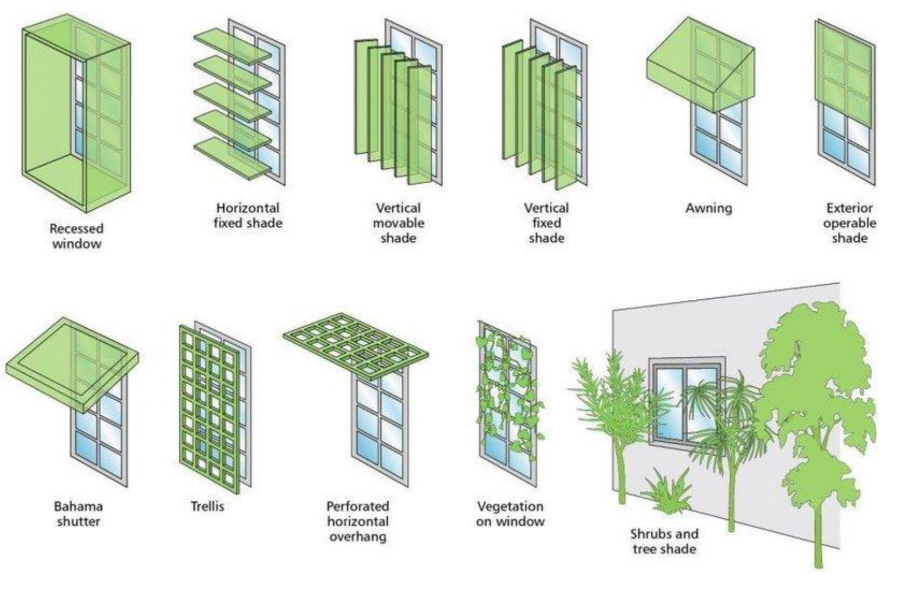


Figure11: All types of shading for a better insulation, source: .researchgate.net

-There are three types of glazing: clear, absorbent, and reflective. To improve glazing's ability to keep heat in, heavy gases like argon or krypton can be put between the glass layers. Another way to improve glazing is to add a layer of silver oxide on the inside glass. These methods make glazing more effective than regular glazing (see figure 12 and 13).

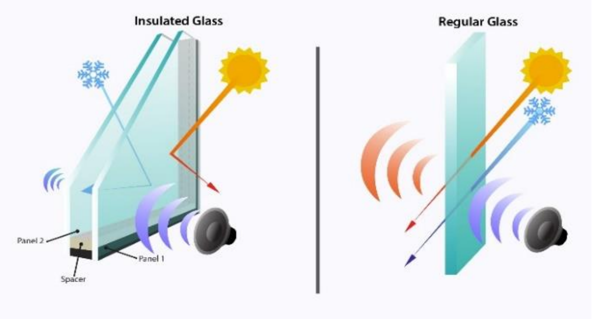


Figure 12: the difference between a regular glass and double glass for sound and heat insolation source: : ldycdn.com

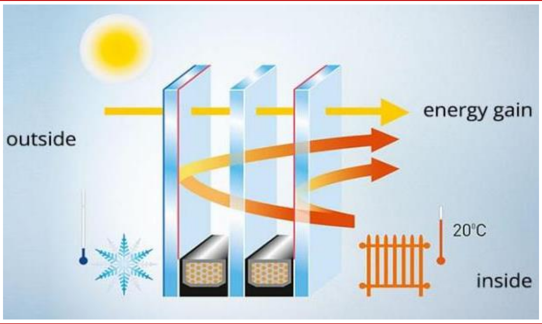


Figure 13 : triple glass effect for a better insolation ,source: windows24.com

- Finally, we contemplated other interventions in building elements.

The windows and joinery need to prevent heat loss. The materials used for joinery determine how effective it is. There are three types of joinery:

- Wooden joinery is good at keeping heat in but needs regular maintenance (see figure14).
- PVC joinery also keeps heat in but has mixed effects on energy and the environment (see figure15).
- Aluminium joinery is durable and can be combined with wood (see figure 16).

		
Figure 14: wood window frame with double glass,source: assets-global.website-files.com	*Figure 15: PVC window frame with single glass ,source : swastikaluglaze.com*	*Figure 16: Aluminum window frame with double glass ,source : tostemindia.com*

2.1. 2. The differences between the three types of carpentries:(table 1 below)

Wooden windows	**uPVC windows**	**Aluminium windows**
- Regular maintenance to guarantee great aesthetics and natural beauty. - Natural insulating properties (better at trading heat) - The most expensive window option. - With proper maintenance they can last a lifetime.	- Maintenance-free and easy to clean. - Extremely thermally efficient material - Low cost - Low-mid range life expectancy.	- Low maintenance. - Great thermal efficiency on higher-quality aluminum windows - More expensive than uPVC. - More robust and durable than uPVC and wooden windows.

- These passive strategies are to achieve 'Net zero-energy buildings' or 'nearly zero-energy buildings', buildings must improve performance and energy efficiency by reducing energy consumption to zero or very low levels, which can be recovered by generating energy from renewable sources.

  [Rodriguez-Ubinas & al. 2014]. Recent research suggests that passive design and regional climatic conditions are crucial for achieving energy efficiency in buildings. Low-energy buildings should incorporate hybrid energy systems to reduce energy consumption. There is a direct link between energy usage, thermal comfort, and passive design.

- The between energy usage, thermal comfort, and passive design:

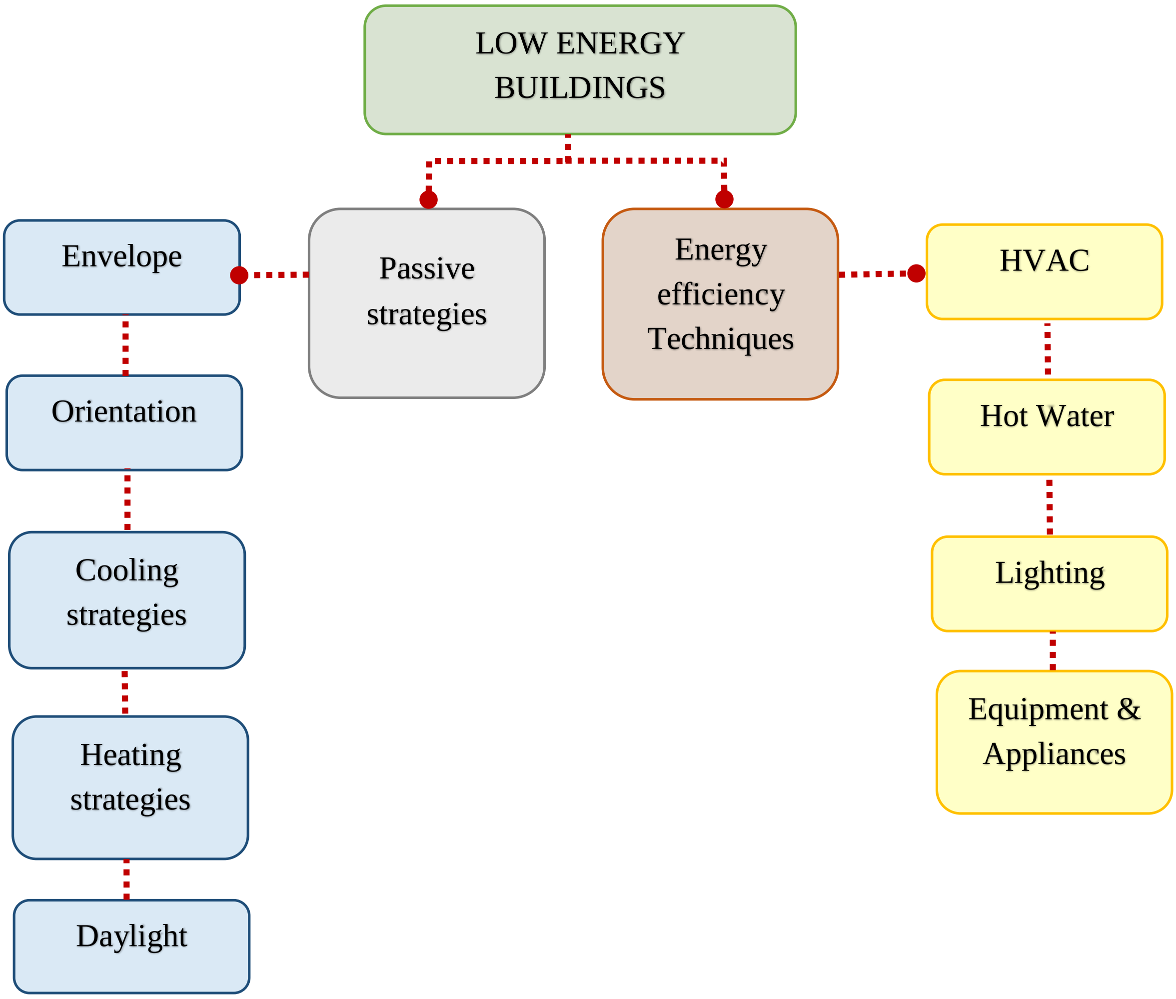


diagram 6: the link between energy efficiency techniques and passive strategies or a low energy building source: Rodriguez-Ubinas

2.2Active Intervention Solutions:

Passive actions should be the first step in energy rehabilitation. The goal is to reduce the energy demand of the building by using passive strategies as pre mentioned before. Once that is done, the systems responsible for lighting, heating, cooling, ventilation, and hot water should be as efficient as possible to reduce energy consumption.

Low consumption active measures were implemented to work together with the passive strategies or a building that is not only energy efficient but produces more energy than its need.

In that case renewable installations, such as thermal solar energy, photovoltaic solar energy (see figure 17), wind energy (see figure 18), biomass , and the geothermal energy help reduce consumption and have less environmental impact. We can use renewable energy sources as long as they don't affect the authenticity of the building. We also have to consider protecting their heritage status.

Figure 17: thermal solar energy, photovoltaic solar energy, source:greenmatch.co

Figure 18 : wind energy in houses , source : i.pinimg.com

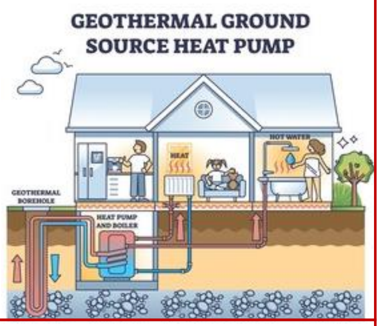


Figure 19:Geothermal energy , source : shutter stock.com

- The next step is to analyze examples where we can see the direct scenarios that can be done in energetic rehabilitation in old traditional fabric after all the data and research has been gathered to understand the relationship between the physical and cultural relationship between the environment and the creation of historical buildings and the proper interventions that must be done in different cases of historical buildings and, in the case of rehabilitation energetic, the proper interventions that must be done to achieve a low energy building all while maintaining and respecting its heritage.

III.Analysis of examples:

1. the Montarroio case study, in a degraded area of Coimbra, Portugal:

This was an experiment to determine the best technique for an old building located in the traditional fabric of Coimbra's ancient city center. Montarroio, where they established five superposed intervention scenarios using BIM chronological dimension the information is summarized in the following table:

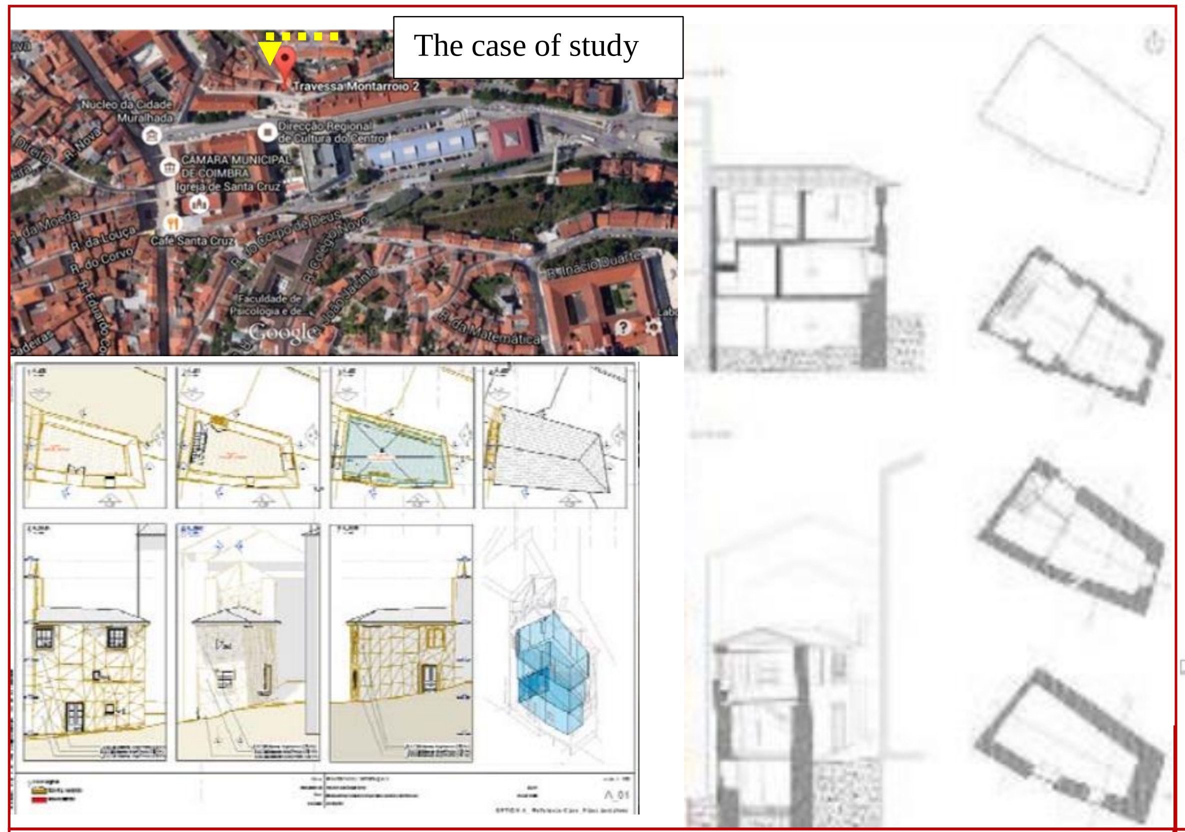


Figure 20: The location , plan and measurements of the house in Coimbra, Portugal, source: EECHB-2016 Energy Efficiency and Comfort of Historic Buildings

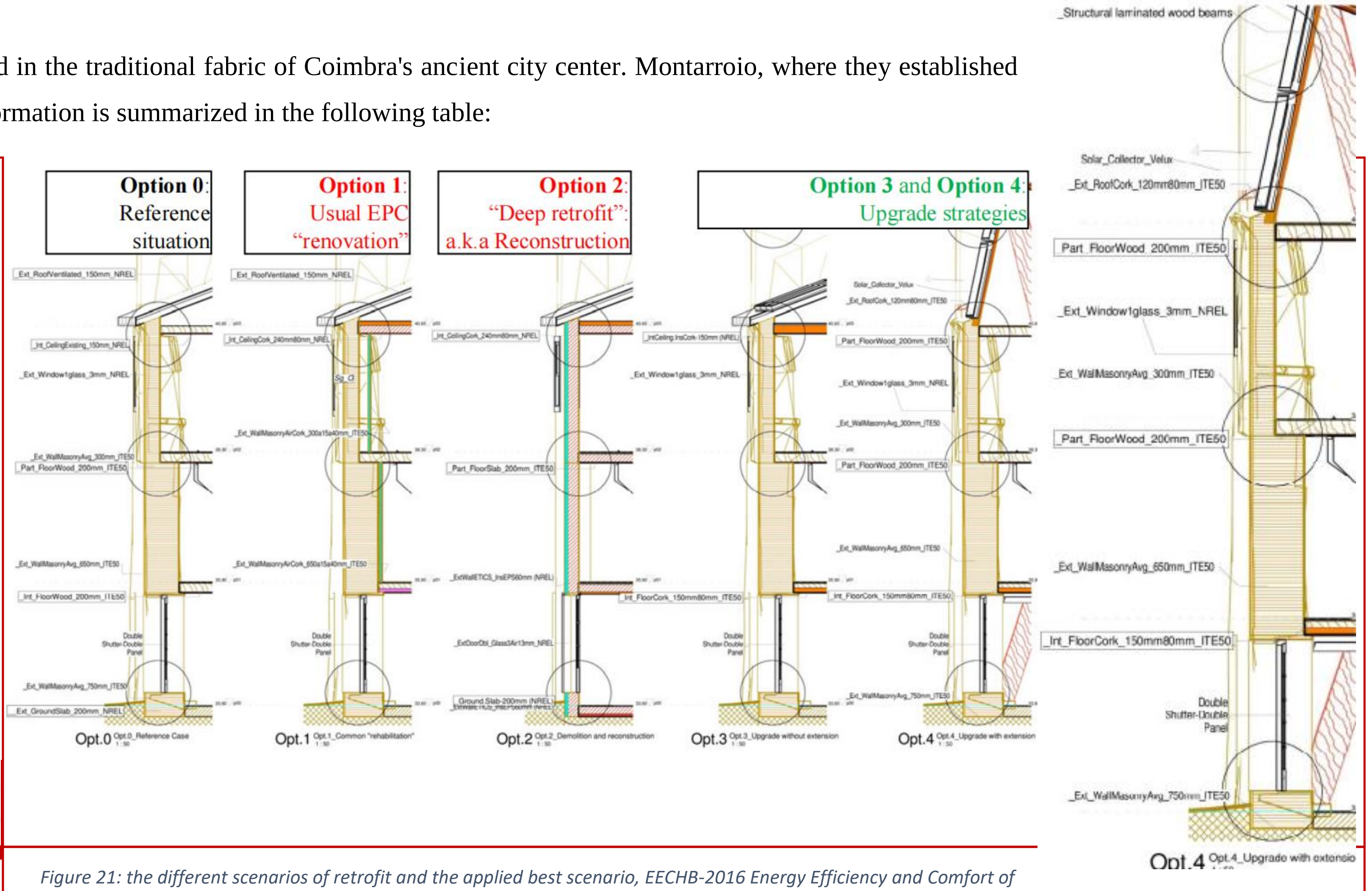


Figure 21: the different scenarios of retrofit and the applied best scenario, EECHB-2016 Energy Efficiency and Comfort of Historic Buildings

Location	Dimensions and measurements	Intervention scenarios	Results of the Intervention Scenarios
located in the center of Coimbra Portugal, with strong restrictions imposed by its location facing "Jardim da Manga" National Monument, and the UNESCO protection area. Total site area: 22 m2 Useful heated area: 35,86 m2	measurement, Laser Scan, Photogrammetry, and drone aerial views were done to assess the situation and state of the house	Five scenarios were made based on the type of intervention: - option 0 is the reference to the actual state -Option 1 is rehabilitation change and upgrade the ceiling the interior walls, - option 2 is demolishing and reconstructing -Option 3 is upgrading with and without an extension -In option 4 upgrade rehabilitation with extension.	the best option in all scenarios is rehabilitation upgraded strategies without extension followed by rehabilitation upgraded strategies and the worst in this case is demolishing and reconstruction in Initial Investment, annualized Life Cycle Costs (LCC) in 30 years [see annex]

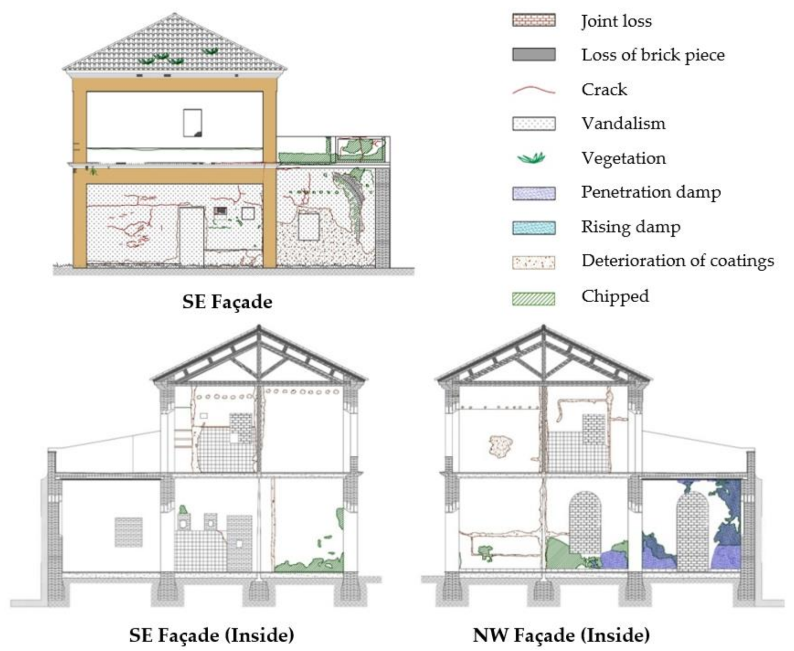
- This example shows that the best option is in numerous circumstances. It's crucial to remember that, even though it was the ideal intervention in this specific instance, it might not be the greatest course of action for all ancient buildings. Every structure is distinct in terms of its historical significance, construction techniques, materials, and architectural style. As such, the rehabilitation plan needs to be customized to the unique attributes and requirements of the structure. This shows that it is possible to achieve energy efficiency while honoring the building's architectural heritage through careful design, implementation, and ongoing management. This not only preserves our architectural legacy for future generations but also provides a cozy and environmentally friendly space for the building's occupants.

2. Sustainable Retrofitting Criteria in Heritage Buildings: Case **Study in Seville (Spain):**

This example suggests two intervention/rehabilitation strategies The chosen location is a secure structure in Seville, Spain's San Bernardo district [María Cimiano-Prados 2023]. In this regard, and with a primary focus on the positive characteristics of the building envelope. Each option's positive, energy, environmental, and financial elements are compared and evaluated.

The rehabilitation of the historic 19th-century "Pabellón de Vías y Obras" structure in Seville, Spain's San Bernardo area. This case of study classified the site as a partially protected building any interventions must preserve the roof system and façades see Figure 24 of the current state After taking all the necessary measurements of the current state obtaining the necessary documents for the architectural building plans and assessing the damage see Annex 2, two models were:

Figure 22: current-state pictures and section , source : creativecommons.org



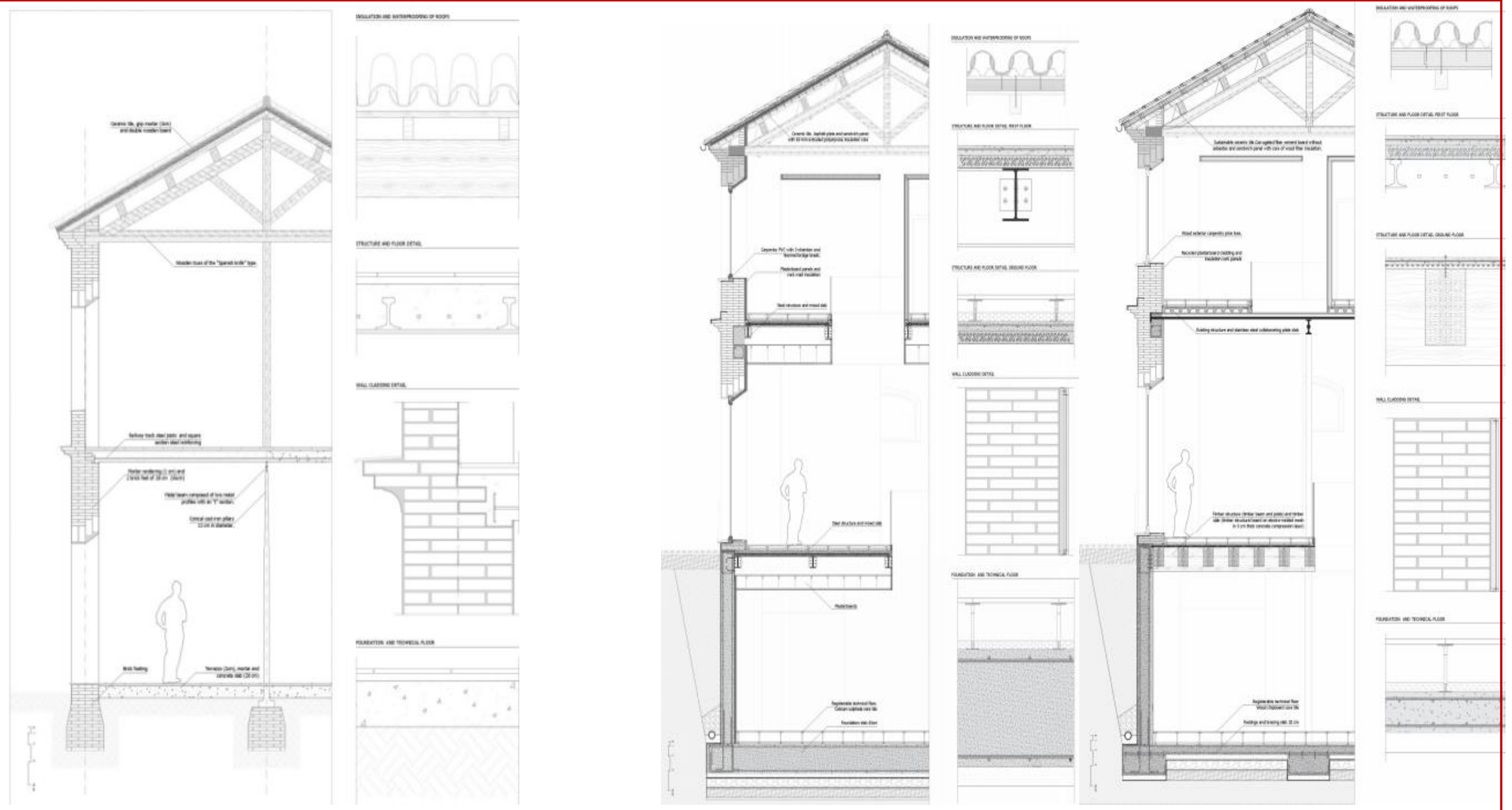


Figure 23 : The dirent section o the current state, model A and model B , source creativecommons.com

- the building interventional sheet with both models and their results:

Current state	Model A	Model B	energy consumption of both models
The envelope is generally characterized by a very slow, cumulative deterioration brought on by bad weather and inadequate upkeep. See Annex 2	The traditional plan preserves the roof's "knife"-style wooden truss while demolishing the existing steel structure to construct a new metal structure See Annex 2 for the constructive details	The eco-efficient plan is alternative that seeks an to decrease the amount of trash produced during transportation. Respecting the ceiling in the shape of a "knife" and other steel railway parts that support the bottom floor, are to be preserved.	comparing the overall qualifications for both solutions, a small reduction in proposal B's use of non-renewable primary energy and its carbon dioxide emissions as compared to model A by 2%, scoring a C certification for both models. See Annex 2.

- The tactics employed in these models offer insightful knowledge for further rehabilitation initiatives, the aim is to encourage sustainable and respectful approaches in the energetic rehabilitation

➢ CONCLUSION:

After the state-the-art and the two examples analysis, it’s important to determine that a building's energy efficiency can be achieved while maintaining its architectural legacy, which is a difficult balance that calls for careful design and implementation.

First and foremost, it's critical to recognize that each structure has a distinct architectural style and historical value. These components must be preserved when working on any kind of rehabilitation and not only energetic rehabilitation. This means that any energy-saving strategies must respect the building's historical integrity and be considerate of its current architectural characteristics.

This can only be accomplished by doing a thorough evaluation of the building's energy performance and current state. This entails examining the building's layout, materials used in construction, and usage trends to find areas where energy efficiency can be raised without detracting from the building's unique features. To lessen heat, gain in the summer and loss in the winter, for example, insulation can be added to the building envelope; however, this must be done without altering the building's appearance.

Next, it's important to choose energy-efficient technologies and systems carefully. Modern, highly efficient heating and cooling systems can greatly enhance a building's energy efficiency, but to preserve the building's historic charm, they must be smoothly incorporated into the architecture. For instance, solar panels can be mounted on a building's roof, but their placement needs to be such that they don't obtrusively block the view.

In addition, the building's inhabitants have a significant impact on how energy-efficient it is. The total energy efficiency of the building can be greatly impacted by teaching people about energy-efficient practices and giving them the resources to track and manage their energy use.

Energy rehabilitation is an ongoing process, rather than a one-time event. The successful operation of energy-saving measures and the preservation of a building's architectural legacy rely on routine monitoring and maintenance.

CHAPTER III: CASE OF STUDY

- **Introduction**:

Blida is a city with a population of around 180,000 people, located at the contact of the Atlas Blideen and Mitidja, and is situated about 45 km from Algiers, the capital of the country. The city's name comes from the Arabic word "Belda", which means a city, town, or small country. Blida was founded in 1519 by Sidi-Ahmed El-Kebir and it welcomed Andalusian immigrants. The Old Town of Blida has undergone many changes over the years but still retains its charm. Its identity is linked to its streets, squares, Hammamet, and mosques, and its culture is deeply ingrained in the memories of its inhabitants.

The city is renowned for its French-influenced architecture and modern, tree-lined streets. It has a rich architectural and urban heritage, characterized by an organic fabric inherited from the Turkish era, which was further developed during the colonial period. Like every medina or Casbah, the old town of Blida has its own unique culture, traditions, and customs, shaped by its inhabitants.

Figure 24 : view of the colonial facade, source: pinimg.com

Figure25: view in the upper part of Douirette, source: author

I. Urban Analysis:

I. 1. In the heart of northern Algeria:

1.1. *Central Hub:* Its location 47 km southwest of Algiers and 26 km northeast of Medea reinforces its central role in the Algerian urban network.

1.2. *Southern Border*: Blida, located on the southern edge of the Mitidja plain at 22 km from the sea, offers a transition between more mountainous regions and the coastal plain. This position uniquely influences not only its climate but also its role in regional connectivity.

1.3. *Urban Extension*: The extension of the urban unit of Blida to neighboring communes, such as Ouled Yaïch, Soumaa, Bouarfa, Beni Mered, and Guerouaou, testifies to its regional influence. This expansion strengthens the social, economic, and architectural links between these communities.

Figure 26 : the wilaya of Blida in relation to Algiers source : gifex.com team work edited by the author.

2. Metropolitan Crossroads:

Blida is a city located in the north-central region of Algeria. It has a strategic location as it serves as a metropolitan crossroads, connecting major urban centers such as Algiers and Boumerdes. This positioning has made Blida an important hub for socio-economic and cultural exchanges between these cities. The city's accessibility has facilitated the movement of people, goods, and services, leading to the growth of trade and commerce. Blida's cultural diversity and rich history have also contributed to the exchange of ideas and traditions between different communities. The city's significance as a crossroads has made it a vibrant and dynamic destination for travelers and locals alike.

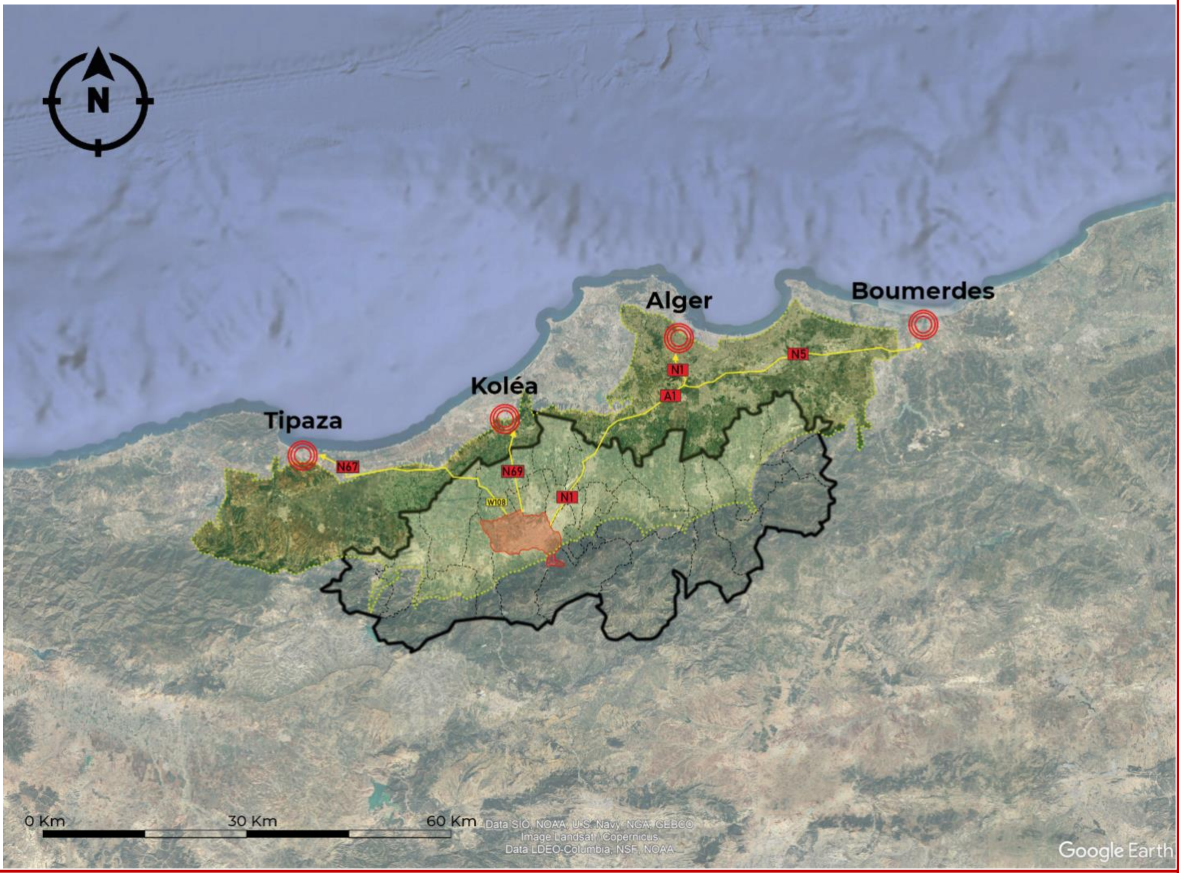


Figure27 : Blida as Metropolitan Crossroads source: google earth edited by team work author .

3. Delimited Urbanization:

- Blida's urbanization and land management faced natural and artificial challenges, including fertile agricultural land in Mitidja, sloping piedmont land, rivers, road networks, communal boundaries, railway, and the A1 motorway (East-West) (see figure below). Urbanization in this area would have a significant impact on the region's natural resources.
- The artificial constraints were the Military Zone and Industrial Zone. These zones are designated for specific purposes and are not suitable for urbanization.
    - Overall, the urbanization of Blida and land management presented several challenges that required careful consideration and planning to ensure that the region's natural resources were not compromised.

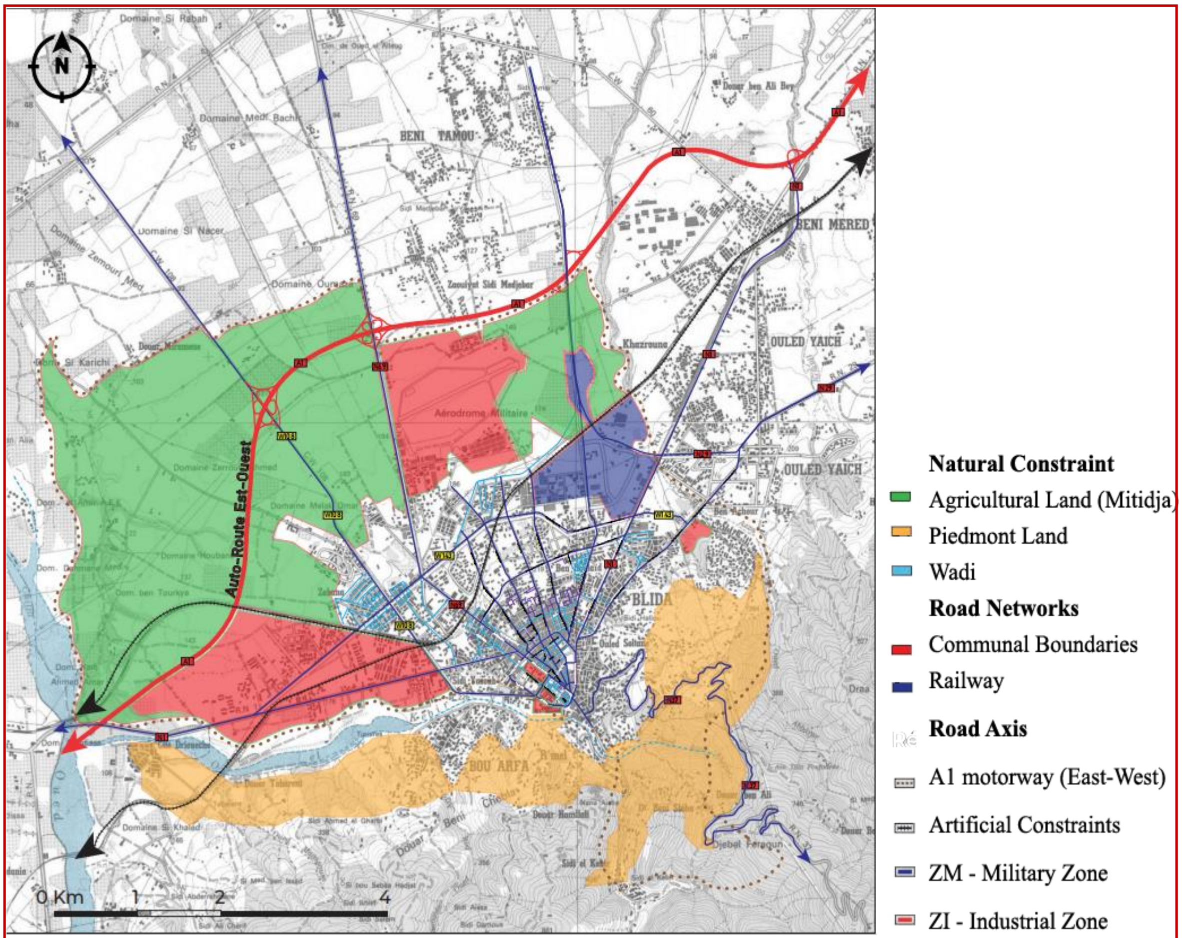


Figure28: Delimited Urbanization in Blida, source: PDAU 2022 URBAB, edited by team work author .

3. 1. Open Fan:

The territory of Grand Blida, by its privileged central position, whether at the local, regional, or national level, is a crossroads between the regions of the East, West, Center, and South encompassing all the most important urban structures. richest and richest with a local and regional character. the most modernized.

The Grand Blida is also crossed by several types of communication routes which offer it an equipped, modernized space, thus coveted by the entire regional and national population.

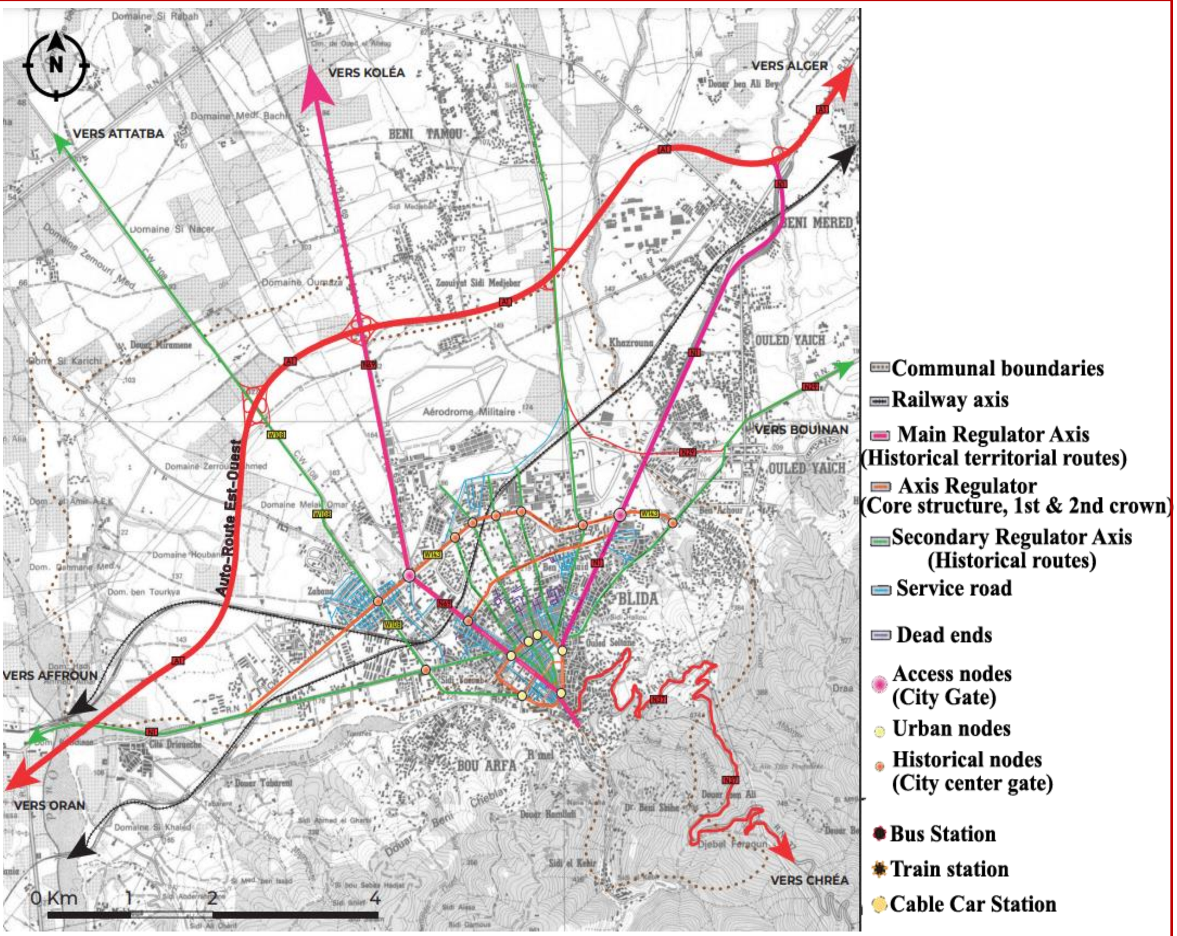


Figure29: A dive into the structure and efficiency of the city's road infrastructure source: pdau 2022 urban edited by teamwork author

3.2. Blida, between Education and Industry:

Blida is a region situated in the northern part of Tel center, spanning across 1482.8 km². It is bordered by Tipaza and Algiers to the north, Ain Defla to the west, and Médéa to the south, with Boumerdes and Bouira to the east, see figure below. The population of Blida is evenly distributed between genders, with infants comprising the largest group at 37%, followed by children at 34%, young adults at 21%, and seniors at the remaining percentage see figure below. Education and industry are the primary fields of work in Blida.

The Blida center, covering an area of 53.00 km², houses a population of 163,586 with a population density of 3,087km². The population has seen a steady annual growth rate of 1% from 1998 to 2008 see figure below.

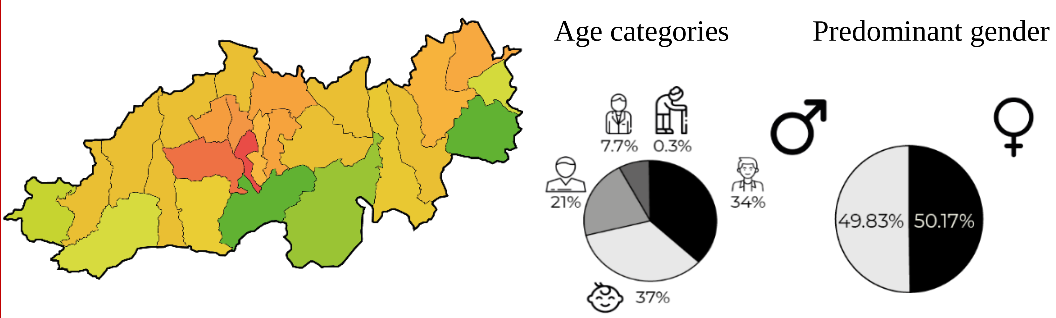


Figure 30: Blida and the age categories , source : .ons.dz

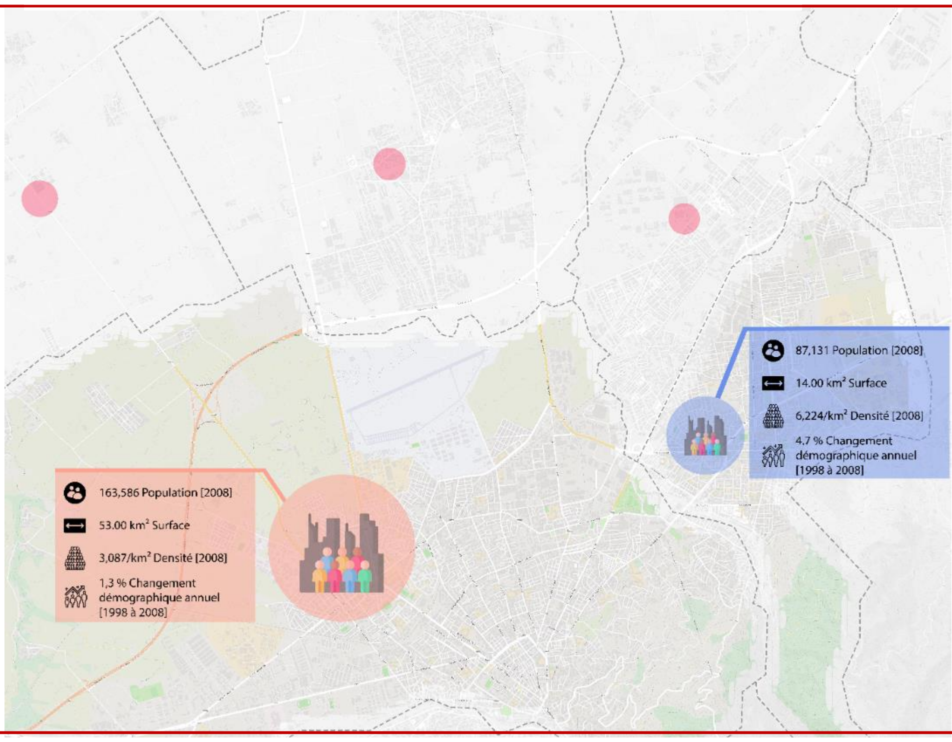


Figure 31: Scrutiny of built structures, and equipment that defines the face of Blida source: mapcarta , edited by : team work the author .

4. Growth of the Rose:

4.1 Urban growth and extension towards the fertile Mitidja Plain:

Blida is a town that was founded by Wali Sid Ahmed El Kebir in 1519. The town was settled at the confluence of the Taberkachent ouedi and was named by the indigenous population of the Bliden Atlas. The fan shape of the city was structured around the alluvial cone of the watercourse, which is known today as "Oued Sidi El Kebir» (see Figure 32). After being expelled from Spain during the Spanish Inquisition in 1520, the Andalusian Moors sought refuge on the North African coasts, particularly in Algiers and Cherchell. They constructed a small village adjacent to that of the Berber tribe known as "Ouled Soltane" in the northern region. After allying with the Turks, the city was extended and a casbah was created, guarded by a total of 5 doors, and was the center of power in front of all the tribes of Mitidja (see figure33.) Unfortunately, in 1825, there was an earthquake that destroyed a large part of Blida.

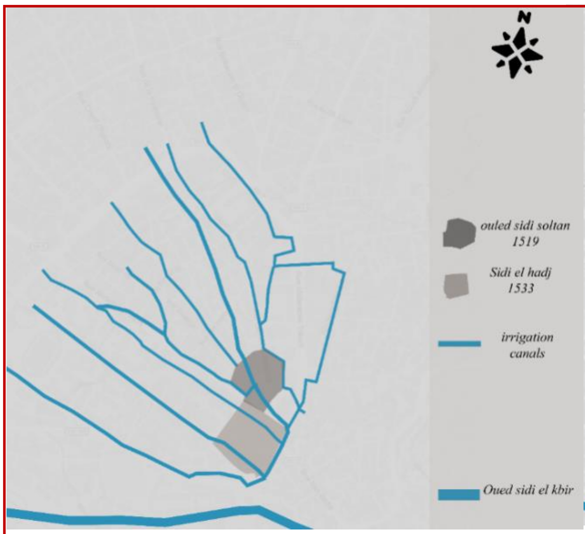


Figure 32: creation of Blida in the 14th century , source : mapcarta edited by the author

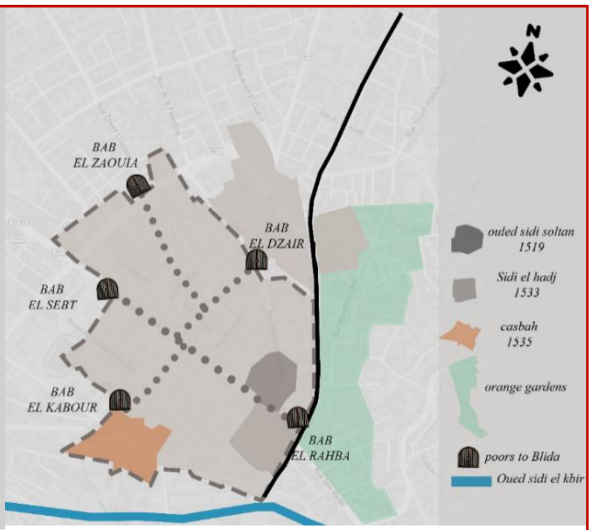


Figure 33 : the full shape of the old Blida , source : mapcarta , edited by the author

-The creation of Blida in the 14th-century Ouled Soltane in the south, Hdjer Sidi Ali in the north, 1533 followed by the emigration of the Andalusians and their settlement in the southern part of Ouled Soltane which resulted in diverting the Sidi Kbir ouedi and creating irrigation canals.

-The city allied with the Turks. It extended to the north in the shape of a fan, with three gates: Errahba, Sebti, and Kouihkha. The walls were later extended, creating the casbah with two additional southwest doors.

Soon after, the French colonization surrounded the city with two military bases and then created five more. In 1842, they took control of Blida and changed its shape by restructuring the urban spaces. This was achieved by superimposing a new frame on the old one, which led to Blida extending in a fan shape. This expansion resulted in the demolition of the rampart and the creation of new neighborhoods to the west, outside the original boundaries of the city (review figure 34) the new neighborhood was Douirette created in 1916. Between 1935 and 1960 Blida witnessed rapid growth directed by the main axes north and north-west (view illustration

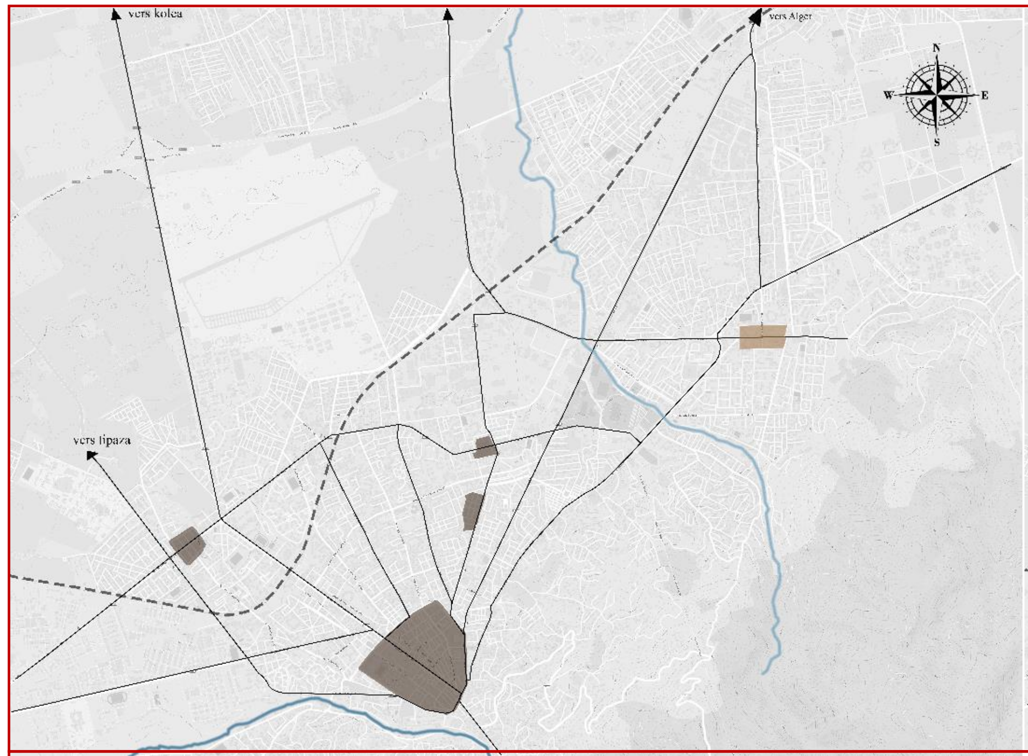


Figure 34: the start of the colonial core in Blida the first phase, source: mapcarta edited by the author.

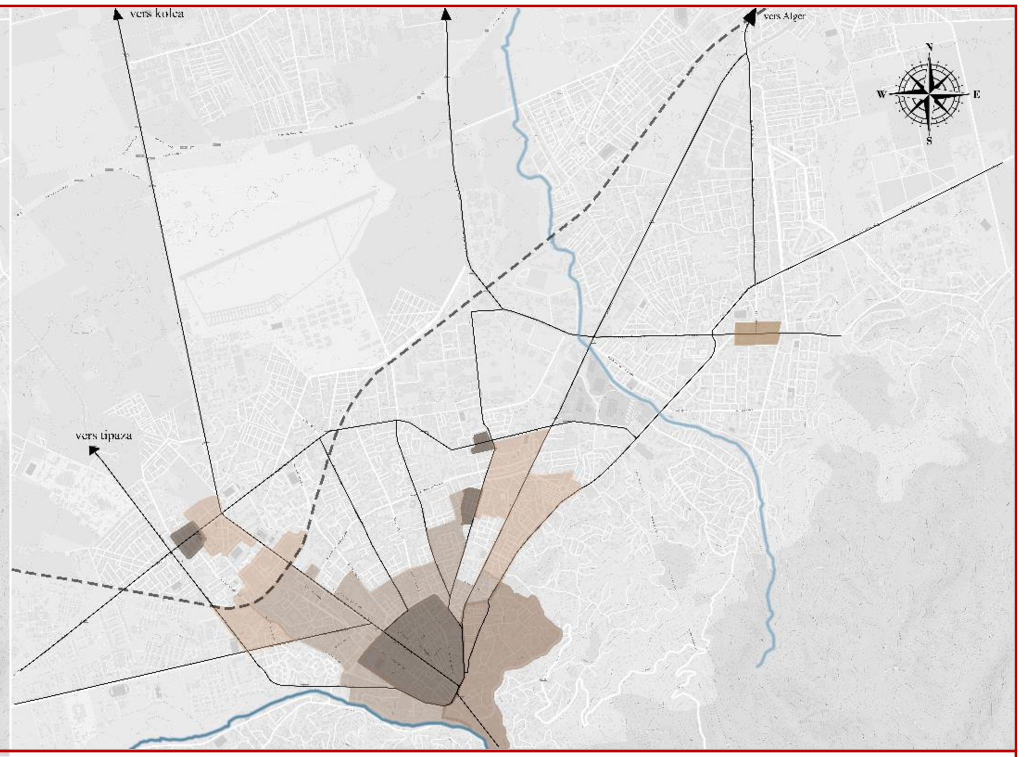


Figure 35: the evolution and expansion of the colonial core, source; mapcarta , edited by the author

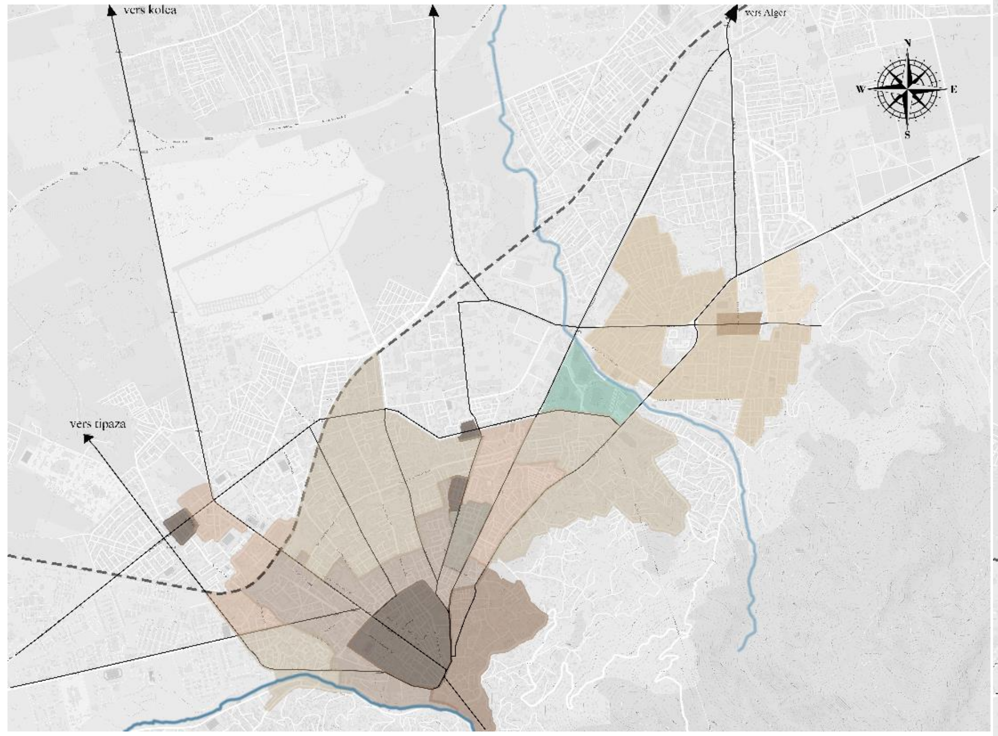


Figure 36: expansion of Blida after the revolution, source: mapcarta, edited by the author

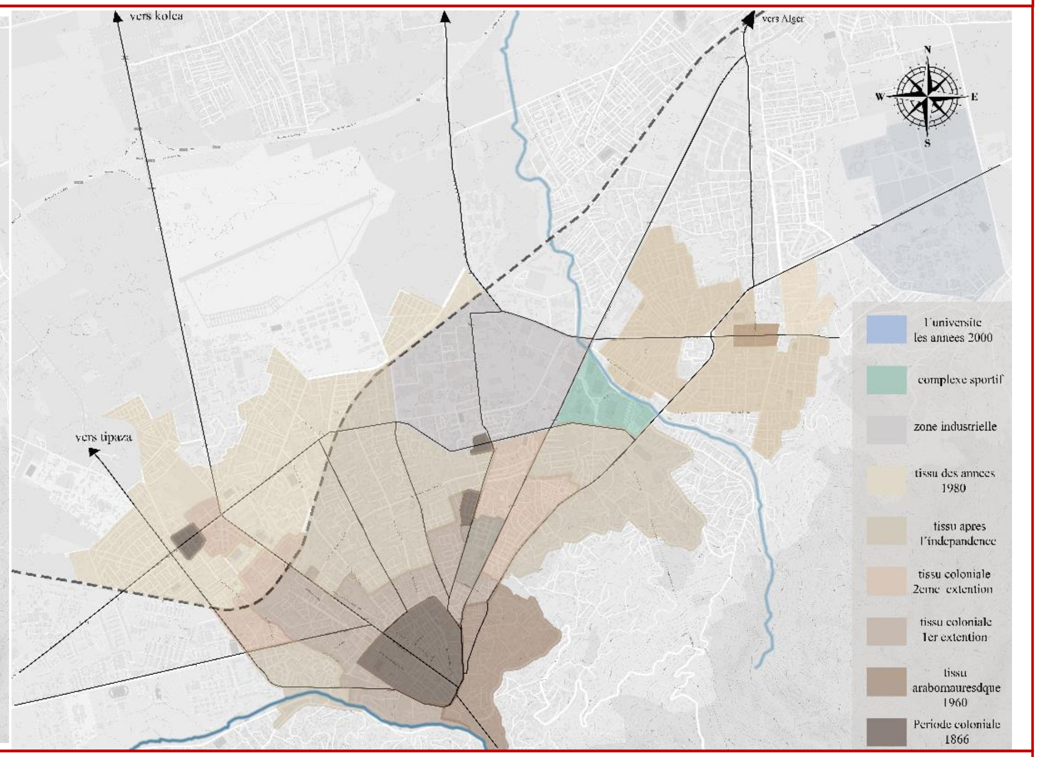


Figure 37: full bloom of Blida from the core to ouled yaich , source : mapcarta , edited by the author

4 .2. Seasons in 24 hours!

Blida's climate is characterized by a dual impact, stemming from its geographical location between the Mediterranean Sea and the mountainous terrain. The mountainous topography, which towers over the region, and the sea, located a mere 25 kilometers away, both exert a significant influence on the area's weather patterns.

- The Blida region experiences two distinct seasons annually. From May to September, temperatures rise to an average of 35°C, making it a hot and dry period. This is followed by a cold and rainy season that lasts from the end of September to March, with average rainfall ranging from 500 to 700 mm and temperatures plummeting to 12°C.

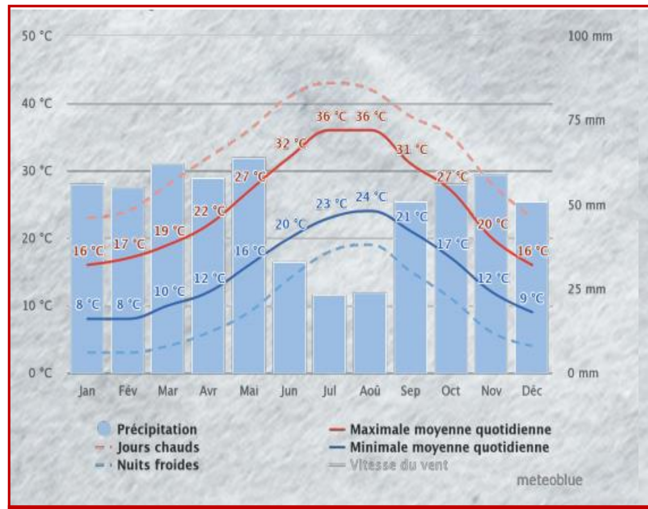


Figure 38 : the precipitation in Blida , source : meteoblue

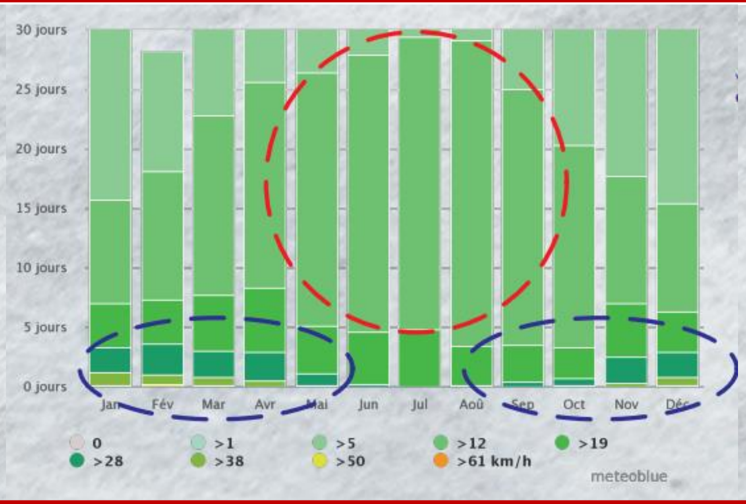


Figure 39 : hot and cold wind in blida , source : meteoblue

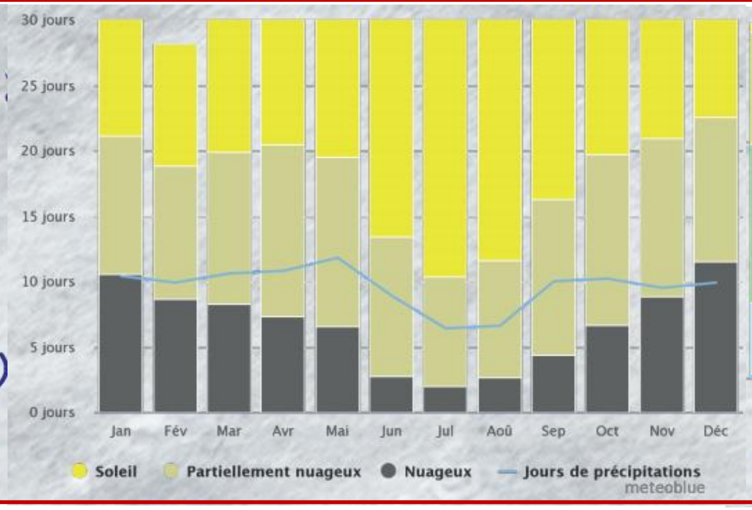


Figure 40 : tempreture in blida, source : meteoblue.

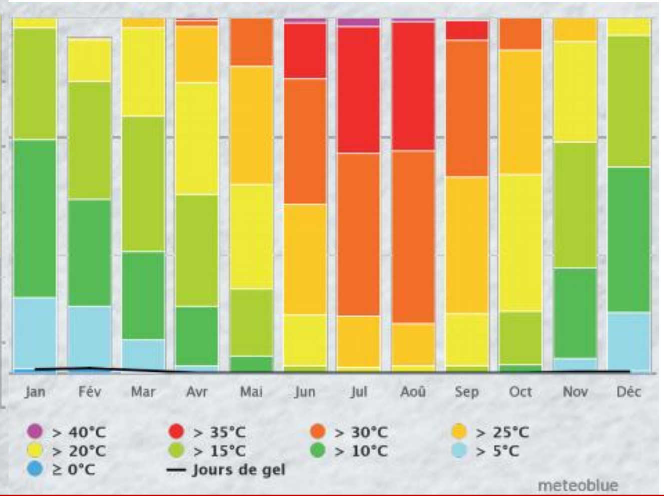


Figure 41 : ensoleillement in Blida, source : meteoblue

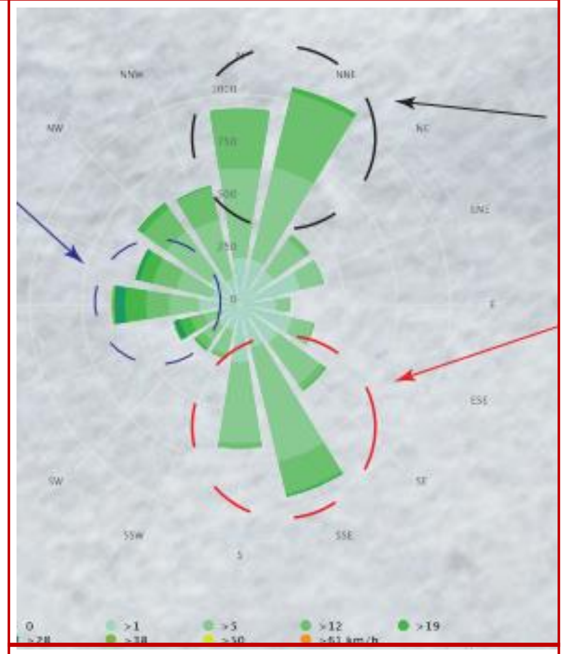


Figure 42: direction in the Wind, source: climate

- Throughout the year, the prevailing winds come from the North and North-North-East, but in winter, they shift to the West and West-North-West. During summer, the winds come from the South-East and South.
- Humidity levels in the Blida region during December and January can reach as high as 82%. However, due to drought and continentality in sirocco weather, the humidity gradually decreases, reaching a value of 57% by August.
  - ➢ After conducting a thorough analysis, it has been determined that to achieve a comfortable and sustainable living environment, it is imperative to utilize insulation materials specifically designed for thermal insulation. The use of anti-humidity materials and monitoring systems is also necessary to maintain optimal indoor air quality.

In addition, it is highly recommended to implement rainwater harvesting as a means of conserving water resources. This can be achieved by collecting and storing rainwater for use in non-potable applications such as irrigation.

Moreover, it is crucial to avoid openings on the west side of the building as this is where the sun sets and the building is most susceptible to heat gain. Instead, openings should be placed on the east and north sides of the building where there is less direct sunlight.

Lastly, taking advantage of potential solar and wind energy is vital for sustainable living. Incorporating solar panels and wind turbines can significantly reduce the dependence on traditional energy sources and promote sustainability.

II. The casbah of Blida: "DOUIRETTE"

1. Douirette from the past to the present:

1.1 the pre-colonial period:

Blida is an Algerian city nestled near the Sidi el Kbir river. Its rich history dates back to 1519 when the Ouled Sidi Siliman tribe first settled in the area, followed by sidi el Hadj in 1533. The Ottomans constructed the awe-inspiring casbah of Blida in 1553, complete with a protective rampart and five entryways. To the east of the old town lies Douirette, celebrated for its lush, fertile land teeming with picturesque orange tree gardens

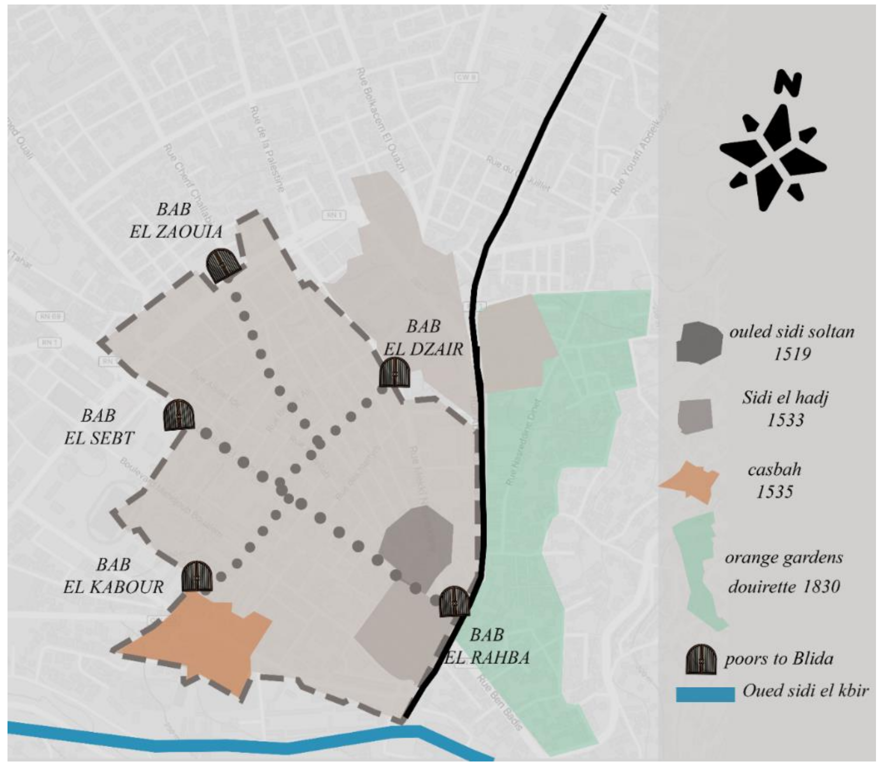


Figure43: Near the old Blida lies a fertile area filled with orange tree gardens: "Douirette" source: mapcarta, edited by the author

1.2. colonial period:

Blida underwent a significant transformation during the colonial occupation. The once fertile orange orchards in the eastern region were replaced by an Arab-Andalusian style fabric and Douirette was established in 1916. The Algerian citizenry's living quarters were also engulfed by colonial buildings, much like the casbah of Algiers. However, unlike Algiers, only a small number of colonial buildings were erected in Blida, and the occupied section was established post-mask

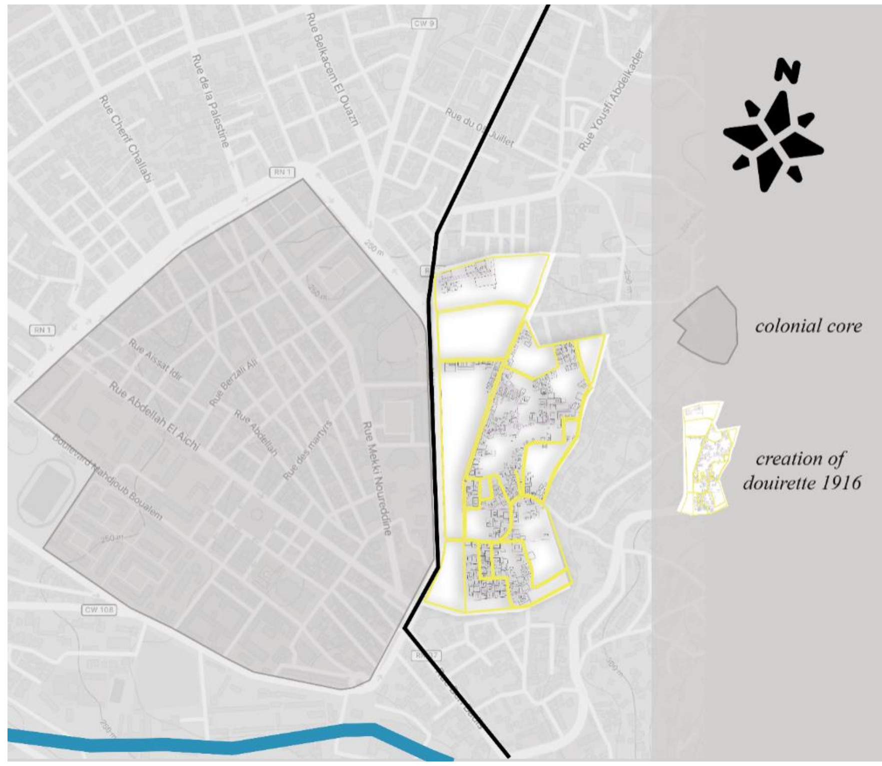


Figure44: The Creation of the casbah of Blida:" Douirette 1916" , source : mapcarta , edited by the author

1.3. Douirette in the post-colonial period:

After the liberation of Algiers, the city experienced significant urban growth which led to the small town of Douirette becoming a densely populated old center. Today, Douirette stretches from the colonial core to Sidi El Kbir, and from the graveyard to near the river of Sidi El Kbir

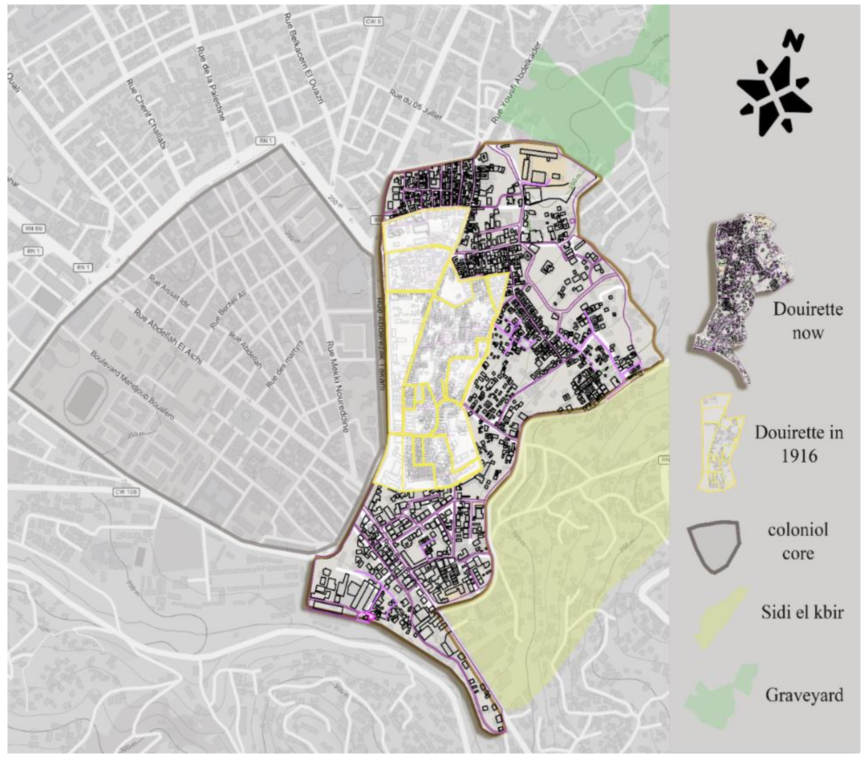


Figure45: from a Douirette to a dense old center, source: mapcarta, edited by the author

Over the years, Douirette has transformed from orange tree gardens to a small town and a refuge. It is located in the vicinity of the historic center of Blida and has witnessed numerous changes, which have given it a heritage value. However, the passage of time has not been kind to Douirette, and due to the lack of maintenance and expansion, it has become more densely populated and degraded.

II.2. access to Douirette from the big scale to the small one:

2. 1. Accessible by all roads – from Blida to Douirette-:

The POS B 18 Douirette covers a vast area of 60 hectares and is conveniently accessible via major roads such as RN n°37 towards Chrea in the south and the road leading to RN n°1 towards Algiers to the west. The site can be accessed by internal service roads, including road 9, road 69 from Oued Alleug, road 108 from Chiffa, and a road from Ouled Yaich. The entire land area of the site has already been occupied. The site is bounded to the north by the seat of the Wilaya and Cite des Palms, to the south by Cite Bouslimani Oued Sidi El Kebir, to the east by the Christian cemetery, Cite Slimane Chaachoue, Cite Bardaoui, and to the west by the city center.

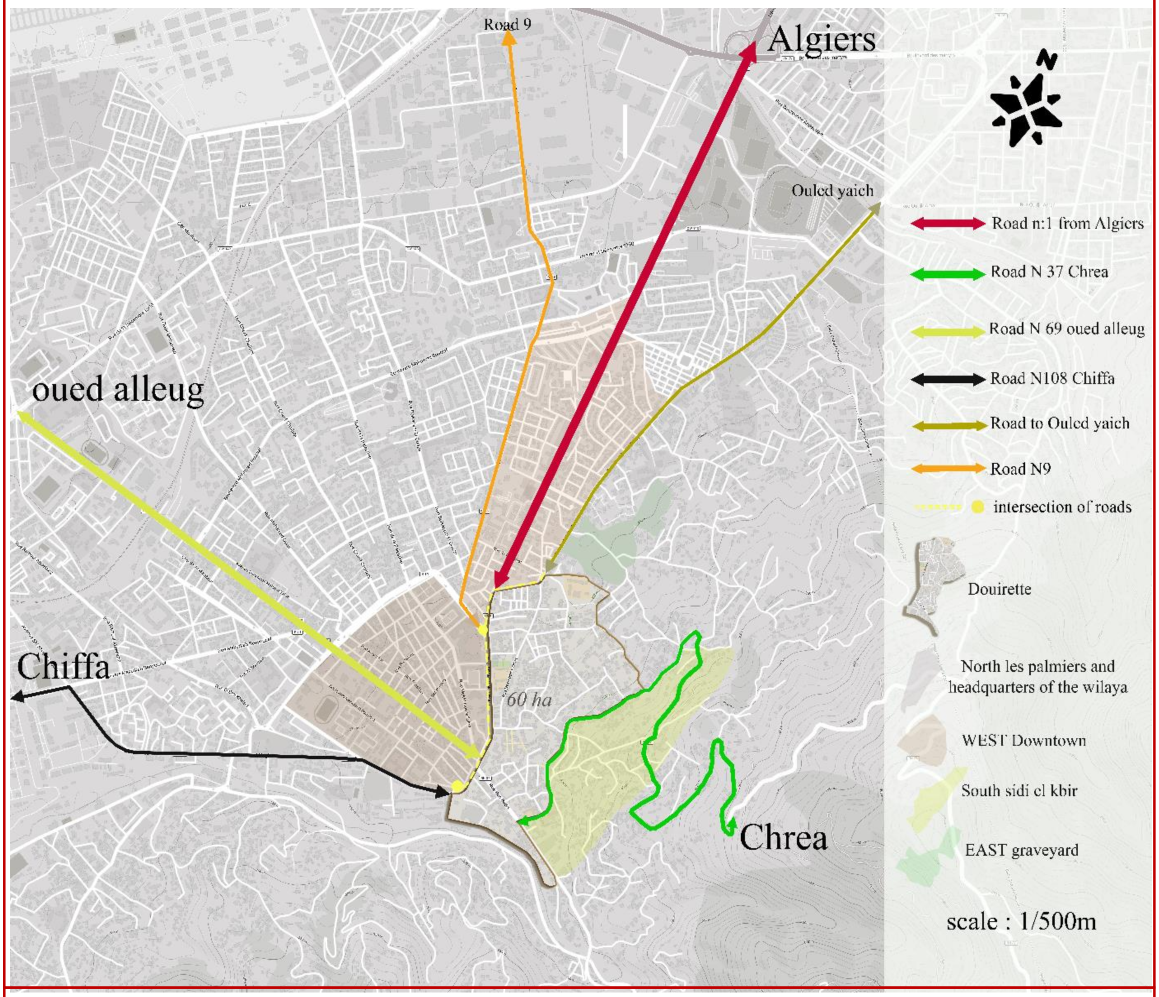


Figure46: Accessible by all roads –from Blida to Douirette- source: mapcarta edited by the author

2.2. approachable from the outside but not accessible on the inside:

compared to the small scale of blida – Douirette the later can be accessed through five different avenues: Youcefi Abdulkader, Kritli Mokhtar, Houari Mahfoud, from downtown, and El Qods Boulevard. All these avenues meet at one significant intersection, which experiences a high traffic flow. As it is an important road, multiple buses stop here, with the furthest bus stop being an eight-minute walk away, and the nearest being right at the entry of Douirette. Access to Douirette is easy, whether by car or foot, and important facilities such as a mosque, pharmacy Ben Sahli, post office, two elementary schools, and one high school (Ben Cherchali) (see figure 49). Although Douirette can be accessed from all roads from its periphery, it can be challenging to access the interior streets due to their narrow, mechanical roads. The rest of its streets are divided into three types: Mechanically accessible streets, alleys that are only accessible by foot, and impasse which are footpaths with dead-end.

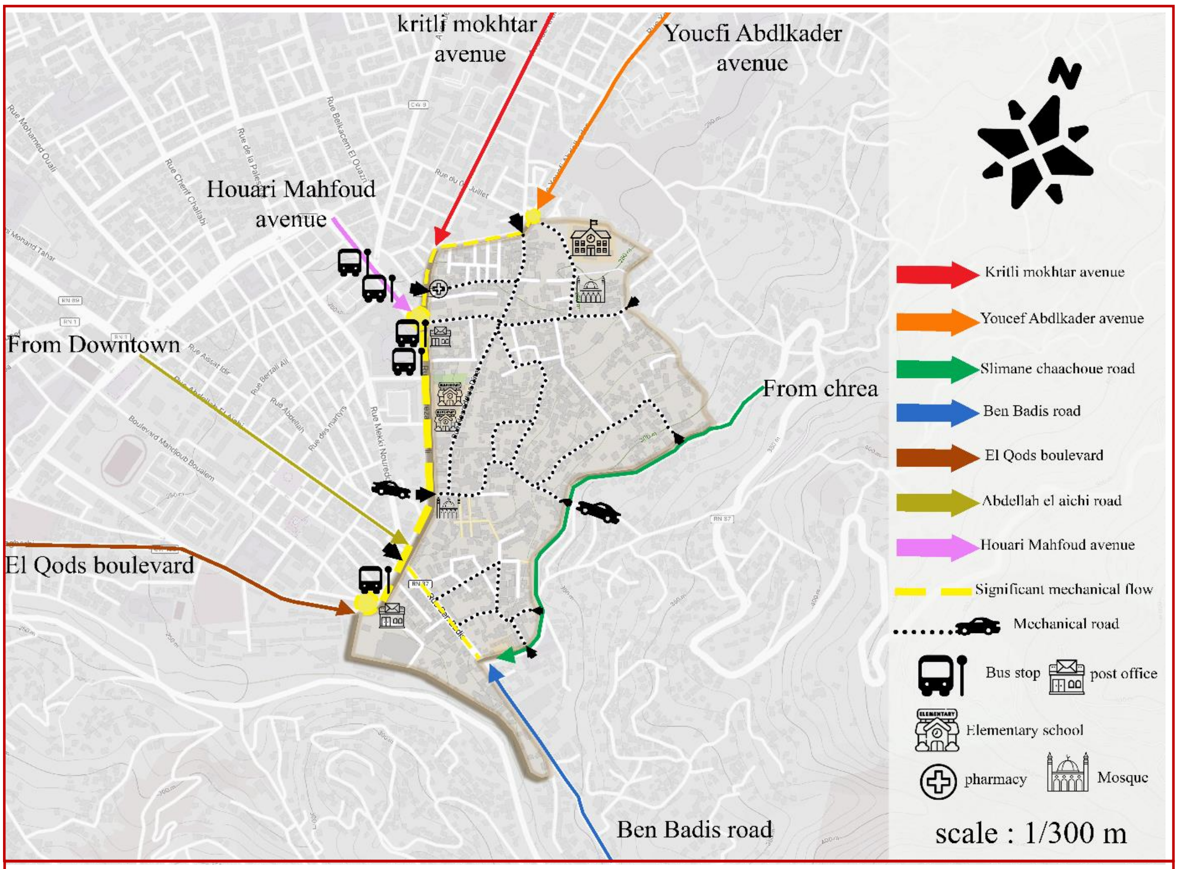


Figure47: Approachable from the outside but not accessible on the in inside source: mapcarta edited by the author

II.3.Douirette from the inside:

3.1. Form, structure, state of Douirette:

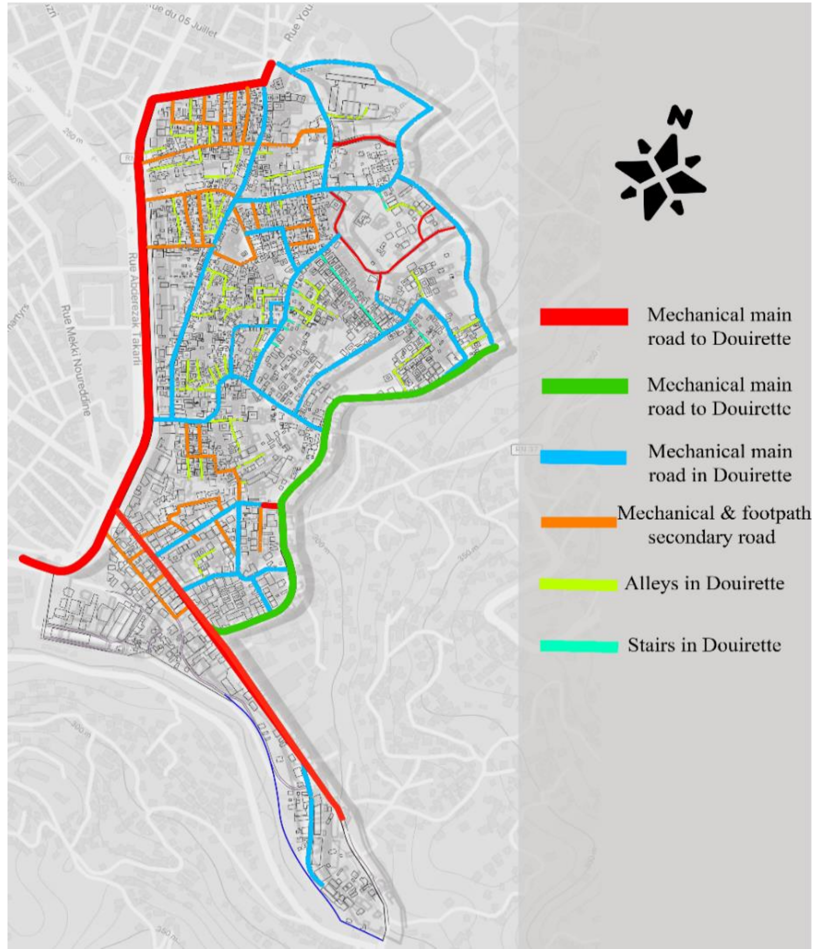


Figure 48: Closed on itself because of its few and narrow Streets source: mapcarta , edited by the author

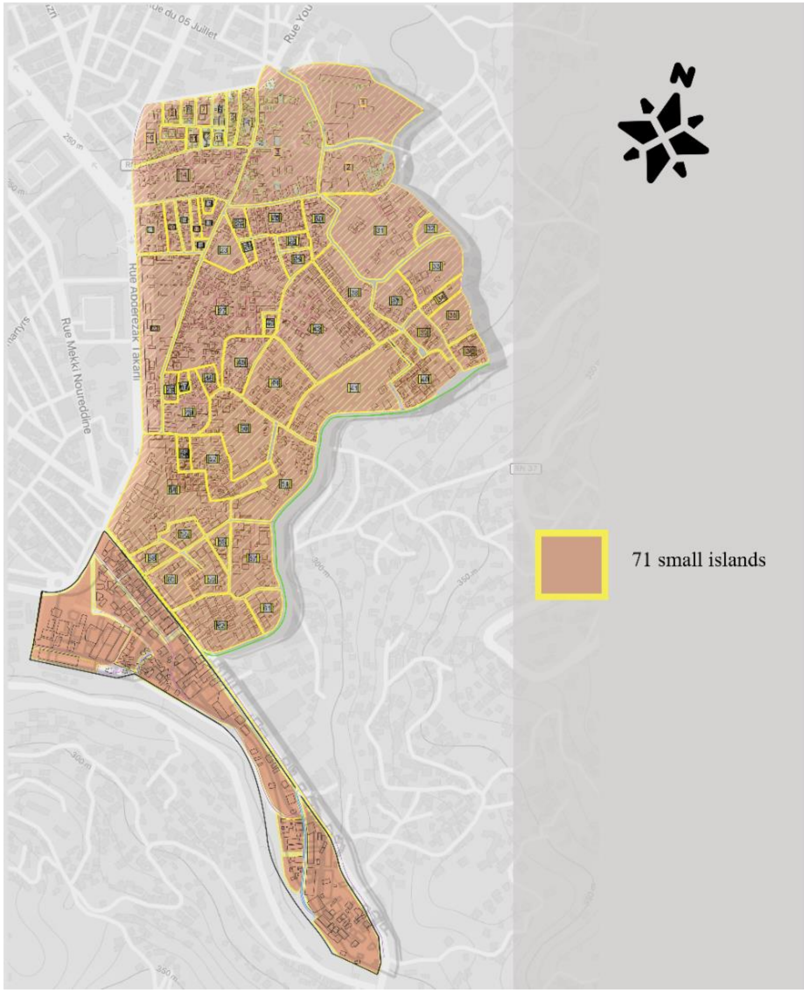


Figure 49:from the street to the Montagne with 71 small plots of land source: mapcarta, edited by the author

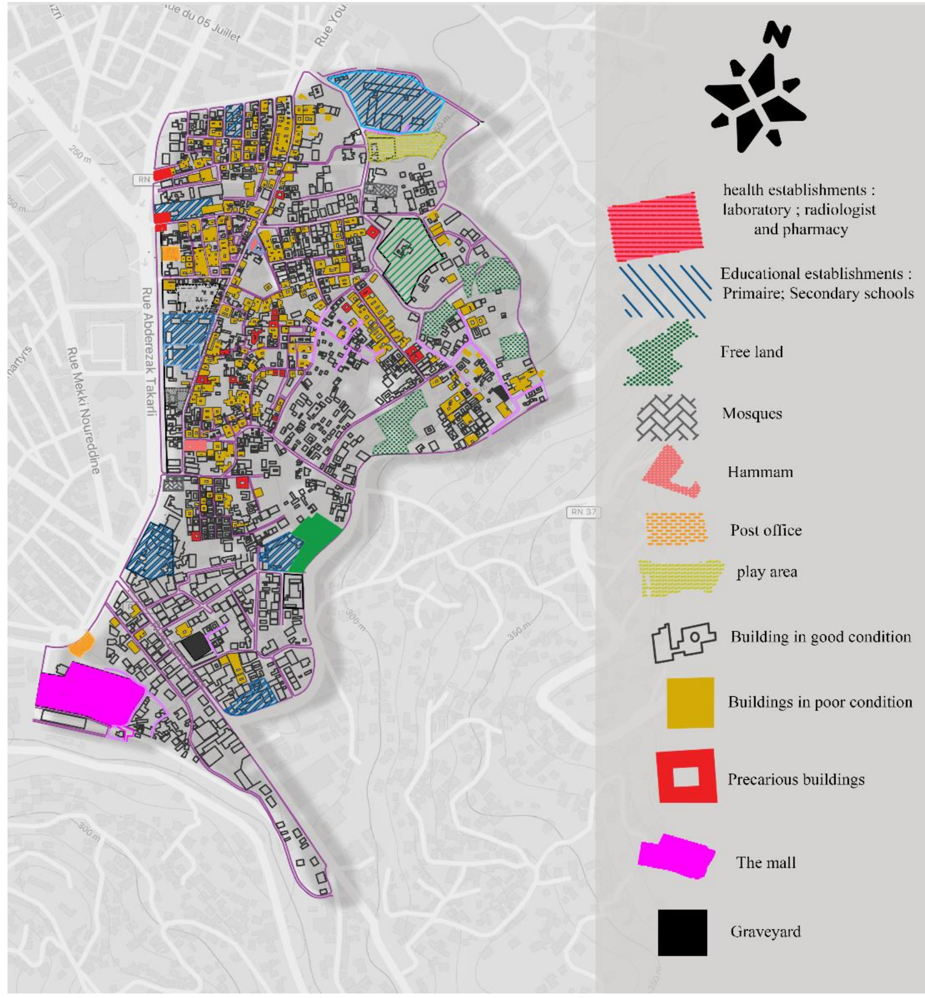


Figure50: Dense old center with few equipements and poor house condition source: mapcarta , edited by the author

- Douirette is connected by one important mechanical main road that is in red it comes from Ouled Yaich and can continue to sidi kbir or to Chrea by the green one, on the inside the main mechanical road is represented in blue which is a narrow road that only allows one car to pass, which is why there are more footpath and alleys that can be the main mean of transport. and because Douirette is an old neighborhood it has a lot of alleys that lead to a dead end , and its famous by its stairs due to its high topography.

- According to the POS B18 Douirette has expended to 71 small islets from its original state due to the high demography that is increasing every year which lead to its expending from street to the montagne near chrea.

- Although Douirette is an old center that benefits of 60 HA area but unfortunately it has little equipment and major poor housing condition, the health establishments are very few, and no big medical center, no playing area for the kids or any leisure space. The houses that are in good condition are very few with a lot of houses in poor condition or precarious house.

3.2. The state of Douirette & what remains:

3.2.*A sequential analysis: the duality of Douirette (between the real Douirette and its made-up façade):*

Figure 51: Hidden heritage by a mask of colonial houses & commerce source: mapcarta, edited by the author, photos taken by the author.

- In the figure above we can observe that much like how colonial architecture once covered the casbah with its grand facade, the lower portion of Douirette in Blida features an interesting blend of modern and colonial styles, all of which have been repurposed for commercial use. Meanwhile, the true essence of Douirette lies in its highest point, where the famous stairs ascend towards Chrea.

3.2.B sensory analysis (a look from the old road Etienne dient street):

Figure52: Etienne Dinet busy and lively street source: mapcarta, edited by the author, photos taken by the author.

- The authentic Douirette experience begins on Étienne Dinet Street, named in honor of the renowned French painter Nasr ad-Din. The street starts at the celebrated Mosque of Moudjahid and passes through the local market, offering several noteworthy attractions, such as the oldest hammam, Moukhat, and Zahar, a distinguished artist. Additionally, you will come across several bakeries, one of which was the oldest in all of Blida when there were only a handful of bakeries. The street exudes energy and liveliness, teeming with activity just like its showcased in the figure. The frame template on this street is mostly ground floor + 1st floor.

3.2.C sensory analysis (starting and ending with a mosque):

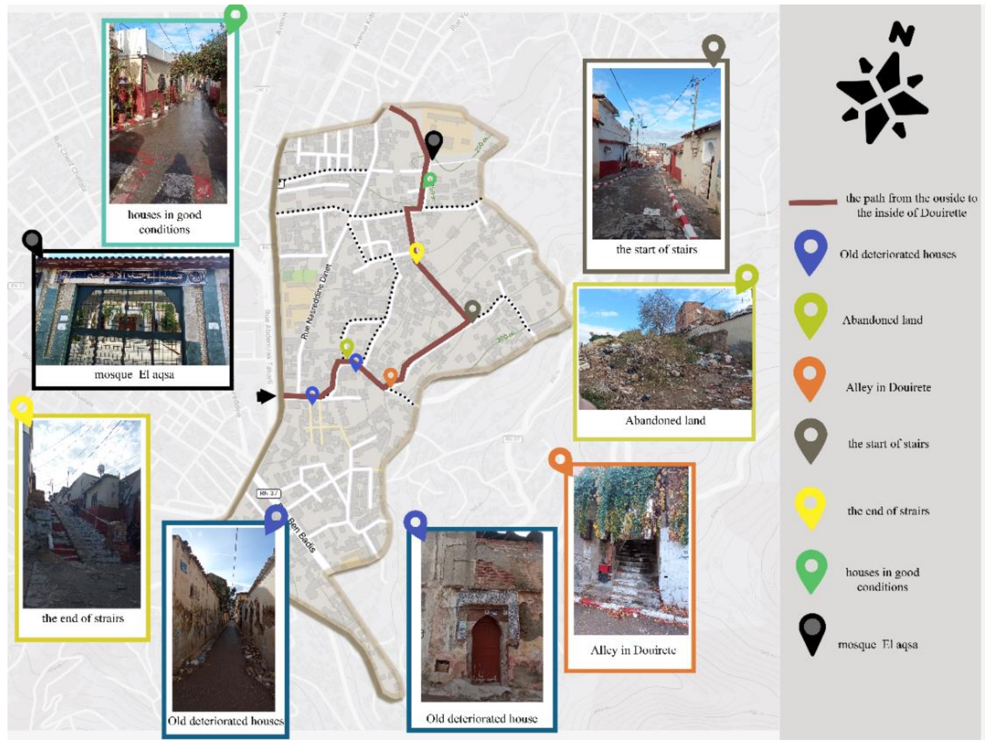


Figure53: In the depth of Douirette lies a hidden charm , source : mapcarta , edited by the author , photos taken by the author.

- Upon closer examination of Douirette, from the local market near the El Moudjahid mosque to the Mosque of El Aqsa, we observe numerous dilapidated homes and abandoned lands in ruins. Nevertheless, Douirette maintains its timeless appeal through its traditional fabric showcased by its alleys. The stairways serve as a link between the lower part, accessible by cars and foot, and the upper part, which can only be reached on foot. It is worth noting that several houses are in good condition, while others require renovation or rehabilitation to preserve the unique character and heritage of Douirette's homes as the path is show cased in the figure above.

3.3 Samples of Houses in Douirette:

Blida has a rich cultural history, shaped by the influence of its local citizens, Moresque and Ottoman populations. In particular, Douirette's architecture reflects this diversity, resulting in a unique blend of styles that can be seen in its houses (see figure below). While some resemble the houses in the casbah, it's worth noting that the interior spatial distribution is the same in all Douirette houses. The common features shared with the casbah include a gallery on the patio, arched doors, and the same tiling on the walls and floor. This is the first type of house we noticed. The second type is simple and modest, featuring only a patio with the same spatial distribution but fewer decorations. Lastly, we observed a hybrid of the first two types, featuring a patio with no gallery but decorated with tile on the walls and floor, and all arched doors. The red-tiled roof, arched doors, and introverted nature with windows on the inside are common to all Douirette houses. Most are single-story with an attic room as an addition.

Figure54:: Samples of Houses in Douirette source : mapcarta , edited by the author , photos taken by the author

III. Energetic analysis of "DOUIRETTE":

III.1. From the street to the Montagne:

The Douirette area is close to the historic core of Blida, surrounded by colonial architecture and commercial establishments at its facade. With a steadily increasing population, the urban area of Douirette is also experiencing growth, particularly towards the Chrea mountain. Douirette's topography varies from 10% at its lowest point to 25% at the border with Sidi el Kbir see figure below, in that topography, we can see that the majority of the houses are located behind the colonial facade significantly influences the local climate by providing ample natural sunlight and cooler temperatures. Moreover, the area benefits from natural ventilation due to its topography, with prevailing winds from west-south, north, and northeast directions see figure below.

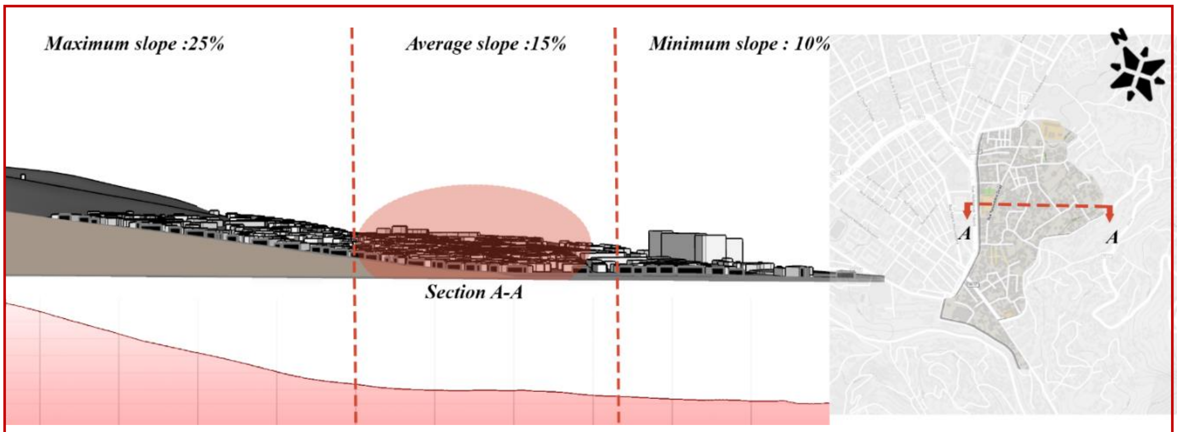


Figure 55: From the street to the Montagne Douirette's topography, source : section google earth , mapcarta edited by the author

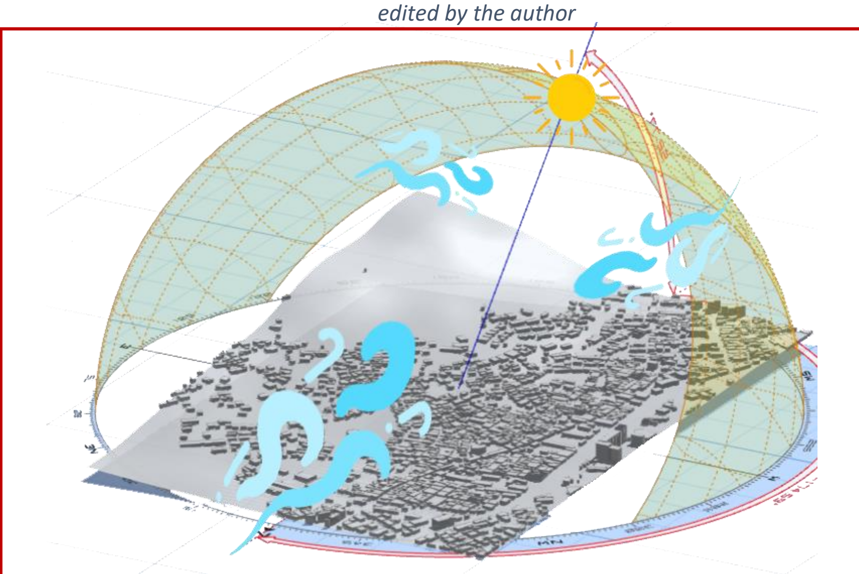


Figure56: Good sunshine and Cool area in Douirette source author

III.2. The distinct climate in Douirette:

Despite being located in Blida Douirette features a distinctive climate characterized by warm to hot summers and cold winters. Summer temperatures typically span from 14°C to 33°C, while winter temperatures range from 5°C to 27°C see figure below. Summers tend to be dry, with an average rainfall of 49mm, whereas winters are cold and rainy, with an average rainfall of 120mm see figure below. Predominant winds originate from the Northwest and West-Northwest directions with the greatest frequency, while winds from the East and Southeast are less common and generally have lower speeds based on the wind rose see figures below.

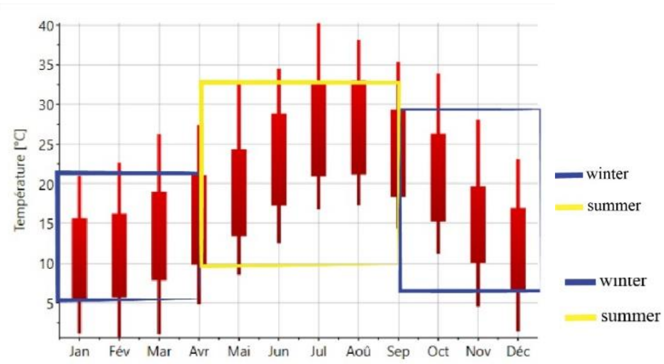


Figure 57: the temperature in Douirette source: metronome edite by the author

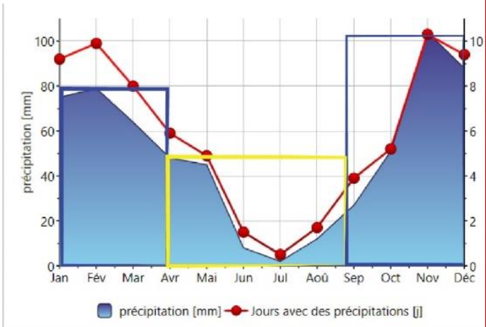


Figure 58: the precipitation in Douirette source: metronome edited by the author

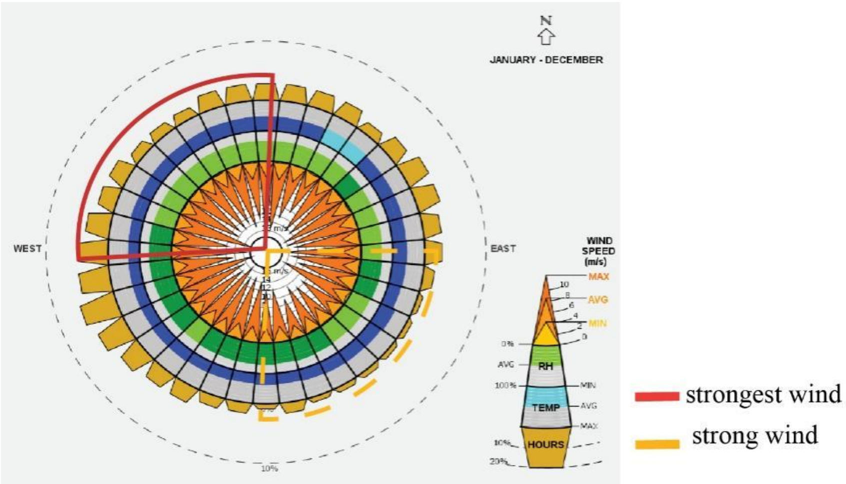


Figure 59: the dominant wind in Douirette source: climate consultant edited by the author

III. 3. Givoni diagram for Douirette:

3.A winter season in Douirette managing the internal heat gains:

In Douirette, the Givoni diagram shows different strategies to maintain indoor comfort in both summer and winter. Focusing on the winter season, which includes the coldest months from October to February, the diagram reveals several key findings.

The largest factor contributing to indoor heat is internal heat gain, accounting for 41.5% of the time. This emphasizes the need for efficient appliances, lighting, and occupancy management. Additionally, heating and humidification are required for 29.1% of the time, indicating the necessity of indoor heating in cold conditions.

Passive solar strategies, both low and high mass, are important and cover 34.1% of the time. Utilizing passive solar heating can significantly reduce energy consumption for heating.

Evaporative cooling strategies account for 5.6% of the time, particularly useful in dry climates. See figure below

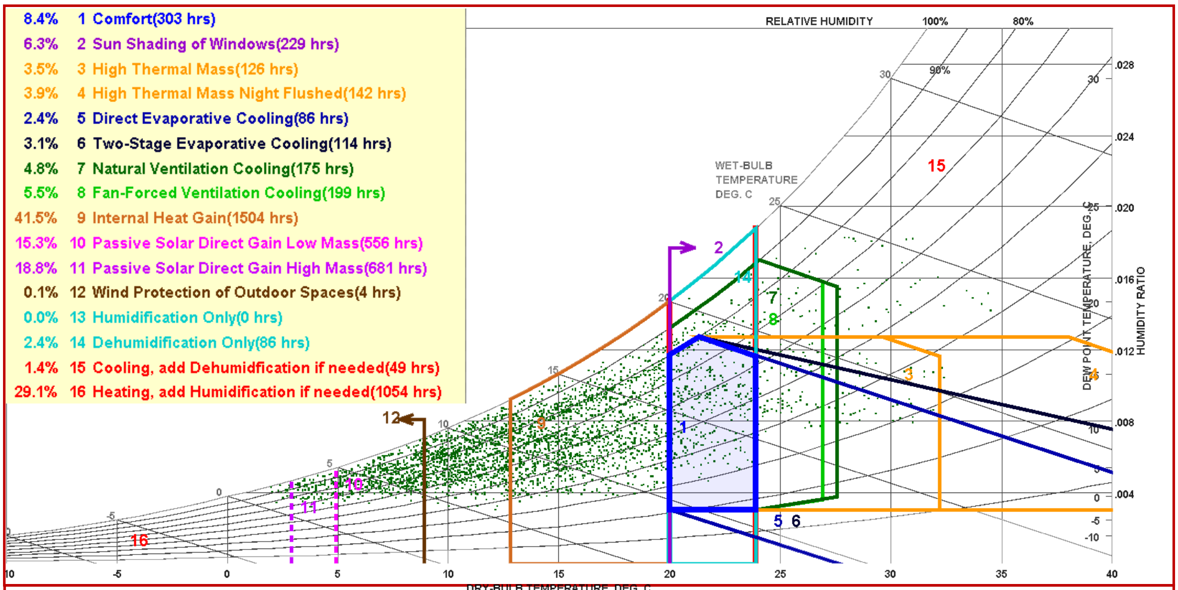


Figure 60: Givoni diagram of Douirette from October to February source: climate consultant

In summary, the Givoni diagram underscores the importance of managing internal heat gains, utilizing passive solar heating, and ensuring proper ventilation to achieve energy-efficient and comfortable indoor environments during the colder months and shows that the comfort zone is in 20c to 27.

3. B. summer season in Douirette in need of sun shading:

During the summer season, from May to September, the Sun Shading of Windows is the most important factor (35.1%) in reducing solar heat gain. This is followed by the importance of Natural and Fan-Forced Ventilation (23.3% and 28.1% respectively) to enhance cooling through effective air movement. Internal Heat Gain remains significant (15.2%), highlighting the ongoing need to manage internal sources of heat.

Evaporative Cooling (25.8% combined) is useful in dry climates, lowering temperatures through evaporation. High Thermal Mass Strategies (26.6% combined) indicate the effectiveness of using materials that can absorb and release heat to stabilize indoor temperatures.

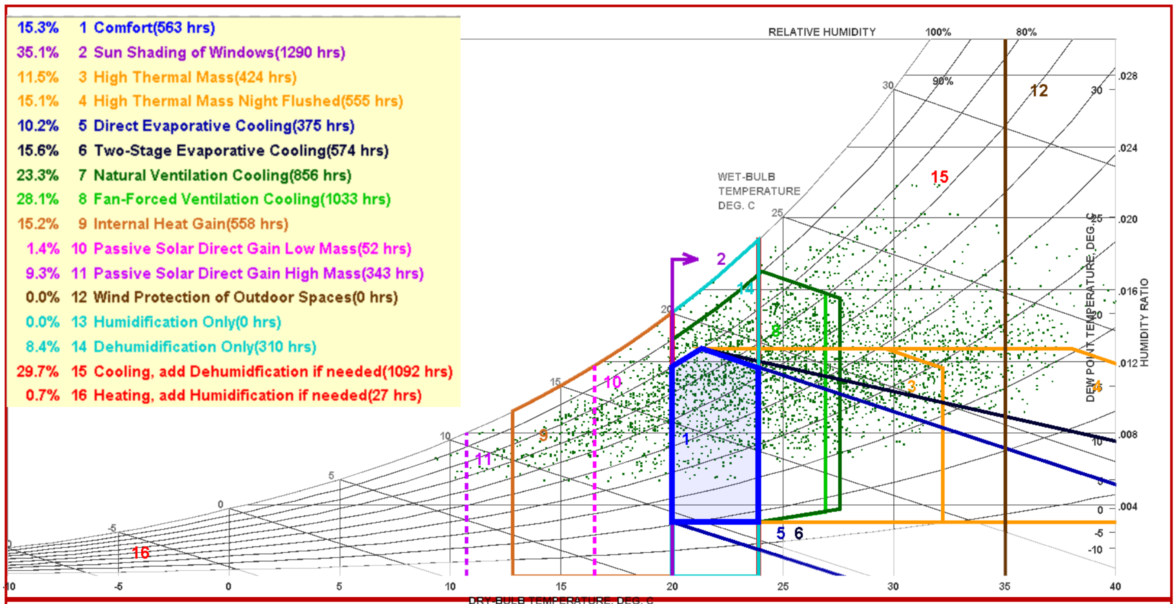


Figure61: Givoni diagram of Douirette from May to September source: climate consultant

Cooling with Dehumidification (29.7%) is crucial during periods of high temperature and humidity, where combined cooling and moisture control are essential. See diagram below

- During the warmer months, the comfort zone is also between 20 c and 27c so, it is crucial to have effective sun shading, ventilation, and strategies to manage heat and humidity. This requires a combination of passive and active cooling techniques to maintain indoor comfort while considering internal heat gain, in we propose the same solution but adding effective HVAC Systems such as Hybrid Cooling Systems and dynamic Shading Systems

IV. Preserving the old while building the new Douirette (urban interventions in the old urban fabric):

First and foremost, it is important to understand that Douirette is situated along the line of Crete that extends from Chrea to Descend to Blida, Douirette this line is one of the three that descend, see figure below. The rich history of Douirette is intricately linked to this geographical trajectory, serving as a bridge connecting the past to the present. This connection is manifested through the preservation and revitalization of historical elements, as well as the restructuring of architectural developments to cater to the needs of Douirette's residents, the chosen study area is a combination of the dense old part that is situated in the low promontory and the new almost non-urbanized that is in the high promontory all in 10,70ha so that we can balance between the past and the present that works for the future, creating by that a new image or Douirette one that preserves the old while builds the new and can keep up with the changes of time .

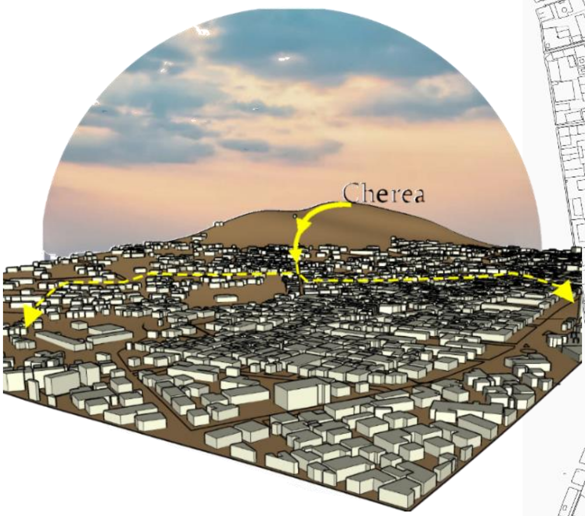


Figure62: line of Crete from chrea to Douirette 3D source: author

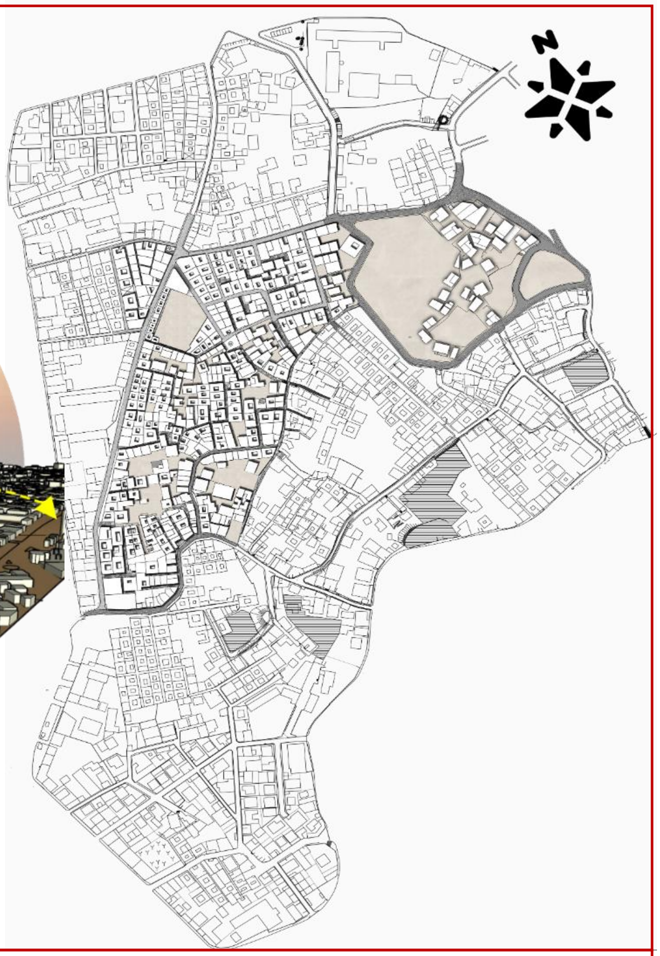


Figure 63: case of study and current state of Douirette, source: POS B18, edited by the author

IV.1.Following the first path:

The origins of this course are linked to the earliest human settlements near water sources. It seeks to replicate or revisit the historical water channels created by the Andalusians, descending from the high promontory to the low promontory, which consists of a residential area and what is proposed to balance Douirette as an educational/healthcare new area.

In Douirette, five spring water elements are located in the old parts, which are currently closed off except for one that has been restored. The second element consists of the two mosques that mark the beginning and end of Douirette. The first mosque, el Moudjahid, is located at the start, while at the end is El Qods. Between the start and finish, we come across the oldest hammam Mokhebat, and the second hammam Zahar. These are the characteristics of Douirette see figure below.

After many visits and investigations in Douirette, we can predict that it has many problems on many levels: mobility and transportation, economics, culture and social, and the local heritage such as:

- Infrastructure and urbanism level: Poor condition of the mechanical road and stairs, almost nonexistent pedestrian paths, unorganized urban fabric in some areas, and poor condition of dead ends leading to the houses.
- Economical level: Douirette has the oldest bakeries and some artisanal shops, but they are not well-known or frequented. Currently, the area is mainly used for residential purposes, with a few small grocery stores. Due to the lack of jobs and opportunities, many young people are unemployed and turning to drugs.
- culture and social level: Despite its proximity to the city center, Douirette suffers from a serious shortage of green spaces and communal areas for families, as well as an insufficient supply of public resting areas.
- the local heritage level: The built frame's degradation has had a severe impact on the houses, leading to the complete ruin of some and leaving others in a state of poor condition.

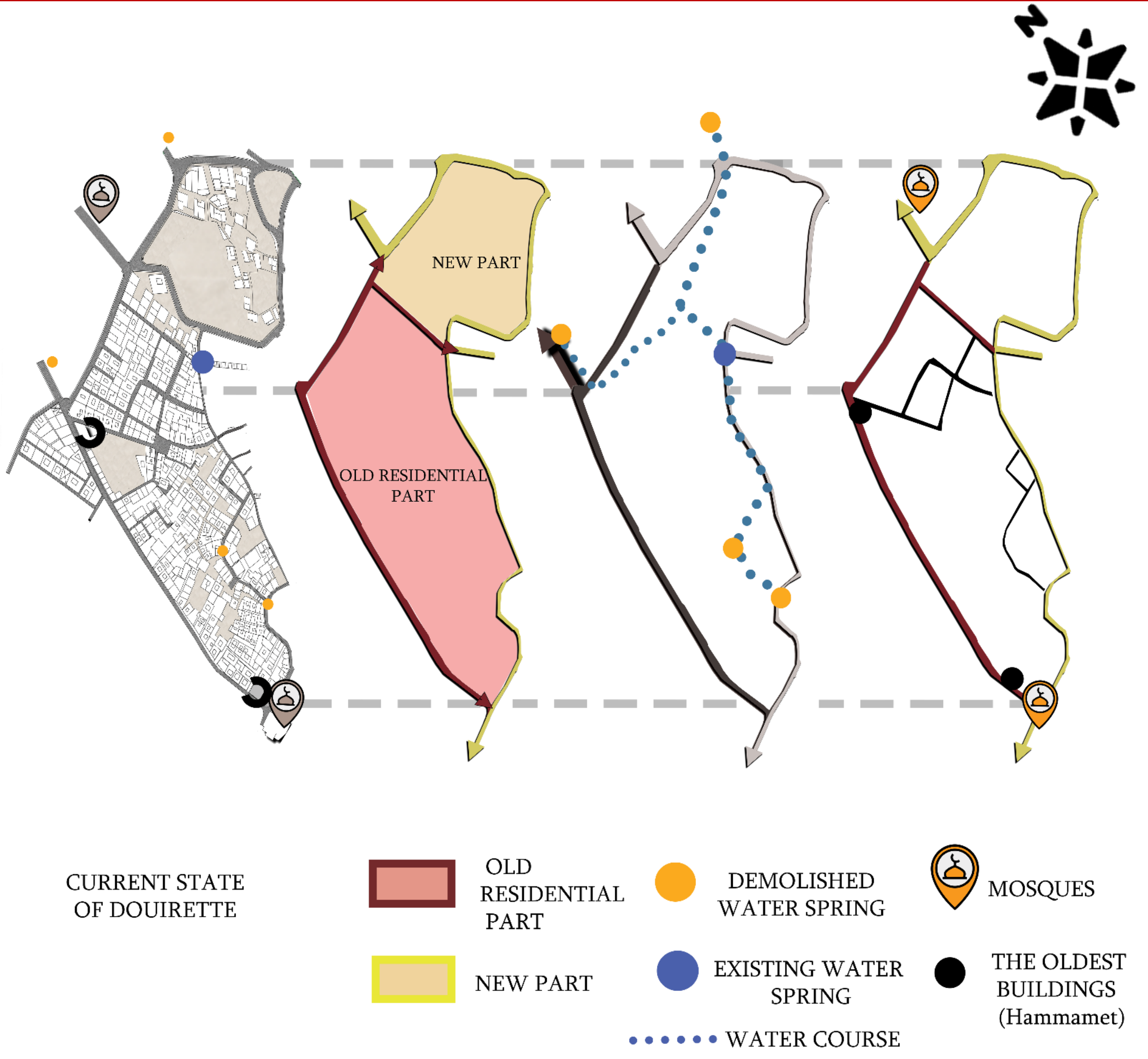


Figure 64: current state of Douirette and its characteristics elements, source: POS B18; edited by the author.

IV.2. The trace of the past and the potential of the future:

Following the problems of Douirette already mentioned at several levels, we propose the following urban interventions:

- Infrastructure and urbanism level: reconstruction of the ruined road as well as the ruined stairs, redevelopment of the stairs, and the breakthroughs.
- Economical level: For the commercial / health part we will introduce a community service project, for young people to optimize job offers, and save addicts from harmful habits, It is a project for all age categories, giving all equipment so that the project is successful; A project dedicated or children because there is a lack of equipment for children and adults in Douirette; This part especially represents the future a good future away from harmful habits.
- culture and social with heritage level: creating a garden/plot is an imitation of the Andalusian gardens as seen that Blida has been occupied and inhabited by them and Douirette is their creation, it is also a large-scale وسط الدار (imitate the patio of the house) revitalization and creation of new water springs works as both preserving the heritage and also to solve the lack and shortage of water in Douirette. See appendix for the detailed urban interventions.

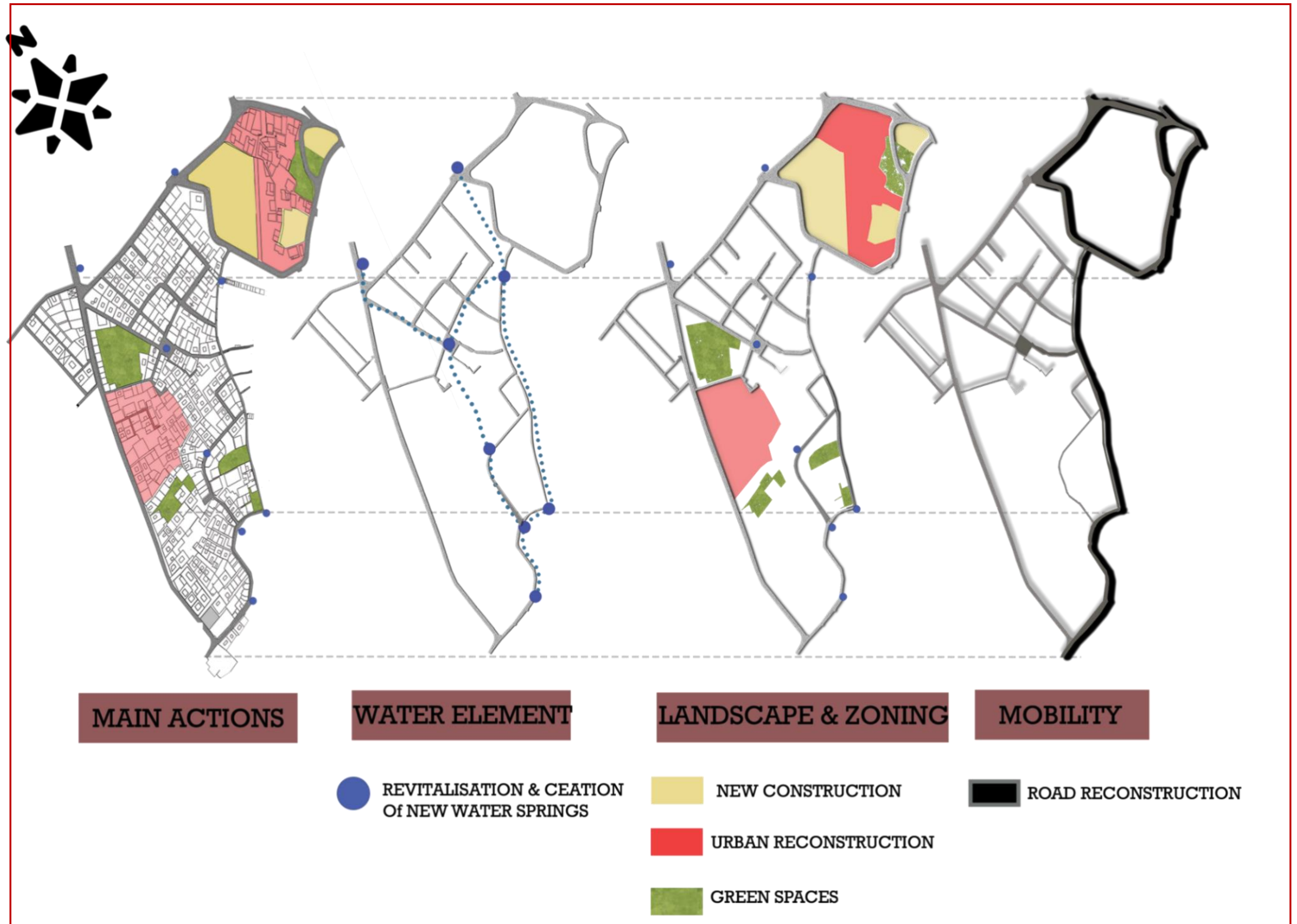


Figure 65: enhancing Douirette on multiple levels while preserving the past and building the future source: pos B18 edited by the author.

IV.3. Preserving the old while building the new Douirette:

Once the main urban interventions have been sorted, we can proceed to categorize the detailed actions as per said in four levels that are detailed in the annexe.

3.1.The chosen intervention:

The last urban intervention that we will be undertaking is the energetic rehabilitation of historical houses. These houses, which are located on the road of Etienne Dinet, were carefully chosen after an educational outing with our teachers and a thorough inspection. Additionally, the local citizens played a crucial role in the decision-making process, making sure that the chosen houses aligned with our needs and preferences.

Figure 66: plan of the area of study that indicates the chosen houses, source : author

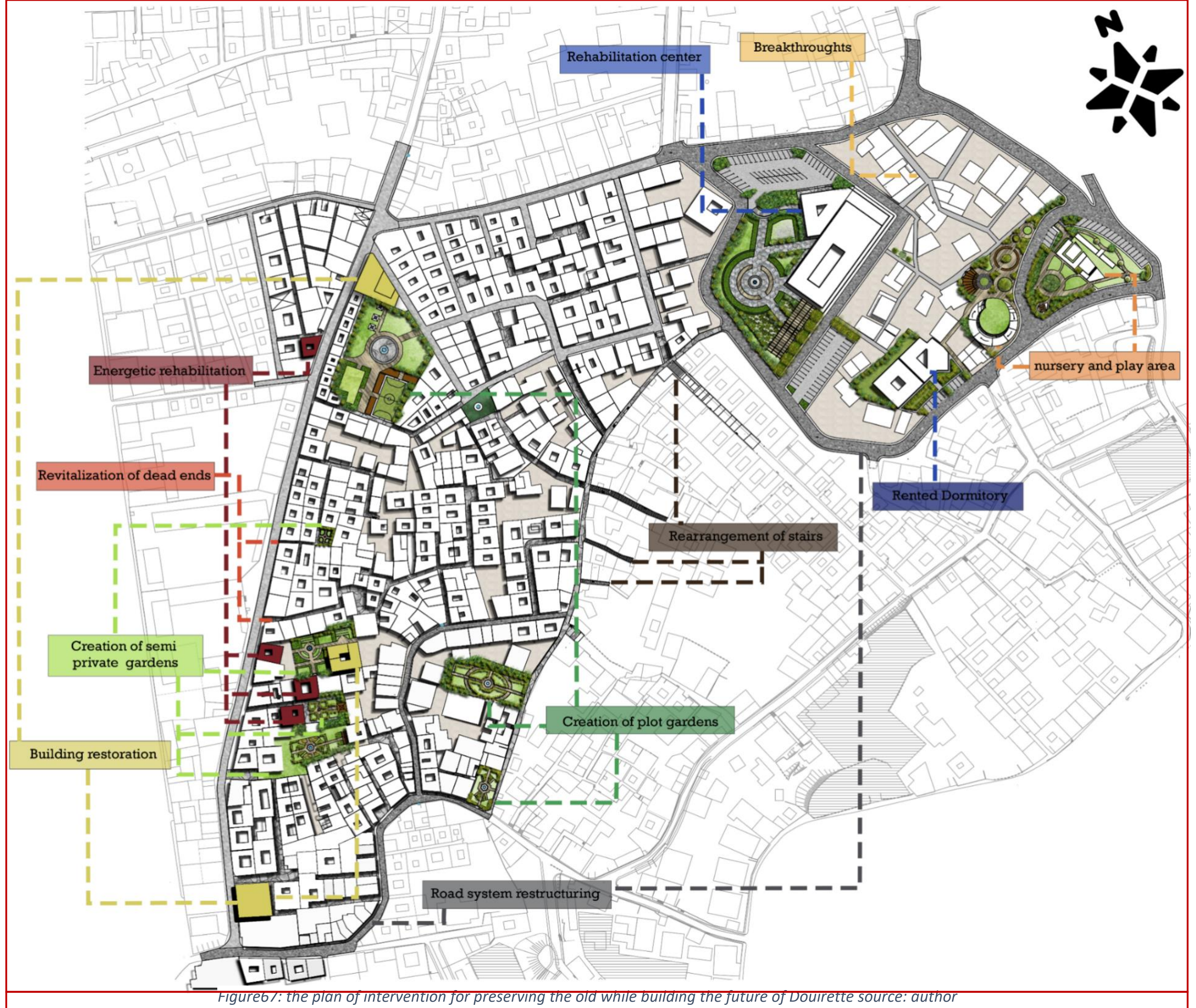


Figure67: the plan of intervention for preserving the old while building the future of Douirette source: author

➤ CONCLUSION:

Now that we have a thorough grasp of the surroundings in Douirette, we may close this chapter. This knowledge goes beyond the local climate to include the surrounding natural environment and distinctive regional architecture. The information gathered from this investigation has been crucial in helping us make decisions about the best and most relevant approaches for the energy rehabilitation of Douirette's historic fabric. It has enabled us to find solutions that not only work well with the local architecture and surroundings, but also improve them. Hence, the knowledge acquired in this chapter is beneficial not only for the ongoing effort but also for future endeavors that may help Douirette and possibly other comparable regions

CHAPITRE IV: DIAGNOSIS SIMULATION AND RESULTS

- ## INTRODUCTION:

After gathering theoretical data and doing a thorough examination of the local climate in the city, we have reached a point in our thesis where After carefully sorting through the urban interventions, it was decided to energetically rehabilitate one of the houses in Douirette.

First, putting together a sample of the houses in Douirette before we can carry out this plan. We will be able to determine which of these buildings are the oldest and which require the most urgent energetic rehabilitation thanks to this dataset. Give a thorough explanation of our on-site visits, the house diagnostic process, and the simulation method in the upcoming chapter. Our energetic rehabilitation project will use this chapter as a road map, indicating the shift from theory to practice and laying the groundwork for the practical application of our research.

I. CHOICE OF CASE STUDIES:

I.1. PRESENTATION OF THE STUDY CORPUS:

Following numerous site visits and with the assistance of my teachers and the corporation of the locals, I selected our homes that fit into three categories: good examples with light and heavy intervention, some bad examples that negatively impacted the building's identity and energy consumption, and finally one example with a small intervention.

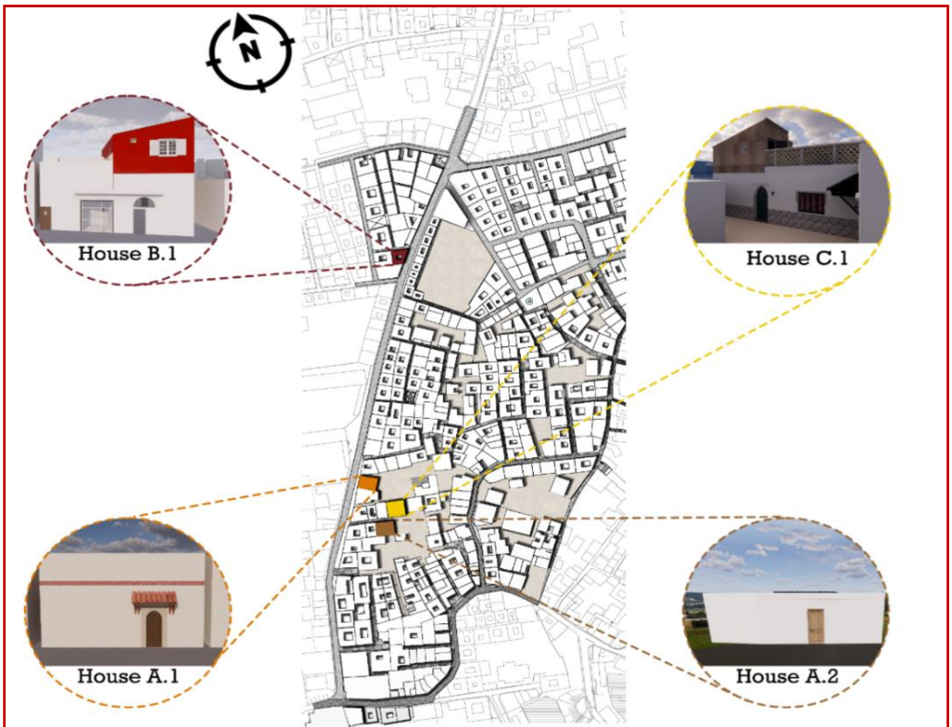
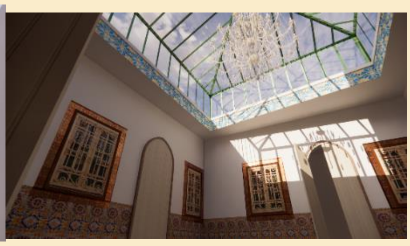


Figure 68: the location of houses on the Etienne dient road , source : the author

We then divided the examples into three groups: good transformation, bad transformation, and light or nearly no transformation. The location of these examples, which is the first core of Douirette on Etienne dient Road, is precisely marked in the study area plan below. It is also summarized in the table that follows based on their energy consumption:

positive transformation A	House A.1	 
positive transformation A	House A.2	  3D model of house A.2
negative transformation B	House B.1	  3D model of house B.1
non-transformation C	House C.1	  3D model of house C. 1

I.2. CRITERIA FOR CHOOSING CASE STUDIES:

2. 1. House A.1:

The house in discussion is situated in a prime location, directly adjacent to Etienne Dinet Road in Douirette. Because of its location, it has a certain prominence and accessibility that contribute to its overall significance in the local landscape.

The residence, which we will call House A.1, is mostly utilized for residential purposes. Its traditional construction style is a tribute to the area's architectural history. The house has 116.09 square meters of total surface area, made up of a ground floor and a rooftop.

The house's construction process is very interesting. It uses bearing walls, a joist floor, and wooden battens. The house's introverted character is one of its distinctive qualities. The patio, the only source of light in the house, is the focal point of the facade and is accessed through the entrance door. This design component has both practical and beautiful qualities. the charm of the traditional house. The house is currently occupied by one family member, who is also the owner. This person takes on the duty of caring for and protecting this architectural treasure. The location of house A.1:

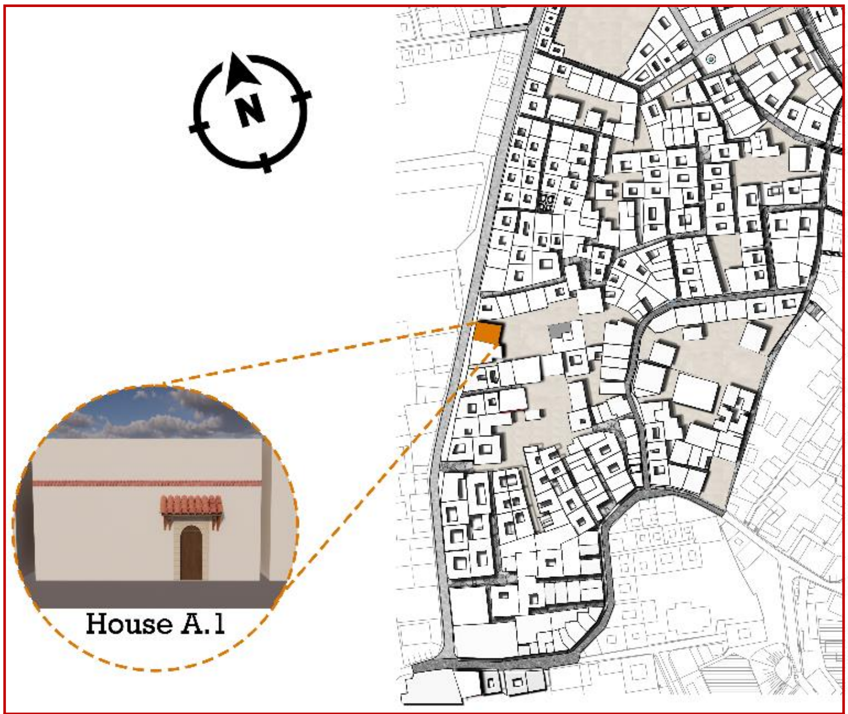


Figure 69: House A.1 in Douirette the intervention site, source: the author

To sum up, House A.1 It is a monument to Douirette's architectural skill and cultural legacy, setting a high standard for other buildings to follow, this particular house was picked because of the improvement that took place in covering the previously open patio, which made the home more comfortable and required less energy, additionally, the owner was very cooperative and helpful [see figure 81], there is more to House A.1 than just a residence, an ideal combination of traditional construction and contemporary comforts [see figure 81]. It is a monument to Douirette's architectural skill and cultural legacy, setting an example for other traditional buildings to follow.

Figure 70: the first visit to the house, source: the author

Figure71: the contrast between traditional construction and the innovation, source author

House A.2:

Contrary to the first described house that was located in direct contact with Etienne Dinet Road this one is accessed by an impasse that is impasse Younes [see figure 84], giving it a more private aspect it necessary that this house is located in an impasse that is owned by the bencherchali family one of the founding families of Douirette. The house is built in a traditional style that has a strong connection to the area's architectural history.

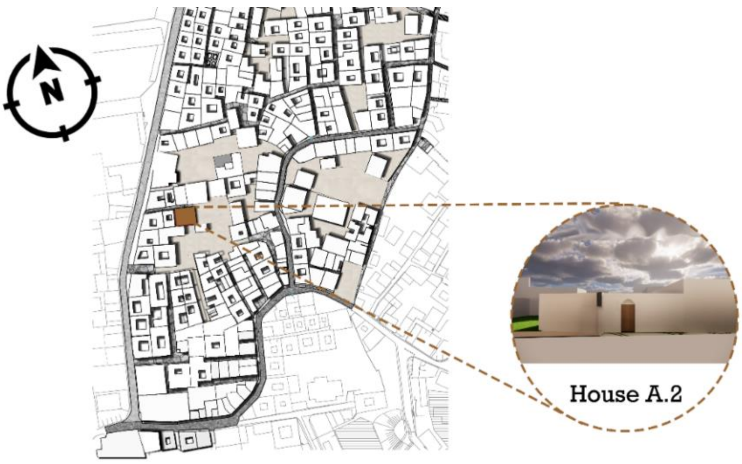


Figure 72: house A.2 location in the intervention area, source the author.

Figure 73: the impasse that leads to the house, that is on the right source the author

All of the living areas of the single-story home are on the ground floor. With 134.46 square meters of total surface area, it is home or a small family of four.

The house was built using a very unique technique. It has a bearing wall composed of the organic building material adobe. Joists and wooden battens make up the floor structure, which together provide structural stability. The house is an example of one of Douirette's historic homes and a testament to the town's extensive architectural heritage. it features a patio at the center of an introspective design. The gallery that encircles this patio creates a private indoor area that is well-lit by natural light.

To make the house more livable, renovations were recently completed. More living space was created by adding an extension room. Additionally, several kinds of insulation were put in to increase interior comfort.

The house next door, House C.1, and this one have a unique bond. A shared garden, that improves outdoor living, uniting them. In addition to offering a place for leisure and entertainment, this communal garden helps the locals feel more like a community.

To sum up, this house is more than just a place to live. It is a representation of traditional architecture, a piece of history, and a way to live sustainably. It is a beloved feature of Douirette's architectural landscape because, despite the renovations and changes, it has managed to maintain its original charm and character.

Figure 74: the before and after o the house the different interventions, source owner of the house

2.3. House B. 1:

House B.1, a two-story residential building with a total area of 112.62 square meters, is home to two family members. It has an advantage due to its advantageous location, which is reachable from a number of pathways and impasses, most notably the Etienne Dinet road [see figure below]. However, in addition to being a place of residence, the house also has a special place in the community as a bakery. Being the first in Douirette and the 45th in all of Blida in 1975, this bakery has a long history. Serving the neighborhood for many years,

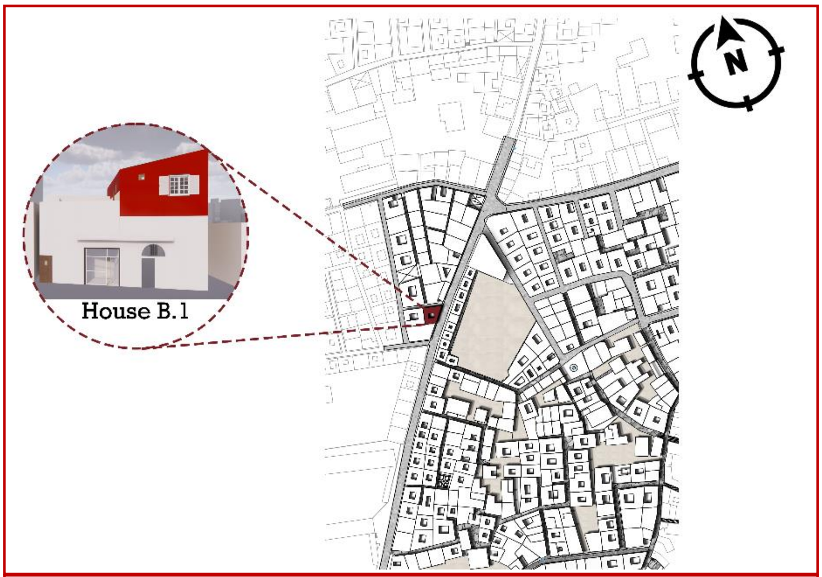


Figure 75: House B 1located in the heat of Etienne Dinet Road, source the author

Unfortunately, the house is currently in a challenging situation despite its rich history and significant patrimonial value. The unplanned second-floor extension is a threat to its heritage. The house's architectural integrity is compromised by this extension, which is out of keeping with its traditional construction style. The extra floor affects the house's energetic behavior in addition to its appearance.

The house's energy consumption and comfort levels were balanced, even though it was initially built for a particular climate and way of life. The unscheduled extension, however, upsets this equilibrium and can result in higher energy costs and lower levels of comfort.

Furthermore, the renovation process has included the patio, which is an essential part of traditional homes for natural light and ventilation. The unforeseen coverage further disturbs the energy behavior of the house because the patio is essential to preserving the microclimate within the house.

In conclusion, despite House B.1's important role in Douirette's past and community, unforeseen renovations are endangering its legacy. These modifications affect the house's energy efficiency and comfort levels in addition to disturbing the architectural harmony of the building. It serves as a reminder of how crucial it is to carefully plan renovations of historic buildings while also honoring traditional building techniques.

Figure 76: the ground floor and the first next to the extension and the patio renovation source the author,

2.4. House C.1:

This house is connected to House A.2 especially because there is a shared garden between the two properties and an impasse that leads to the house. The common outdoor area among the residents not only improves their quality of life but also strengthens their sense of belonging.

The traditional architectural style house was constructed with the primary purpose of being a place of residence. Living areas are dispersed throughout the first and ground floors of this two-story building. With 194.04 square meters of total surface area.

Figure 77: house C. 1, in the dead end of impasse Younes, source the author

Figure 78: the house is located at the end of this impasse source the author

The bustling house, home to a family of six, is undergoing repairs. Despite its historical and architectural value, the oldest house is showing signs of deterioration. A major issue is the closed-off patio, disrupting the house's microclimate. Previously, the patio allowed natural light and ventilation, but this modification is now impacting comfort levels and speeding the house's deterioration.

In summary, even though this house is highly valuable historically and architecturally, it urgently needs to be rehabilitated and preserved. It acts as a reminder of how crucial it is to honor conventional building practices and materials, particularly when working with historic properties.

Figure 79: the main entrance through impasse Younes, source: the author

Figure 80: the patio of the house, source: author

- As a result, the chosen case studies are categorized into good transformations, which positively impact the house's energy performance and indoor comfort while maintaining and respecting the local architectural heritage. We also have a case of bad transformation that resulted in an energy-consuming house with low indoor comfort, which should be avoided. Lastly, we'll study a house that underwent minimal or no transformation, and we'll focus on energetically rehabilitating it to improve its performance while preserving its heritage and local character. The next step is to diagnose the houses to better understand them on the three dimensions mentioned in the second chapter.

I.3. HOUSE DIAGNOSIS:

3. 1. HOUSE A.1:

3. 1. A. Heritage diagnosis:

- construction period: this house was Built in the 1800s.
- The intervention was made throughout the years*:*

Over the years, this house has seen various interventions and modifications to adapt to the changing needs of its residents. One of the most significant changes was the addition of a roof that now covers the patio of the house. The entrance of the house has an additional sanitary facility installed, the space distribution is similar to traditional houses a patio surrounded by the other rooms, see figure below:

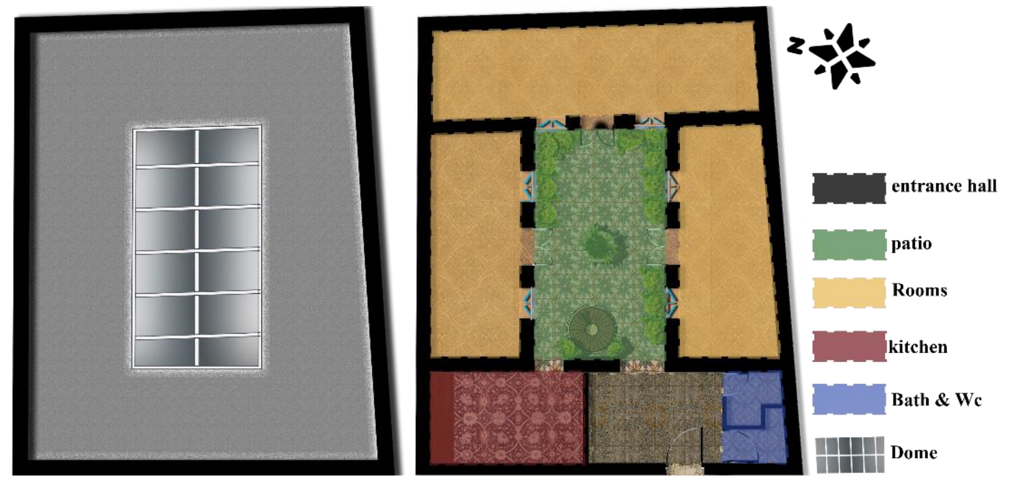


Figure 81: ground floor and Terrace plan source the author

A spiral staircase was added to provide access to the terrace and a unique architectural feature to the house. The wooden bedroom doors were rebuilt to replicate the original design while retaining the traditional aesthetic appeal, significant repairs were done to fix the roof's waterproofing. This was a crucial intervention that not only protected the house from water damage but also enhanced the longevity of the structure.

Lastly, to ensure privacy and security, a window and two doors that used to connect the house to the neighbors were closed off. This change helped to define the boundary of the house and ensure the privacy of the residents. In conclusion, these interventions, while necessary, ensure that changes meet current needs without damaging the historical and architectural integrity of the property.

- The construction details involve the use of a bearing wall with adobe brick, floor joists, and wooden battens for structural support, the construction will be detailed in the technical diagnosis.
- The characteristic elements of the patio, tiled floors, window tiles, and elegantly arched doors.

Figure82: the changes that accrued in the house , source author

3. 1. B. Technical diagnosis:

- an overall description of the house: In good condition after the small renovation, including the replacement of damaged parts.
- Constructive details, element dimensions constituents: bearing adobe wall with a thickness of 50 cm, thuja joist floor, and wooden battens 30cm with a Board thickness of 15cm, and to top it with poor concrete and lastly waterproofing.

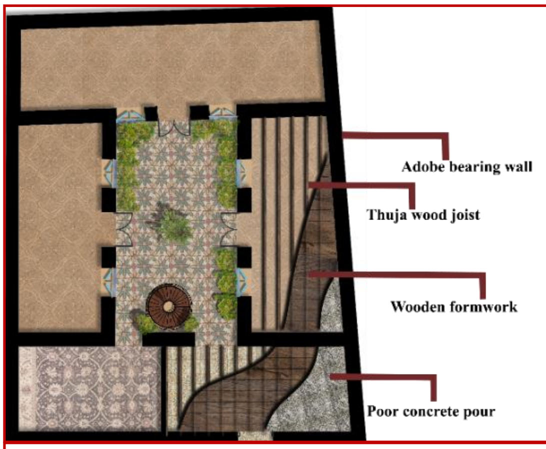


Figure 83 : construction détails, source the author

Figure 84 : a section of the house , source the author

- orientation and volumes: The house has a trapezoidal shape and is oriented towards the southwest. There is an opening in the middle.
- Openings: due to its introverted nature, aside from the entrance, the patio is the sole source of natural light, With Some windows and small openings on top of the room doors.
- physical interactions with the surrounding buildings: The house is introverted in nature as it has only one opening to the exterior and a patio. Moreover, there is no interaction with its neighboring houses on the ground floor due to a change that occurred in the house. Specifically, two doors that used to connect the house with its neighbors have been closed off.

Figure 85: the interaction of the house with its surroundings vs the patio atmosphere, source author

3. 1. C. Energetic diagnosis:

- The actual energy consumption of the existing building: After a reading of the electricity factors [see appendix], This house's consumption is Electricity: 3552kw/year, Gas: 9233,6 kW/year with a Total: 12785.6 kW/year /m² and by that this house is in class ‘**C**’ certification a class C rating indicates that the house is relatively efficient but has room for improvement.

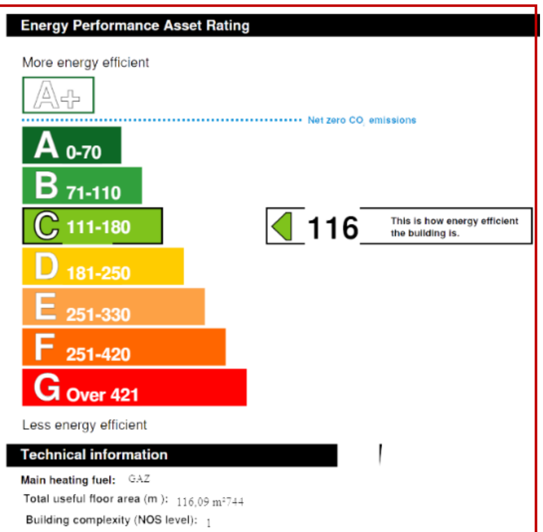


Figure 86: energy performance certificate, source: the author

- The overall heat losses of the building, as well as their distribution by components [walls, windows, floors]: The majority of heat loss occurs in the patio rather than the rooms. However, the house is well-insulated due to its thick walls and internal windows, as well as the covered patio.
- The conditions of management and use of the building: The house is well-maintained thanks to the owner who keeps up with maintenance, as previously mentioned.
- The level of indoor comfort, according to the seasons: The covered patio serves as an effective shield from the sun and cold weather, thereby ensuring a consistent level of indoor comfort.

3. 2. HOUSE A.2:

3. 2. A. Heritage diagnosis:

- construction period this house was Built in the 1800s, and renovated in 2019
- The intervention that was made: The house has undergone several significant improvements to enhance its functionality, comfort, and aesthetic appeal. glass has been installed in the gallery of the patio to create a clear separation between the hall and the patio while allowing natural light to flow through [see figure below]. A small room was removed to create a larger master bedroom [see figure below], providing more spacious living quarters. The door from the removed room has been replaced with a window to improve natural light and ventilation. The sanitary facility was changed to another space between the rooms to avoid going out.

Figure 87: the plan of the house before and after the renovation source: the author

Additionally, the patio has been renovated with renewed walls and tiles, enhancing its visual appeal, the original wooden doors have been replaced with similar ones to maintain the home's character and ensure durability,

and a water tank has been installed underground to provide a reliable water source due to the water problem in Douirette [see figure below]. The sealing of the rooms has been updated, which could potentially improve insulation and energy efficiency. Finally, the roof's waterproofing has been repaired [see figure below], a crucial intervention for preventing water damage and ensuring the longevity of the house.

Figure 88: the dffirent intervention that were done in the house , source : the owner of the house

-
- The construction details involve the use of a bearing wall with adobe brick, floor joists, and wooden battens for structural support, brike, concrete, Rockwool insolation, false ceiling, the construction will be detailed in the technical diagnosis.,
- The characteristic elements of the patio, its gallery, arched doors, tiled floors, window tiles [see figure below].

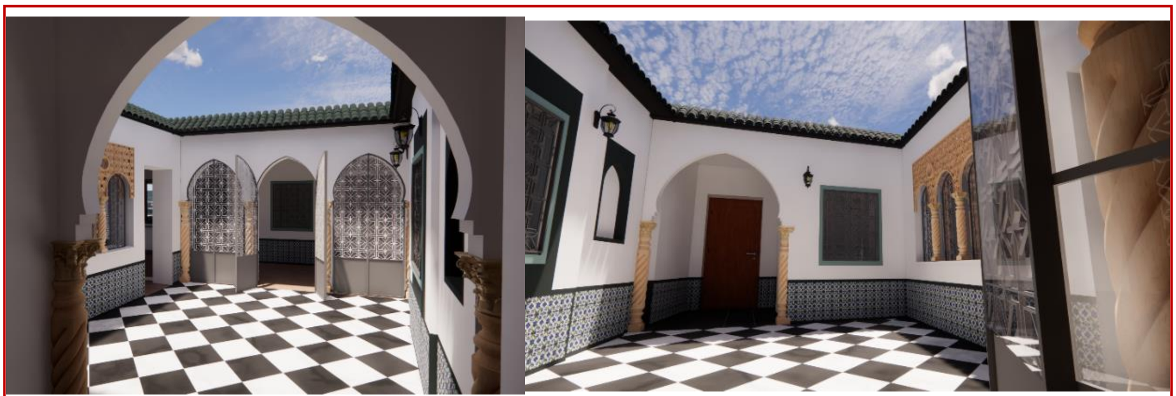


Figure89: interior 3D model view that show the inside of the house source: author

3. 2. B. Technical diagnosis:

- an overall description of the building: The house is generally in very good condition due to all the changes made.
- an overall description of the building: bearing adobe wall with a thickness of 50 cm with white plaster on the inside, false ceiling with insolation with Rockwool, thuja joist floor, and wooden battens 30cm with a Board thickness of 15cm, and top it with poor concrete and lastly waterproofing.

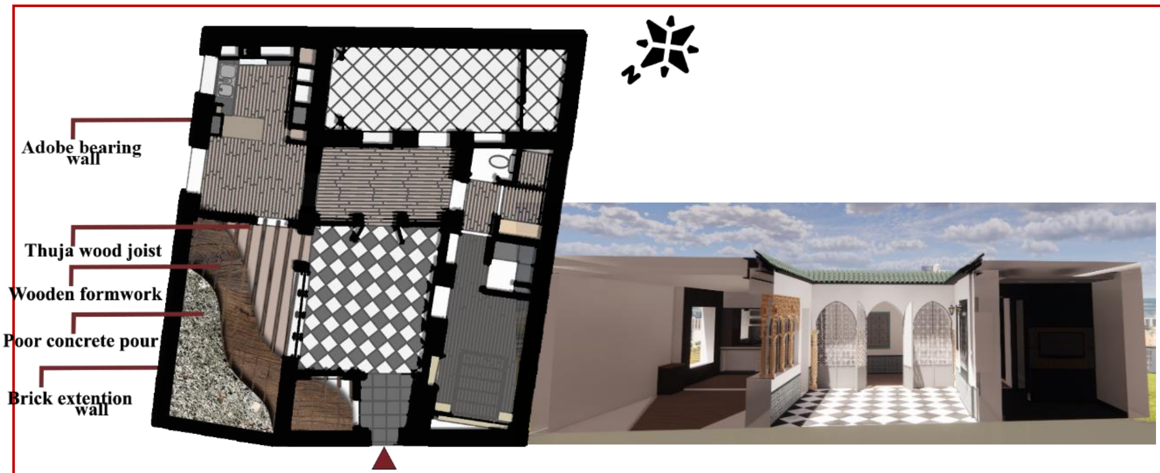


Figure 90: a construction details with a section of the house ,the author

- orientation and volumes The house faces Southwest with a central patio in the shape of an almost perfect square.
- openings The patio is the only source of natural light, with the entrance door and two windows overlooking a family garden
- the physical interactions with the surrounding buildings The house has no direct interaction with the neighbors, but a garden provides a connection to the adjacent house.

Figure 91 the houses interaction inside and outside the house the author

3. 2. C. Energetic diagnosis:

- The actual energy consumption of the existing building: After an inspection with the house owner, the electricity factors Total: is 37335.86 kw/ m²/year and this house is in class 'E' certification a class E rating indicates that the house consumption is high although its isolation and after all the renovations that were done but the reason is that there are so many devices that consume energy such as the water pump, the heater and AC in the closed gallery as well as the Pc station due to the owners occupation [both architects].

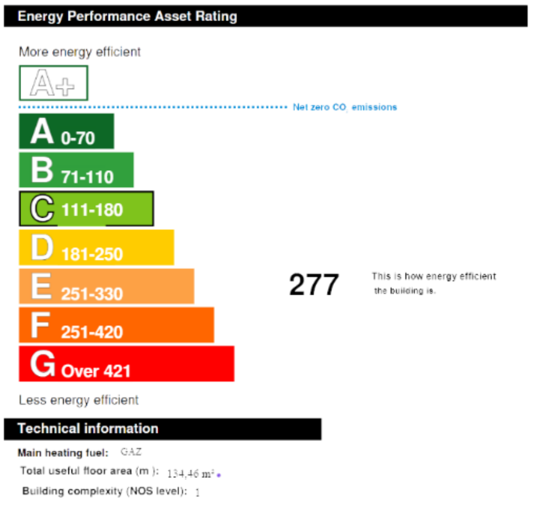


Figure 92 energetic preformance the authorr

- The overall heat losses of the building, as well as their distribution by components [walls, windows, floors] The patio is the main source of heat loss and the gallery due to the simple glazing, but thanks to wall insulation, window and door renovations, and minimal heat loss, it doesn't affect other rooms.

- The conditions of management and use of the building and the indoor comfort: This house is in excellent condition due to the renovations and upkeep it has undergone, and the indoor comfort is high but in contrast the energy consumption it very high

3. 3. HOUSE B. 1:

3. 3. A. Heritage diagnosis:

- construction period 1900s
- The building was expanded with the addition of a second floor. In addition, an internal entry was built within the bakery to provide access from the house to the baking area. Furthermore, the patio was enclosed with plastic material. Lastly, a sanitary facility was installed on the first floor [see figure below].
- Construction detail: bearing wall, joist floor, and wooden battens., Concrete construction on the 2nd floor.

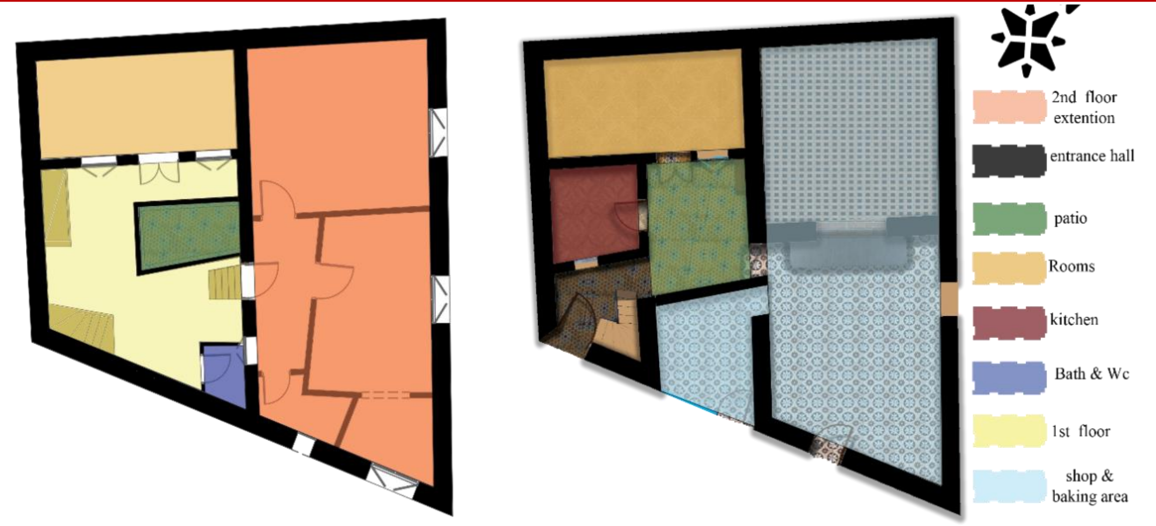


Figure 93:house plan that showes the house distrebuition the author

- the specific characteristic elements of the space, which include the presence of a patio, intricately designed floor tiles, decorative window tiles, and elegant arched doors.

Figure 94 the second-floor extension and the added door, the patio of the house, the author

3. 3. B. Technical diagnosis:

- an overall description of the building: The condition of the house is a cause for concern, as it is currently in a state of disorder due to a lack of maintenance and the addition of a second floor. Immediate attention to these issues is necessary to restore the property to a livable standard and prevent further damage.

- constructive type, element dimensions' constituents, bearing wall with a thickness of 50 cm, joist floor, and wooden battens 30cm with Board thickness of 15cm. 2nd floor was added with Brick walls, concrete, and tile for the rooftop.

Figure 95 construction details in plan and section ,the author

- orientation and volumes the house is oriented in the east-south with Trapezoidal form with an opening in the middle.
- The patio is the main source of natural light for both the ground and first floors, with small openings above the doors and a few windows providing access. The second floor has three exterior-facing windows for additional natural light.

Figure 96 Photos of the house , the author

- the physical interactions with the surrounding buildings: The house can be divided into three parts: the ground floor store with direct access, the remaining ground floor with inverted rooms and a patio as the only source of light, and the extroverted second-floor extension with street-view windows.

3. 3. C. Energetic diagnosis:

- The actual energy consumption of the existing building: The house uses a lot of electricity due to an added extension that blocks natural light. The heaters are not needed as much because the oven provides warmth and its chimney extends to the 2nd floor. The plastic patio cover causes the house to become hot in the summer. The total electricity usage is 6989 kw/year, placing the house in class 'F' certification, indicating very high energy consumption. [see appendix]

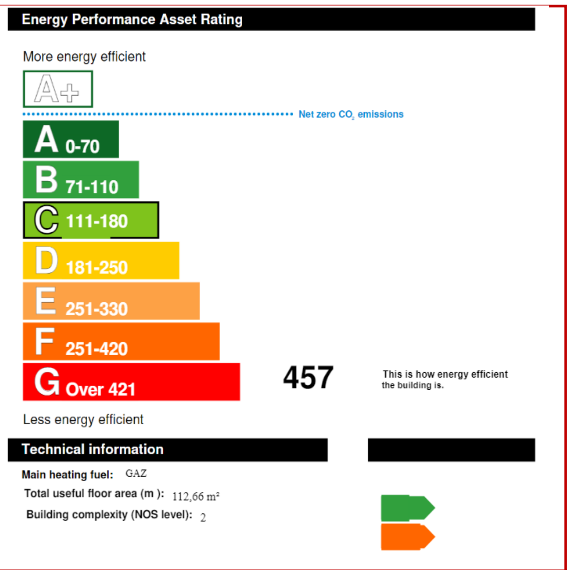


Figure 97: energy performance certificate o house B.1, the author

- The building loses most heat through the outward-facing second-floor extension, while the ground and first floors have minimal heat loss. The patio's plastic covering creates a greenhouse effect on the lower floors.
- The conditions of management and use of the building Due to neglect and a dysfunctional layout caused by an extension, this house is in poor condition.
- The indoor comfort level varies with the seasons. In winter, the small space and chimney provide comfort, but the patio leaks due to improper covering. In summer, the plastic covering on the patio causes excessive heat.

3. 4. HOUSE C. 1:

3. 4. A. Heritage diagnosis:

- construction period Built in the 1800s this house is Over 150 years old
- The intervention was made The added kitchen, the added dome that covers the patio,
- Construction details old adobe wall bricked with earth, fine lime coatings (inside and outside), IPN metal joist and slat floor with a solid slab of poor concrete and covered with plaster.

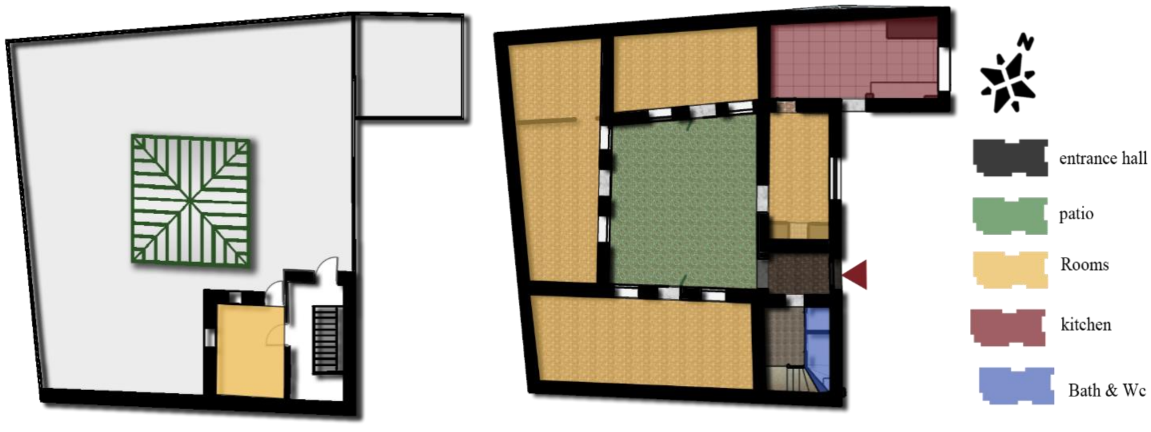


Figure 98 : plan of house C.1 showing the distribution the author

- The patio is adorned with an array of distinctive elements that exude elegance and charm. From the meticulously laid floor tiles to the intricately designed window tiles, the arched doors, and the meticulously crafted wall tiles, each detail contributes to the unique character of the space. The wooden decorations and the exquisite window and patio glass further enhance the overall atmosphere, creating a captivating and welcoming ambiance.

Figure 99 the characterestics of house C.1 , the author

3. 4. B. Technical diagnosis:

- an overall description of the building: Due to the excessive size of the house and lack of maintenance, it is in poor condition.
- constructive type, element dimensions' constituents: old wall bricked with earth, fine lime coatings (inside and outside) 45 cm joist floor, and wooden battens 30cm with Board thickness of 10cm.

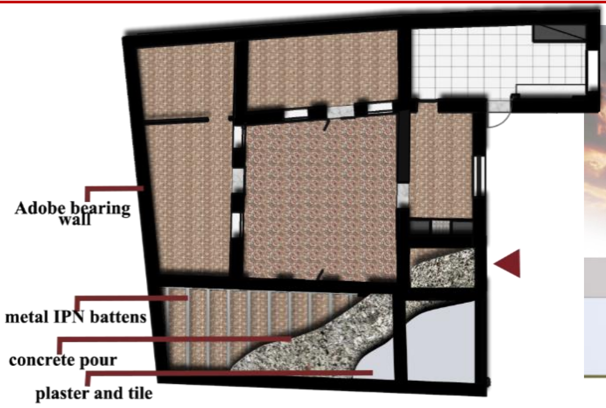


Figure 100 constroction details of house C.1 , source the author the author

- The house has an almost perfect square shape and is oriented to the southwest with a central patio.
- Apart from the entrance, the patio serves as the primary source of natural light, thanks to its tall windows and small openings positioned above the room doors. The tall windows allow ample sunlight to filter into the space, creating a bright and airy atmosphere. Meanwhile, the strategically placed small openings above the room doors contribute to the overall circulation of natural light throughout the area see figure above.

Figure 101 physical interaction of house C.1 , source the author the author

- the physical interactions with the surrounding buildings The house seems to be introverted as it only has a patio and small, high windows. Additionally, there is no interaction with its neighboring house, which is only connected by a garden in between.

▪ The actual condition of the house The house is showing signs of wear and tear, with various elements beginning to deteriorate. The walls have cracks and peeling paint, the roof has missing shingles, and the windows are becoming foggy and difficult to open. Overall, the house is experiencing a decline in its condition the details in the table :

Wall, roof condition	The walls have undergone significant wear and tear, resulting in deep cracks and vulnerability. Water leaks have caused substantial damage, potentially leading to mold growth, and posing a health hazard.	 
Roof, openings, and the patio glass	The patio glass is severely cracked and fragile. The window glass shows signs of damage. The roof appears significantly damaged, likely due to external factors.	 
Tiles, floor, paint, window frame	Some rooms show significant wear and tear: broken and torn tiles on the floors, visible decay on wooden frames, and faded, peeling paint on the walls. Immediate attention is needed to restore the affected areas.	 

Table: The current state of house C.1

3. 4. C. Energetic diagnosis:

- The actual energy consumption of the existing building is in Class G this house represents the lowest level of energy efficiency. It characterized by high energy consumption and significant heat loss with 102176,67kw/year.

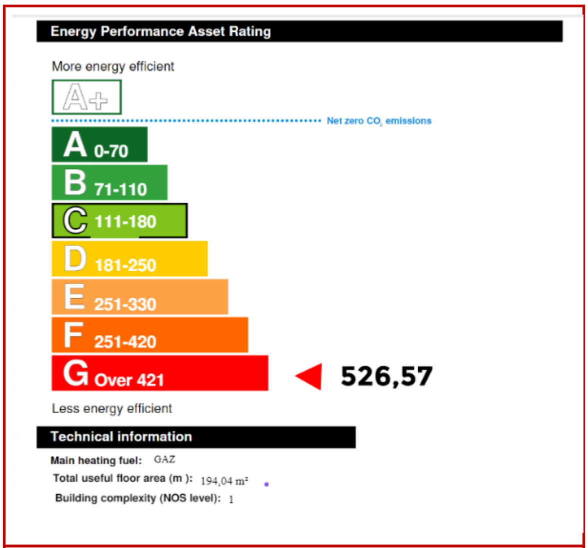


Figure 102 nergetic preformance certfiicate o house C , source the author the author

- The overall heat losses of the building, as well as their distribution by components (walls, windows, floors The majority of heat loss occurs in the patio rather than the rooms. However, the house is experiencing a greenhouse effect due to the patio dome,
- The conditions of management and use of the building The house is in degraded condition due to its age and the lack of maintenance.
- The level of indoor comfort, according to the seasons The covered patio serves as an effective shield from the cold weather and rain but, in the summer the patio is unbearable due to the greenhouse effect that is because of the dome glass covering the patio opening.

  - Upon completing a comprehensive assessment of all our properties, we have identified that the final house necessitates significant energy-efficient upgrades and rehabilitation. The rehabilitation of this last property will involve the implementation of advanced design-builder software, which will allow for the precise planning and execution of energy-efficient measures tailored to the specific requirements of this case.

II.SIMULATION TOOLS:

II.1. Presentation of studied cases: [House C. 1 دار العائلة]

A comprehensive simulation was carried out to analyze and enhance the energy consumption of historic house C.1. Given its status as the oldest house in the area, the optimization process took into account not only energy efficiency but also the preservation of its heritage value.

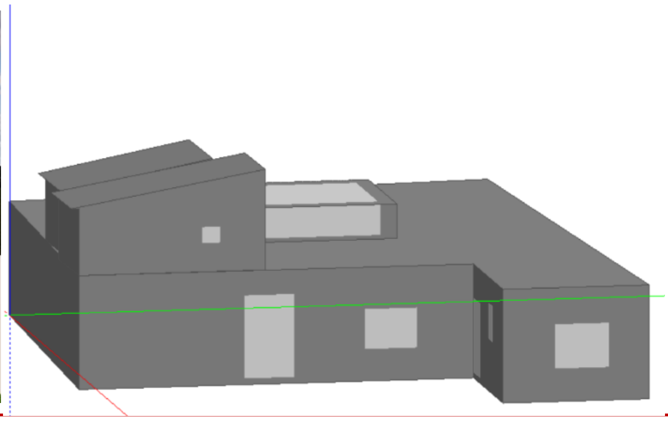


Figure 103 , 104: 3D Model of house C in design builder the author

II.2. Presentation of the simulation software:

Design builder is a thermal modeling software user friendly for building modeling and capable of a large variety of environmental performance parameters, with this software we can achieve:

-Access to the properties of materials, insulators, glass, and HVAC items.

-Take the environmental temperatures of the summer and winter buildings.

-Get the annual energy consumption needs.

-an ASHRAE analysis returning thermal comfort data, thermal balance, ventilation, etc.,

-Build in real 3D shaded view (BIM Marquette).

-Model the building with window-making assistants, construction composition, and automatic wall-type detection that can prevent annoyance or drawing.

-Make an occupation, mechanical ventilation, window openings, or berry stored or internal input... planning according to the day: type, months, hours by config tables.

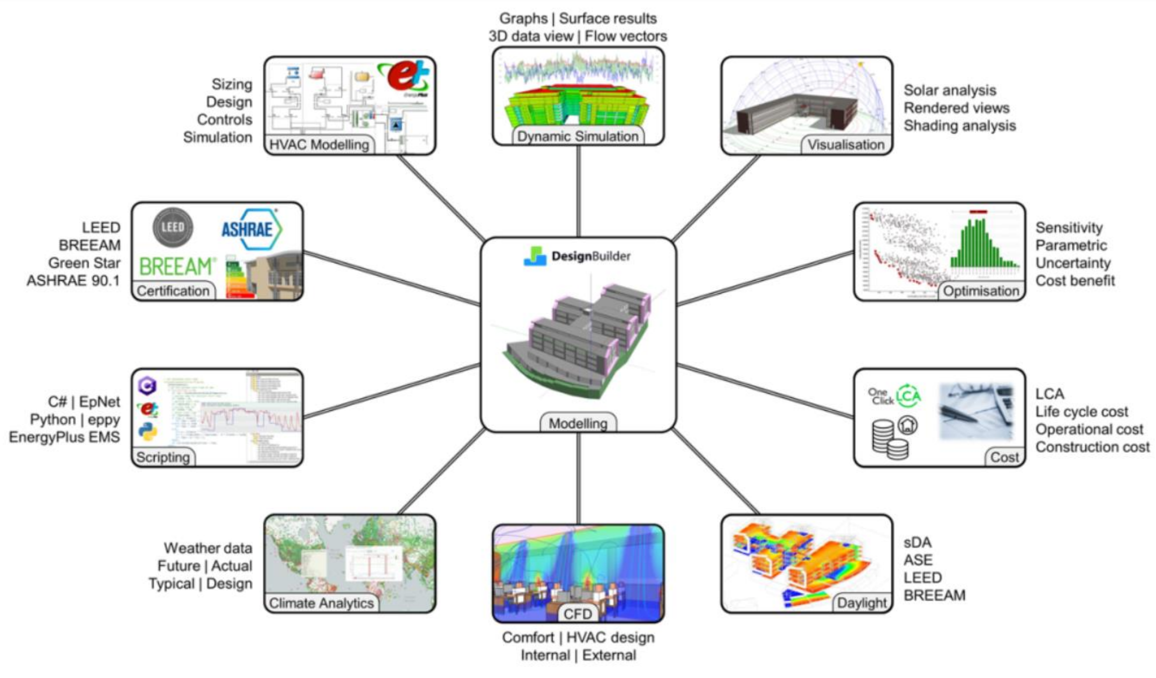
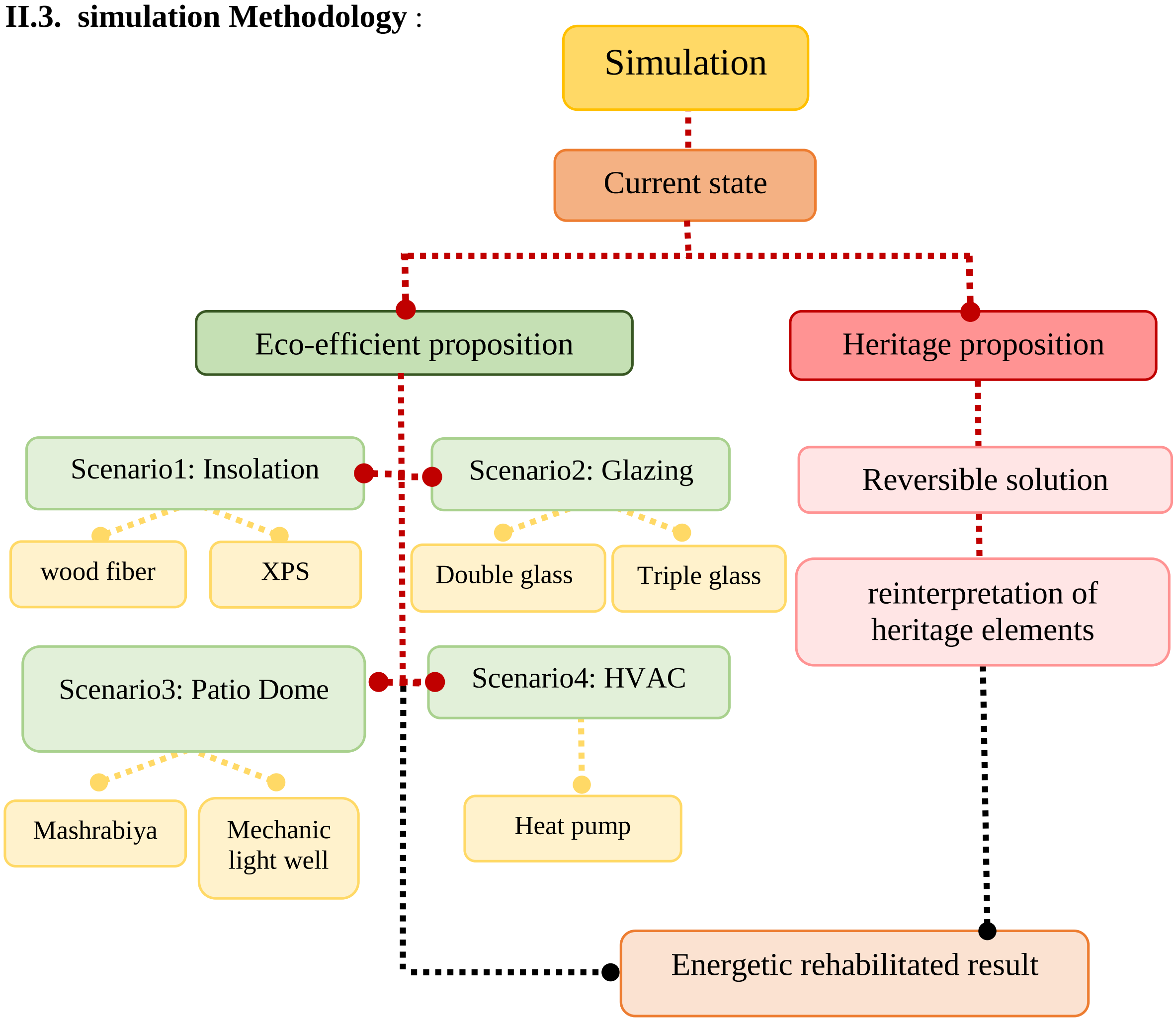


Figure 105, source : designbuilder.co.uk

II.3. simulation Methodology :



Diagrame8 5, source :the author

3.1. Choice and characteristics of materials:

	Element		**Composition**	**Thickness** [cm]	**conductivity** W/m·K	**density** kg/m³	**Specific heat** J/kg·K
	Current abode wall		Plaster	45	0.8	2000	920
			Adobe				
			Plaster				
	Current flat roof		Metal IPN	20	6.09	2463.5	813.2
			Thuya wood				
			Concrete				
			Plaster				
SC 01	wood fiber insolation	Wall	Wood fiber board	10	0,042	200	230
			Vapour				
		Roof	Wood fiber board	12	0,042	200	230
			Vapour seal	0,02	1	1000	1000
			Plaster board	10	0,25	2800	896
	XPS	Wall	Xps	10	0,035	10	1470
			Vapour				
		Roof	Xps	12	0,035	10	1470
			Vapour seal	0,02	1	1000	1000
			Plaster board	10	0,25	2800	896
SC 02	Double glass		Generic	2.4	1.2	2500	840
			Air				
			Generic				
	Triple glass		Generic clear	3,3	0.8	682	840
			Air				
			Generic clear				
			Air				
			Generic clear				

II.4. simulation and interpretation of results:

4.1. Current state:

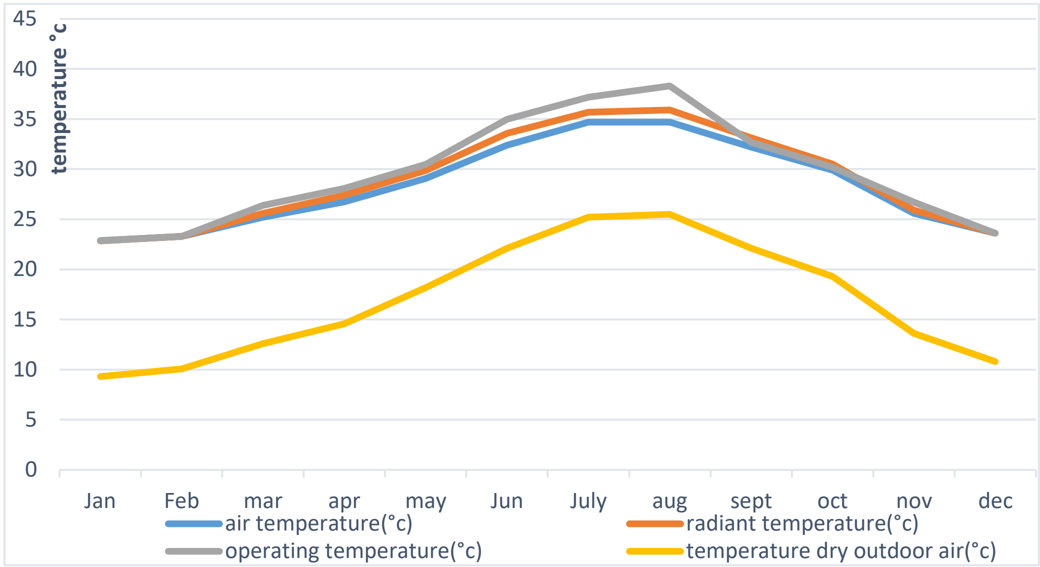


Figure106: the result diagram , source : designbuilder treated by the author

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	22,89	23,28	25,2	26,74	29,06	32,38	34,7	34,7	32,2	29,9	25,6	23,6
radiant temperature(°c)	22,83	23,28	25,6	27,4	29,88	33,59	35,7	35,9	33,13	30,5	25,9	23,6
operating temperature(°c)	22,86	23,28	26,4	28,07	30,47	34,99	37,2	38,3	32,67	30,2	26,7	23,6
temperature dry outdoor air(°c)	9,3	10,06	12,6	14,58	18,19	22,1	25,2	25,5	22,11	19,3	13,6	10,8
humidity(%)	42,95	40,79	36,9	47,2	46,51	48,04	50,7	55,4	53,2	45,2	45,8	43,8
pmv(%)	0,3	0,38	0,82	0,73	1,38	2,4	3,14	4,8	2,33	1,85	0,9	0,45

Figure107: the results of simulation of the current state , source :design builder treated the author

Legend : Comfort zone; overheating; Neutral; Slightly warm; warm; hot

- The results above indicate that we have two periods:

  -The comfort period spans three months, from November to March, with temperatures ranging from 22.86 to 26.7 degrees Celsius.

  -The overheating phase, which spans from April to October, and the temperature swings between 28.07°C to the pick o heat with 38.30°C in August with a level of discomfort of 4, 80%.

- The warm-to-hot environment results from the glass dome covering the patio, which creates a greenhouse effect. This greenhouse effect occurs because the glass traps heat, increasing the temperature and creating a warmer climate within the covered area.

4.2. Eco-efficient proposition:

4.2.A. Scenario1: wall and roof Insolation

4.2.A. 1. Using wood fiber insulation in walls and the roof:

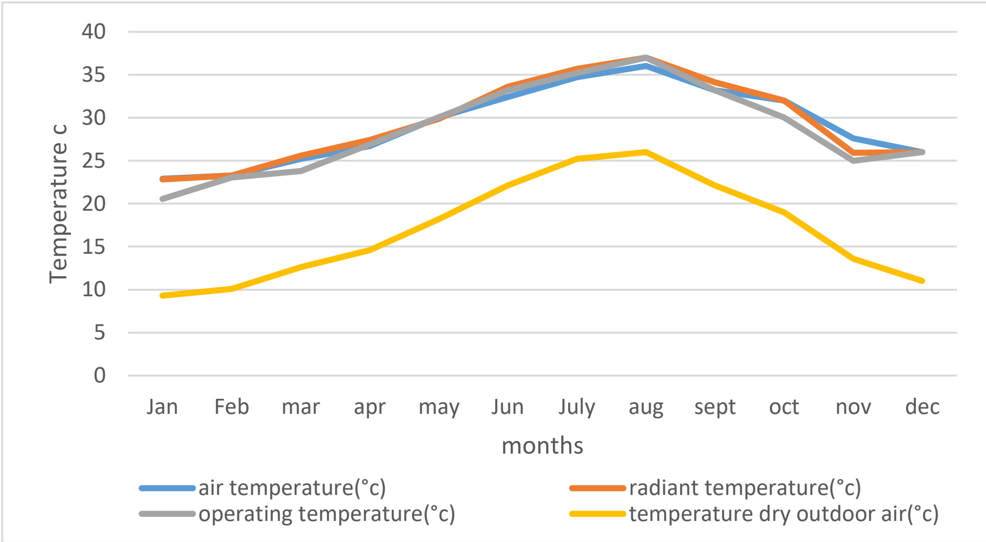


Figure108: the result diagram insolation with wood faiber , source : designbuilder treated by the

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	22,89	23,28	25,2	26,7	30,06	32,4	34,7	36	33,2	32	27,6	25
radiant temperature(°c)	22,83	23,28	25,6	27,4	29,88	33,6	35,7	37	34,1	32	25,9	26
operating temperature(°c)	20,56	23,04	23,8	26,9	30,06	33,2	35,2	37	33,2	30	25	26
temperature dry outdoor air(°c)	9,3	10,06	12,6	14,6	18,19	22,1	25,2	26	22,1	19	13,6	11
humidity(%)	31,02	30,69	31,7	32,2	33,85	32,7	33,3	34	34,8	35	33,4	32
pmv(%)	0,75	0,79	1,23	1,34	1,34	2,4	3,14	3,1	2,73	2	1,3	1

figure109: the results of simulation of wood aiber insolation , source :design builder treated the author

Legend : Comfort zone, overheating, Neutral, Slightly warm, warm, hot

- After trying fiber wood insulation in walls10cm and the roof 12cm The results above in the diagram show that operating temperature curve is in near stable, as well as the humidity is showing low levels and the table indicates that we have two periods:

  -The comfort period spans three months, from November to April, with temperatures ranging from 20.56 to 26.9 degrees Celsius.

-The overheating phase spans from April to October, and the temperature swings between 30°C to the pick o heat with 37°C in August with a level of discomfort of 3, 14 %.

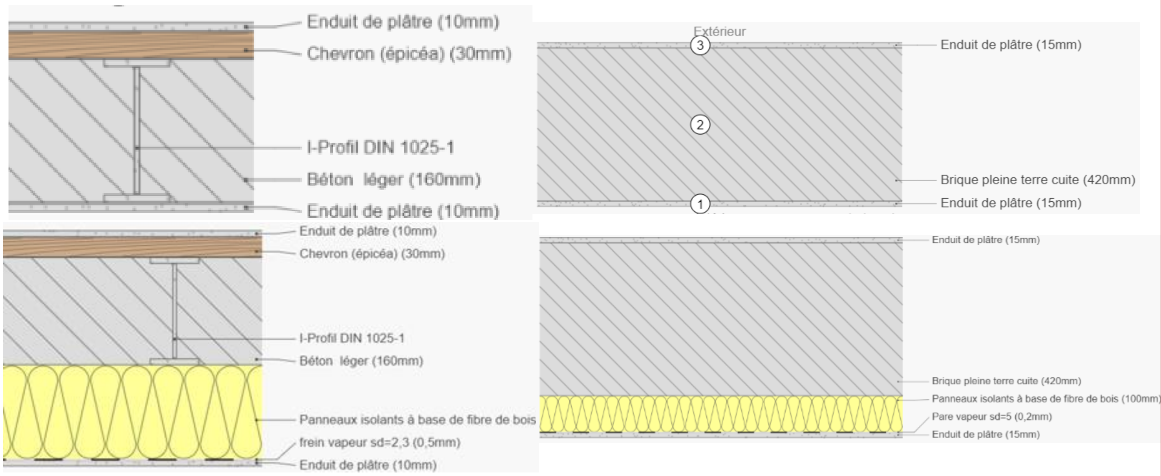


figure110: constraction details in wall and roof insulation with fiber wood , source : the author

- The warm-to-hot environment results from the glass dome covering the patio, which creates a greenhouse effect. This greenhouse effect occurs because the glass traps heat, increasing the temperature and creating a warmer climate within the covered area.

4.2.A. 1. Using expanded polystyrene insulation:

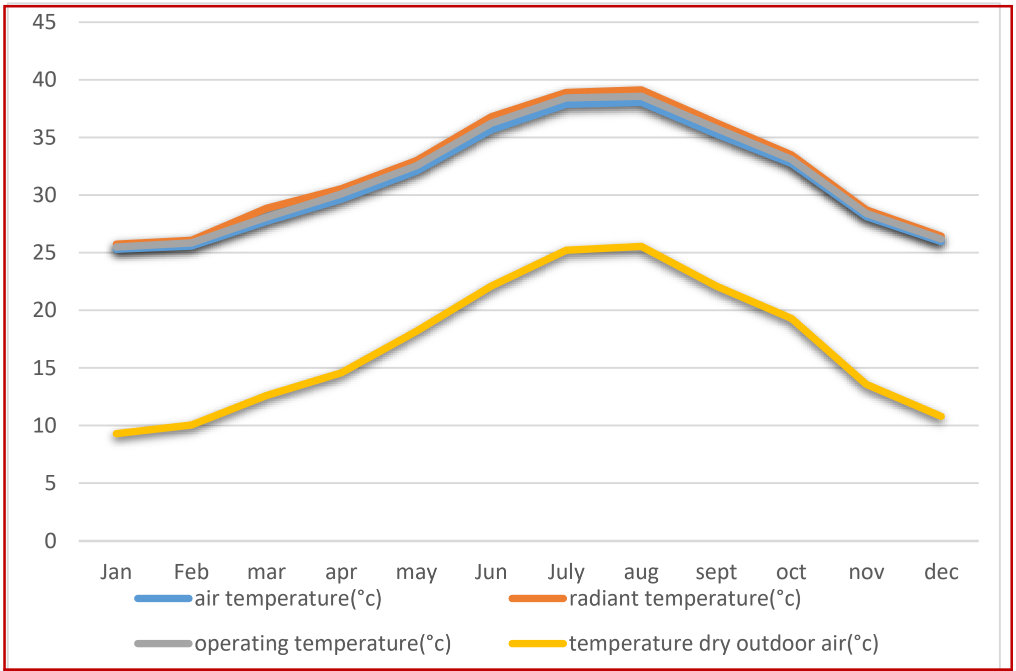


figure111: the result diagram using Xps , source : design builder treated by the author

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	25,29	25,58	27,72	29,63	32,06	35,66	37,86	38,04	35,3	32,7	28,12	25,95
radiant temperature(°c)	25,74	26,08	28,85	30,53	32,98	36,8	38,89	39,11	36,25	33,5	28,71	26,42
operating temperature(°c)	25,5	25,84	28,08	30,09	32,53	36,23	38,42	38,57	35,78	33,1	28,41	26,19
temperature dry outdoor air(°c)	9,31	10,06	12,61	14,58	18,19	22,1	25,22	25,53	22,11	19,3	13,59	10,79
humidity(%)	30,87	27,39	31,11	31,44	32,78	31,4	32,03	32,41	33,92	34,1	32,99	29,4
pmv(%)	0,8	0,87	1,34	1,5	2,23	3,31	3,98	4,03	2,73	2	1,42	0,95

figure112: the results of simulation of the current state , source :design builder treated the author

Legend : Comfort zone, overheating, Neutral, Slightly warm, warm, hot

- This time we tried expanded polystyrene insulation in walls10cm and the roof 12cm The results in the diagram show that the operating temperature is far from the comfort zone although the level of humidity is lower than the first insolation but the indoor comfort isn't all that great, as all as the table above indicate that we have two periods:
  -The comfort period spans three months, from December to February, with temperatures ranging from 26,19 to 25,84 degrees Celsius.
  -The overheating phase is in the rest of the months, and the temperature swings between 28°C to the pick o heat with 38°C in August with a level of discomfort of 4,03 % and high humidity.

➢ As a result, Wood fiber insulation is the superior choice between the two insulation materials because it provides a month's plus of comfort from the initial state. It provides a larger comfort zone from November to April, and even though it falls in the overheating zone for the rest of the months, the temperature is lower than with expanded polystyrene insulation. Additionally, wood fiber insulation being a natural material makes it the perfect choice for historical buildings.

4.2.B. Scenario 2: Glazing

4.2. B.1.Double electrochromic absorptive glazing with aluminium rame:

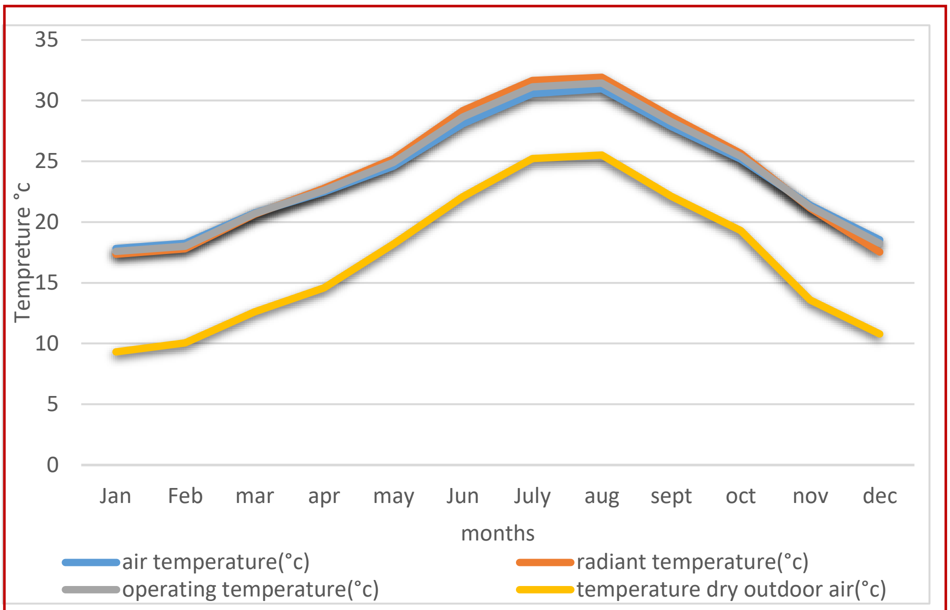


figure113: the result diagram double glazing, source: design builder treated by

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	17,82	18,24	20,74	22,49	24,6	28,11	30,59	30,97	27,86	25,2	21,39	18,53
radiant temperature(°c)	17,36	17,79	20,64	22,77	25,21	29,19	31,66	31,93	28,68	25,7	21,14	17,53
operating temperature(°c)	17,59	18,01	20,69	22,63	24,91	28,65	31,13	31,45	28,27	25,4	21,26	18,25
temperature dry outdoor air(°c)	9,31	10,06	12,61	14,58	18,19	22,1	25,22	25,53	22,11	19,3	13,59	10,79
humidity(%)	46,07	45,14	44,69	45,4	48,47	46,25	46,52	46,76	50,46	50,7	46,72	47,6
pmv(%)	-0,71	-0,62	-0,08	-0,48	0,16	1,24	1,98	2.08	1,16	0.94	0,04	-0,57

figure114: the results of simulation of the double glazing, source: design builder treated the author

Legend : Comfort zone, overheating, under heat, Neutral, Slightly warm, Slightly cool, warm, hot

- After using double glazing, the curve in the diagram is almost steady with astable level of humidity, the table results are sorted into three periods:

- Comfort zone: Extends for 7 months with temperatures ranging from 20 to 28,27°C from March to May and from September to November. The environment is neutral to slightly warm -0.08% 0,94% of the time.
- Under heat period: Lasts for three months from December to February with the lowest temperatures ranging from 17.59 to 18.25°C. The PMV indicates that it's slightly cool to neutral, ranging from -0.71% to 0.16%

- overheating period: Occurs from June to August with temperatures varying from 28.27 to a high of 31.45°C. The PMV indicates that the environment is warm 2.08% of the time.

4.2. B.2.triple glazing with aluminium frame:

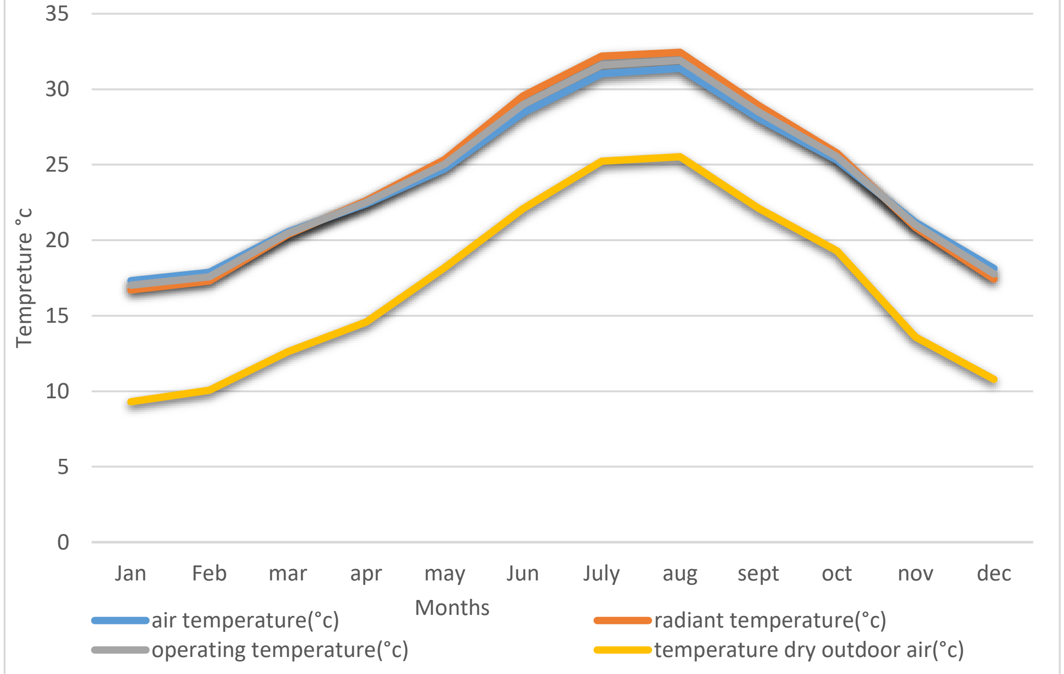


figure115: the result diagram triple glazing , source : designbuilder treated by the author

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	17,33	17,87	20,54	22,41	24,73	28,43	31,02	31,37	28,08	25,3	21,19	18,12
radiant temperature(°c)	16,71	17,29	20,37	22,62	25,33	29,56	32,18	32,43	28,92	25,8	20,85	17,43
operating temperature(°c)	17,02	17,58	20,46	22,52	25,03	28,99	31,6	31,9	28,5	25,5	21,02	17,77
temperature dry outdoor air(°c)	9,31	10,06	12,61	14,58	18,19	22,1	25,22	25,53	22,11	19,3	13,59	10,79
humidity(%)	47,52	46,18	45,25	45,63	48,14	45,39	45,4	45,68	49,83	50,4	47,31	48,85
pmv(%)	-0,81	-0,71	-0,13	-0,51	0,2	1,34	2,11	2,2	1,23	0.96	0	-0.66

figure116: the results of simulation of triple glazing, source: design builder treated the author

Legend : Comfort zone, overheating, under heat, Neutral, Slightly warm, Slightly cool, warm, hot

- the second option is using triple glazing; the results are sorted into three periods:
- Comfort zone: Extends for 5 months with temperatures ranging from 20,46 to 25.50°C from March to May and from October to November. The environment is neutral to slightly warm -0,13% to 0,96 % of the time.

- Under heat period: Lasts for three months the same, from December to February with the lowest temperatures ranging from 17.02 to 17,77°C. The PMV indicates that it's slightly cool to neutral, ranging from -0.81% to -0.66%.
- overheating period: Occurs from June to September with temperatures varying from 28.99 to a high of 31.9°C. The PMV indicates that the environment is warm 2.20% of the time.

  - ➢ Comparing the two types of glazing, double and triple, it was found that double glazing slightly outperformed triple glazing. It effectively lowered the temperature during overheating periods and retained heat during colder periods, making it the optimal choice for our specific situation.

4.2.C. Scenario 3: Patio Dome

4.2.C. 1. Large Mechanic light well:

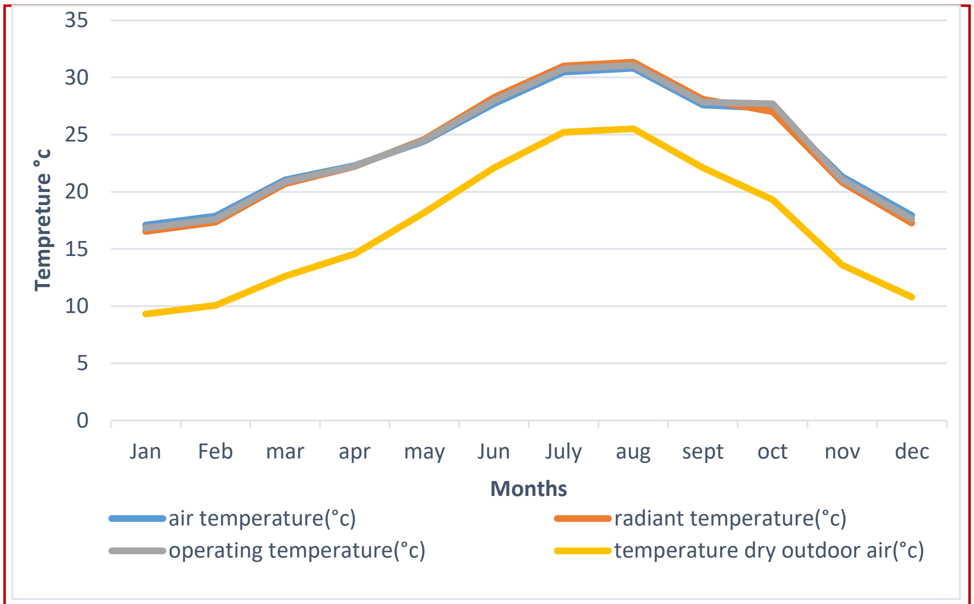


figure117: the result diagram large mechanic light well, source: design builder treated by author

The operating temperature of the patio mechanical cover system is shown in the diagram to be stable when it comes to the outside air temperature. This means that the cover keeps the outside air comfortable by efficiently maintaining a constant temperature. This illustrates the quality and power of the materials and design of the cover.

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
air temperature(°c)	17,09	17,86	21,03	22,3	24,42	27,71	30,47	30,8	27,6	27,3	21,32	17,94
radiant temperature(°c)	16,53	17,34	20,69	22,2	24,59	28,25	31,01	31,33	28,1	27	20,81	17,27
operating temperature(°c)	16,81	17,6	20,86	22,25	24,5	27,98	30,76	31,07	27,85	27,7	21,06	17,61
temperature dry outdoor air(°c)	9,31	10,06	12,61	14,58	18,19	22,1	25,22	25,53	22,11	19,3	13,59	10,79
humidity(%)	48,08	46,19	44,32	46,17	49,5	48,88	49,46	49,69	52,43	45,8	47,2	49,26
pmv(%)	-0,86	-0,71	-0,04	-0,58	0,05	1,06	1,89	1,99	1,05	1,31	0,01	-0,7

figure118: the results of simulation of the large mechanic light well , source :design builder treated the

Legend :

Comfort zone
overheating
under heat
Neutral
Slightly warm
Slightly cool
warm
hot

- Covering the patio with a large mechanic light well has completely changed the building's behavior, dividing it into three periods: overheating, comfort, and under heating, as follows:

- From December to February, the lowest temperature is 16.81°C and the highest is 17.61°C. The Predicted Mean Vote (PMV) indicates that it is slightly cool, ranging from -0.7% to -0.85%.

- The comfort zone is from March to May and from October to November, with the lowest temperature being 20.86°C and the highest 27.7°C, indicating that it is neutral to slightly warm.

- The overheating period is from July to August, with temperatures ranging from 30.76°C to 31.07°C and the environment being warm with1 .99% PMV.

Figure 119: the large mechanic light well assembly , source : gerald-arena.fr

4.2. C. 2. Mashrabiya:

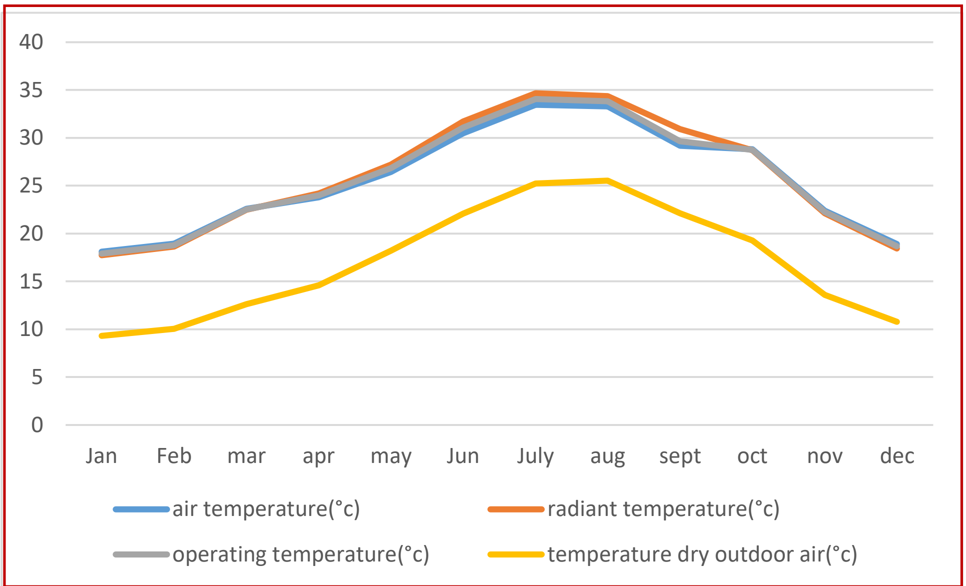


figure120: the result diagram mashrabiya , source : designbuilder treated by author

MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	Dec
air temperature(°c)	18,09	18,94	22,57	23,78	26,42	30,48	33,47	33,28	29,18	28,8	22,4	18,9
radiant temperature(°c)	17,75	18,65	22,47	24,2	27,21	31,7	34,67	34,37	30,9	28,7	22,12	18,45
operating temperature(°c)	17,92	18,79	22,52	23,99	26,82	31,09	34,07	33,83	29,64	28,8	22,26	18,68
temperature dry outdoor air(°c)	9,31	10,06	12,61	14,58	18,19	22,1	25,22	25,53	22,11	19,3	13,59	10,79
humidity(%)	45,47	43,6	41,2	43,23	45,55	43,71	43,84	44,89	49,02	42,8	44,56	46,7
pmv(%)	-0,64	-0,47	0,3	-0,08	0,73	2	2,5	2,4	1,58	1,4	0,25	-0,48

figure121 : the results of simulation of mashrabiya , source :design builder treated the author

Legend :

Comfort zone
overheating
under heat
Neutral
Slightly warm
warm
hot
Slightly cool

Using Mashrabiya as a patio cover results in higher operating temperatures throughout the year, especially in summer. While it provides shade, it doesn't effectively reduce heat, making the patio less comfortable in hotter months.

- Covering the patio with mashrabiya this time had almost the same results like previous option that is also devided in periods: overheating, comfort, and under heating, as follows:

  - From December to February, the lowest temperature is 17.92°C and the highest is 18.79°C. The Predicted Mean Vote (PMV) indicates that it is slightly cool, ranging from-0.47% to -0.64%.

  - The comfort zone is from March to May and November, with the lowest temperature being 22.52°C and the highest 26.82°C, indicating that it is neutral to slightly warm.

  - The overheating period is from June to october, with temperatures ranging from 28.80°C to 34.07°C and the environment being warm with 2.5% PMV.

- Alghouth Masharabiya is an option that suits the heritage aspect of energetic rehabilitation the best option or our case is the Large mechanic light well which had better results than option 2 expanding the comfort zone for 7 months, and has only 2 months in overheat.

4.3. reinterpretation of heritage elements:

to both preserve and reinterpret traditional architectural elements in our energetic rehabilitation case we chose from all the scenarios the materials that are

- reversible so that they don't damage the heritage and like the wood fiber insulation in the walls and roof, not only that it's reversible but also natural.
- the application of the same tiles in the house to replace the old cracked ones.
- Reinterprate the fountain at the center of the patio to optimize the cooling.

figure122: restoring the old tile and fountain, source: the owner of the house

II.5. House C. 1 دار العائلة after the energetic rehabilitation:

After all the modifications and adjustments, the energy performance was optimized from class G to class B. This was accomplished by combining passive strategies, which include increasing interior environmental insolation, switching to double glazing with aluminum frames, replacing the patio dome with a larger mechanic light well to lower internal heat gain, and adding a heat pump HVAC system for one month of heat, as the table and diagram below show that it transformed to having 9 months in comfort zone and 2 months slightly cool and one that is somewhat overheated.

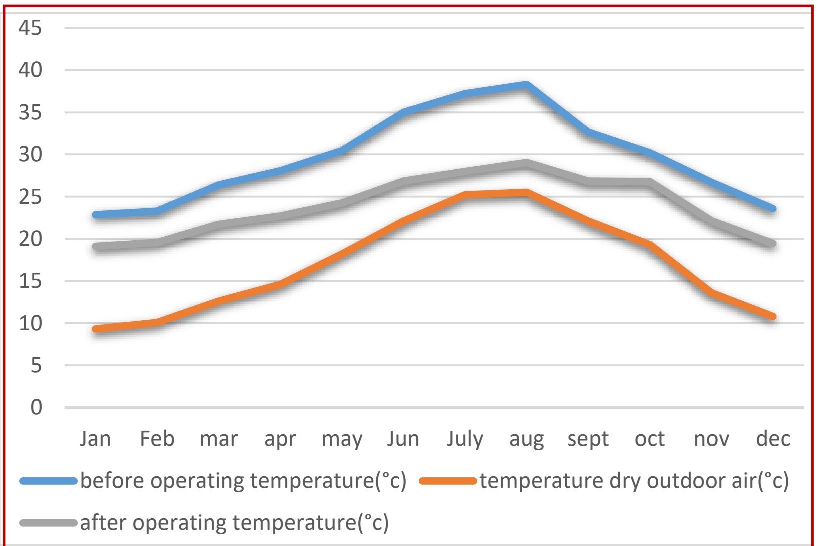


figure123: the results diagram before and after the energetic rehabilitation, source : designbuilder treated by author

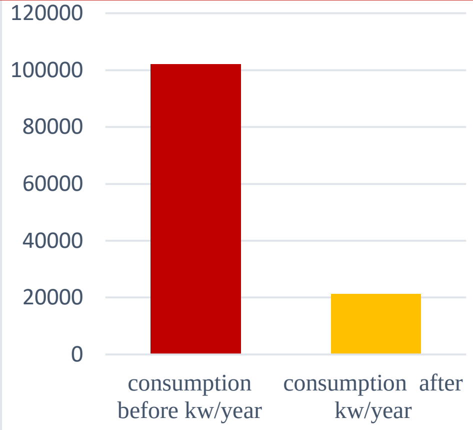
MONTHS	Jan	Feb	mar	apr	may	Jun	July	aug	sept	oct	nov	dec
operating temperature(°c)	22,86	23,28	26,4	28,07	30,47	34,99	37,2	38,3	32,67	30,2	26,7	23,6
humidity(%)	42,95	40,79	36,9	47,2	46,51	48,04	50,7	55,4	53,2	45,2	45,8	43,8
pmv(%)	0,3	0,38	0,82	0,73	1,38	2,4	3,14	4,8	2,33	1,85	0,9	0,45
dry outdoor air(°c)	9,3	10,06	12,6	14,58	18,19	22,1	25,2	25,5	22,11	19,3	13,6	10,8
operating temperature(°c)	19,90	21,09	21,73	22,71	24,26	26,83	27,98	28,06	26,84	26,8	22,16	19,45
humidity(%)	31,06	30,79	32,07	33,5	33,85	32,68	32,8	33,4	34,59	33,1	31,44	32,2
pmv(%)	-0,05	-0,03	0,12	-0,07	-0,03	0,72	1,38	1,49	0,74	1,21	0,21	-0,3

figure124 : the results between the before and after the energatic rehabilitation , source :design builder treated the author

Legend :

Comfort zone
overheating
under heat
Neutral
Slightly warm
Slightly cool
warm
hot

- Not only did the passive strategies optimize indoor comfort but they also changed the energetic behavior of the house from energy-consuming to a high level of energy efficiency due to having good insulation, efficient cooling systems, active ventilation, and use of energy-saving appliances and lighting all that guarantees cheaper energy costs and helps reduce carbon emissions. Furthermore, this home offers a year-round comfortable living space by keeping the interior temperature constant independent of the outside weather.



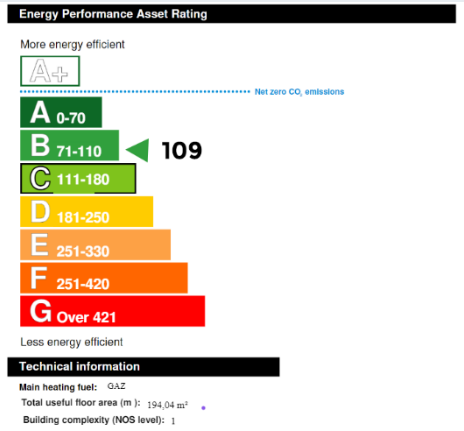


figure125 : the results between the before and after the energetic rehabilitation consumption with the energetic performance certificate , source :design builder treated the author

5. 1. Reduction of energy consumption by photovoltaic panel:

We will integrate active measures to enhance energy efficiency in our old building, one of which is renewable energy, as we have annual energy consumption and our aim is energy efficiency. photovoltaic panels, selecting a 260 Wc or blida panal; a 260 Wc solar panel's dimensions are as follows:

- Length: 1.65 meters
- Width: 1.0 meters
- Surface: 1.65 m2

And so to calculate to cover the Annual energy consumption by the photovoltaic panals we have: Calculation of power requirements in: Power Required = Consumption / Conversion Factor:

- Power requirement = 21 213.13 kWh / 0.85 ≈ 24 957.21 kWh.

Conversion of required power to kWc: Power requirement in kWc = Power required in kWh / 1000:

- Power requirement in kWc = 24 957,21 kWh / 1000 ≈ 24,96 kWc

And the Calculation of the number of panels that are 260wc : Number of panels required = Power required in kWc / Power of one panel.

- Number of panels required = 24.96 kWc / 0.26 kWc ≈ **96 panels.**

And so we need 96 panels to cover the whole energy consumption, those panals take a total surface of 158,4 m²:

- 96 panels x 1,65 m²/panel = 158,4

But the available surface is only 44 m² in the roofs, so the number of panels are:

- Number of panels = 44 m2 / 1,65 m2 = **26,67 PANELS.**

Assuming a production of 1, 650 kWh per installed kWc per year, these panels will Produce annually:

- 26,67 panels x 0,26 kWc/panel = 6,94 kWc
- 6,94 kWc * 1 650 kWh/kWc/an = **11 451 kWh/an.**

These panels will reduce 53.9% Energy consumption by that making the total house consumption:

- 21 213,13 kWh -11 451 kWh = **9762,13 kWh.**
  - ➢ The house's energy efficiency increased from **class B** to **class A** with 50,30 kWh/m2 by using renewable energy.

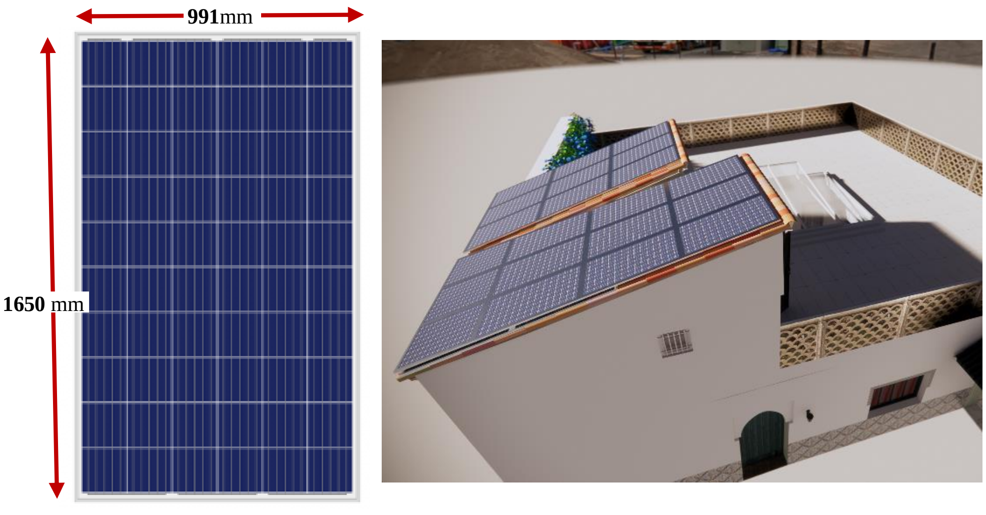


figure126 : the photovoltaic panel and its installation at the roof source : dahsolarpv.com ,and the author

- **CONCLUSION**:

This chapter symbolizes the successful application of the two previous theoretical chapters, which guided us in achieving our goal. We utilized information from the analysis of two examples and applied it to understand the city more. The successful energy rehabilitation in this case was made possible through the utilization of simulation software, allowing us to select the best-case scenario while considering both the house's heritage and its energy performance. In conclusion, we have achieved energy rehabilitation in House C.1, successfully preserving the past while also empowering the future.

- **GENERAL CONCLUSION:**

The energetic rehabilitation of Blida Douirette Ater's ancient fabric demonstrates the power of combining modern simulation tools and optimization techniques for improving indoor comfort and energy efficiency. This research discovered that energy-saving techniques may dramatically lower energy use while raising comfort levels. These techniques include better insulation and effective heating, cooling, and ventilation systems as well as inserting reneweble energy resources. The use of simulation tools allowed for precise estimation of the building's energy performance, identifying the most effective rehabilitation solutions. The optimization process ensured cost-effective actions, maximizing benefits in energy reduction and comfort enhancement.

In order to improve thermal comfort and energy behavior in Douirette, passive techniques can offer the best options, and this thesis validates the idea that an efficient building envelope can improve energy performance. Additionally, active strategies in ventilation and cooling effectively address the internal gains in traditional Douirette houses. The insights and suggestions that come from this research support the combination of active and passive techniques that are specifically designed to fit the special qualities of historical buildings.

This strategy reduces environmental effect while honoring the locale's cultural legacy, making it a role model for related projects. Further study attempts have to concentrate on enhancing these methodologies, particularly with regard to the patio and its characteristics, since they serve as the primary origin of both comfort and discomfort in conventional homes.

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- **FIGURE TABLE :**

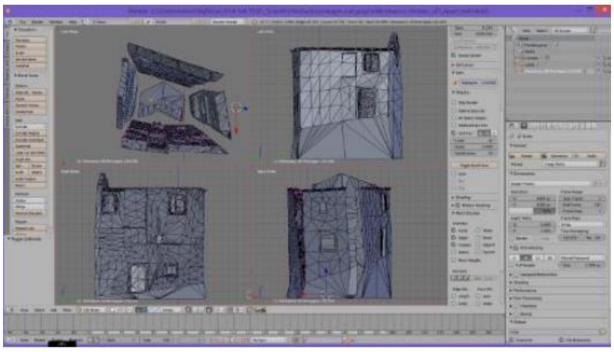
- **TABLES :**

- **APPENDIX 1:**

The 14th-century house was assessed using modern technologies such as tape measurement, laser scanning, photogrammetry, and drone flights. Digital reconstructions and 3D printed scale models were created to show that rehabilitating the old building using different materials is more cost-effective and environmentally friendly than demolishing and reconstructing it. measurement and Laser Scan and Photogrammetry :

Autodesk Revit 2012 model that was exported to the dynamic simulation software using gbXML**:**

Five scenarios were made based on the type of intervention option 0 is the reference to the actual state



-Option 1 is rehabilitation in which they change and upgrade the ceiling the interior walls, and the floor between levels

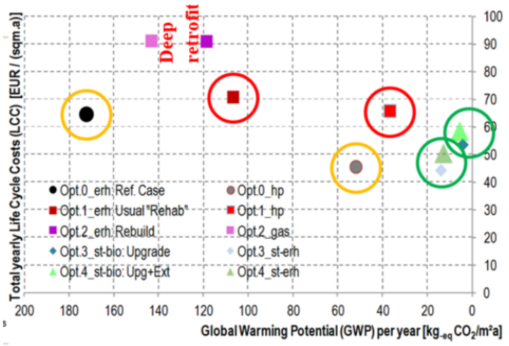
-option 2 is demolishing and reconstructing and Option 3 is upgrading with and without extension in the house:

In option 3 upgrade rehabilitation was in the ceiling with 150mm width and a solar collector, external window glass, and internal floor cork with 150mm 180mm with non-extention.

In option 4 the upgrade rehabilitation with extension, in this case, the upgrade was in the ceiling replaced by an external roof cork with a solar collector, part floor wood, external window glass, and external wall. An internal floor cork.

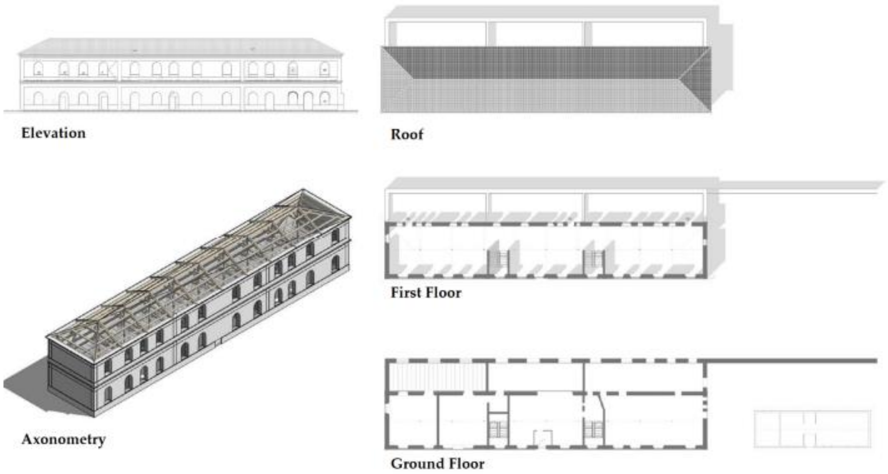
these results show that the best option in all scenarios is rehabilitation upgraded strategies without extension followed by rehabilitation upgraded strategies with extension ‘then the usual rehabilitation and the worst in this case is demolishing and reconstruction in Initial Investment, annualized Life Cycle Costs (LCC) in 30 years: and Global Warming Potential with Life Circle using ecobat:

As you can see in the diagrammed energetic rehabilitation costs less money than the other options and has minimal impact on global warming with minimal life circle costs.



- ## APPENDIX 2:

The second example in Spain: The architectural plans of the building



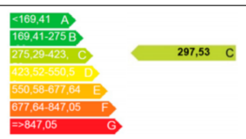
- The constructive details on model A:

A continuous slab of reinforced concrete, 60 centimeters deep foundation. The vertical envelope will maintain the current outer sheet, and laminated plasterboard and semi-rigid rock wool panels will be used for insulation. the roof, a sandwich panel with a 60 mm extruded polystyrene core and an asphalt plate will make up the waterproofing and insulation system. Laminated plasterboard for the fake ceiling and an accessible floor composed of self-supporting panels created by a calcium sulfate base support will make up the finishing materials. Finally, utilizing double glazingand three-chamber PVC thermal break carpentry,

- The constructive details on model B:

for foundations, a bracing slab construction is suggested. In the vertical envelope, composite plaster panels for cladding and natural cork agglomerate panels and 20% recovered sawdust from the demolition of rehab buildings will be used in the acoustic insulation system. Sandwich panels and ceramic tiles will be used for the roof. The use of normal wood carpentry and double glazing. Lastly, a self-supporting, accessible technological floor composed of a compact core of high-density agglomerate particles will be utilized as cladding.

MODEL A	MODEL B
Global non-renewable primary energy consumption (kWh/m² year)	
GLOBAL INDICATOR	



MODEL A	MODEL B
PARTIAL INDICATORS	
Non-renewable primary energy heating	
35.40 kWh/m² year (**A**)	37.20 kWh/m² year (**A**)
Non-renewable primary energy cooling	
36.84 kWh/m² year (**A**)	38.65 kWh/m² year (**A**)
Non-renewable primary energy water	
2.37 kWh/m² year (**C**)	2.37 kWh/m² year (**C**)
Non-renewable primary energy lighting	
219.26 kWh/m² year (**E**)	219.30 kWh/m² year (**E**)

- **APPENDIX 3:**

The road leading from the mosque to the upper area needs to be reconstructed, as well as the stairs.

In the upper region of Douirette, we offer four projects to benefit the community. These projects include a rehabilitation center a community center for addicts in that area, or a place for all age categories. Additionally, we propose a dormitory for families living far away from the rehabilitation center. These projects have the potential to positively impact the local economy by providing local citizens with jobs.

As well as a kindergarten with a playing area for the children, this part, is the newest that represents the future of Douirette by caring for its children and its younger generation, see figure below or the playing area.

The figure below depicts a well-designed playing area for children that includes ample seating and serves a dual purpose by incorporating the reconstruction of a new road. This new road is situated in the recently developed section of Douirette, creating a vital connection between the two parts. The spacious seating area provides a comfortable space for parents and caregivers to relax while their children play. Additionally, the inclusion of the road reconstruction ensures improved accessibility and convenience for residents, allowing for easy movement between the different areas of the town. This thoughtful design not only caters to the recreational needs of children but also enhances the overall infrastructure and connectivity of Douirette.

section and plan of the playing area or children near the nursery , source: author .

- The urban intervention in Douirette focuses on several aspects to improve the ease of movement and relaxation in the area. One of these details involves the reconstruction of the stairs, which will be repainted using vibrant local colors. To further enhance the aesthetic appeal and functionality, more local vegetation will be added, and seating chairs made of wood and steel will be introduced as well the two figures below show the actual state and after the changes proposed.

the before and after of the local stairs in Douirette, source author

the before and after of the local stairs in Douirette, source author

- The public garden/plot aims to recreate the beauty and essence of Andalusian gardens. These gardens hold historical significance as Blida was once occupied and inhabited by the Andalusians. To capture the essence of these gardens, the design includes various corners adorned with local vegetation such as jasmine and lemon trees with the seating areas. The fragrant plants not only add to the visual appeal but also create a refreshing ambiance. At the center of the garden, a magnificent water fountain is installed, reminiscent of the grand fountains commonly found in Andalusian gardens. This central feature not only serves as a focal point but also adds a soothing element to the overall design. The public garden aims to provide a serene and inviting space for locals and even foreigners to enjoy and appreciate the cultural heritage of the Andalusians in Blida and Douirette.

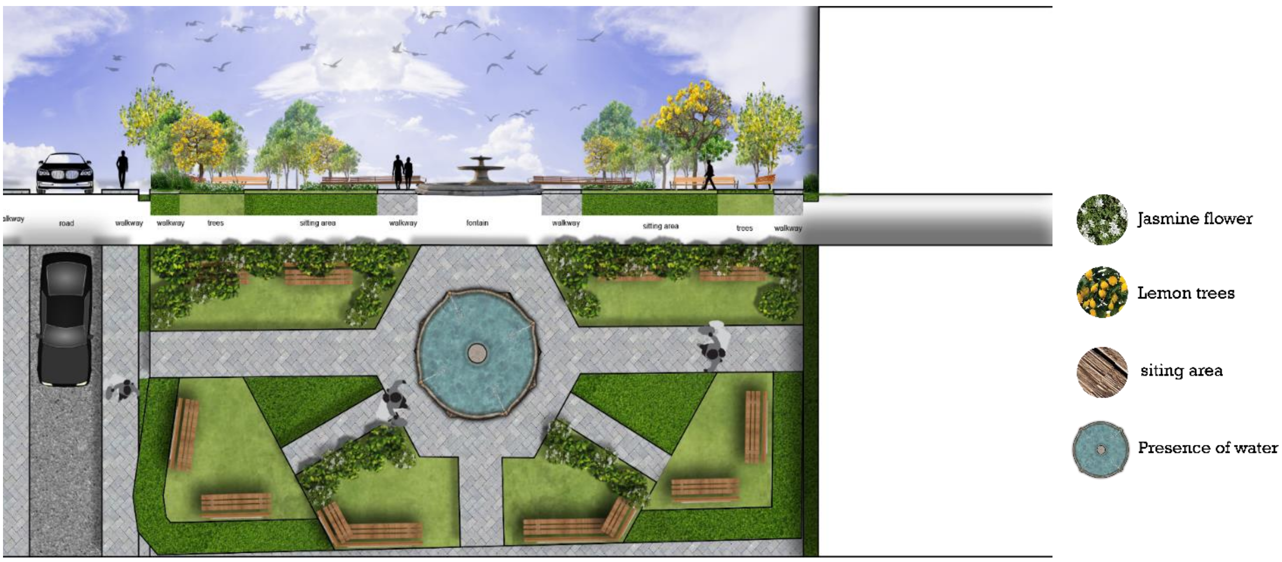
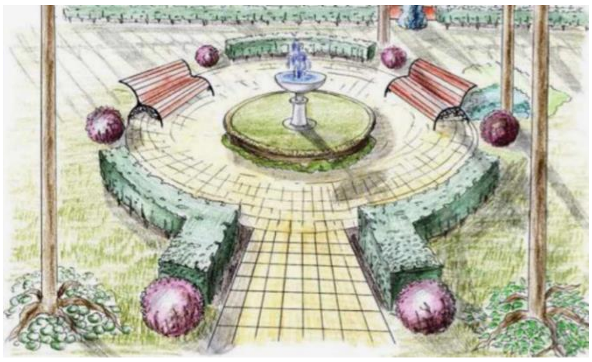


Figure73: section and plan on the public garden created in Douirette source author.



Andalusia jardin inspiration, source : [.free-lancers.net]

inspiration from existent jardin , source : jimcdn.com

- the interventions in the old part of Etienne Dien Road also include the renovation of Douirette's first core. The restoration efforts aim to preserve the historical significance of the area and revitalize its charm. The two famous hammams, Zahar and Mokhbat, are being chosen to be restored to their former glory, ensuring that their architectural beauty is preserved for future generations. Furthermore, a house that had crumbled has been identified for restoration. The owner, who lives alone in this old house that showcases the local style so, a project of a garden with a restaurant in an open-air setting on the ground floor, adds a new dimension to the area's appeal. This initiative aims to attract locals and tourists alike to experience the unique atmosphere of the old part of Etienne Dient Road while enjoying delicious food in a beautiful outdoor setting.

ruined house for a future restoration project, source: author

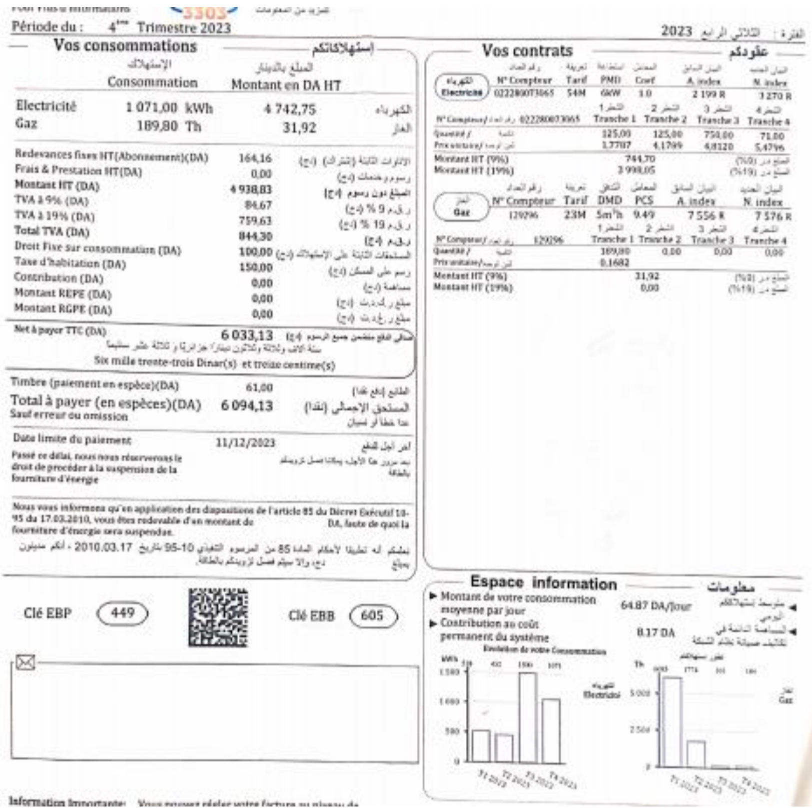
open air restaurant in morocco, the inspiration or crating the same restaurants in Douirette,

- As mentioned earlier, the primary goal of The Urban intervention is to make it easier for people to move around and find relaxation within the designated area. One of the details is focused on the revitalization of dead ends that lead to the houses. These dead ends will be repainted using vibrant local colors, similar to the methods used before. Additionally, we will be changing the floor to further enhance the aesthetic appeal and functionality. Moreover, adding more local vegetation to the walls to create a more vibrant and beautiful environment see figure below or the before and after in the two dead ends.

the before and after of the local stairs in Douirette, source author

the before and after of the local stairs in Douirette, source author

- APPENDIX 4: consumption of house A.1



Période du : 4ème Trimestre 2023

الفترة : الثلاثي الرابع 2023

Vos consommations إستهلاكاتكم

الإستهلاك Consommation		المبلغ بالدينار Montant en DA HT	
Electricité	1 071,00 kWh	4 742,75	الكهرباء
Gaz	189,80 Th	31,92	الغاز

Redevances fixes HT(Abonnement)(DA)	164,16	الإتاوات الثابتة (إشتراك) (دج)
Frais & Prestation HT(DA)	0,00	رسوم وخدمات (دج)
Montant HT (DA)	4 938,83	المبلغ دون رسوم (دج)
TVA à 9% (DA)	84,67	ر.ق.م 9 % (دج)
TVA à 19% (DA)	759,63	ر.ق.م 19 % (دج)
Total TVA (DA)	844,30	ر.ق.م (دج)
Droit Fixe sur consommation (DA)	100,00	المستحقات الثابتة على الإستهلاك (دج)
Taxe d'habitation (DA)	150,00	رسم على المسكن (دج)
Contribution (DA)	0,00	مساهمة (دج)
Montant REPE (DA)	0,00	مبلغ ر.ك.د.ت (دج)
Montant RGPE (DA)	0,00	مبلغ ر.غ.د.ت (دج)
Net à payer TTC (DA)	6 033,13	صافي الدفع متضمن جميع الرسوم (دج)

Six mille trente-trois Dinar(s) et treize centime(s)

Timbre (paiement en espèce)(DA)	61,00	الطابع (دفع نقدا)
Total à payer (en espèces)(DA) Sauf erreur ou omission	6 094,13	المستحق الإجمالي (نقدا)
Date limite du paiement	11/12/2023	آخر أجل للدفع

Passé ce délai, nous nous réserverons le droit de procéder à la suspension de la fourniture d'énergie

Nous vous informons qu'en application des dispositions de l'article 85 du Décret Exécutif 10-95 du 17.03.2010, vous êtes redevable d'un montant de DA, faute de quoi la fourniture d'énergie sera suspendue.

Clé EBP 449 — Clé EBB 605

Vos contrats عقودكم

	N° Compteur	Tarif	PMD	Coef	A. index	N. index
Electricité	022280073065	54M	6kW	1.0	2 199 R	3 270 R

	Tranche 1	Tranche 2	Tranche 3	Tranche 4
Quantité	125,00	125,00	750,00	71,00
Prix unitaire	1,7787	4,1789	4,8120	5,4796

Montant HT (9%) 744,70
Montant HT (19%) 3 998,05

	N° Compteur	Tarif	DMD	PCS	A. index	N. index
Gaz	129296	23M	5m³h	9.49	7 556 R	7 576 R

	Tranche 1	Tranche 2	Tranche 3	Tranche 4
Quantité	189,80	0,00	0,00	0,00
Prix unitaire	0,1682			

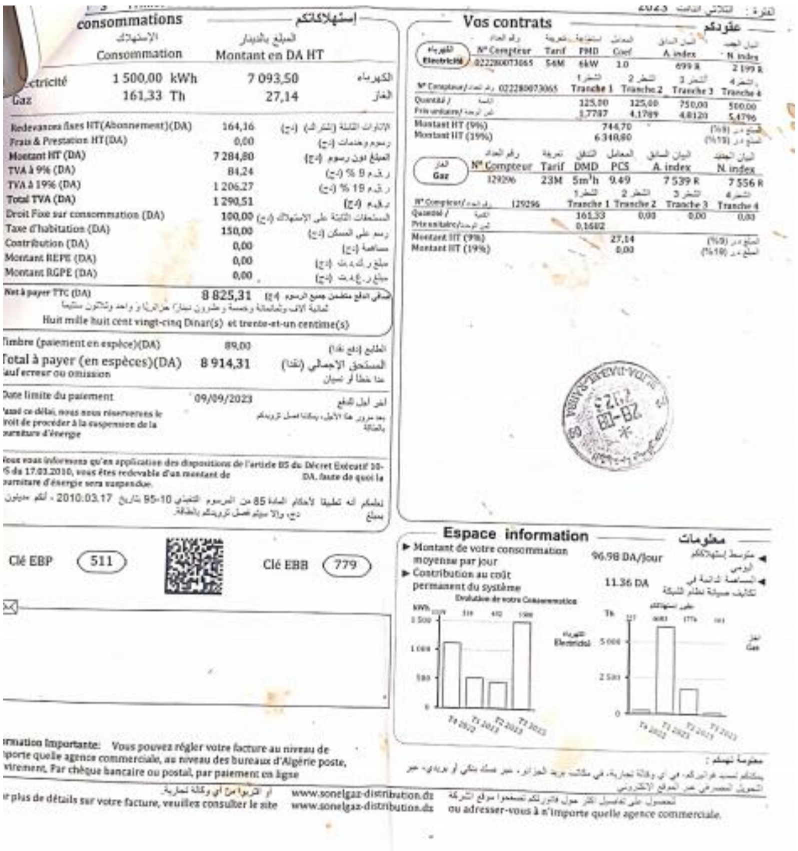
Montant HT (9%) 31,92
Montant HT (19%) 0,00

Espace information معلومات

- Montant de votre consommation moyenne par jour: 64.87 DA/Jour
- Contribution au coût permanent du système: 8.17 DA

Evolution de votre Consommation

Information Importante: Vous pouvez régler votre facture au niveau de



الفترة : الثلاثي الثالث 2023

consommations إستهلاكاتكم

الإستهلاك Consommation		المبلغ بالدينار Montant en DA HT	
Electricité	1 500,00 kWh	7 093,50	الكهرباء
Gaz	161,33 Th	27,14	الغاز

Redevances fixes HT(Abonnement)(DA)	164,16	الإتاوات الثابتة (إشتراك) (دج)
Frais & Prestation HT(DA)	0,00	رسوم وخدمات (دج)
Montant HT (DA)	7 284,80	المبلغ دون رسوم (دج)
TVA à 9% (DA)	84,24	ر.ق.م 9 % (دج)
TVA à 19% (DA)	1 206,27	ر.ق.م 19 % (دج)
Total TVA (DA)	1 290,51	ر.ق.م (دج)
Droit Fixe sur consommation (DA)	100,00	المستحقات الثابتة على الإستهلاك (دج)
Taxe d'habitation (DA)	150,00	رسم على المسكن (دج)
Contribution (DA)	0,00	مساهمة (دج)
Montant REPE (DA)	0,00	مبلغ ر.ك.د.ت (دج)
Montant RGPE (DA)	0,00	مبلغ ر.غ.د.ت (دج)
Net à payer TTC (DA)	8 825,31	صافي الدفع متضمن جميع الرسوم (دج)

Huit mille huit cent vingt-cinq Dinar(s) et trente-et-un centime(s)

Timbre (paiement en espèce)(DA)	89,00	الطابع (دفع نقدا)
Total à payer (en espèces)(DA) Sauf erreur ou omission	8 914,31	المستحق الإجمالي (نقدا)
Date limite du paiement	09/09/2023	آخر أجل للدفع

Clé EBP 511 — Clé EBB 779

Vos contrats عقودكم

	N° Compteur	Tarif	PMD	Coef	A. index	N. index
Electricité	022280073065	54M	6kW	1.0	699 R	2 199 R

	Tranche 1	Tranche 2	Tranche 3	Tranche 4
Quantité	125,00	125,00	750,00	500,00
Prix unitaire	1,7787	4,1789	4,8120	5,4796

Montant HT (9%) 744,70
Montant HT (19%) 6 348,80

	N° Compteur	Tarif	DMD	PCS	A. index	N. index
Gaz	129296	23M	5m³h	9.49	7 539 R	7 556 R

	Tranche 1	Tranche 2	Tranche 3	Tranche 4
Quantité	161,33	0,00	0,00	0,00
Prix unitaire	0,1682			

Montant HT (9%) 27,14
Montant HT (19%) 0,00

Espace information معلومات

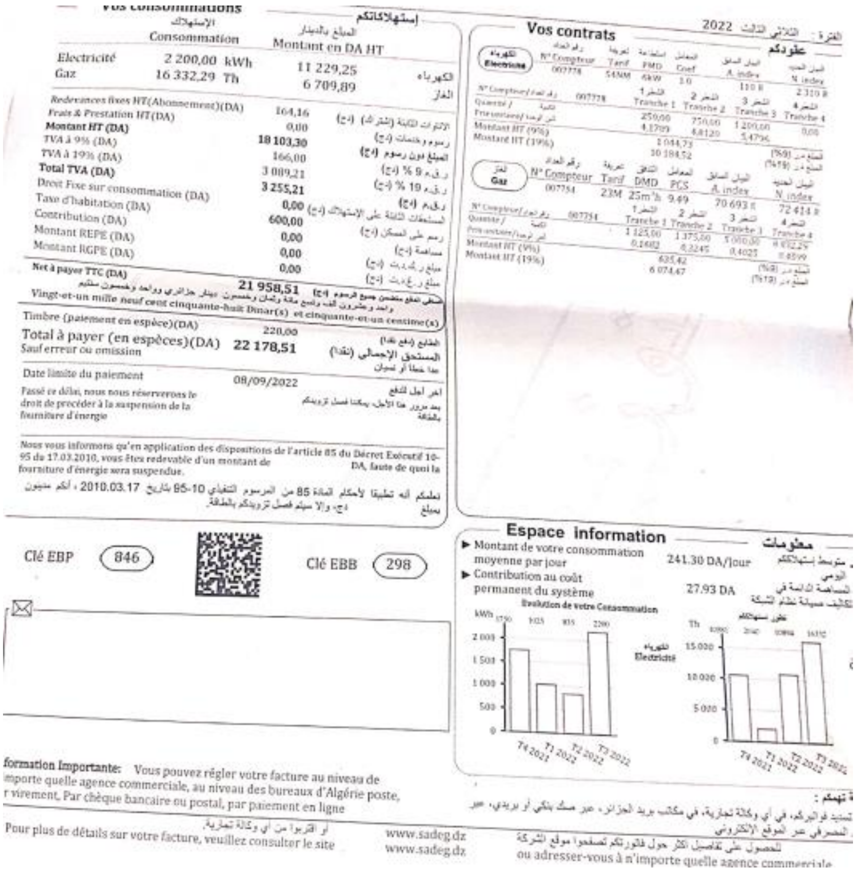
- Montant de votre consommation moyenne par jour: 96.98 DA/Jour
- Contribution au coût permanent du système: 11.36 DA

Evolution de votre Consommation

Information Importante: Vous pouvez régler votre facture au niveau de n'importe quelle agence commerciale, au niveau des bureaux d'Algérie poste, virement, Par chèque bancaire ou postal, par paiement en ligne

Pour plus de détails sur votre facture, veuillez consulter le site www.sonelgaz-distribution.dz ou adressez-vous à n'importe quelle agence commerciale.

- APPENDIX 5: consumption of house B


Vos consommations

	Consommation	Montant en DA HT
Electricité	2 200,00 kWh	11 229,25
Gaz	16 332,29 Th	6 709,89

Redevances fixes HT(Abonnement)(DA)	164,16
Frais & Prestation HT(DA)	0,00
Montant HT (DA)	18 103,30
TVA à 9% (DA)	166,00
TVA à 19% (DA)	3 089,21
Total TVA (DA)	3 255,21
Droit Fixe sur consommation (DA)	0,00
Taxe d'habitation (DA)	600,00
Contribution (DA)	0,00
Montant REPE (DA)	0,00
Montant RGPE (DA)	0,00
Net à payer TTC (DA)	21 958,51

Vingt-et-un mille neuf cent cinquante-huit Dinar(s) et cinquante-et-un centime(s)

Timbre (paiement en espèce)(DA) 220,00

Total à payer (en espèces)(DA) 22 178,51

Sauf erreur ou omission

Date limite du paiement 08/09/2022

Passé ce délai, nous nous réserverons le droit de procéder à la suspension de la fourniture d'énergie

Nous vous informons qu'en application des dispositions de l'article 85 du Décret Exécutif 10-95 du 17.03.2010, vous êtes redevable d'un montant de DA, faute de quoi la fourniture d'énergie sera suspendue.

Clé EBP 846 Clé EBB 298

Vos contrats — Période: 3ème trimestre 2022

Espace information

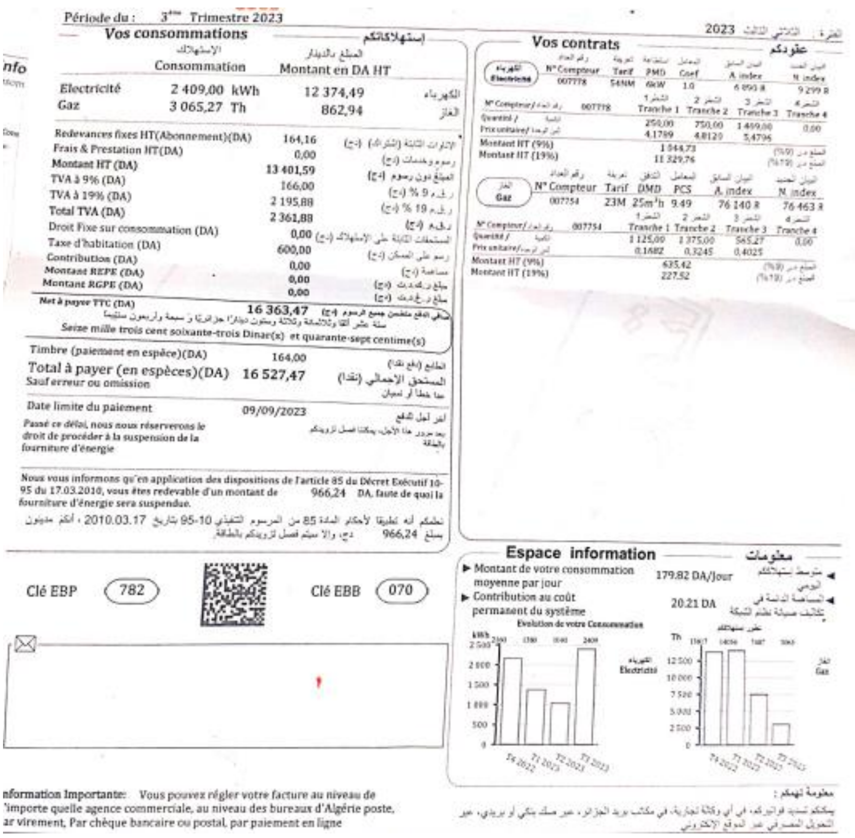
- Montant de votre consommation moyenne par jour: 241.30 DA/Jour
- Contribution au coût permanent du système: 27.93 DA

Evolution de votre Consommation

Information Importante: Vous pouvez régler votre facture au niveau de n'importe quelle agence commerciale, au niveau des bureaux d'Algérie poste, par virement, Par chèque bancaire ou postal, par paiement en ligne

Pour plus de détails sur votre facture, veuillez consulter le site www.sadeg.dz

ou adressez-vous à n'importe quelle agence commerciale


Période du : 3ème Trimestre 2023

Vos consommations

	Consommation	Montant en DA HT
Electricité	2 409,00 kWh	12 374,49
Gaz	3 065,27 Th	862,94

Redevances fixes HT(Abonnement)(DA)	164,16
Frais & Prestation HT(DA)	0,00
Montant HT (DA)	13 401,59
TVA à 9% (DA)	166,00
TVA à 19% (DA)	2 195,88
Total TVA (DA)	2 361,88
Droit Fixe sur consommation (DA)	0,00
Taxe d'habitation (DA)	600,00
Contribution (DA)	0,00
Montant REPE (DA)	0,00
Montant RGPE (DA)	0,00
Net à payer TTC (DA)	16 363,47

Seize mille trois cent soixante-trois Dinar(s) et quarante-sept centime(s)

Timbre (paiement en espèce)(DA) 164,00

Total à payer (en espèces)(DA) 16 527,47

Sauf erreur ou omission

Date limite du paiement 09/09/2023

Passé ce délai, nous nous réserverons le droit de procéder à la suspension de la fourniture d'énergie

Nous vous informons qu'en application des dispositions de l'article 85 du Décret Exécutif 10-95 du 17.03.2010, vous êtes redevable d'un montant de 966,24 DA, faute de quoi la fourniture d'énergie sera suspendue.

Clé EBP 782 Clé EBB 070

Vos contrats — 2023

Espace information

- Montant de votre consommation moyenne par jour: 179.82 DA/Jour
- Contribution au coût permanent du système: 20.21 DA

Evolution de votre Consommation

Information Importante: Vous pouvez régler votre facture au niveau de n'importe quelle agence commerciale, au niveau des bureaux d'Algérie poste, par virement, Par chèque bancaire ou postal, par paiement en ligne