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ABSTRACT

In response to the increasing effects of climate change, many countries, including Algeria, are implementing strategies to reduce greenhouse gas emissions. These initiatives aim to lessen reliance on fossil fuels and promote the adoption of renewable energy sources. Since the building sector is a significant energy consumer, finding solutions to reduce its energy consumption while maintaining optimal comfort for occupants has become essential. Addressing this challenge requires improving energy efficiency through the use of both passive and active strategies.

This study is based on the hypo-deductive methodological approach, and explores the implementation of passive and active strategies to achieve thermal comfort, drawing on extensive research in this area. The subject of our study is a startup incubator located in Ouled Yaich, within the university campus. This project addresses the need for improved educational and leisure services both on and around the campus.

RESUME

En réponse aux effets croissants du changement climatique, de nombreux pays, dont l'Algérie, mettent en place des stratégies pour réduire les émissions de gaz à effet de serre. Ces initiatives visent à diminuer la dépendance aux combustibles fossiles et à promouvoir l’adoption de sources d'énergie renouvelables. Étant donné que le secteur du bâtiment est un important consommateur d'énergie, il est devenu essentiel de trouver des solutions pour réduire sa consommation énergétique tout en maintenant un confort optimal pour les occupants. Relever ce défi nécessite d'améliorer l'efficacité énergétique en utilisant à la fois des stratégies passives et actives.

Cette étude s'appuie sur une approche méthodologique hypo-déductive et explore l'implémentation des stratégies passives et actives pour atteindre le confort thermique, en s'appuyant sur des recherches approfondies dans ce domaine. Le sujet de notre étude est un incubateur de startups situé à Ouled Yaich, au sein du campus universitaire. Ce projet répond au besoin d'améliorer les services éducatifs et de loisirs sur le campus et dans ses environs.

ملخص

استجابةً للتأثيرات المتزايدة لتغير المناخ، تقوم العديد من الدول، بما في ذلك الجزائر، بتنفيذ استراتيجيات لتقليل انبعاثات الغازات الدفيئة. تهدف هذه المبادرات إلى تقليل الاعتماد على الوقود الأحفوري وتعزيز استخدام مصادر الطاقة المتجددة. ونظرًا لأن قطاع البناء يعد من أكبر مستهلكي الطاقة، أصبح من الضروري إيجاد حلول لتقليل استهلاك الطاقة فيه مع الحفاظ على راحة قصوى للمقيمين. ويتطلب مواجهة هذا التحدي تحسين كفاءة الطاقة من خلال الاعتماد على كل من الاستراتيجيات السلبية والنشطة.

تعتمد هذه الدراسة على النهج المنهجي الفرضي-الاستنباطي، وتستكشف تنفيذ استراتيجيات سلبية ونشطة لتحقيق الراحة الحرارية، مستندةً إلى أبحاث مكثفة في هذا المجال. موضوع دراستنا هو حاضنة للشركات الناشئة تقع في أولاد يعيش، داخل الحرم الجامعي. ويهدف هذا المشروع إلى تلبية الحاجة إلى تحسين الخدمات التعليمية والترفيهية داخل الحرم الجامعي وفي المناطق المحيطة به.

Keywords:

Renewable energies, passive and active strategies, thermal comfort, startup incubator, energy efficiency.

Mots-clefs :

Energies renouvelables, stratégies actives et passives, confort thermique, incubateur de startup, efficacité énergétique.

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INDTRODUCTION 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 écoquartiers 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

CHAPTER I: INTRODUCTION

General Thematic:

All the advanced technology in the different fields surrounding us, is merely the far result of the industrial revolution. This latter, indeed rose in the 18th century thanks to fossil fuels energies, that are basically stored energies in organic matters found in the earth's crust, called fuels.

Fossil Fuels are also known as non-renewable energies, the reason for this appellation is that these energies run out. Their excessive and irrational use, led to two major problems: the current climate crisis that is global warming, and the insufficiency in energy, facing population growth. Global warming is the result of the excessive release of GHG[1] like carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), into the atmosphere, resulting from burning fossil fuels. The contribution of these gases in stocking the heat the earth receives from the sun, caused an imbalance in the global climate, that came from the increase in the global temperature over the decades. As consequences, the earth has been witnessing damaging natural disasters, on both human and material scales.

Research have shown the different percentages of GHG in the atmosphere, the carbon dioxide gas is abundant in the atmosphere, resulting from: fossil fuel and industrial processes (65%), and forestry and other land use (11%).

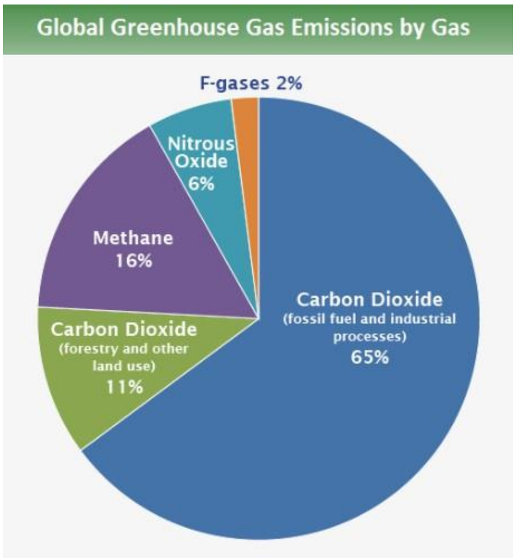


Figure 1 : Global Greenhouse Gas Emissions by Gas   Source: IPCC (2014) Exit

1 GHG: Green House Gases.

Based on global emissions from 2010: we note that the majority of (CO_2) comes from fossil fuels and industry processes.

In addition, the global consumption of fossil fuels and the reliance on them, has been increasing rapidly throughout the years, according to the United Nations climate action: "About 80 percent of the global population lives in countries that are net-importers of fossil fuels -- that's about 6 billion people who are dependent on fossil fuels from other countries, which makes them vulnerable to geopolitical shocks and crises".

The more the consumption, the more the concentration of GHG in the atmosphere, as a consequence, the world has been witnessing an increase of the global temperature, that is why in 2015 the Paris climate agreement[2] has had place, and its overarching goal about global temperature increase, is "to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to limit the temperature increase to1.5°C above pre-industrial levels"

In addition to that, the United Nations global Compact reported that:" Global temperatures are already up 1.1°C and the 2021 Emissions Gap Report shows that with the present nationally determined contributions and other firm commitments of countries around the world, we are on track for a catastrophic global temperature rise of around 2.7°C by the end of the century."

2 Paris climate agreement: a legally binding international treaty on climate change. It was adopted by 196 Parties at the UN Climate Change Conference.

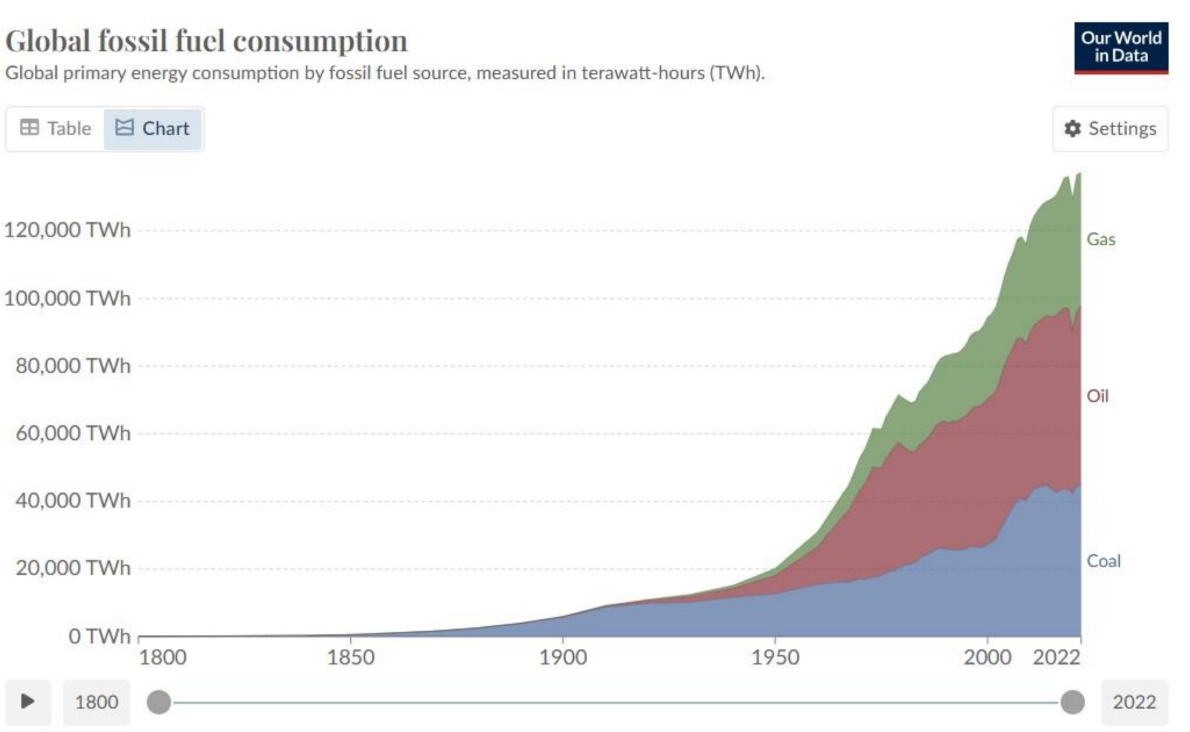


Figure 2: Global Fossil Fuel Consumption   Source: Fossil Fuels - Our World in Data

We also note, that the global fossil fuel consumption has been increasing rapidly for the past 8 decades.

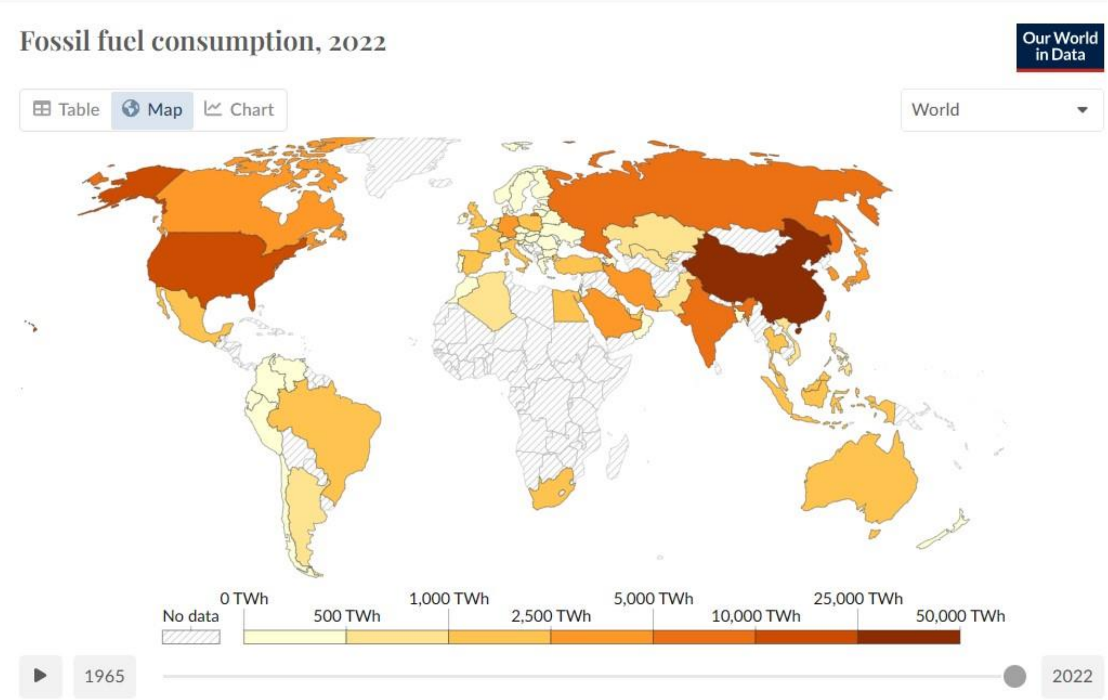


Figure 3: Fossil Fuel Consumption   Source : Ibid

We note that economically strong countries are the most consuming of fossil fuels (USA, Russia, China, Canada, Australia).

The presented above statistics, and the data about global fossil fuel consumption, and global temperature increase, that researchers reached to, show that the world would collapse very soon if countries wouldn't do something about their energy consumption habit, and look for an alternative solution concerning energy consumption.

Renewable energies[3], are the alternative solution, on one hand they do not run out, and on the other, their exploitation for producing electricity and heat, doesn't release GHG, in addition to that every country has potential for renewables.

Therefore, countries like Sweden, Germany, UK, Iceland, Kenya…. are taking advantage of their renewables' resources. In 2012 Sweden has reached 50% renewable energy, that was supposed to be reached by 2020, they succeeded to reach those 8 years ahead of schedule. These countries seek to increase the renewables' use throughout the years, this will have a very good impact on the environment and will help in slowing down the global temperature increase in the coming decades.

"Cheap electricity from renewable sources could provide 65 percent of the world's total electricity supply by 2030. It could decarbonize 90 percent of the power sector by 2050, massively cutting carbon emissions and helping to mitigate climate change." According to the United Nations climate action.

Concerning the building and construction sector, "The 2022 Buildings-GSR[4] finds that, the sector's total energy consumption and CO_2 emissions increased in 2021 above pre-pandemic levels. Buildings' energy demand increased by around 4% from 2020 to 135 EJ – the largest increase in the last 10 years. CO_2 emissions from buildings operations have reached an all-time high of around 10 $GtCO_2$, around a 5% increase from 2020 and 2% higher than the previous peak in 2019."

The reliance on renewable energies in this sector, will have a very good impact on the environment, since it will contribute in reducing the release of carbon dioxide (during

[3] Renewable energies: Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed.

[4] Buildings-GSR: The "Global Status Report for Buildings and Construction" (GSR) is an annual report that assesses the progress of the buildings and construction sector in reducing energy consumption and greenhouse gas emissions.

construction "embodied carbon"[5] and during operation "operational carbon"[6]) into the atmosphere. That is possible by integrating them in buildings, so they will produce green electricity[7] and heat, and that makes buildings sustainable[8].

General Problematic:

Algeria possesses vast potential in both renewable and fossil energy resources. Historically, the country has relied heavily on fossil fuels to meet its energy demands, with oil and gas exports contributing 93.6% of national export revenues and nearly 50% of the national budget.

However, this reliance has also made Algeria one of the largest greenhouse gas emitters in Africa, following South Africa and Egypt. The country's efforts to provide affordable and reliable electricity have primarily depended on burning fossil fuels.

5 Embodied carbon: Embodied carbon is the carbon dioxide (CO_2) emissions associated with materials and construction processes throughout the whole lifecycle of a building or infrastructure.

6 Operational carbon: The amount of carbon emitted during the operational or in-use phase of a building.

7 Green electricity: electricity produced from renewable resources.

8 Sustainable: Capable of being continued with minimal long-term effect on the environment.

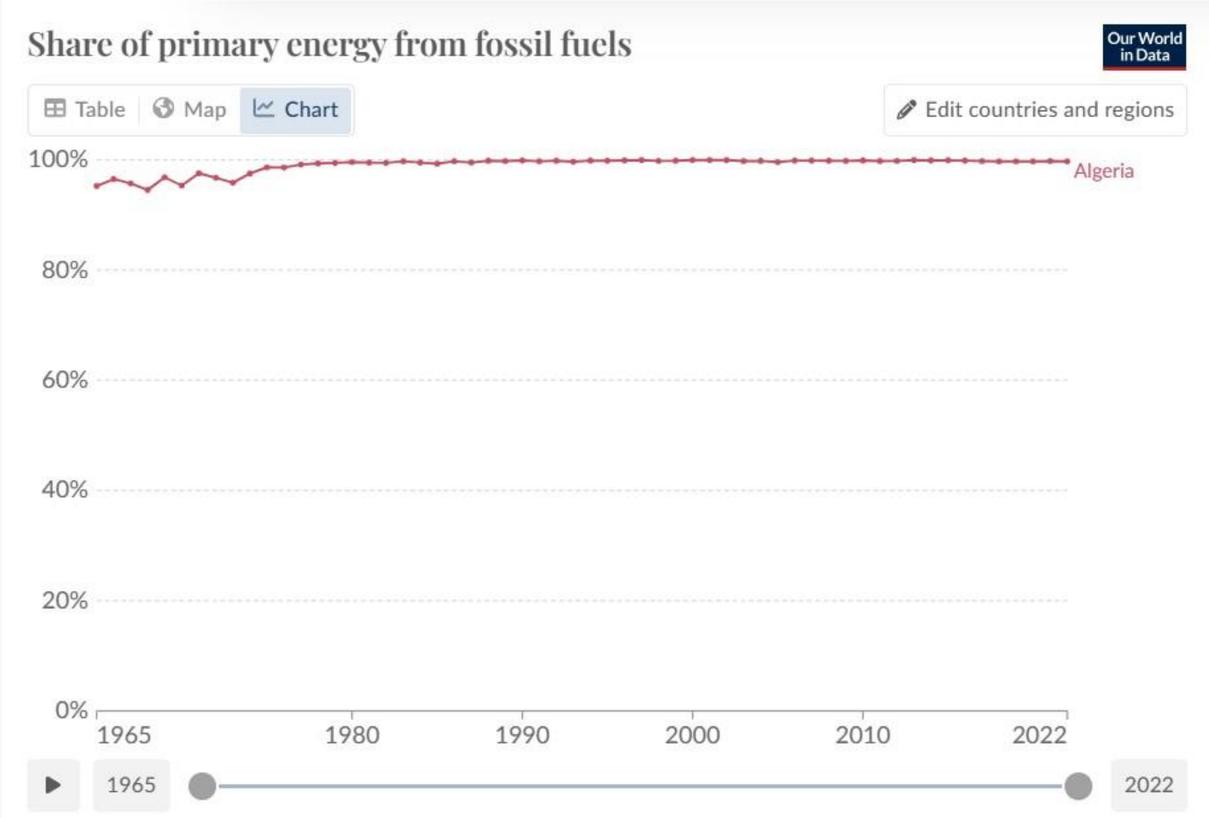


Figure 4: Share of primary energy fossil fuels (Algeria) Source*: Ibid*

In the figure above we note that Algeria has almost reached a 100% in 2022 (99.71%), and depends completely on non-renewables.

Despite Algeria's historical dependence on fossil fuels, the government is fully aware of the climate crisis and is actively planning to leverage its vast renewable energy potential. In 2011, the Ministry of Energy and Mining introduced Law No. 11-11, aimed at financing and promoting renewable energy projects. This legislation lays the foundation for future renewable energy programs and the country's sustainable development. These initiatives target having 27% of Algeria's energy mix come from renewable sources by 2030. In addition to that Algeria's renewable energy potential includes solar, wind, geothermal, and hydro resources, respectively:

- Solar potential: The duration of insolation over almost the entire national territory exceeds 2000 hours annually and can reach 3900 hours (highlands and Sahara). The energy received annually on a horizontal surface of 1m² is almost 3 KWh/m² in the North and exceeds 5.6 KWh/m in the Far South.

- Wind potential: the South is characterized by higher speeds than the North, more particularly in the South-East, with speeds greater than 7 m/s and which exceed the value of 8 m/s in the region of Tamanrasset (In Amguel). Concerning the North, we generally notice that the average speed is low. However, we note the existence of microclimates on the coastal sites of Oran, Bejaïa and Annaba, on the high plateaus of Tébessa, Biskra, M'sila and El bayadh (6 to 7 m/s), and the Great South (>8m/s).

- Geothermal energy potential: The compilation of geological, geochemical and geophysical data made it possible to identify more than two hundred (200) hot springs which were inventoried in the northern part of the country. Around a third (33%) of them have temperatures above 45°C. There are high temperature springs reaching 118°C in Biskra.

- Hydro potential: The overall quantities falling on Algerian territory are significant and estimated at 65 billion m3, but ultimately benefit the country little: reduced number of days of precipitation, concentration in limited areas, high evaporation, rapid evacuation to the sea. Schematically, surface resources decrease from north to south. The useful and renewable resources are currently estimated at around 25 billion m3, of which approximately 2/3 are surface resources.103 dam sites have been identified. More than 50 dams are currently in operation.

To achieve the aimed RE project, centers like the Renewable Energies Development Center (CDER)[9] and the National Center for Integrated Building Studies and Research (CNERIB)[10], are taking action in: developing and implementing scientific and technological research and developing programs for energy systems exploiting solar, wind, geothermal and biomass energy, and making studies and research missions in the building sector in the broad sense, respectively.

According to the different studies of CDER: The building sector energy consumption represents 41% of overall national consumption, followed by the transport sector (31%), industry (19%), and agriculture (7%). This leads the building sector’s stakeholders to share responsibility in terms of adopting renewable energies in buildings.

[9] CDER : Centre de Développement des Energies Renouvelables, est un centre de recherche, issu de la restructuration du Haut-Commissariat à la Recherche, qui été créé le 22 mars 1998.

[10] CNERIB : Centre National d’Etudes et de Recherches Intégrées du Bâtiment,

Based on that here's the question that comes to our mind:

- ✓ **What strategies can Algeria implement to reduce its heavy reliance on fossil fuels and promote renewable energy adoption in the building sector, given its vast renewable resources and the growing need for energy efficiency?**

Specific Problematic:

The city of Blida, belongs to the metropolitan area of Algiers, but it does not receive the same importance the rest of the cities belonging to the same metropolitan Area receive: the city has been neglected in terms of introducing new services to its population, and in terms of introducing RE to its energy mix, despite the fact that it is dynamic and holds different services (sanitary, educational, commercial…). In order to revalue the city, and transform it into an attracting pole, especially for young people from all over the country, we propose the commune of Ouled Yaich, precisely the university campus area, to introduce a business incubator center, that will rely on Renewable Energies to function. Business Incubators invite young people to develop their ideas and transform them into products (from an intangible thing to a tangible one), in addition to that, exploiting Blida's city RE resources in the building sector, will help reduce a huge amount of carbon dioxide in the atmosphere and will definitely take the aimed energy mix project beyond expected (it will help increase the aimed percentage of RE generation in Algeria's energy mix by 2030).

Based on that here are the following questions that come to mind:

- ✓ **What are the most effective types of renewable energy (RE) that can reduce the energy consumption of new buildings while ensuring a satisfactory level of thermal comfort for users?**

Research Hypothesis:

These questions led us to think of the following hypothesis:

- ❖ Solar and wind are Blida's city RE potentials, since the city is situated in north Algeria, it is well exposed to both sun and wind.
- ❖ The use of passive and active strategies that take advantage of solar potential, makes it possible to improve thermal comfort.

5 Research Objectives:

This research has medium-term and long-term objectives, and they are the following:

- Ensure thermal comfort and reduce carbon footprint.
- Achieve sufficiency in renewable energies.
- Energize the University campus area throughout the year.
- Revalorize the city of Blida as part of the metropolitan area of Algiers through attractiveness.

Methodological Approach:

The methodology that we are following in this work is the hypothetico-deductive method. This methodological approach is a scientific method used for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge, it consists of observation, background research, hypothesis creation, deductive reasoning, design experiments, data collection, data analysis, comparison with hypothesis and finally a conclusion where we support or refute the hypothesis.

This work consists of two major parts which are: the theoretical part and the practical part.

-The theoretical part**:** this section relies on documentation:

We will provide a comprehensive understanding of the subject through an extensive bibliographical search of books, theses, reports, articles, and more.

This step will also involve identifying the key theoretical aspects related to our research theme, sustainable development, sustainable architecture, renewable energies, startup incubators…

-The practical part: this section contains, different scale analysis, urban intervention, startup incubator project, and finally the dynamic thermal simulation.

The different scale analysis consists of: project example analysis, our study area urban analysis including the AFOM analysis and sensory analysis. These will be followed by the urban intervention, the startup incubator project and finally the dynamic thermal simulation.

The softwares that we will be using are the following:

For the graphical part: AutoCAD, Sketchup,Enscape and photoshop.

For the simulation part: Design builder.

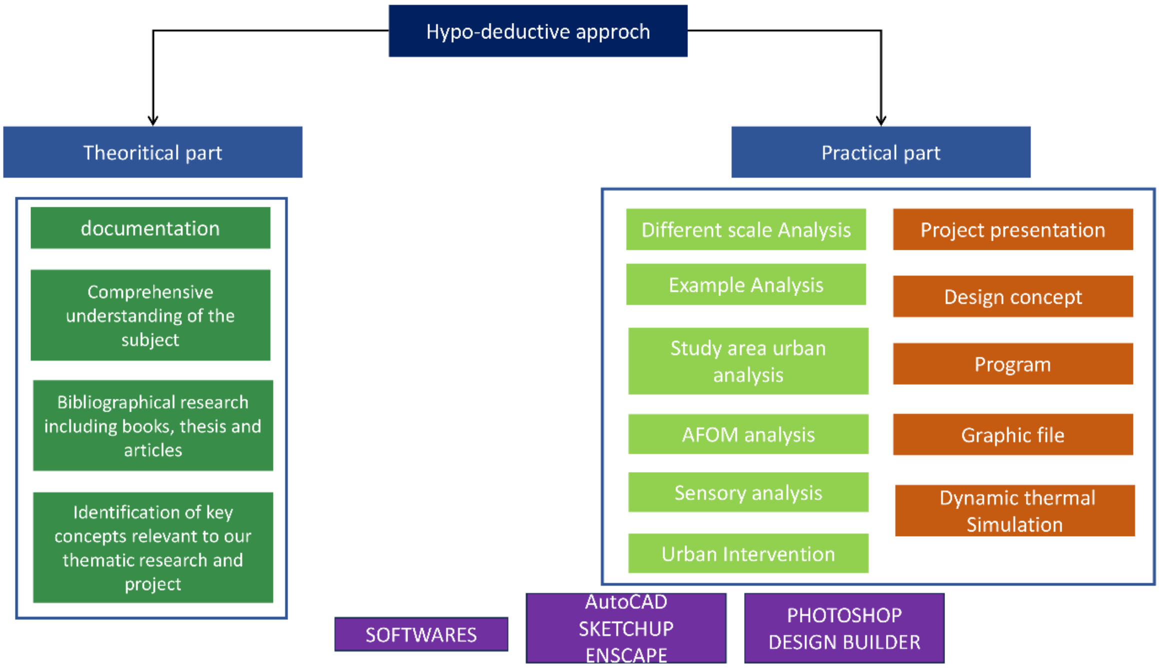


Figure5: an illustration showing the applied methodological approach

Source: Author

7 Dissertation Structure:

In this thesis, we aim to provide comprehensive information to help achieve our objectives.

The thesis is structured into four parts: the first part is the introductory chapter, the second covers the state of the art, the third focuses on the case of study, and the fourth is dedicated to the simulation and discussion of the results.

CHAPTER 01: The introductory chapter:

The introductory section of this thesis outlines the overall theme and concept, addresses the general and specific research questions, and discusses the objectives, issues, and various methodological approaches.

CHAPTER 02: State of the art:

This chapter consists of two parts. The first part covers the key concepts related to the project theme and the architectural project to provide a comprehensive understanding. The second part includes an analysis of incubator project examples to fully grasp their distinct features and operations.

CHAPTER 03: Case of study:

This section focuses on the urban aspects, including an analysis of the study area's urban environment, an AFOM analysis, and a sensory analysis. The goal is to identify the challenges faced by the study area and develop an action plan. This will be followed by an urban intervention to address the identified issues, and finally a site analysis where our project will be implemented.

CHAPTER 04: Simulation result and discussion:

This chapter covers an introduction to the thermal dynamic simulation where the meaning of it and its purpose are explained, followed by dynamic thermal software examples, the choice of using design builder, the software operating method. After that, the introduction of materials used in every single scenario, The calculation of PV panels number needed to power a 50 m² office area (coworking space in our case), followed by the introduction of all dynamic thermal simulation scenarios (passive and active) and finally concluded by reminding the hypothesis and affirming them.

CHAPTER II: STATE OF THE ART

INTRODUCTION:

In this second chapter, we first explain the basic concepts of sustainable development and energy efficiency, then we introduce the most used renewable energies in the building sector, followed by the Algerian policy about renewable energies in different sectors , followed by the definition of comfort and its different types, and finally moving to the project part , where we explain what incubators and startups are , the Algerian policy about these latter , and then finally conclude this chapter with an example analysis , to better understand the architectural functioning and the spatial distribution of a startup incubator.

I. Definition and concept development:

1 Sustainable development:

1.1 definition:

"Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs." This widely used definition of sustainable development was written in the Brundtland Report [11]released by the UN in 1987, and it stands for ensuring the meet of current needs of the earth's resources while preserving the capacity of future generation to meet their own needs.

Sustainable development aims at developing the economy, the society and the environment, these latter are called the 3 pillars of sustainable development:

- Environmental sustainability: involves mitigating environmental impacts and safeguarding ecosystems and natural resources over the long term.
- Social equity: ensures that all individuals have access to essential resources and services such as education, healthcare, food, and housing, thereby addressing human needs, reducing inequalities, and promoting social cohesion.
- Economic efficiency: aims to alleviate extreme poverty and provide meaningful employment opportunities while ensuring that economic activities are conducted in a manner that benefits both humans and the environment without causing harm.

[11] Burtland report: officially known as "Our Common Future," is a seminal document in the field of sustainable development. Published in 1987 by the World Commission on Environment and Development (WCED), which was chaired by Gro Harlem Brundtland, the then-Prime Minister of Norway, the report laid the foundation for modern sustainability practices and policies.

1.2 The principles of sustainable development:

- Solidarity*:* means helping each other out, whether it's between countries, people, or generations. For instance, we save resources so more people can benefit from them.
- Precaution: means being careful in our decisions to avoid causing harm to our health or the environment. For example, we limit CO2 emissions to slow down climate change.
- Participation: involves everyone, no matter their job or status, working together on sustainable projects to make them successful.
- Responsibility: means that everyone, whether they're citizens, business owners, or farmers, should take responsibility for their actions. If someone causes damage or pollution, they should help fix it, like paying a tax for polluting industries.

1.3 Sustainable Development goals:

Often referred to as SDGs or Global goals, they were established by the UN in 2015 to serve as a worldwide initiative urging action to eradicate poverty, safeguard the environment, and promote peace and prosperity for all individuals by the year 2030. They are a total of 17 goals form which only environment related ones will be mentioned:

- Clean water and sanitation
- affordable and clean energy
- sustainable cities and communities
- responsible consumption and production
- climate action
- life below water
- life on land

2 Sustainable architecture:

2.1 definition:

Sustainable architecture means designing buildings with the environment, economic and social aspect in mind. It involves every aspect of the planning and construction process using eco-friendly materials, planning smart systems for heating, cooling, and water, managing waste responsibly, and making sure buildings fit well into their surroundings, in other words it aims to minimize the environmental impact of buildings by seamlessly integrating them into the surrounding landscape.

3 Bioclimatic architecture:

3.1 definition:

Bioclimatic architecture integrates environmental conditions into building design to cater to the occupants' needs. It examines the climate of the building's location and considers various elements to optimize resource utilization and minimize environmental impact. The goal is to ensure occupants' comfort while minimizing resource consumption.

3.2 Bioclimatic architecture building strategies:

- Soil: In bioclimatic architecture, the soil's climatic effects are utilized to moderate temperature fluctuations throughout the day. Buildings are often partially embedded in the ground to harness the heat released by the soil, providing insulation and stability. Geothermal energy, a renewable resource, is commonly employed to maximize this benefit.

- Orientation: Proper orientation of buildings is crucial in bioclimatic architecture for effective temperature regulation and energy efficiency. Strategic placement and the use of shading devices, such as blinds or vegetation, enable precise control over temperature variations throughout the day and across seasons.

- Insulation: Sustainable insulation materials are prioritized to minimize environmental impact. Bioclimatic architecture favors external thermal insulation and materials with high thermal inertia, such as stone, brick, or concrete. These choices ensure efficient thermal regulation while respecting environmental principles.

- Ventilation: Adequate ventilation plays a key role in maintaining thermal comfort within bioclimatic buildings. Mechanical ventilation systems are often employed to ensure air quality and optimal temperature levels while promoting energy efficiency.

- Morphology: the morphology of the building has a great impact on the thermal comfort, if the indoor spaces are compact, their morphology helps in preserving the heat, and if they are open spaces with high ceilings for example, their morphology contributes to heat loss.

3.3 Bioclimatic architecture conception principles:

Bioclimatic design focuses on harnessing solar energy effectively. During winter, buildings aim to capture, diffuse, and retain solar energy to maximize warmth. Conversely, in summer, the focus shifts to shielding the building from excessive solar radiation and dissipating built-up heat. Bioclimatic design centers around three key principles:

- Capture/Protect from heat:
- Transform, diffuse heat:
- maintain heat or freshness:

4 Energy Efficiency:

4.1 definition:

Energy efficiency involves using less energy to achieve the same task or outcome. This can apply to homes and buildings that require less energy for heating, cooling, and operating appliances and electronics. It also extends to manufacturing facilities that consume less energy to produce goods.

A building is considered energy efficient when it uses less energy to achieve the same tasks. This efficiency is achieved by optimizing various factors.

4.2 Ratio between reception capacity and energy consumption:

The energy efficiency of a building is determined by the ratio between the energy received by the system and the total energy it consumes. This process involves various techniques designed to minimize energy usage in a home while maintaining optimal thermal comfort. The primary goal of efficient energy consumption is to operate effectively while using the least amount of energy possible.

4.3 Strategies ensuring energy efficiency:

4.3.1 Passive strategies:

- Thermal insulation:_It significantly determines the energy performance of a building and should be optimally enhanced with insulation. This can include using triple glazing for doors and windows to prevent heat loss. External thermal insulation is also a highly effective method to maximize the building's insulation.

- Ventilation: optimizing your ventilation system helps reduce energy losses. A controlled mechanical ventilation system is one of the best solutions for this purpose.
- Building's orientation: buildings that benefit from natural heat and sunlight consume less energy than those that are landlocked.
- Electrical equipment: the choice of lighting and appliances significantly impacts energy consumption. Selecting more energy-efficient equipment is essential for achieving energy efficiency.

4.3.2 Active strategies:

The use of renewable energies that will generate power to power:

- Air conditioning devices
- Heating devices
- Mechanical ventilation
- Lighting

5 Renewable energies:

5.1 definition:

Renewable energies often called 'green energies' or 'clean energies' are energies produced by specific means of production, from unlimited resources, available without time limit or reconstitute more quickly than they are consumed.

Renewable energies are the total opposite of fossil energies, whose stocks are limited and non-renewable on the human time scale: coal, oil, natural gas.... On the contrary, renewable energies are produced from sources such as the rays of the sun, or wind, which are theoretically unlimited on a human scale.

5.2 Different types of renewable energies:

5.2.1 solar energy: this energy comes directly from capturing solar radiation. specific sensors of energy absorption are used, to absorb solar rays and rebroadcast them according to two main operating modes:

- a Photovoltaic solar (photovoltaic solar panels): solar energy is captured for the production of electricity.

- a Thermal solar (solar water heater, heating, solar thermal panels): the heat from the sun's rays is captured and rebroadcast, and more rarely used to produce electricity.

Figure 6: An image showing a field of photovoltaic panels

Source : AZoCleantech.com

Figure 7: An image showing a field of thermal solar heat collectors.

Source : AZoCleantech.com

5.2.2 wind energy: about wind power, the electricity is produced through the following way: the kinetic energy of the wind drives a generator that produces electricity. There are several types of renewable wind energy:

onshore wind turbines, off-shore wind turbines, floating wind turbines, etc. But the rule remains generally the same for all these types of renewable energy.

Figure 8: An image showing a field of wind turbines.

Source : justenergy.com

5.2.3 Hydro-electric power: The kinetic energy of water (rivers, dams, ocean currents, tides) activates electricity-generating turbines. Marine energies are part of hydraulic energies.

Figure 9: An image showing a hydroelectric dam

Source: graconllc.com

5.2.4 Biomass: the combustion of materials whose origin is biological (natural resources, crops or organic waste), produce energy called biomass energy. There are three main categories:

-Wood

-Biogas

-Biofuels

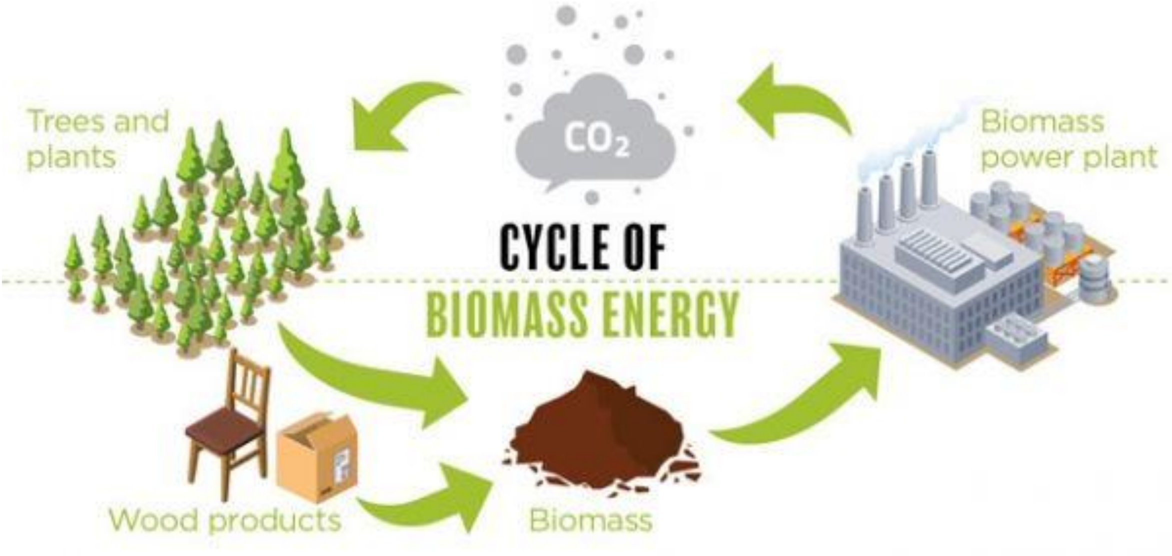


Figure 10: An illustration of the cycle of biomass energy

Source Civicissues.com

5.2.5 Geothermal energy: The energy comes from heat emitted by the Earth and stored underground. Depending on the resource and the technology implemented, the calories are used directly or converted into electricity.

Figure 11: An image showing a geothermal power plant

Source Powercurrents.com

5.3 Most Popular RE integrated in buildings:

The 2 popular renewable energies integrated in buildings due to their potentialities, are: solar energy, and wind energy.

5.3.1 solar energy systems:

They're also called active systems, because their operating mode is direct, as mentioned above, we distinguish 2 types of solar systems: the photovoltaic solar and the thermal solar, each system has its own components and own operating mode.

- Photovoltaic solar:

This system produces electricity for all sort of fields, it powers vehicles, buildings, road lights, lighthouses, with different or simple configurations.

The way the photovoltaic system works to produce power, is the following:

- The system consists of 6 individual components:

a solar panel/panels, a charge controller, a Battery Bank, an inverter, a utility meter, and an electric grid.

The solar panels are composed of cells made of semiconductor materials, these latter are used to convert the sun's energy captured by the solar photovoltaic panels, into electricity. The charge controller, the inverter and the battery bank interfere as follows:

The charge controller is placed right after the Photovoltaic array, and protects the battery from over charging by regulating the DC[12] from the solar panels, right after comes the battery that makes sure to store the energy produced, and then comes the inverter whose role is to convert electricity from DC to AC[13]. The utility meter is used to measure the electricity consumption and finally the electric grid used as a backup, during periods when the photovoltaic system doesn't cover the building's energy needs.

12 DC: direct electric current.

13 AC: alternative electric current.

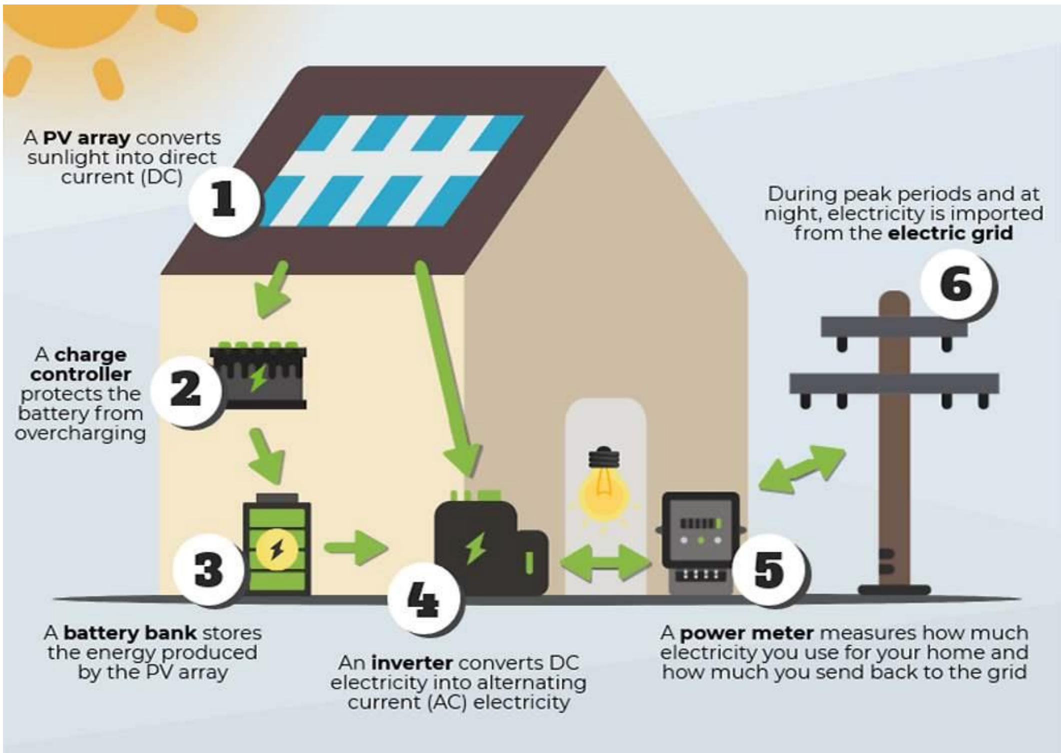


Figure 12: An illustration showing the components of a photovoltaic system

Source : arka360.com

- <u>The components of a Photovoltaic solar panel:</u>

Silicon is a key material in solar panels because it helps turn sunlight into electricity. But making a solar panel isn't as simple as just using silicon. There are actually six important parts that work together to create a solar panel:

- Silicon Solar Cells: These are the heart of the solar panel. They're made from silicon and are what actually convert sunlight into electricity.
- Metal Frame: This provides structure and support to the solar panel. It keeps everything together and protects the delicate components inside.
- Glass Sheet: This covers the top of the solar panel and acts as a protective layer. It lets sunlight through while keeping out things like rain and dust.
- Standard 12V Wire: This is the wiring that connects the solar cells together and carries the electricity they produce.
- Bus Wire: This is another type of wiring that helps connect the solar cells to each other and to the rest of the solar panel.

These parts all come together to create a solar panel, which can then be used to generate electricity from sunlight.

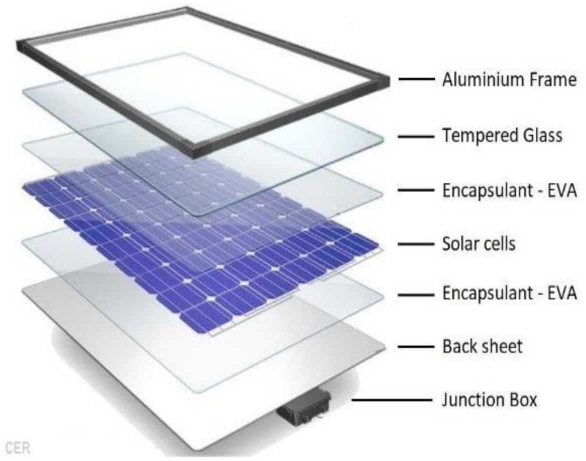


Figure 13: An image showing the components of a photovoltaic panel

Source : powergenerationworld.com

- Types of photovoltaic solar panels:

There are two main types of conventional photovoltaic solar panels, which differ mainly in the composition of silicon: monocrystalline panels and polycrystalline panels. The main difference between the two technologies lies in the crystal purity of the panel cells.

- Monocrystalline panels: are composed of solar cells made of a single cell of silicon.
- Polycrystalline panels: are composed of solar cells made from several fragments of silicon melted together.

- The difference between Monocrystalline panels and Polycrystalline panels:

- Performance efficiency:

The efficiency of a solar panel's performance is determined by the ratio of the energy it captures to the energy it produces, with any remaining energy being lost as heat.

Monocrystalline solar panels typically exhibit higher efficiencies compared to polycrystalline solar panels. This is because monocrystalline solar cells are made from a single crystal, unlike polycrystalline cells which are composed of multiple crystals. The single crystal structure of monocrystalline cells enhances their spectral response, resulting in higher energy production.

-Monocrystalline solar panels' performance efficiency varies between 16 and 24 %.

-Polycrystalline solar panels' performance efficiency varies between 14 and 20 %.

- Lifespan:

Both monocrystalline and polycrystalline solar panels come with warranties for both physical durability and efficiency. The physical warranty typically lasts 15 to 30 years and covers any physical damage to the panels. The efficiency warranty, on the other hand, extends for 20 to 30 years and guarantees the panels' efficiency after 25 years of use. For instance, an 80% efficiency guarantee after 25 years means that the panels will still produce 80% of the electricity, they generated in their first year of operation. Despite producing less energy over time, the panels remain operational and effective.

- In terms of the ecological footprint:

Both monocrystalline and polycrystalline solar panels are manufactured from silicon, a conductive material that enables photovoltaic cells to generate electricity from sunlight. Silicon is derived from silica, a chemical element abundant in the Earth's crust.

The process involves extracting silica, refining it into silicon, and then crystallizing it into ingots that are later cut into thin strips. These manufacturing processes are known for their high ecological footprint, as they are polluting and require significant energy.

However, monocrystalline solar panels have a higher ecological footprint compared to polycrystalline ones due to the greater material losses incurred during their production, which can be two to three times higher. Despite this, the higher efficiency of monocrystalline panels allows them to offset their ecological footprint more rapidly than polycrystalline panels.

- <u>Advantages and disadvantages of Photovoltaic solar panels:</u>

Table 1: Advantages and disadvantages of solar panels

Advantages	**Disadvantages**

-Renewable and clean energy production	-Performance dependent on weather and brightness
-Reduction of carbon emissions	-May require additional energy sources during periods of low solar production
-Contribution to the energy transition	-Aesthetic issues in certain regions
-Reduction of energy costs	-Initial investment
-Energy autonomy	
-Low maintenance	
-Installation flexibility	
-Durability	
-Property valuation	

- Factors affecting performance efficiency of a photovoltaic solar panel:

It is important to recognize that the process of generating electricity from solar energy is not completely efficient. Environmental factors, such as temperature, dirt accumulation, and shading, along with losses in electrical components, can impact the efficiency of a photovoltaic (PV) system.

- Temperature:

Solar panel efficiency is influenced by temperature, with higher temperatures negatively impacting performance.

Standard sunlight intensity is used to calibrate the nominal power of photovoltaic (PV) modules indoors at a temperature of 25°C. However, the actual outdoor operating temperature of these modules is typically higher than 25°C, with varying heat dissipation conditions. To more accurately compare the outdoor power generation of solar modules, the concept of Nominal Module Operating Temperature (NMOT) is introduced.

Research indicates that temperature affects solar PV system efficiency, with a typical loss rate of 0.5% per degree Celsius above 25°C.

Table 2: a table showing PV panels temperature characteristics

Source: eco-greenenergy.com

NMOT	41 °C ±3 °C
Temperature coefficient of Pmax	-0.35%/°C
Temperature coefficient of Voc	-0.30%/°C
Temperature coefficient of Isc	+0.05%/°C

- Soiling:

Accumulated material on the surface of photovoltaic (PV) panels can obstruct light from reaching the solar cells, thereby reducing power generation. Power loss due to soiling varies significantly, depending on the type of soiling (such as dust or snow) and the frequency of cleaning.

Dust on the light-receiving surface of the module initially decreases the surface's light transmittance and subsequently alters the incident angle of some light, causing uneven light dispersion in the glass cover.

Research indicates that, under identical conditions, the output power of a clean solar module is at least 5% higher than that of a dust-covered module. Moreover, increased dust accumulation further diminishes the module's output performance.

Figure 14: An image of dusty solar panels Source: depositphotos.com

- Shading:

Shading occurs when trees, buildings, terrain, or other objects block sunlight from reaching solar panels. The impact of shading on a solar installation's power output can vary widely. For instance, if one solar cell in a string of cells is shaded, the unshaded cells before it can transfer their energy as heat into the shaded cell. This can create a hot spot, which, if sustained, can potentially damage the solar panel.

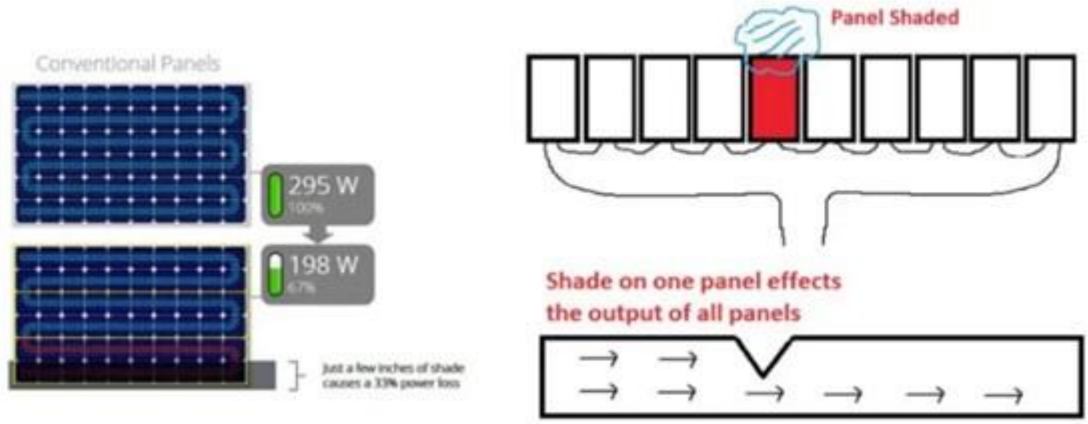


Figure 15: An illustration showing the effect of shading on a solar panel

Source: eco-greenenergy.com

- Miss match:

Manufacturing variations can cause modules of the same type to have slightly different electrical characteristics, leading to a performance loss due to mismatch between modules.

- Inverter Efficiency:

Converting DC to AC via an inverter typically achieves an efficiency of around 96-97%. Inverters generally perform better when the DC input power is high. However, their conversion efficiency significantly decreases when the input power is much lower than the inverter's rated capacity.

- Age:

Solar panels tend to produce less energy as they age, with an average annual performance decline of approximately 0.5%.

- Thermal Solar:

It uses the Sun's radiation to transform it directly into heat. The system contributing to this operation consists of thermal panels often referred to as solar collectors, that capture the sun's heat to heat water in buildings. Thermal solar panels therefore make it possible to supply the building with domestic hot water, but also to supply its heating system if the latter is connected to a hot water circuit (heated floor or water radiators).

- <u>The components of a thermal solar system:</u>

- Solar collectors:

Primary and secondary circuits:

Heat exchanger:

Storage tanks and pumps:

- Pipe lines:

Main control panel:

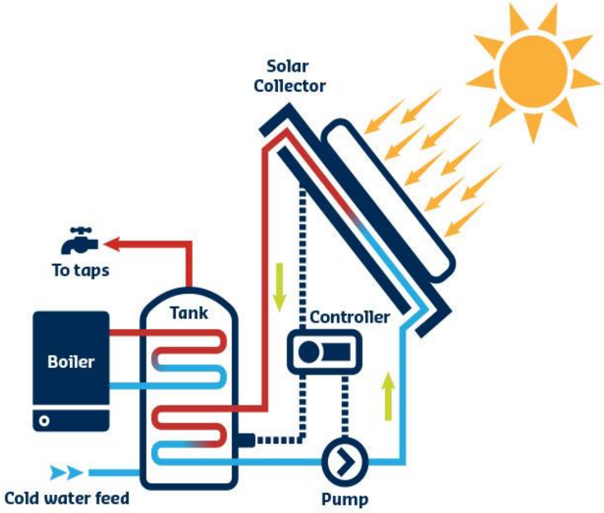


Figure 16: An illustration of the thermal solar system components

Source : bascottrenewables.co.uk

- <u>The components of a solar collector:</u>

Cover: This is a see-through material, usually glass or special plastic, placed over the solar panel. It helps to keep heat inside and prevent heat loss.

Air channel: This is a space between the cover and the absorbent plate. It helps balance heat loss and prevents overheating by allowing air to flow.

Absorbent plate*:* This part of the panel absorbs sunlight and transfers it to a liquid that flows through pipes. It needs to absorb sunlight well and release heat slowly.

Pipes or ducts: These are tubes attached to the absorbent plate. They carry the heated fluid to a storage tank.

Insulating layer*:* This covers the whole system to prevent heat loss, keeping the heat inside where it's needed.

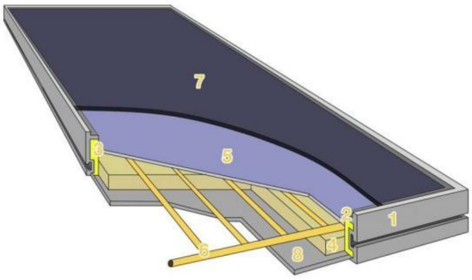


Figure 17: An illustration showing the components of a solar collector

Source : blogmech.com

- Types of Solar collectors:

There are several types of thermal sensors, the following are the main ones:

Evacuated tube collectors: placed side by side, these tubes do not contain air for a better insulating power against heat loss.

Glazed flat collectors: they contain a metal plate in contact with the tubes housing the heat transfer fluid. An insulating product helps retain heat in the tubes.

Unglazed sensors or "carpets": filled with liquid, they are more fragile, because they are not protected by glass.

- Advantages and disadvantages of thermal solar collectors:

Table 3: advantages and disadvantages of thermal solar collectors

Advantages	**Disadvantages**
-A profitable investment	- Requires a backup system
-Renewable energy consumption	-Requires space
-High efficiency	-dependent on weather conditions
-Low maintenance	-High purchasing cost

-Money saving	-Unaesthetic
-Ensuring domestic hot water production and heating	

- Factors affecting performance efficiency of a thermal collector:

Here are the following factors that can affect the performance efficiency of a thermal collector:

- Solar Radiation Intensity: This is how much sunlight hits a solar collector. More sunlight means more energy for the collector.
- Solar Radiation Angle of Incidence: The angle of the sunlight hitting the collector matters. If it's not hitting directly, the collector won't work as well.
- Collector Orientation: The direction the collector faces matters. Facing south is usually best because it gets the most sunlight during the day.
- Collector Tilt Angle: The angle of the collector also affects how much sunlight it gets. Different angles work better in different places.
- Ambient Temperature: How hot or cold it is outside can affect how well the collector works.
- Wind Speed: Wind can affect how much heat the collector loses, which affects its performance.

5.3.2 Wind Energy system:

Wind power, also referred to as wind energy, is a form of renewable energy that leverages the kinetic energy of wind to generate electricity. This is achieved through the use of wind turbines, which transform the rotational motion of the blades driven by the wind into electrical energy.

- Types and applications of wind energy:

Wind turbines generate electricity that can be utilized on-site or transmitted to the electrical grid. Generally, the energy output of a turbine is directly related to its size, the following are the types of wind energy applications:

- Distributed wind energy (on site wind energy):

Distributed wind energy refers to wind energy projects designed to meet on-site energy needs. Distributed wind turbines generate electricity directly for homes, schools, businesses, and farms, providing a localized power source.

Distributed wind energy installations are defined by their application to serve on-site energy demand rather than by the size of the turbine. Typically, turbines used for distributed applications are smaller than 20 megawatts. Those installed near homes usually range from 1 to 10 kilowatts, but larger sizes are also used. Individual or small clusters of megawatt-scale wind turbines can power commercial and industrial facilities, agricultural operations (like farms or ranches), community facilities (such as schools and office buildings), public campuses (including colleges and hospitals), and isolated grids (such as those in small islands, remote areas, or tribal communities).

- Land based wind energy:

Large wind energy projects on land use modern, efficient turbines to make electricity on a big scale. Utility companies usually own and operate these projects, selling the power they produce to users like homeowners through the electrical grid.

These projects use huge turbines on land, with rotor blades that can be over 75 meters long. Because they're so big and the projects cover large areas, setting up utility-scale wind turbines involves coordinating with environmental agencies, utilities, governments, and the public. Regulations control where they're placed, how far they must be from other infrastructure (known as "setback"), and ensure health, safety, and environmental concerns are addressed.

- Offshore wind energy:

Offshore wind energy is a newer form of wind energy that involves capturing wind power from turbines located in bodies of water.

In water depths of less than 60 meters, offshore wind turbines can be installed directly onto the ocean floor. These are called fixed-bottom offshore wind turbines. They use various types of foundations, such as monopiles, which are single stems pounded into the seafloor by pile drivers, to support the turbine towers.

- Components of a wind turbine:
    - Rotor: Blades and Hub
    - Drive Train: Low-Speed Shaft (LSS), Bearings, Couplings, Gear Box, High-Speed Shaft (HSS), Brakes
    - Electrical: Generator, Power Electronics
  - Control: Pitch motor and gears, Yaw motor, gears and brakes, sensors (wind and direction)
  - Support Structures: Tower, Nacelle.

Basically, the electricity produced by a wind turbine is produced mechanically. Any wind turbine consists of a set of blades, right beside them a box called a nacelle, and a shaft or a gear box, the wind makes the blades spin, creating kinetic energy, the blades' rotation, also make the shaft in the nacelle turn and a generator in the nacelle converts this kinetic energy into electrical energy. The wind turbines we know are linked to an electrical grid, that will aliment buildings, but small wind turbines integrated in buildings exist, and have the same operating mode as the familiar ones.

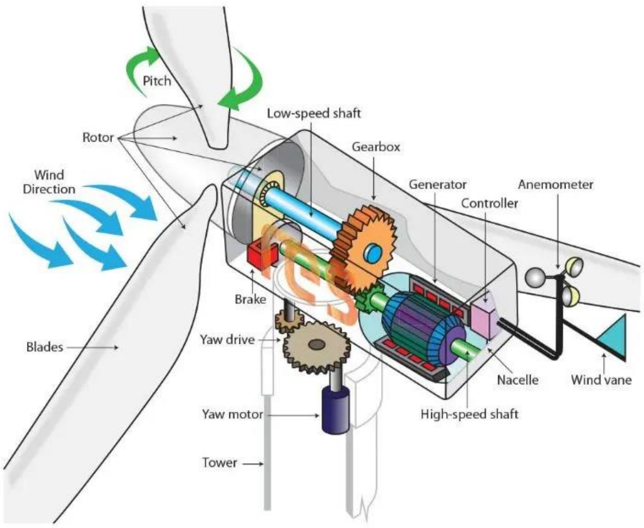


Figure 18: An image showing the different components of a wind turbine

Source : windmillstech.com

- Types of wind turbines:

The size of wind turbines varies significantly. Blade length is the primary factor determining how much electricity a turbine can generate. Small turbines, which can power a single home, typically have a capacity of around 10 kilowatts (kW). In contrast, the largest operating turbines can generate about 15,000 kW (15 megawatts), with even larger models under development. Wind turbines are often clustered together in wind power plants, or wind farms, to supply electricity to power grids.

- Horizontal axis wind turbines: Often called HAWT, they have blades like airplane propellers, usually three. The largest ones can be as tall as a 20-story building, with blades over 100 feet long. Taller turbines with longer blades produce more electricity. Almost all wind turbines in use today are horizontal-axis turbines. They're composed of a horizontal motor shaft and an electrical generator; these latter are both located at the top of the tower.

- Wind turbine vertical axis: also known as VAWT, they feature a vertical rotor shaft with the generator and gearbox located at the base of the turbine. The rotor blades are uniquely shaped to efficiently capture wind energy from any direction. The Darrieus turbine, designed in 1931 by Georges Darrieus, looks like a big, two-bladed eggbeater and is the most common type. These turbines can be up to 100 feet tall and 50 feet wide. However, they are not used much today because they don't work as well as horizontal-axis turbines.

- Advantages and disadvantages of wind turbines:

Table 4: advantages and disadvantages of HAWT wind turbines

HAWT advantages	HAWT disadvantages
High performance and reliability	Servicing is challenging due to the height. Most models require a crane to install a new generator or drivetrain.
Wind is stronger at higher altitudes.	Requires a yaw system to follow the direction of the wind
Commercial success	
Self-starting capability	

Can be positioned at higher altitudes to benefit from stronger winds.	

Table 5: advantages and disadvantages of VAWT wind turbines

VAWT advantages	VAWT disadvantages
It is omnidirectional, eliminating the need for gears and controls to track the wind.	The Darrieus design cannot self-start unless properly oriented.
The generator and drivetrain are located at ground level, making maintenance easier.	Known for poor reliability because lift forces reverse direction with each revolution
	Wind is weaker and more turbulent at ground level due to obstructions

6 Algerian policy in the renewable energy sector:

The country is launching an ambitious program for the development of renewable energies (RE) and energy efficiency. The strategy used to achieve this program, is the focus on the development of inexhaustible resources such as solar power, and their use to diversify energy sources.

6.1 Renewable energy program: The country committed to the path of renewable energies in order to provide global and sustainable solutions to environmental challenges and the problems of preserving energy resources of fossil origin, by launching the renewable energy program that consists of installing renewable power of around 22,000 MW by 2030 for the national market, with the maintenance of the export option as a strategic objective, if the market conditions permit.

6.2 Energy efficiency program: aims to achieve energy savings of around 63 million TEP by 2030, for all sectors (building and public lighting, transport, industry) and this, in introducing efficient lighting, thermal insulation and solar water heaters, and encouraging their manufacturing locally, by creating local industries, in addition to introducing clean fuels (LPGc and NGc), and efficient industrial equipment. This program will reduce CO_2 emissions by 193 million tons.

Its goal is to produce and provide the same good and services, but using as little energy as possible, that's by including actions that favor the use of forms of energy best suited to different uses and requiring changes in behavior and improvement of equipment.

Encouraging a variety of actions and projects is essential for the successful implementation of this program, aiming to foster the development of a sustainable energy efficiency market in Algeria over the long term.

The incorporation of the energy efficiency dimension across various sectors brings about numerous economic and social advantages. This integration not only enhances the quality of citizens' living environments but also provides a strategic response to the imperative of energy conservation. The positive outcomes extend to the national economy through job creation, wealth generation, and environmental preservation.

The program concentrates on key consumption sectors, specifically construction, transport, and industry, which exert a significant influence on energy demand.

6.3 For the building sector:

The program is designed to promote the adoption of innovative practices and technologies, particularly focusing on the thermal insulation of both new and existing constructions. Comprehensive measures will be incorporated during the architectural design phase of housing to ensure energy efficiency.

Additionally, there is an emphasis on facilitating the widespread adoption of efficient equipment and devices in the local market, with a specific focus on solar water heaters and energy-efficient lighting. The ultimate goal is to enhance the comfort of homes while minimizing energy consumption.

The development of a local industry for thermal insulation and efficient equipment, including solar water heaters and energy-efficient lamps, is seen as a key factor in advancing energy efficiency within the construction sector.

In total, a savings target exceeding 30 million TOE (tons of oil equivalent) is set for 2030, distributed as follows:

- Thermal insulation: The aim is to achieve a cumulative gain exceeding 7 million TEP14 (tons of oil equivalent).
- Solar water heaters: The objective is to realize energy savings of over 2 million TEP.
- Low consumption lamps (LBC): Anticipated energy gains by 2030 are estimated at nearly 20 million TEP.
- Public lighting: The goal is to achieve energy savings of almost one million TEP by 2030, contributing to the reduction of community energy bills.

6.4 For the transportation sector:

The program seeks to encourage the utilization of readily accessible and environmentally-friendly fuels, specifically LPGc and NGc. The primary goal is to diversify the fuel supply infrastructure and decrease the reliance on diesel. This not only brings about positive effects on health and the environment but also leads to a projected savings of over 16 million TOE by 2030.

6.5 For the industrial sector:

The program is geared towards motivating manufacturers to enhance their energy efficiency. Given that the industrial sector is poised for resurgence, managing energy consumption becomes a critical challenge. The aim is to achieve savings exceeding 30 million TEP in this sector. To enhance overall energy efficiency, the following measures are planned:

Widespread implementation of energy audits and the monitoring of industrial processes, enabling the identification of significant sources of energy savings and the formulation of corrective action plans.

Promotion of initiatives aimed at curbing excess energy consumption in industrial processes, with state support provided for financing such operations.

14 TEP: Tonne équivalent pétrole: amount of energy contained in a ton of crude oil.

7 Renewable energies in buildings:

7.1 building sector energy consumption in Algeria:

The building sector in Algeria is referred to as an energy-intensive sector, it absorbs 41% of total final energy consumption, which makes it the leading energy consumer in Algeria, reported an official from the National Agency for the Promotion and Rationalization of Energy Use (APRUE)15.In addition to that, the high energy consumption in the building sector, causes negative impacts on the environment, such as greenhouse effect, urban island heat effect16 and air pollution.

the adoption of the policy of integrating RE in future buildings in Algeria, will slow down or maintain the total final energy consumption percentage.

''Energy is used for various reasons throughout the building's life cycle. 94.4% of the total energy used in these phases is consumed for heating/ventilation/air conditioning (HVAC) systems that provide comfort conditions during the usage phase''

''In order to reduce this rate, passive methods and renewable energy sources should be used instead of mechanical systems to provide comfort conditions'', book: Renewable Energy: Technologies and Applications), published: February 17th 2021 edited by Taner, Tiwari and Ustun.

7.2 Challenges and solutions for implementing Renewable Energy systems in constructions:

Depending on renewable energies to generate electricity for a building, to heat or cool that building is a very conscious act, but their integration is a construction sometimes faces some challenges, that fortunately their solutions exist, here are the following challenges and their solutions:

- Initial cost: The significant barrier to incorporating renewable energy systems into construction lies in the considerable initial expenses tied to installation and equipment. For example, substantial upfront investments are needed for solar panel arrays or wind turbines, which may discourage builders and developers from adopting renewable energy solutions.

15APRUE : Agence nationale pour la promotion et la rationalisation de l'utilisation de l'Energie.

16Urban island heat effect: An urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat.

- Solution: Government incentives and tax credits offer a substantial means to alleviate the initial costs associated with implementing renewable energy systems. Construction companies can enhance the financial viability of this transition by capitalizing on these financial incentives.
- Grid Integration: Effectively incorporating renewable energy systems into the current power grid presents a notable challenge in construction projects. The sporadic nature of renewable energy sources, like solar and wind, necessitates meticulous coordination to guarantee a steady and dependable energy provision.
- Solution: Employing advanced energy storage systems, such as batteries or flywheels, enables the storage of surplus energy during peak generation times and its release during periods of low generation. Furthermore, the adoption of smart grid technologies capable of overseeing and harmonizing energy supply and demand can facilitate the seamless integration of renewable energy systems into the existing grid.
- Limited Space: In numerous construction projects, the challenge of limited space arises when integrating renewable energy systems. Conventional solar panel arrays or wind turbines typically demand extensive areas for optimal efficiency, a condition not always met within construction sites.
- Solution: Companies can investigate alternative options, such as building-integrated photovoltaic systems (BIPV), incorporating solar panels into the structure itself, such as windows or roofing materials. Furthermore, small-scale wind turbines can be installed on the rooftops of taller buildings, requiring minimal space.
- Complex project approval process: Approval processes for construction projects are inherently intricate, and the integration of renewable energy systems introduces an additional layer of complexity. Acquiring permits and complying with regulations frequently leads to delays in implementation, escalating overall project costs.
- Solution: Streamlining the approval process can be achieved through collaboration among construction companies, renewable energy providers, and regulatory authorities. Involving all stakeholders from the outset allows for the identification and prompt resolution of potential obstacles, contributing to a smoother approval process.

8 Comfort and well-being:

8.1 definition:

Comfort generally refers to scenarios where the body's movements and positions are perceived as pleasant, or where no effort is required to maintain a sense of well-being. It is a state of well-being that originates from three sources: physical, functional, and psychological.

8.2 Types of comfort:

8.2.1 Sound comfort:

Acoustic comfort is the state of well-being experienced in an environment where sound is controlled and managed. It extends beyond mere decibel levels, encompassing the quality of sounds and their impact on concentration, communication, rest, and overall health. Characterized by the acoustic attenuation of walls, it depends on the quality of the facade materials and their ability to reduce external noise.

8.2.2 Visual comfort:

Visual comfort is a subjective impression influenced by the amount, distribution, and quality of light. A visually comfortable environment allows us to see objects clearly and without strain, in a pleasant and well-lit atmosphere.

8.2.3 Olfactory comfort:

Olfactory comfort is influenced by odors, with potential disturbances arising from both external and internal sources within buildings. Odors primarily originating from kitchens and bathrooms, along with volatile organic compounds (VOCs) emitted by walls, interior furnishings, and equipment, as well as water vapor from cooking and showers, can be significantly mitigated. This mitigation is achieved through continuous ventilation, either natural (though difficult to regulate) or through the more stringent use of single or double flow mechanical ventilation systems (CMV).

8.2.4 Thermal comfort:

It is a physical sensation, linked to temperature, and specific to each individual. In winter, good thermal comfort is linked to a sufficient feeling of warmth (neither too much nor not warm enough). In summer, this feeling of heat must be limited and ensuring a certain coolness inside any building is a must. Thermal comfort can therefore be defined as the sensation of well-being felt in a given atmosphere, and relating to several criteria, both external and relating to each individual.

8.3 Thermal Comfort:

8.3.1 Parameters defining the thermal comfort:

Thermal comfort is linked to other parameters than temperature, it is linked to humidity, air velocity, the building's insulation and of course the occupant clothing and their metabolic rate, in addition to the parameters associated with internal heat gains pertain to the gains produced within a space by sources other than the heating system. These sources may include lighting, electrical appliances, and station computers, among others.

For general comfort in a sedentary environment, ASHRAE Standard 55 [17]suggests a temperature range of:

-For Winter is has to be between 20°C and 23.5 °C, for summer it has to be 22.5 and 26.1 °C.

- Air temperature: It holds the utmost significance in determining human comfort as it directly governs convective exchanges, a key component of the thermal balance. The external air temperature undergoes daily fluctuations, with peak temperatures observed in the mid-afternoon and minimum temperatures late at night. This variability is influenced by solar input and the emission of long-range radiation towards the celestial vault.

Within a confined space, air temperature is not uniform. Variations in air temperatures manifest, particularly in proximity to cold surfaces and heating sources.

- Air velocity: Air velocity significantly influences convective and evaporative exchanges, impacting the occupant's sensation of thermal comfort, particularly when it exceeds 0.2 m/s.

- Humidity: The humidity level in the air affects cutaneous evaporative exchanges, determining the air's evaporative capacity and, consequently, the effectiveness of sweat-induced cooling.

Within the range of 30% to 70%, relative humidity has minimal impact on the perception of thermal comfort. However, excessively high humidity disrupts the body's

[17] ASHRAE Standard 55: Thermal Environmental Conditions for Human Occupancy is an American National Standard published by ASHRAE that establishes the ranges of indoor environmental conditions to achieve acceptable thermal comfort for occupants of buildings.

thermoregulation by impeding the evaporation on the skin's surface. This leads to increased perspiration, placing the body in an uncomfortable state for extended periods.

- Occupant clothing***:*** Clothing establishes a microclimate beneath it, influenced by its thermal resistance, which alters heat exchanges between the skin and the surroundings. The fundamental purpose of clothing is to sustain the body in acceptable thermal conditions, irrespective of the season. Its primary function is as a thermal insulator, particularly crucial in winter and cold environments. This insulation role is quantified through the determination of a clothing index, expressed in Clo.
- Occupant metabolic rate: Activity stands as a crucial factor in determining an individual's thermal sensation, representing the amount of heat generated by the human body, essentially reflecting the individual's metabolism. In instances of exceptionally high activity, it can lead to sensations of discomfort due to heat, even when weather conditions are highly favorable.
- Internal heat gains:

The comfort within a space is directly impacted by the magnitude of internal gains. These contributions are deemed inevitable once the premises are occupied. It is important to recognize that these gains can fluctuate based on the occupants' behavior, thus serving as a factor exacerbating heat discomfort. Architectural interventions have limited efficacy in addressing this aspect. Effective ventilation and responsible occupant behavior stand as the primary means to mitigate these contributions and their impact on the indoor temperature.

8.3.2 Active and passive strategies to ensure thermal comfort:

In order to obtain and maintain the optimal temperatures of both summer and winter, technical and design methods must be applied for a healthy environment.

- <u>Passive strategies:</u>

They are the design methods that make sure to provide the optimal thermal comfort with less or zero energy, by taking advantage of the natural sources like the sun and wind, to heat or cool the building. These are the most common passive strategies:

- Building’s orientation: The building can be oriented in a way that takes advantage of solar gain or winds to reduce heat load, as it can also be oriented in a way that protects the building from unwanted solar gain or winds to maintain its inside thermal comfort.

- Natural Ventilation: It utilizes the air to ventilate the building, in order to do that, the buildings' windows and doors are designed facing each other to let the air circulate and renew the indoor air.
- Water body: It is very efficient for hot climates; it helps create a micro climate by creating a cooling effect because it absorbs the heat and help in lowering the temperature of the space.
- Landscaping: Weather if it's an indoor one or an outdoor one, it creates a huge difference, for example trees creating a barrier to reduce heat gain in summer season.
- Materials: For example, materials that have a very efficient thermal insulation, and a very little thermal loss, they contribute in maintaining the indoor temperature constant.
- Natural lighting: It improves the interior atmosphere, and reduces the cost of electricity.

- Active strategies:

They are systems that require power to function, the following are some of them:

- Mechanical ventilation: Also known as HVAC, it is used to provide controlled air flow, fans or air handling unite are examples of mechanical ventilation.
- Air conditioners: They can do both cooling and heating.
- Central heater: Transfers heat to the radiators or to the heating surface via the distribution system (set of pipes for example). Radiators and heated floors are heated by hot water. The heat is distributed into the room through the emitters.

8.4 Thermal comfort in offices:

Here are the primary aspects to consider in order to ensure an optimal thermal comfort in an office:

- Optimize the building's thermal load by strategically aligning its orientation and enhancing the envelope design.
- Utilize office equipment and lighting systems that diminish internal heat loads.

- Evaluate air intakes, prioritizing clean outdoor air or implementing suitable filtration to purify outdoor air of inferior quality.

Reduce source pollution by thoughtfully selecting building materials.

- Develop an efficient ventilation supply and distribution system, along with a robust thermal control strategy.
- Choose energy-efficient equipment and implement precise controls to execute the designed ventilation and thermal control.
- Commission the comprehensive design, installation, and operation of these systems

II. BUSINESS OR STARTUP INCUBATORS:

II.1 Definition of a startup:

The term "startup" denotes a company in its initial operational phases. Typically established by one or more entrepreneurs, startups aim to create a product or service based on perceived market demand. In the early stages, these companies often face high initial costs and limited revenue, prompting them to seek capital from various sources.

1.1Characteristics of a startup:

- Temporary: A startup is not meant to persist as a startup indefinitely. Being in the startup phase is not an end goal in itself. It is a distinctive stage, and the primary objective is to transition out of it.
- Exploring a Business Model: As a startup, the essence lies in delivering unique value to customers through a product or service that has not been previously offered. The pivotal task for a startup is to discover and construct the corresponding Business Model that aligns with this distinctive proposition.
- Industrializable/Reproducible: This implies that a startup is in search of a model that, once proven successful (i.e., generating revenue with a clear understanding of how it is generated), can be replicated on a broader scale, in different locations, or implemented by others.
- Scalable (for exponential growth): Another hallmark of a startup is its scalability. This involves having a model where, as the number of customers grows, the profit margins increase. The initial customers may be more costly than subsequent ones, creating a scalable structure. It is this scalability, combined with the reproducibility

of the model, that enables startups to achieve rapid and extensive growth within a short timeframe.

1.2 Startups contribution to the Algerian economic development: According to a study conducted by the Algerian website "l'entrepreneur algérien," startups have the potential to invigorate the Algerian economy across various sectors (the Algerian entrepreneur, 2021).

1.2.1 TICS (Information and Communication Technologies):

- Streamline the interactions of Algerian citizens with the administration through the implementation of e-administration.
- Reduce waiting times for the issuance of administrative documents.
- Enhance communication and administrative management within state institutions in Algeria through centralized digital platforms.
- Combat corruption and enhance administrative transparency.
- Foster the digital economy through e-commerce and widespread adoption of e-payment in Algeria.
- Optimize management and communication within Algerian companies.
- Digitize documents within the company as much as possible.
- Significantly reduce the time required for business creation in Algeria through e-administration.

1.2.2 Education:

- Promote the widespread use of digital media in Algerian schools.
- Simplify parent-student-teacher relationships by encouraging communication and daily student monitoring.
- Expand access to knowledge by establishing 100% virtual libraries for Algerians.
- Enhance learning methods with the latest technological advancements from startups in the fields of communication and psychology within the school environment.
- Generalize the use of E-Learning.

1.2.3 Transport :

- Improve traffic flow by leveraging the latest technologies from startups, including neural networks and real-time traffic monitoring.
- Enhance the daily lives of Algerian citizens by providing real-time information on the arrivals and departures of public transport.
- Centralize single subscription systems for all common Algerian transportation.
- Enhance the tracking of goods through real-time traceability.

1.2.4 Health:

- Gradually introduce remote consultations in Algerian hospitals.
- Optimize hospital management by improving appointment scheduling, patient file monitoring, implementing decision support tools, and providing patient guidance at the medical center level.
- Map the Algerian health network to enable citizens to quickly locate the medical center they need.

1.3 Definition of a business/startup incubator:

Startup incubators are entities that provide assistance to entrepreneurs in refining their business concepts. These organizations are known for offering guidance and support to ventures with the potential to enter the market. To facilitate this process, they furnish a range of services and resources aimed at aiding entrepreneurs in the comprehensive definition and development of their projects. These resources can be broadly categorized into three main groups:

- Guidance: Assisting entrepreneurs in delineating their project's model and objectives, assessing viability and results, securing financing, partners, and investors, and preparing essential elements such as business plans, market analysis, and marketing strategies.
- Training: Offering specialized courses, mentoring, and business-oriented training to help entrepreneurs recognize and exploit business opportunities. Legal and accounting guidance is also provided to ensure comprehensive support.

- Infrastructure*:* Supplying material resources and dedicated workspaces where entrepreneurs can actively engage in their business activities and foster growth.

‘’ The Business Incubator's core mission involves attracting, supporting, and directing individuals with creative and innovative ideas to turn these ideas and innovations into economically productive projects, and to establish START-UP enterprises that generate financial profits, contributing to the creation of economic wealth and diversification of exports’’, Source: univ-setif2.dz.

Startup incubators strive to foster the creation of new companies, champion innovation and entrepreneurship, alleviating the costs and risks borne by entrepreneurs during the early phases of their business ventures. These entities may take the form of private, university, or governmental institutions. Based on their focus, they can be categorized as:

- General Startup Incubators: These organizations consider proposals from any business sector, without distinguishing the type of activity to which the proposed idea is oriented.
- Specialized Startup Incubators: Concentrating on specific sectors, these incubators exclusively entertain proposals related to their designated field of action, such as social initiatives, sports ventures, or technology-oriented projects.

1.4 The functioning of a Startup Incubator:

Startup incubators operate in the initial phase of a startup's journey, specifically in the 'pre-seed' stage, where the project is defined and shaped. The operational process is divided into four stages:

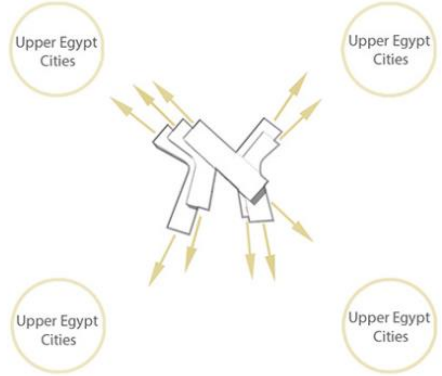
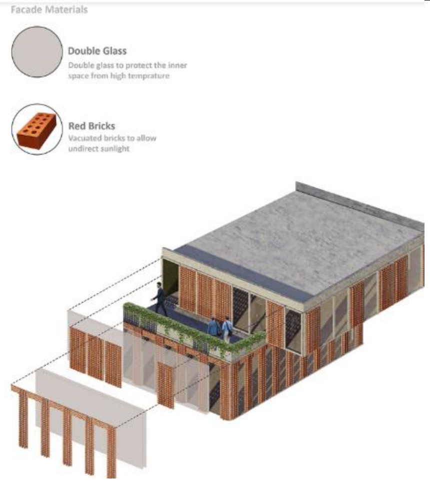
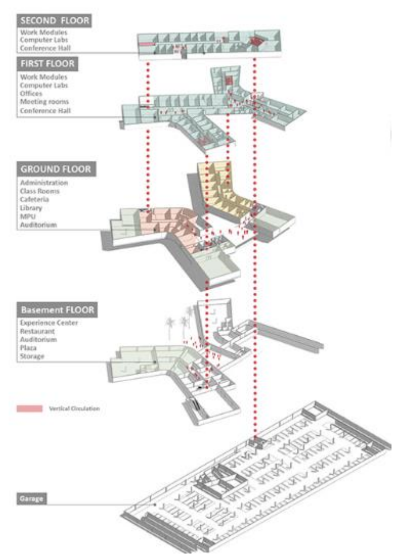
- Selection*:* Incubators issue calls for entrepreneurs to present their business ideas. Subsequently, they scrutinize and assess these proposals, selecting the ideas they deem worthy of further development.
- Pre-incubation: Essential procedures for initiating a new project are undertaken during this phase, including tasks such as market analysis and business plan development. The business plan outlines the project type, action plan, target audience, and other crucial elements. The startup incubator guides and advises entrepreneurs to ensure compliance with these procedures.
- Incubation: This stage marks the project's launch, with the implementation of the business plan formulated in the previous phase. Different business areas, such as

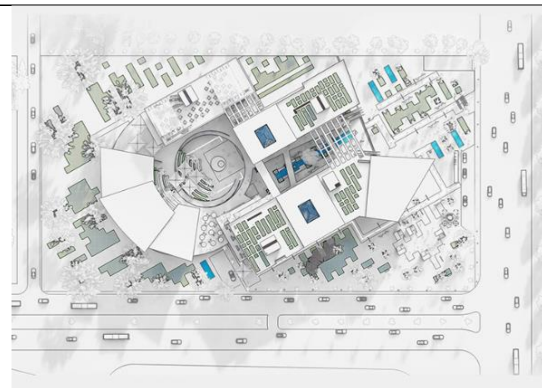
marketing and human resources, are established, and work is organized by areas. Experts and advisors from startup incubators closely monitor the project's progression, offering support to the entrepreneur.

- Post-incubation: The final phase involves the analysis of the project's evolution. Startup incubators evaluate growth possibilities in the medium and long term, considering potential changes in the business strategy if results fall short of expectations.

II. 2 Example Analysis:

Table6: table of example analysis

EXAMPLE	FORM	ENVELOPE	SURROUNDINGS	FUNCTION
 **THE EMITTER BUSINESS INCUBATOR** **EGYPT** Assuit	 -This form was obtained going from a basic form, which is a parallelepiped, that was spread into two parts following North-South, East-West direction, translating the attraction of people, from all directions, and finally the superposition of a parallelepiped-oriented north-south allowed the connection of the two entities.	 -The materials used in the envelope are bricks and doubles glass, they are disposed in layers, to prevent temperature increase inside the building -The arrangement of the bricks made it possible to create a new pattern, allowing the interaction between the inside and the outside, Also allowing a big light entry and shadow creation to decrease the high temperature of the space.	 -As Assuit is a very hot city, the created form allowed to create a sort of atrium provided by waterways allowing cooling by natural ventilation, also the creation of green spaces surrounding the whole building are disposed in a way that’s inviting people to the project.	 -The project consists of 5 levels in which the functions are served in a hierarchical manner, the 2 levels underground which are an underground parking and a basement are dedicated to the public, because they include the following functions: auditorium, restaurant, exhibition space, a waiting room, and a basement, the 3 levels above ground are semi public and private respectively. The ground floor area is semipublic, followed by the private area that holds the incubator functions which are the coworking spaces, the startup offices, the computer labs ...

 **NEXUS INNOVATION HUB EGYPT** New administrative capitale	 -This form was generated from a basic form, that is a parallelepiped, extruded form site, split into 4 entities, oriented parallel into the north direction and then finally shaped inro these forms.	 -This project facades respond to the solar orientation: the north facing openings have been maximized for natural light and views, while the exposure has been minimized on the sunny side. The north facing facades are composed of glass creating curtain walls The sunny sides facades are composed of bricks	 -The surrounding exterior of the building is imagined as a computer component, or an electronic card, the surrounding is filled with diverse furniture that provide varying degrees of interaction and tasks to be carried out. -The people there are imagined like electrons or bits of information, they circulate and exchange to form a complex network to greater intelligence.	 The building is composed of 7 floors, 2 basements for underground parking, a ground floor containing functions for the public use, like shops, coworking rental spaces, exhibition halls. From the first to the fifth floor the functions are for semipublic, and private use respectively. The building has a spatial hierarchy in privacy. The functions we find in these floors are the following: lecture halls, managers room, Meeting rooms…

II.3 Conclusion :

Based on comprehensive research into renewable energies for the building sector, specifically photovoltaic and wind energy, we now understand how these energies work to generate power, their components, their advantages and disadvantages, the factors affecting their performance, in addition to understanding the concept of both passive and active strategies and their ability to ensure thermal comfort… and finally gaining knowledge about innovation in the economical field by understanding the concept of startups and also the concept of startup incubators, reinforcing that by establishing an architectural example analysis that describes and explains the hierarchy in design and functionality as well as the harmony between the design and functionality to offer better spaces for better performances.

CHAPTER III: CASE OF STUDY

1 Introduction:

Given the interest in innovation and creating startups to do so, in parallel with contributing to the country's economic growth as well as the great lack of startup incubators infrastructures in Blida city. Our vision prioritizes both economic innovation and the rejuvenation of Blida city, particularly by enriching the university center. We aspire to drive economic growth by inspiring individuals of all ages with innovative ideas to materialize their abstract concepts into tangible products. To achieve this, we aim to introduce them to a startup incubator center, offering the ideal environment for their endeavors.

2 City Presentation:

Blida city, often referred to as "The City of Roses," derives its name from the classical Arabic term "boulayda," meaning a small town or region, which is the diminutive form of "Bilad" (country, region). Over time, this term evolved into "Blida" in dialectal Arabic, a name that gained prominence during French colonization. Additionally, the city is affectionately nicknamed "Ourida," meaning "little rose," further accentuating its association with the symbol of the rose.

2.1 Blida Geographical Location:

Blida, part of the metropolitan area of Algiers, is situated beneath the majestic Chrea mountain, a prominent peak within the Tell Atlas range, enjoys a picturesque location along the right bank of Oued Sidi el Kebir. Located approximately 48 km southwest of Algiers, the capital of Algeria. Blida occupies a central position between Algiers and Tipaza to the north, Bouira and Boumerdes to the east, and Ain Defla to the west. To the south, Blida is bordered by Medea, the Atlas Mountain of Chrea, and the captivating Chiffa Gorges. Boasting a population exceeding one million residents, Blida spans an extensive area of 53,26 km², solidifying its significance as a major urban center in the region, because it contains different imposing infrastructures (University, hospitals, Chrea touristic complex…).

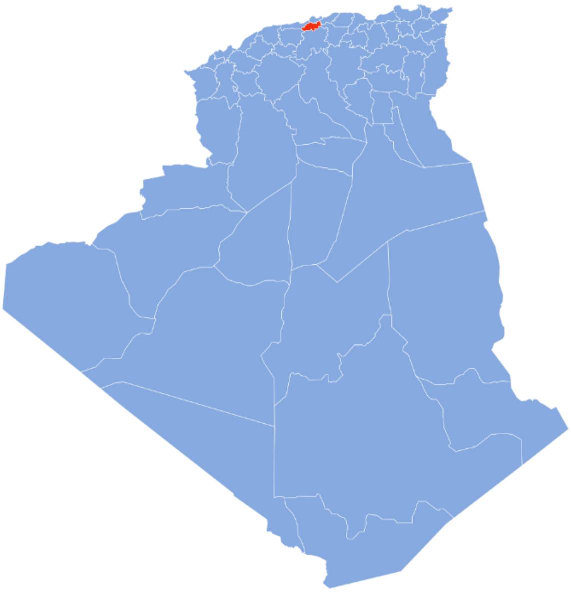


Figure 19: Blida' city situation

Source : Wikipedia.com

Figure 20: Blida's city situation in the metropolitan area of Algiers

Source: Google earth, edited by author

2.2 Blida's city choice Criteria:

- The city of Blida has a great value, and that's by: being part of the metropolitan area of Algiers, having a strategic position and a rich historical heritage.
- The desire to choose a city with a dry climate.

2.3 Blida's city historical approach:

Similar to cities worldwide, Blida has undergone a transformative journey of development and evolution. To gain a deeper insight into this progression, it is essential to delve into the city's origins across various historical periods. By examining the genesis of Blida throughout its different epochs, we can identify the factors contributing to its growth and discern the enduring characteristics that have shaped its identity over time.

The following are the chronological historical periods that shaped Blida city:

2.3.1 Around 1519:

The city was established by a marabout in the vicinity of the Sidi el Kebir watercourse.

2.3.2 The Ottoman period: (1533-1830):

Around 1533, Pasha Kheir brought Moors expelled from Spain to Algeria, who settled on the shore following an appeal launched by Sid Ahmed El Kebir. Legend has it that the creation of the city required only three elements: a spiritual element with Sidi el Kebir, a political element with Pasha Kheir, and a technical element with the Andalusians. The town, situated in an isolated and hostile environment, was characterized by a maze of small, narrow, and winding streets, in addition to that, it was fortified with adobe ramparts measuring 3 to 4 meters high, and had access provided through six gates:

-Bab Er-Rahba

-Bad Ed-Zair

-Bab El-Khouikha

-Bab Es-sebt

-Bab Ez-Zaouia

-Bab El-Qbour.

Blida is enveloped by cemeteries to the North-East, North-West, and South, while the inner city (Intramuros city) boasts a highly concentrated residential area characterized by small houses featuring patios and rooftop terraces. The initial urban infrastructure established by the Turks included the construction of the Sidi El Kebir Mosque and a communal oven. Subsequently, additional mosques were erected, along with a variety of administrative buildings.

Figure 21: A picture showing the architectural style during the Ottoman period

Source :mahlakiyaelblida.org

2.3.3 Around 1825:

Devastation within the city resulted from earthquakes.

2.3.4 French Occupation: (1830-1962):

Shortly thereafter, another calamity befell Blida, albeit of a different nature and one less natural, as Algeria fell under French occupation. In 1830, the French army made its initial entry into the city, prompting astonishment among the local Blidean population. Four years later, **in 1834**, Blida faced another invasion by French troops. Subsequently, **in 1838**, two military camps were established to oversee the city and its surroundings: the upper camp and the lower camp. These camps eventually evolved into the suburbs of Joinville (Zabana sector) and Monponsier (Ben Boulaid).

In **1842,** following the end of the Mitidja war, the first European families started to inhabit a city deserted by its original population. European-style houses began to emerge in the city center, interspersed among Moorish-style residences. Establishing urban order became imperative for them, focusing primarily on:

-Defensive structures.

-Religious establishments.

-Public spaces.

-military hospital.

-2 courts.

-city hall.

-police station.

Figure 22: A picture of Grand hotel d'orient facade, showing the colonial architectural style

Source: algeriemesracines.com

The city kept enduring changes at the urban and architectural scales, the following are the most important changes:

1846: The Algiers-Blida railway line was constructed.

1859: The Blida railway station was inaugurated.

1926: The ramparts were demolished, and ring boulevards were erected in their place.

1958-1960: The most significant waves of urbanization occurred during the war of independence, notably under the Constantine plan. This period witnessed the construction of collective buildings, and the emergence of HLM (Montponsier district), les bananiers neighborhood and l'Armaf.

2.3.5 Post French occupation period:

The departure of the Europeans led to the sale and subsequent acquisition of a substantial real estate legacy, which eventually became state property. Within the urban confines, the development of neighborhoods and European-style villas persisted. However, beyond the urban periphery, informal settlements emerged, lacking adherence to any urbanization standards.

The city's expansion unfolded spontaneously. Furthermore, urbanization started to evolve in the 1970s, spurred by the initiation of industrialization programs and efforts in administrative and academic oversight.

Figure 23: an image of AADL social housing in Blida.

Source: flickr.com Rabie Foufa

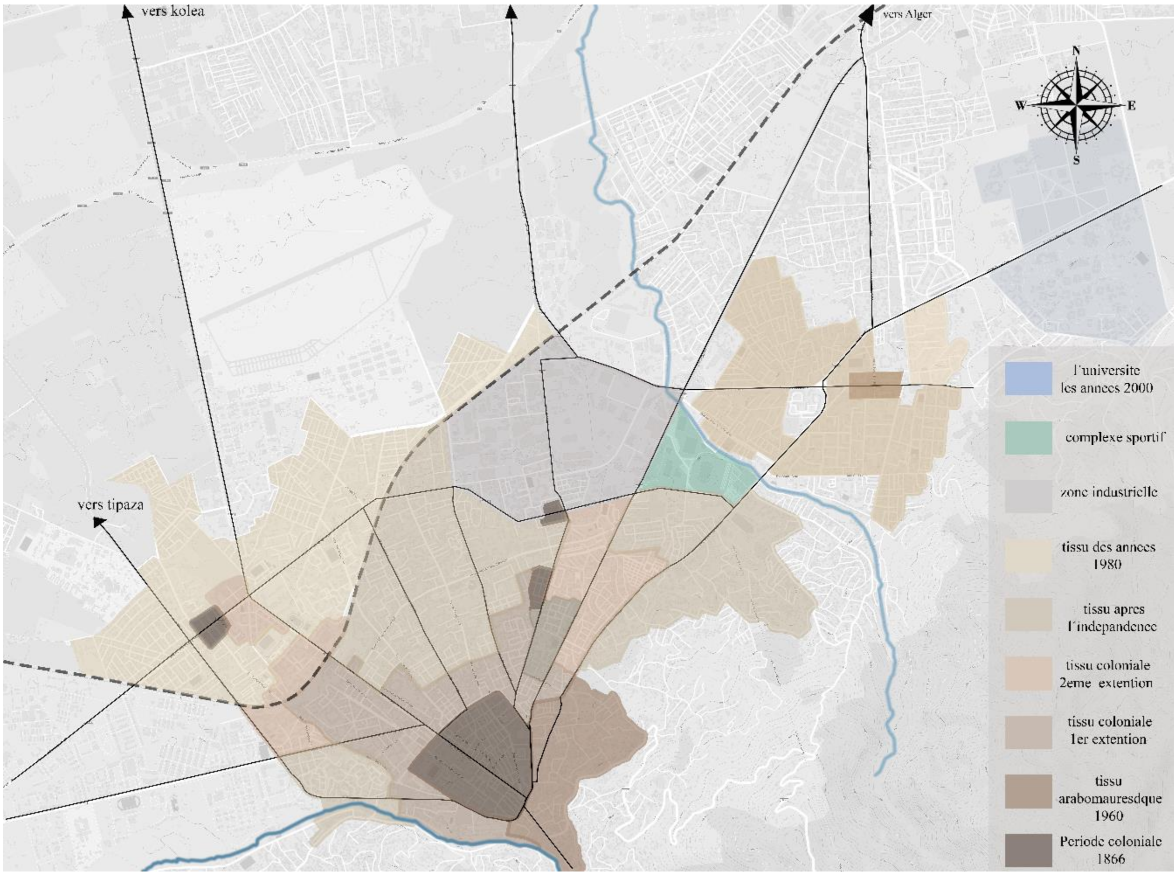


Figure 24: a map showing the growth of Blida's city during the historical periods.

Source : Author.

2.3.6 Conclusion:

Searching throughout Blida city history and understanding the different architectural styles, and urban plannings that have been introduced to the city during the different epochs that it has been through, helped us understand and value othe city's architectural identity, by reminiscing it into future projects.

2.4 Ouled Yaich Presentation:

The commune of Ouled Yaïch, an extension of Blida city, is home to over 100,000 residents and has grown to become the largest agglomeration in the Blida province. In the 1970s, it was merely a small village. The area's oldest inhabitants are the Aïchi, after whom the town is named, Ouled Yaïch. Neighborhoods like Touarès, Ben Amour, Meliani, and the Russian and Spanish quarters have helped shape the town. Starting in the 1980s, significant land availability enabled various development programs.

The first major project brought new residents with the construction of 1,000 rental social housing units. This mega-housing project marked the rapid development of Ouled Yaïch. However, a lack of forward-thinking urban planning has resulted in Ouled Yaïch becoming a soulless dormitory town. The city center retains some character primarily around the old colonial-style houses. Despite numerous housing projects, including social housing, AADL, LSP, LPA, and LPP, Ouled Yaïch lacks a cohesive style. The expansion of concrete structures has occurred at the expense of the environment, leaving the town without gardens or green spaces.

2.5 Commune of Ouled Yaich choice criteria:

- University center commune.
- Lack of leisure and educational services.

2.6 Ouled Yaich geographical Location:

The commune of Ouled Yaïch is centrally located within the Blida province, approximately 4 km northeast of Blida, around 42 km southwest of Algiers, and about 29 km northeast of Médéa.

The commune is boarded:

To the north: Beni Mered

To the east: Blida

To the west: Guerouaou

To the south: Chrea

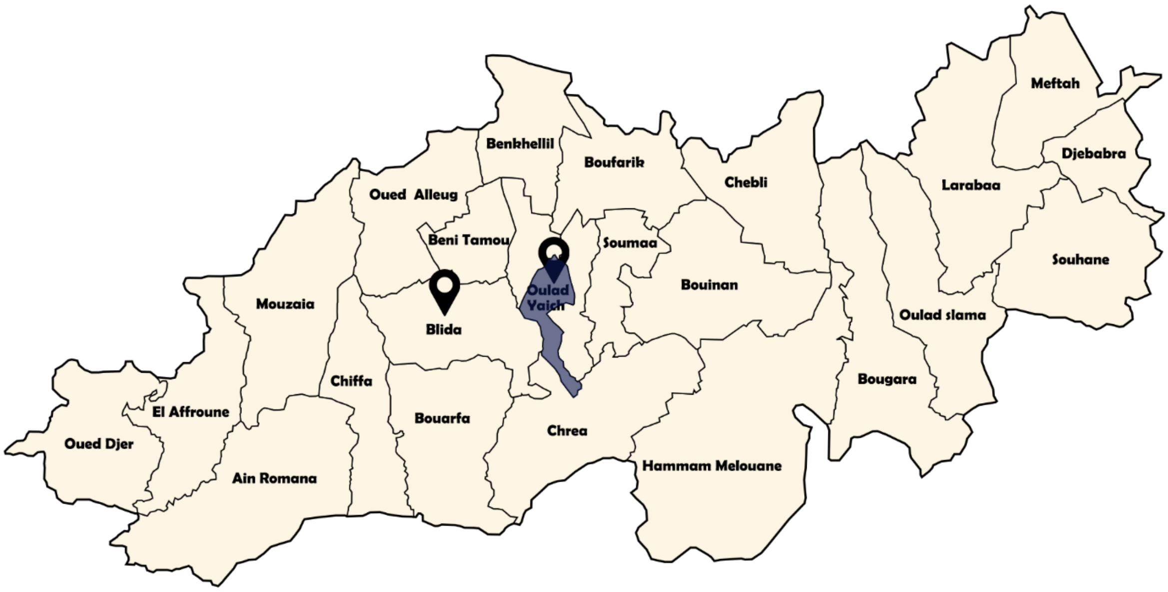


Figure 25: Ouled Yaich situation, in Blida city

Source: Wikipedia.com

2.6.1 Ouled Yaich Topography:

Ouled Yaich is located on a terrain from which we can consider a large part as a flat terrain, the part considered hilly is the southern part of Ouled Yaich, that introduces us to the mountains of Chrea forming part of the Atlas Al Telli.

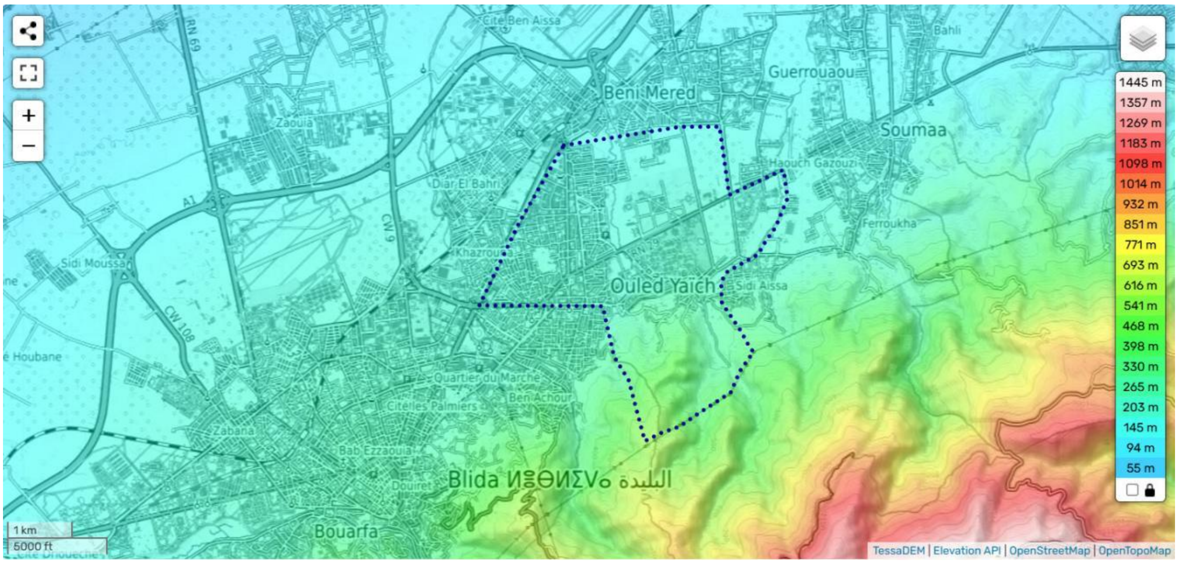


Figure 26: A map showing Ouled Yaich topography

Source : fr-fr.topographic-map.com

2.6.2 Accessibility:

Ouled Yaich is an important municipality of Blida's city, because it contains different kinds of services, public services, different scale educational services, different kinds of trades…which makes it accessible from different scale roads, which are the following:

-AutoRoute 01 (the high way)

-Route 01 (road 01)

-Bouinane

-Chemin de wilaya 09 (wilaya path 09)

-Douirette.

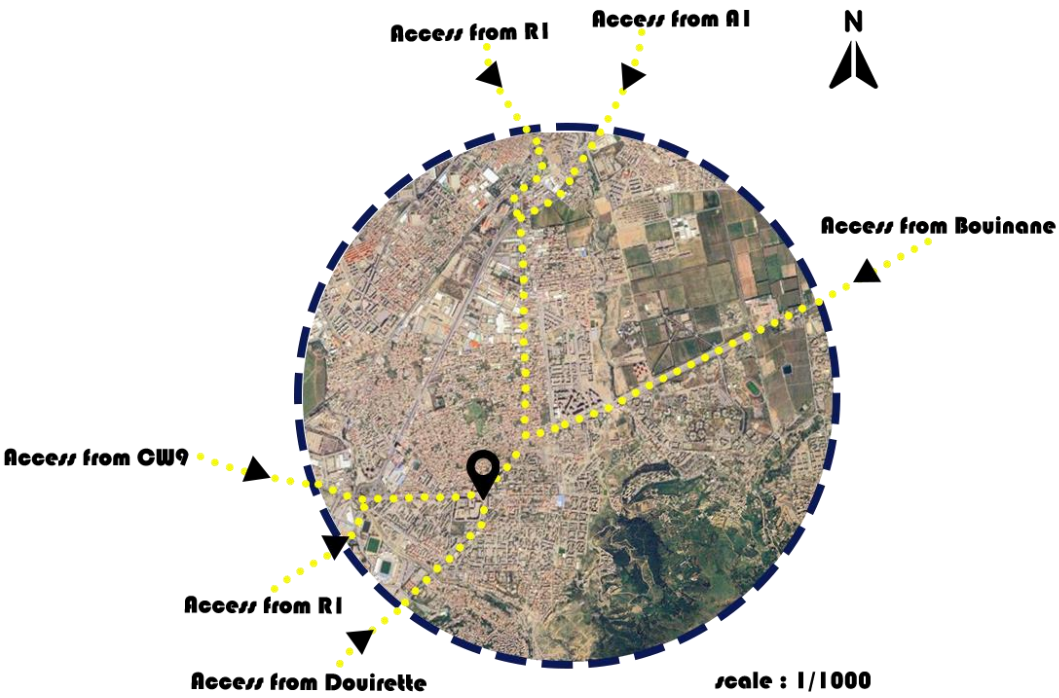


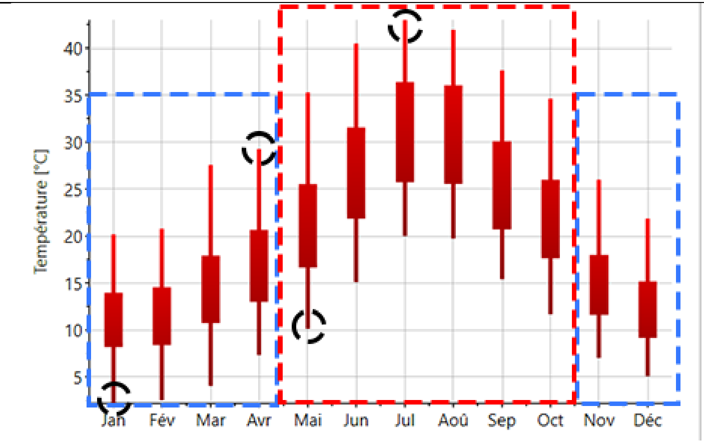
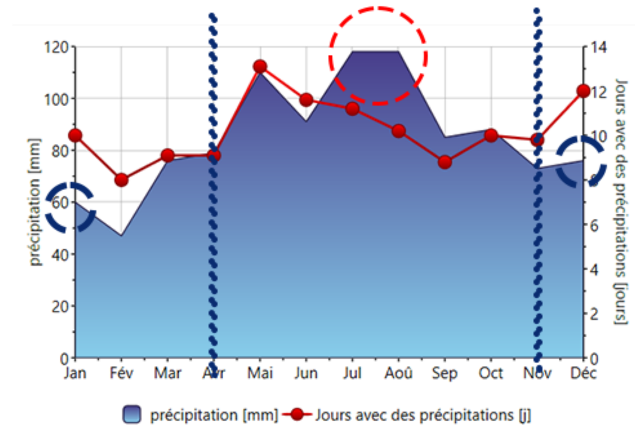
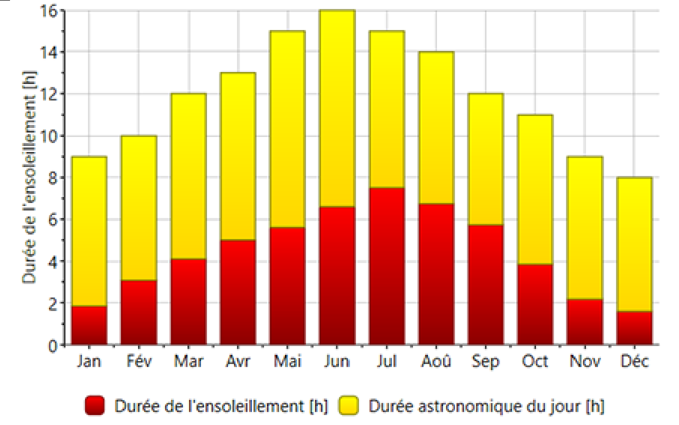
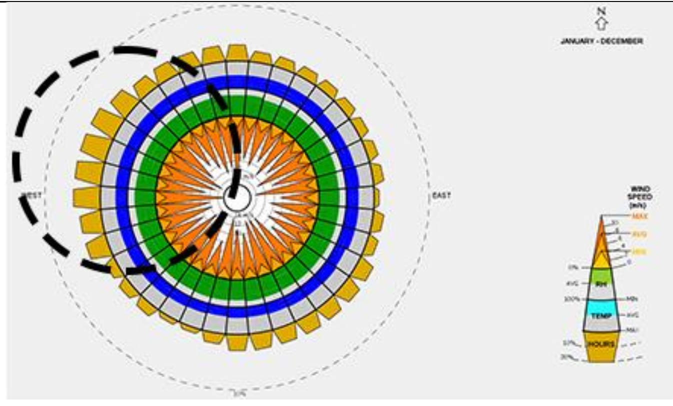
Figure 27: A map showing the different scale roads leading to Ouled Yaich

Source: Google earth, edited by author

2.6.3 Ouled Yaich climate analysis:

In this analysis, we will conduct a climatic assessment on two scales. Initially, we will present climatic data to obtain a comprehensive understanding of the climatic conditions of our case study area using two software tools: Meteonorm and Climate Consultant V6, developed by the University of California. Subsequently, we will delve into a detailed climatic analysis of Oulad yaich municipality in Blida. This analysis will utilize the Sozoklay diagram, enabling us to select bioclimatic strategies that are well-suited to the specific climatic conditions of the site.

Table7: Table showing Ouled yaich climate analysis.

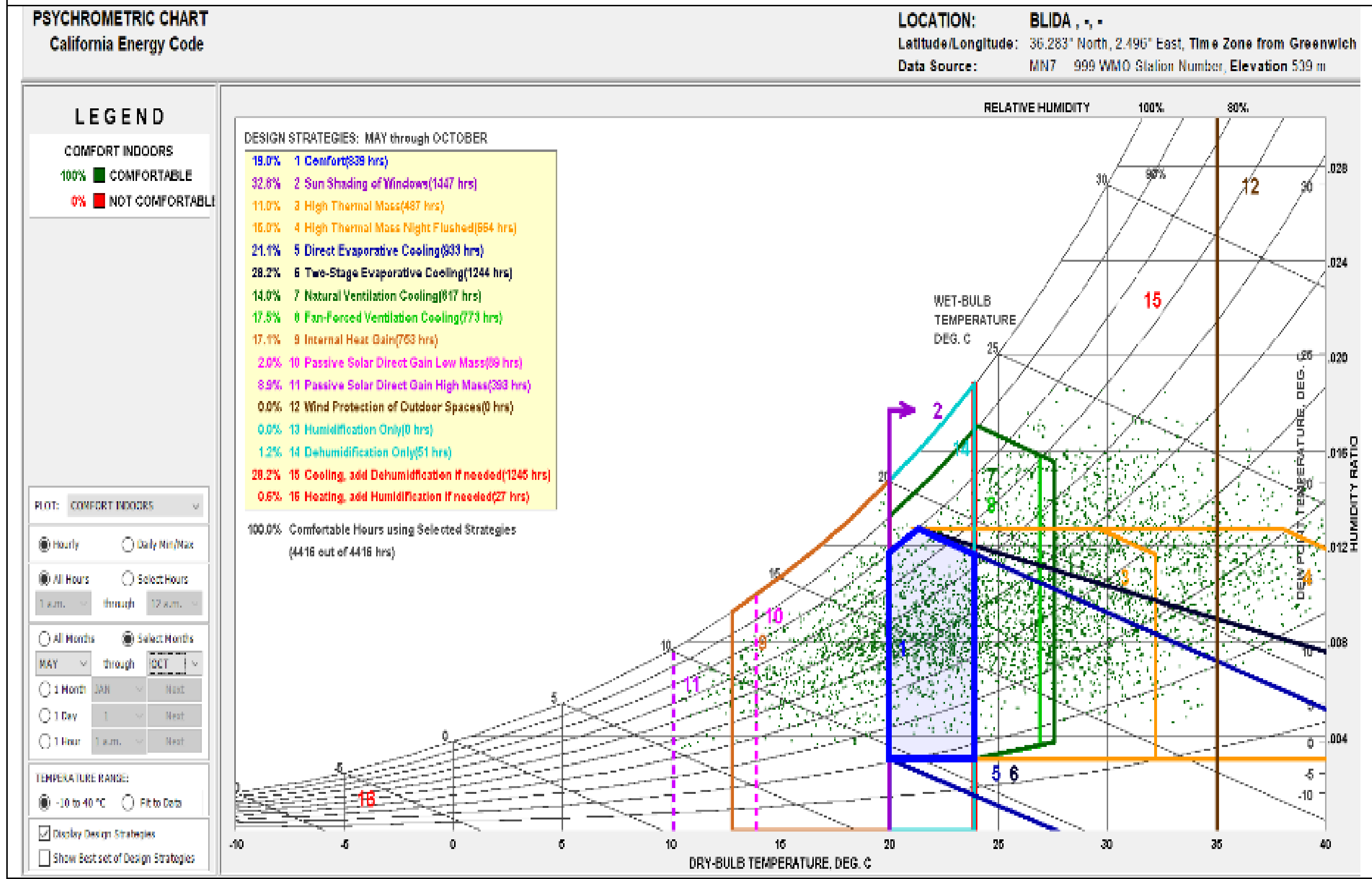
A VERY HOT SUMMER	UNBALANCED PRECIPITATIONS	GENEROUS SUNSHINE	WINDS
			
we note that: Cold season's temperatures: Max: 28°C, Min:0°C Hot season's temperatures: Max: 45°C, Min: 10°C.	**we note that:** unbalanced precipitations, in which the cold season experiences less precipitations on a daily basis compared to the hot season, despite the rational fact that there are more days with expected precipitations in the cold season than the hot one.	**we note that:** our study area receives a huge amount of sun energy. In summer, the duration of sunshine reaches its peak at 7 hours per day, whereas in winter, it does not exceed 6 hours.	**we note that:** the prevailing winds come from the Northen west.

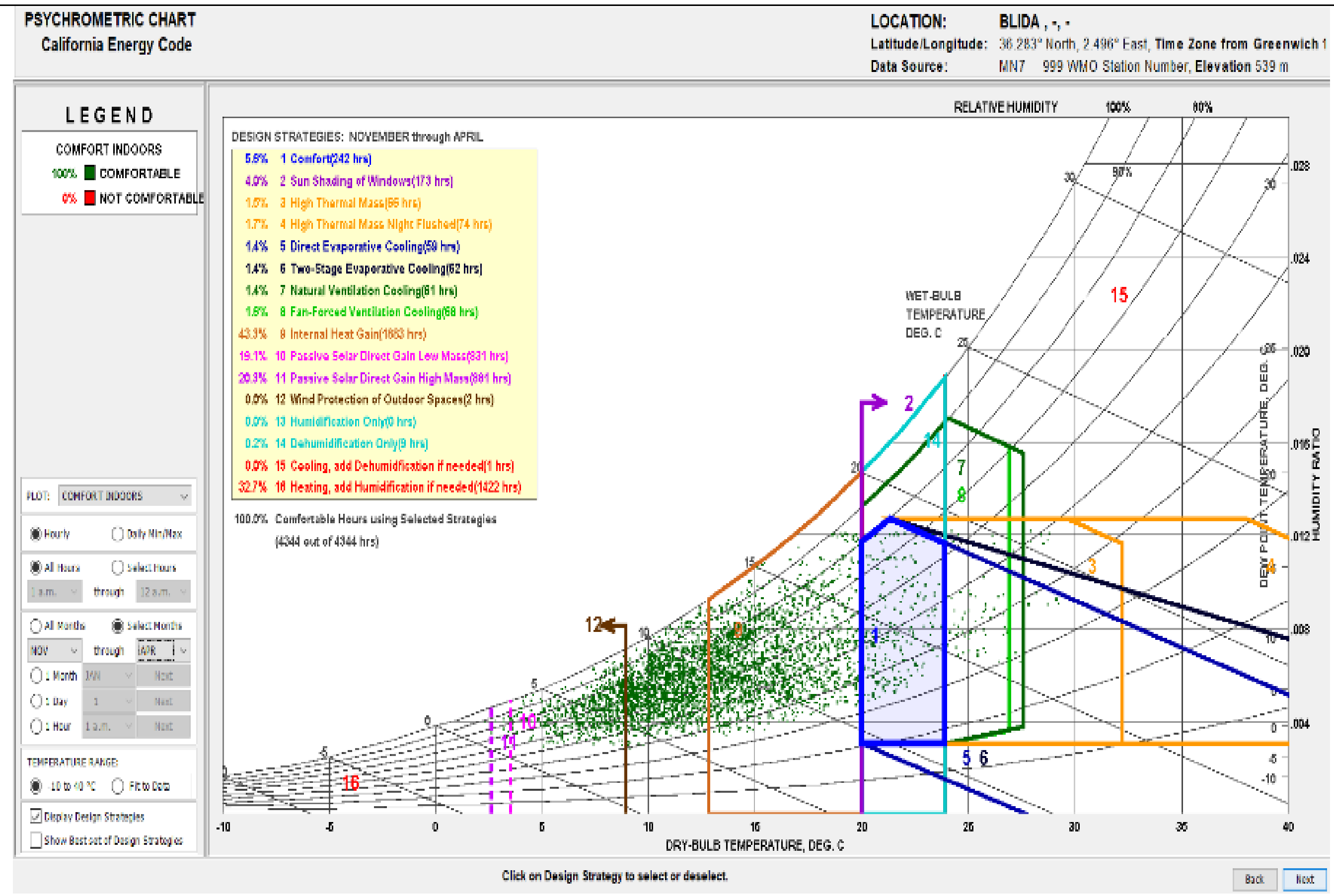
SYNTHESIS

Based on the climatic analysis, we determined that the city resides within the **dry bioclimatic stage**. The climate is typified by **hot and arid conditions** during the summer months, while winters are characterized by **humidity and cold temperatures**.

2.6.4 Bioclimatic analysis using psychometric diagram (Sozoklay):

Table 8: Table showing bioclimatic analysis

<table>
<tr><th>SUMMER SEASON PSYCHOMETRIC DIAGRAM :</th><th>WINTER SEASON PSYCHOMETRIC DIAGRAM :</th></tr>
<tr><td>


</td><td>


</td></tr>
<tr><td>During the summer season that extends from MAY to OCTOBER, the most recommended passive strategies are the following: sun shading of windows, two stage evaporative cooling, internal heat gain, and high mass night flushed.</td><td>During the winter season that extends from NOVEMBER to APRIL, the most recommended passive strategies are: passive solar direct gain high mass, and the recommended active strategy is heating.</td></tr>
</table>

3 Study Area:

3.1 Delimitation:

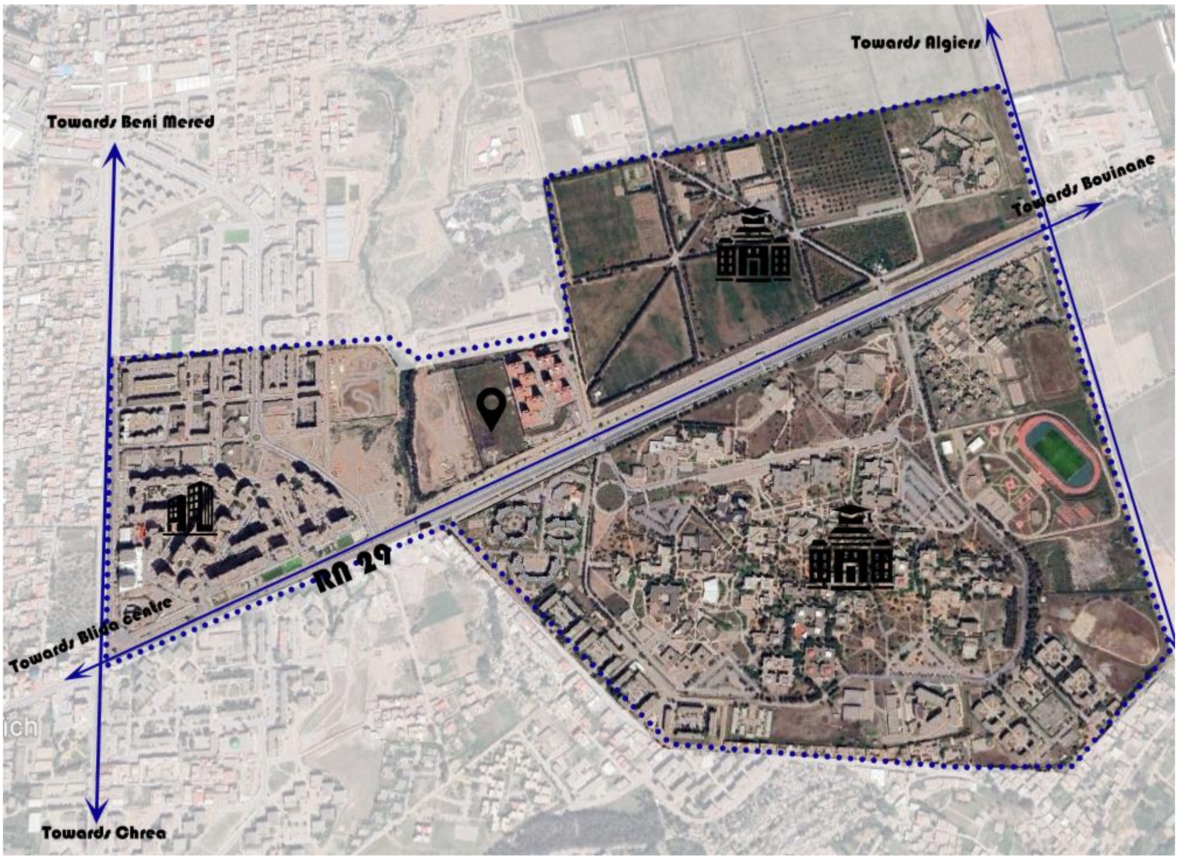


Figure 28: an image showing the study area delimitation *Source: Google earth, edited by author*

- The proposed site: Startup incubators are usually located in technology parks, in a university campus or in a university center, The pinned site is the most suitable for such service, in terms of attractiveness, liven up the area, and therefore revalue it.

Our study area consists of the following services:

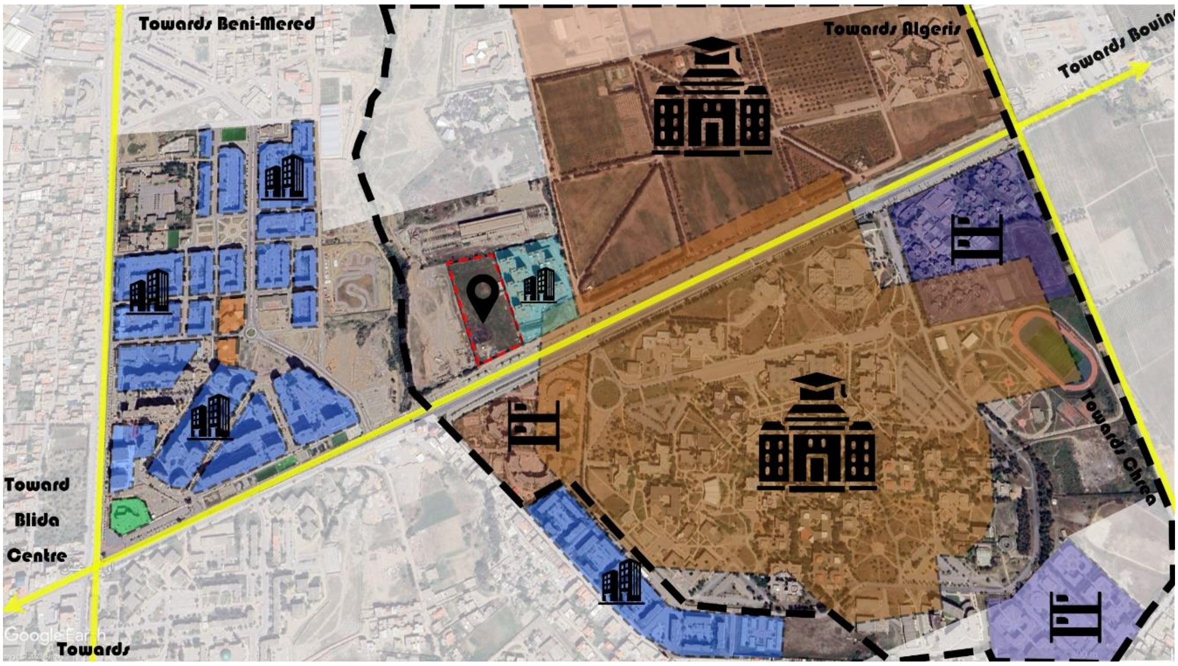


Figure29: An image showing the study area different services. *Source: Google earth, edited by author.*

- Residential buildings
- University dorms
- University
- APC headquarters
- Leisure services

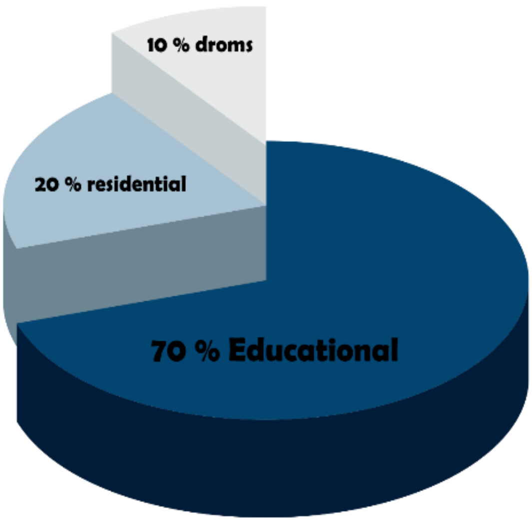


Figure 30: cheese diagram showing the different percentages of land use occupied by the study area services

Source: Author

The university of Blida occupies a huge portion of land in our study area.

3.2 Accessibility and means of transportation:

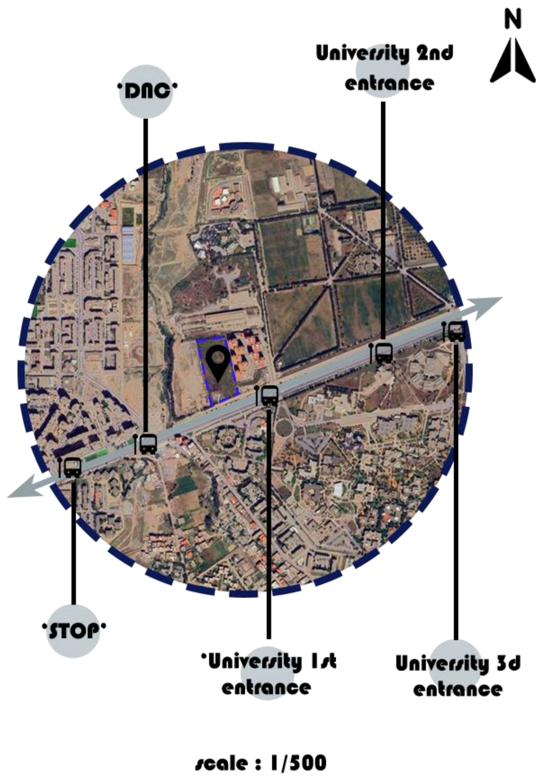


Figure31: A map showing the different bus stops in our study area

Source: Google earth, edited by author

Our study area is accessible by 2 means of transportation: a mechanical one and a pedestrian one.

-The mechanical one consists of: cars and busses, as we note 5 bus stops from west to east along the way:

- ‘STOP’ bus stop
- ‘DNC’ bus stop
- University first entrance bus stop

- University second entrance bus stop
- University third entrance bus stop

3.3 Study area urban analysis:

3.3.1 sensory approach:

The study area, is situated within POS C5 as per the updated PDAU 2015, positions it favorably at the eastern gateway of the municipality of Ouled Yaich. We opted for this study area due to several factors:

- firstly, the proximity from the University of Saad Dahleb.
- secondly, the noticeable absence of facilities.
- finally, the promising availability of land resources.

3.3.2 typo morphological approach:

a-Map of the road network: Hierarchy of roads:

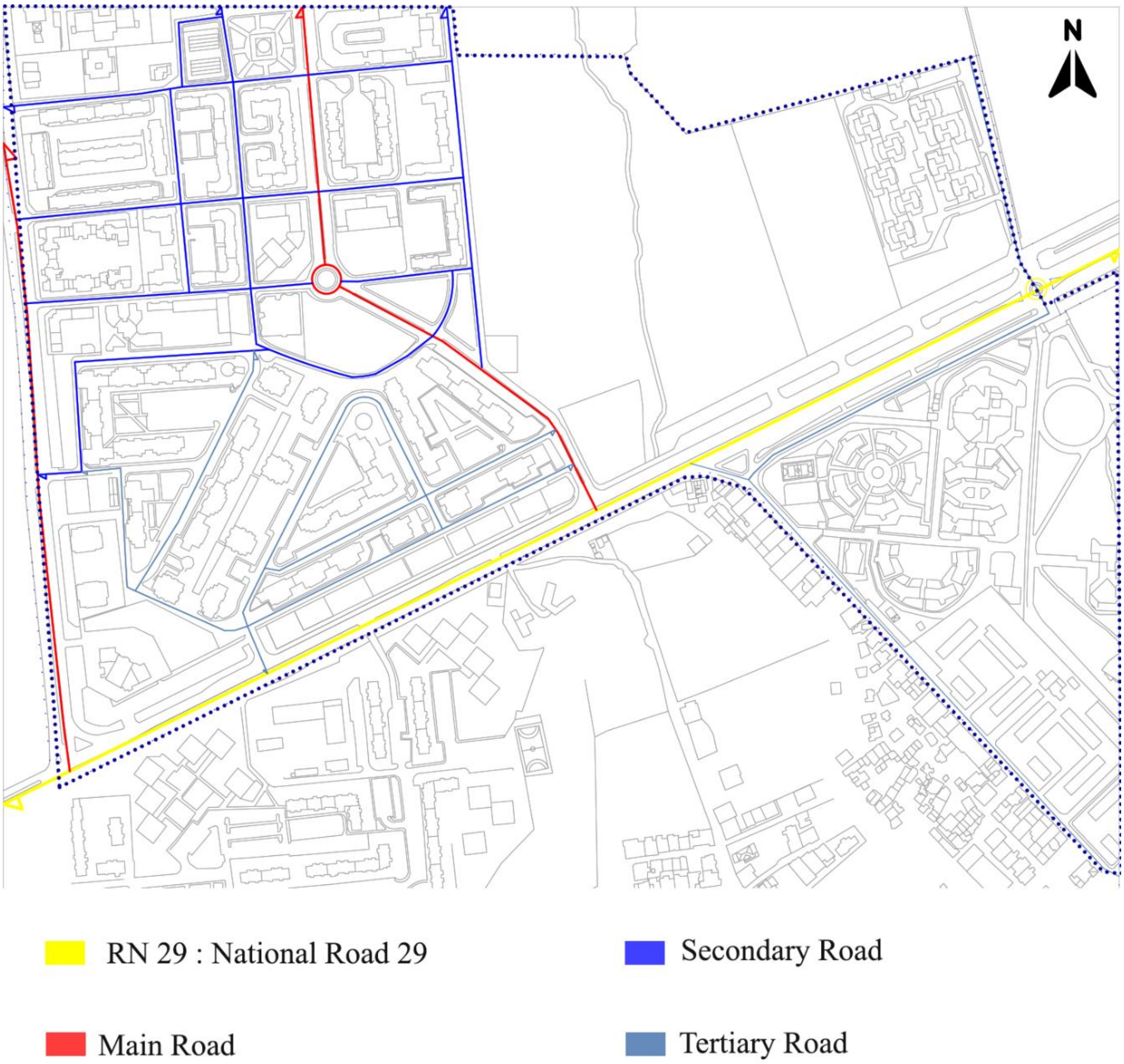


Figure32: road system map, scale: 1/200 Source: Author

The study area is served by 4 types of roads of different importance, we can categorize them into 4 essential types:

- The national road RN 29 that links the commune of ‘OULED YAICH’ with the commune of ‘SOUMAA’
- Main roads connecting the different areas of the commune of Ouled Yaich
- Secondary roads structuring and serving the islands
- Tertiary roads serving closed blocks

Synthesis: this area is well structured, this latter's road dissertation results with a checkerboard pattern.

b- Map of the unbuilt spaces:

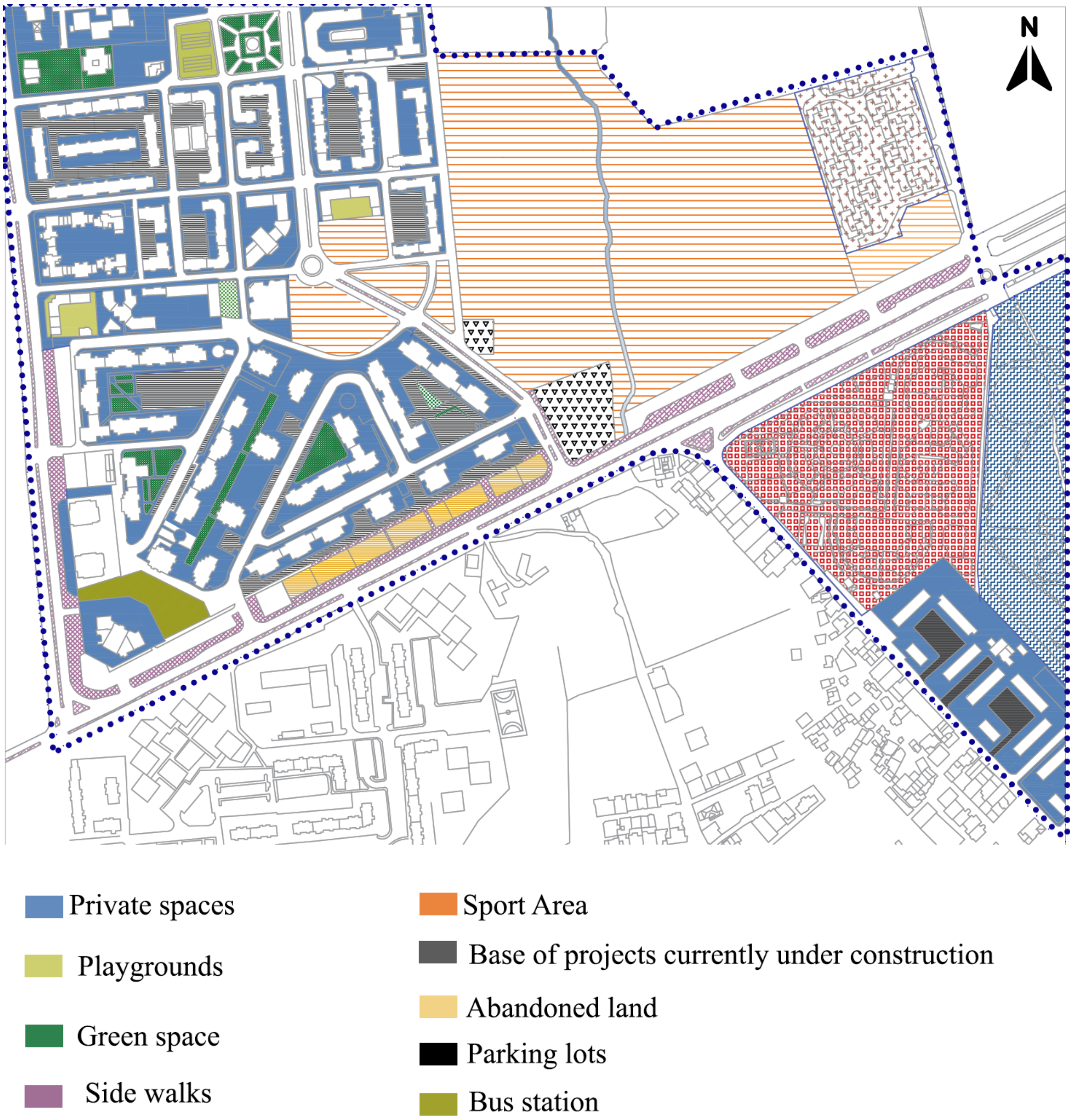


Figure33: unbuilt spaces system, scale 1/2000 *Source: Author*

Description: This map describes the different unbuilt spaces situated in our study area.

We notice different types of unbuilt spaces:

- Natural spaces: River

-Green urban spaces: public garden, small green areas inside neighborhoods

-Leisure spaces: Sports Area (football playground)

-Transport infrastructure: only vehicle roads

In addition to the parking lots situated inside the ADL neighborhoods, private playgrounds inside schools and the bus station.

Synthesis: Our study lacks of Urban parcs, green spaces surrounding buildings and a development with urban furniture throughout the river.

c-Map of the Built spaces:

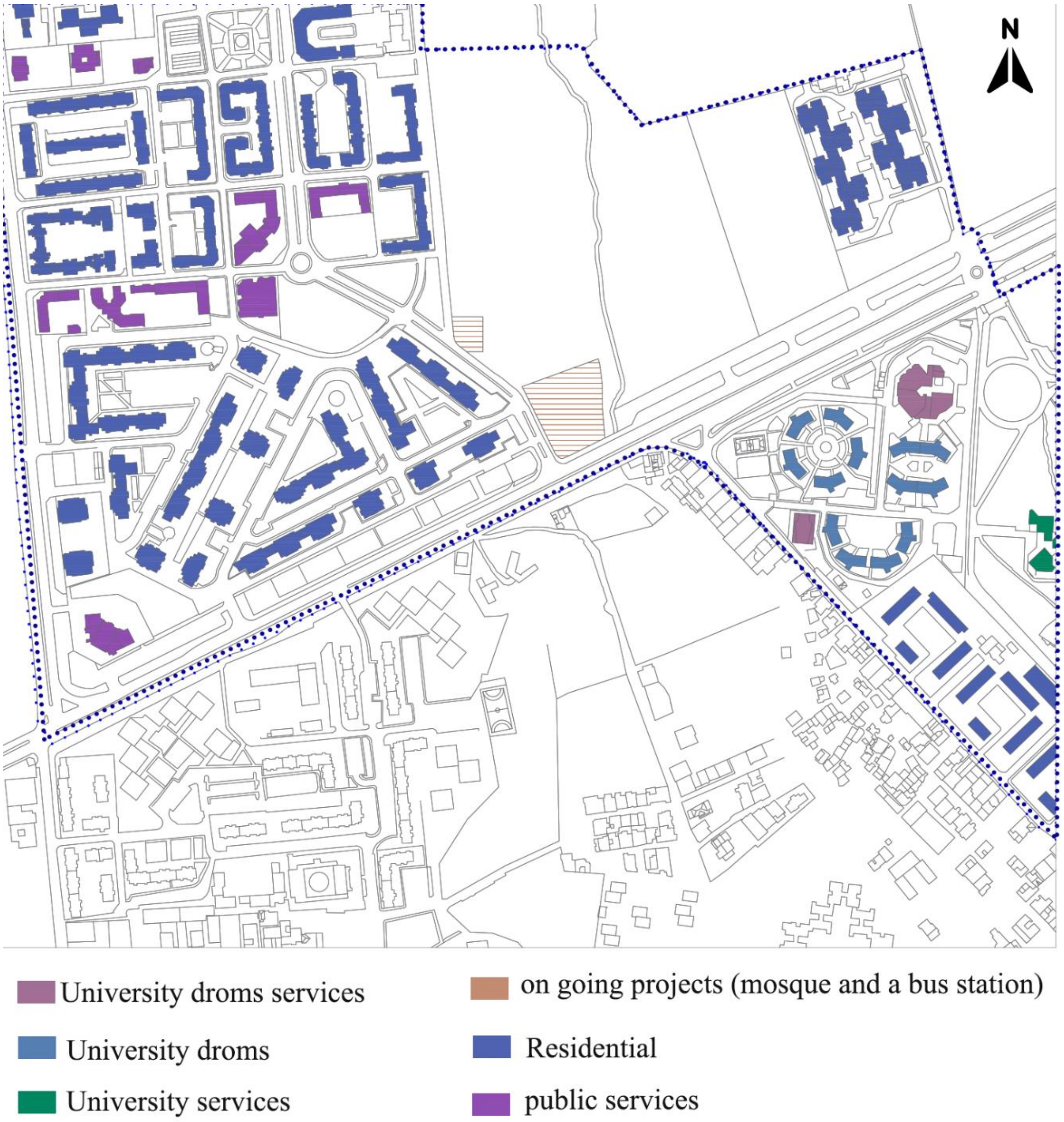


Figure 34: built spaces system scale 1/2000 source: Author

Our study Area consists of the following services: Residential services, educational services, and some public services consisting of the APC headquarters and 2 leisure services which are:

3.4 Sensory and Sequential analysis:

The Sequential analysis involves linking urban morphology with human sensory perception to facilitate the appreciation of "imageability," which refers to the ability to identify oneself within a given space. Through immersion in our study area, we were able to discern several sequences. Please refer to the sequential analysis map provided below for further details.

Our study Area has been divided into 4 sequences because of the different sensations felt in each sequence's urban space.

1st Sequence: A strong atmosphere: Crowded and noisy: due to the presence of a bus stop, it is always crowded and noisy, it also has important mechanical and pedestrian flows, due to the disposition of services like: APC headquarters, a middle school….

2nd Sequence: A calm secure atmosphere: due to the presence of residential buildings, so it basically contains neighborhoods, that are less crowded.

3rd Sequence: Very calm but insecure: due to the physical interruption, this sequence has less buildings than the previous ones.

4th Sequence: University Campus: a seasonally energized area: a seasonally important mechanical and pedestrian flow, which means this area is seasonally crowded, which makes its security low.

Figure35: A map showing the different sequences of our study area source: Google earth, edited by author

4 Urban Intervention:

4.1 Problematic:

The present problematic in our study area, is not only that it is the lack of energizing services, but also the presence of a physical urban interruption or it can also be referred to as the absence of a transitional area between the university campus and the services situated on the west of the university campus.

Figure36: a map showing the current problematic of our study area   Source: Google earth, edited by author

4.2 PDAU and POS recommendations:

-The PDAU recommendations for this area are for it to be urbanized

- POS: This area belongs to the P.O.S C5, it is situated on the north of the RN 29, and the POS recommends to carry out a development study for this area, that is intended for collective housing.

Figure37: a map showing our intervention area   Source: Google earth, edited by author

4.3 AFOM analysis:

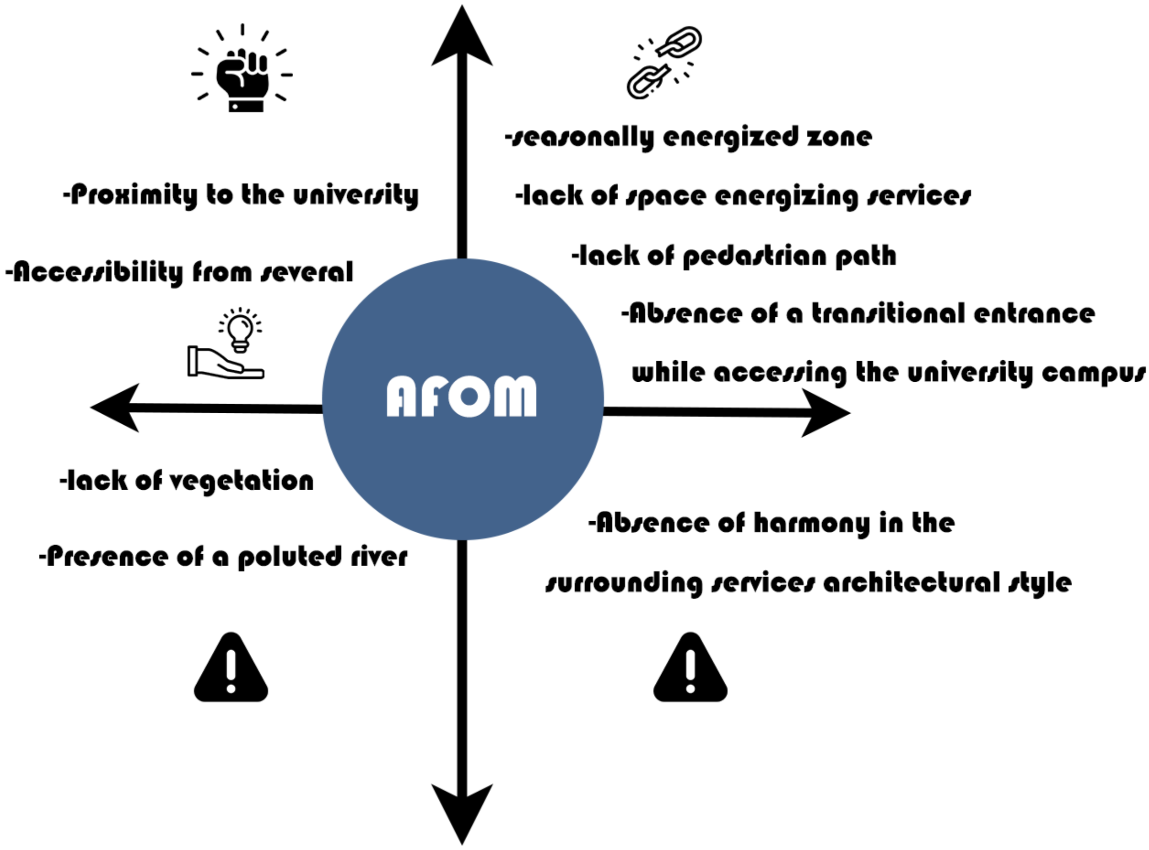


Figure38: a scheme showing the AFOM analysis of our study area *Source: Author*

4.4 Schemas:

The POS recommendation won't help solve the problem of the "seasonally energized area", but in fact it will transform this area into a 'dormitory town'.

The actions taken to prevent that, are mainly to inject energizing services, green spaces and educational services, leading to a promiscuity and communication.

To get there we started by the extension of the roads as well as the creation of new roads following the same principle of the existing urban layout, to finally result in a checkerboard layout.

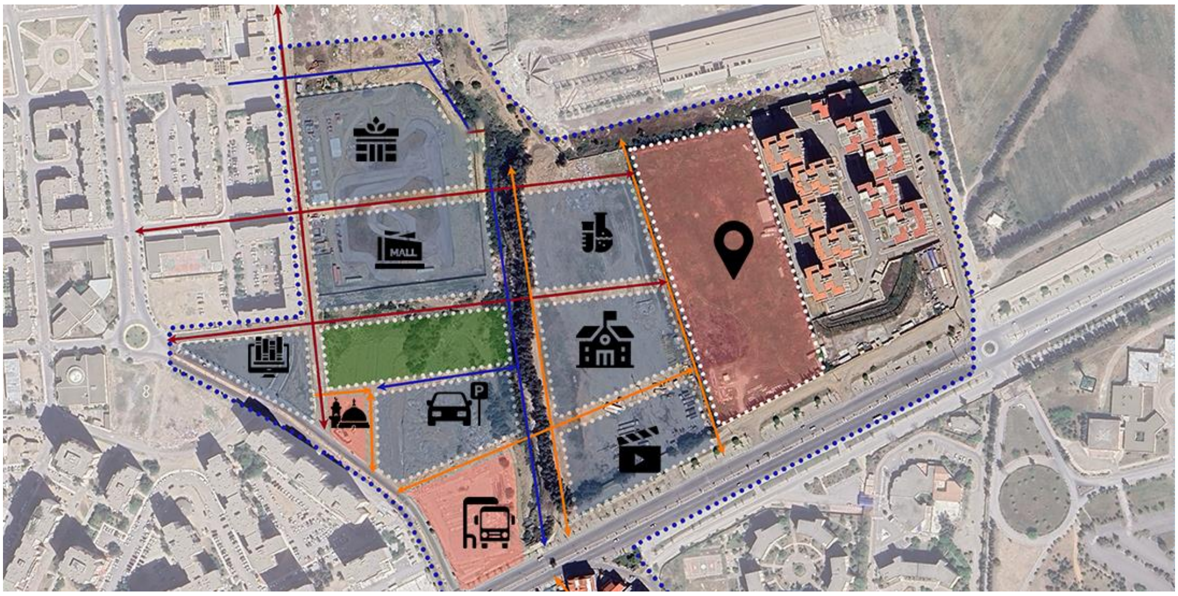


Figure39: a map showing the scheme of actions taken in our intervention area   Source: Google earth, edited by author

4.5 Master plan:

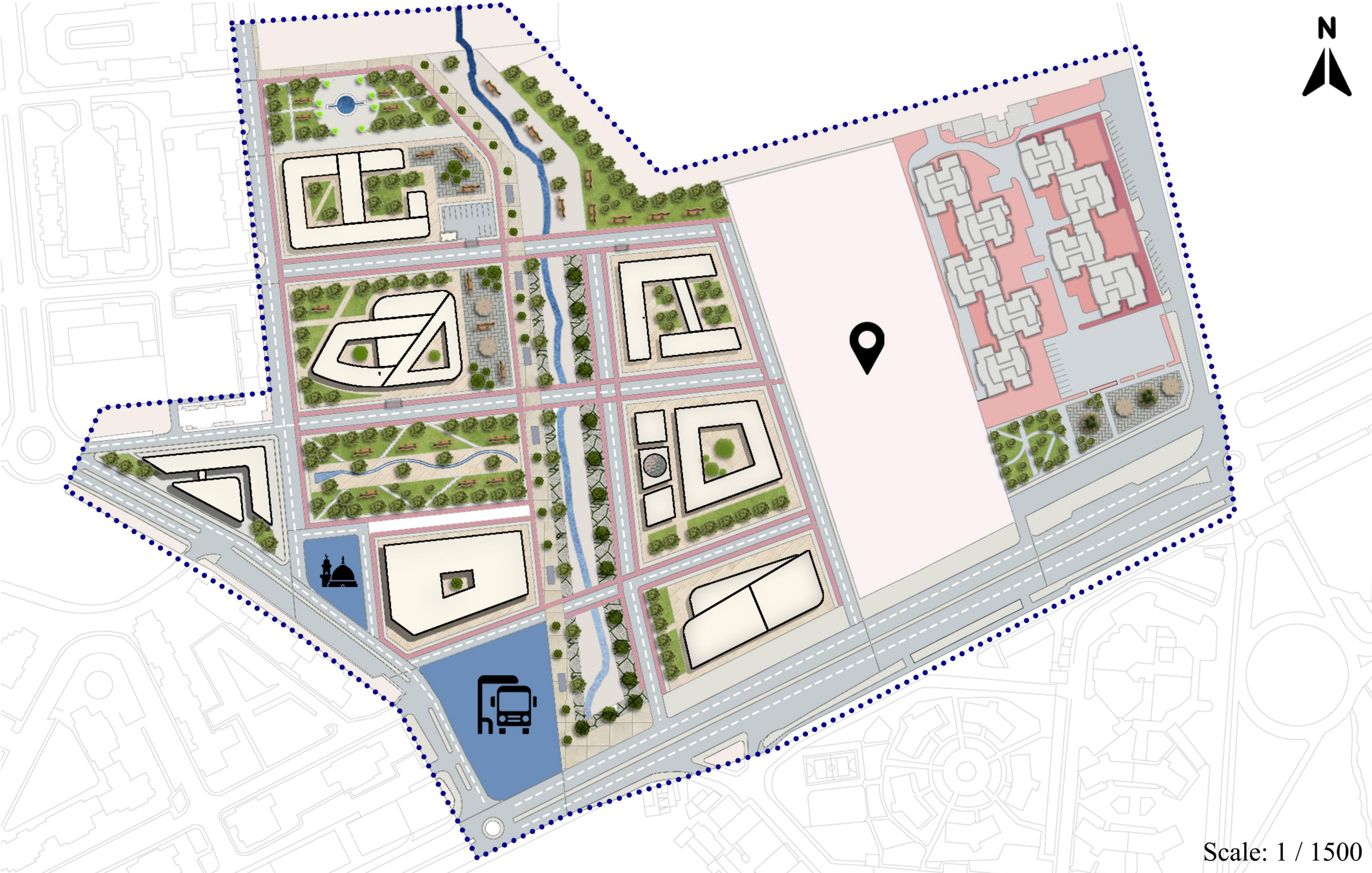

N
Scale: 1 / 1500

Figure 40 : Urban intervention master plan

Source: Author

Figure 41: urban intervention 3D shot

Source: Author

Figure 42: Urban intervention 3D shot

Source: Author.

Figure 42: Urban Intervention shot. *Source: Author*

Figure 43: Urban Intervention shot *Source: Author.*

Figure 44: Urban Intervention shot *Source: Author*

Conclusion:

the proposed startup incubator in Blida strategically aligns with both local economic aspirations and the city's historical and urban context. Blida’s unique geographical position, its climate potential, its rich cultural heritage, and its central role within the metropolitan area, make it a prime location for fostering innovation and supporting eco-friendly behaviors. By enhancing its university center and addressing the urban challenges within Ouled Yaich, this initiative aims to provide the necessary infrastructure for startups, stimulate economic growth, and transform the area into a dynamic hub of entrepreneurship and development. The proposed urban interventions will address existing gaps by introducing essential services, improving connectivity, introducing green spaces and enhancing the area's attractiveness. This comprehensive approach ensures that the project will not only rejuvenate Blida but also contribute to its long-term sustainability and socio-economic vitality.

CHAPTER IV: SIMULATION

1 Introduction:

1.1 Simulation meaning:

A simulation replicates the operation of real-world processes or systems through the use of models. These models represent the key behaviors and characteristics of the chosen process or system, while the simulation demonstrates how the model evolves under various conditions over time.

Simulations are typically computer-based, utilizing software-generated models to support decision-making for managers and engineers, as well as for training purposes. These techniques enhance understanding and experimentation, as the models are both visual and interactive.

1.2 Dynamic thermal simulation:

A dynamic thermal simulation (DTS) is a computer-based modeling technique that allows for the simulation and prediction of a building's thermal performance. This simulation takes into account various factors such as building materials, room layout, and systems for ventilation, heating, and cooling, as well as external climatic conditions.

1.3 The Significance of Dynamic Thermal Simulation in Architectural Projects:

Dynamic thermal simulation is essential for architectural projects for several reasons:

- Optimizing Design: It helps architects design buildings that are more energy-efficient by evaluating factors such as orientation, thermal mass, and solar protection. This leads to better bioclimatic design, which maximizes natural resources for heating and cooling.
- Enhancing Comfort: By analyzing how different design choices impact internal temperatures, architects can ensure that buildings maintain a comfortable environment year-round. This reduces the need for mechanical heating and cooling, leading to improved thermal comfort for occupants.
- Energy Efficiency: Dynamic thermal simulation provides detailed insights into a building's energy consumption. It identifies potential areas of energy loss and suggests improvements, resulting in buildings that use less energy and have lower operational costs.

- Environmental Impact: By minimizing the need for artificial heating and cooling, dynamic thermal simulation helps reduce the carbon footprint of buildings. This contributes to more sustainable architectural practices.
- Cost Savings: Energy-efficient designs not only lower utility bills but also reduce the need for expensive HVAC systems. This makes the construction and maintenance of buildings more economical in the long run.
- Compliance and Certification: Many building codes and sustainability certifications, such as LEED, require proof of energy efficiency. Dynamic thermal simulation provides the necessary data to meet these standards and achieve certifications.
- Predictive Analysis: It allows architects to predict the building's performance under various conditions, including extreme weather events. This foresight ensures the building remains functional and comfortable in all scenarios.
- Informed Decision Making: By simulating different design options and their impacts on energy use and comfort, architects can make informed decisions that balance aesthetics, functionality, and sustainability.
- Longevity and Durability: Understanding how a building will perform over time helps in designing structures that are more durable and require less maintenance, ensuring long-term benefits for both owners and occupants.
- Reducing Discomfort and Air Conditioning Needs: From the initial design stages, it helps identify and eliminate potential sources of discomfort, reducing the dependency on air conditioning and other energy-intensive systems.

In summary, dynamic thermal simulation is a critical tool in modern architecture, enabling the creation of buildings that are not only more comfortable and efficient but also environmentally responsible and economically viable.

1.4 Dynamic thermal simulation softwares:

There are numerous dynamic thermal simulation (DTS) software tools available on the market. The following are some examples:

Table 9: Table showing different dynamic thermal simulation softawres

EXAMPLE	DEFINITION
Energy plus	Open-source software from the U.S. Department of Energy. It is widely used for modeling commercial and residential buildings.
ClimaWin	Developed by the French company Izuba Energies and primarily used in France, ClimaWin is a software application that models various building types and heating, ventilation, and air conditioning (HVAC) systems. It also includes features for analyzing indoor air quality and natural ventilation.
PLEIADES	Developed by the CSTB (Scientific and Technical Centre of Building) group in France, this software facilitates dynamic thermal simulations to optimize the design of heating, ventilation, and air conditioning (HVAC) systems. It offers advanced features for precise and detailed simulations.
TRNSYS	Commercial dynamic thermal simulation software enables the modeling of complex energy systems, including solar thermal power plants, heat pumps, and energy storage systems.
DesignBuilder	Energy simulation software that combines functionalities for building modeling, HVAC system design, and daylight analysis.

DesignBuilder SOFTWARE	

1.5 The software used:

Design Builder: DesignBuilder is a software tool based on EnergyPlus, utilized for measuring and controlling energy, carbon emissions, lighting, and comfort. It simplifies the building simulation process, enabling quick and cost-effective comparison of alternative building designs through functional and performance-based analysis methods.

This software integrates rapid three-dimensional building modeling with dynamic energy simulations, distinguishing it as a unique software tool for creating and evaluating building designs. Specifically developed modules ensure effective use at any stage of the design process, from initial concepts to detailed designs. Its user-friendly interface requires minimal parameters to explore a wide range of design opportunities, making complex building modeling accessible even to non-expert users with innovative productivity features.

1.6 Simulation settings:

1.6.1 Climate data:

When initiating a new file in DesignBuilder, the first step is to specify the location, which ensures inclusion of climate data tailored to the intervention site's region—in this case, the city of Blida. DesignBuilder lacks a built-in weather database for Blida, so we utilized Meteonorm software to generate precise hourly weather data specific to this location.

Subsequently, this weather data was incorporated into DesignBuilder's simulation parameters in the form of EnergyPlus Weather Files (EPW). These EPW files include detailed climate information essential for accurate simulations:

-Outdoor temperature: Monthly averages and seasonal extremes.

-Relative humidity: Daily and seasonal fluctuations.

-Wind speed and direction: Impact on heat transfer.

-Solar radiation: Daily intensity and seasonal distribution.

-Ground temperature: Influence on heat loss through the ground.

By utilizing EPW files generated by Meteonorm, DesignBuilder conducts dynamic thermal simulations grounded in precise climate data tailored to our project's specific location in Blida. This approach ensures the analysis produces dependable results that are pertinent to assessing and guaranteeing thermal comfort in the project.

1.6.2 The intended use of the building:

The second simulation parameter involves defining the intended use of the buildings. Our project comprises three blocks oriented in a consistent direction. For modeling in DesignBuilder, we selected the third block, which encompasses offices for rent, coworking spaces, meeting rooms, laboratories, and workshops.

The intuitive user interface of DesignBuilder allows us to streamline modeling by importing a 2D drawing in DXF format from AutoCAD. When initiating a new block for modeling, configuration involves setting geometry conventions, defining the building's primary use category (non-residential), and specifying the project sector (Office building).

Furthermore, it is crucial to specify the building activity (Office building) since we will be simulating a coworking space within the 3rd block. This setup enables DesignBuilder to simulate thermal comfort according to predefined parameters, including ideal ambient temperatures set for each space.

2 Building Modeling:

2.1 Description of the modeled space:

The next step after establishing the simulation parameters is modeling the areas. The chosen area for this simulation is a coworking space due to its occupancy by users and its facades facing south and east. This makes simulating these spaces with various construction, glazing, and HVAC variables highly significant.

2.1.1 coworking space:

This space is oriented directly to the south and east. Its characteristics are as follows:

- Floor Area and Volume: The floor area is 50 m², and the volume is 199.6 m³.
- Occupancy: The occupancy density is 0.1 persons per square meter, with a metabolic rate corresponding to light office work (standing/walking).
- Temperature Settings:
- Heating: Set to 22°C, with a lower limit of 12°C.
- Air Conditioning: Set to 24°C, with an upper limit of 28°C.
- Equipment: The area is equipped with computers.

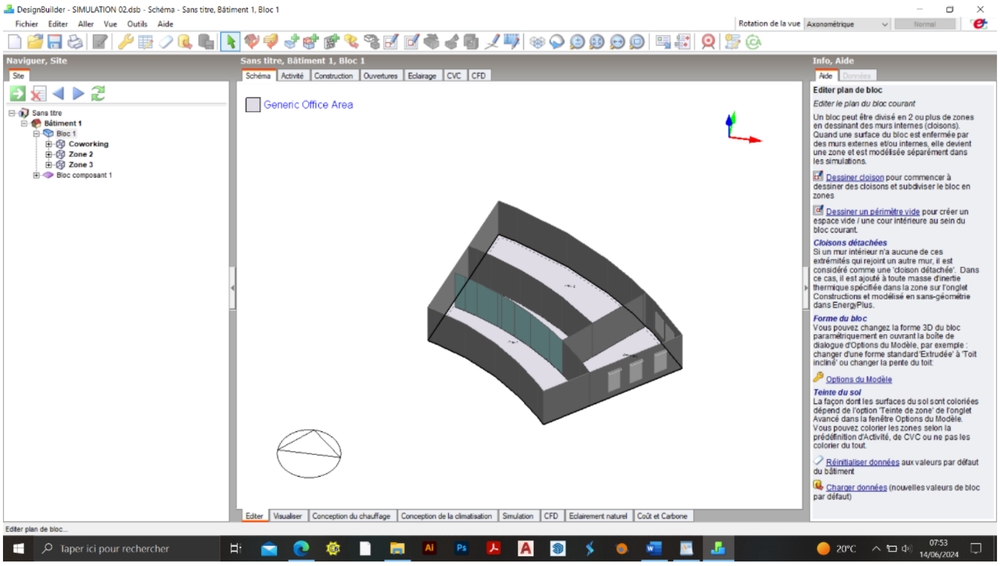


Figure45: an image showing the model making phase in design builder

Source : Author.

2.2 Construction element details:

2.2.1 Passive strategies:

2.2.1.1 First scenario:

<u>a-Material properties:</u>

In this Scenario, conventional non-insulated materials were chosen for the external walls, internal partitions, floors, and glazing. These materials are representative of typical construction standards and establish a reference point for evaluating the building's initial thermal and energy performance before considering any improvements in future scenarios.

Table 10: table showing the characteristics of the component elements used in the 1st scenario.

Component element	Composition	Width (cm)	Conductivity (W/m-k)	Specific heat (J/kg-K)	Density (Kg/m3)
External walls	Hollow brick	15	0,84	800	1700
	Air blade	5	0,3	1000	1000
	Hollow brick	10	0,84	800	1700
Internal partitions	Hollow Brick	10	0,84	800	1700
Lower floor on ground	Compression slab	10	1,7	900	2400
	Poured concrete	5	1,4	840	2300
	Polysterene	1	0,038	1400	15
Intermediate floor	Reinforced Concrete slab	20	2	1000	2200
Glazing	Simple glazing	0,6	0,96	840	2500

b-First scenario objectives :

- Establishing a baseline: This scenario acts as the initial reference point for evaluating the building's thermal and energy performance. All enhancements in subsequent scenarios will be evaluated relative to this starting configuration.
- Identifying vulnerabilities: Using non-insulated materials helps pinpoint thermal losses and areas needing improvement. This approach enables precise targeting of interventions to enhance thermal comfort effectively.

- Offering comparative data: The outcomes from this scenario will serve to quantify the impact of various improvements introduced in subsequent scenarios. Each enhancement will be assessed against this baseline to gauge its effectiveness.

2.2.1.2 Second Scenario:

In the second scenario, we implemented enhancements focused on enhancing the building's thermal comfort through the integration of insulating and sustainable materials. These upgrades specifically targeted the external walls, glazing, and floors. The goal of this scenario is to decrease thermal losses in the building compared to the first scenario.

a-Material properties:

Table 11: table showing the characteristics of the component elements used in the 2nd scenario.

Component element	Composition	Width (cm)	Conductivity (W/m-k)	Specific Heat (J/kg-K)	Density (Kg/m3)
External walls	Hollow brick	15	0,84	800	1700
	Glass fiber batt	5	0,04	840	12
	Hollow brick	10	0,84	800	1700
Internal partitions	Hollow Brick	10	0,84	800	1700
Lower floor on ground	Slab on grade, heated, fully insulated	16	1.4	840	2400
Intermediate floor	Concrete Cast cellular	20	0,25	1000	1600
Glazing	Glazing	0,6	0,024	840	1500
	Argon Gaz	0,7			
	Glazing	0,6			

b-Second Scenario Objectives:

- Enhance thermal insulation: Adding glass fiber batt to external walls and using cellular concrete in intermediate floors, and using a slab on grade fully insulated for the lower floor on ground reduces heat loss.
- Enhance thermal comfort: These materials improve indoor comfort by stabilizing temperatures, reducing the need for heating and cooling.

2.2.1.3 Third Scenario:

The changes made in this scenario concern the exterior walls, in this scenario we opted for aerated cellular.

a-material properties:

Table 12: table showing the characteristics of the component elements used in the 3rd scenario.

Component element	Composition	Width (cm)	Conductivity (W/m-k)	Specific Heat (J/kg-K)	Density (Kg/m3)
External walls	Aerated cellular	30	0,1	840	800
Internal partitions	Hollow Brick	10	0,84	800	1700
Intermediate floor	Concrete Cast cellular	20	0,25	1000	1600
Lower floor on ground	Slab on grade, heated, fully insulated	16	1.4	840	2400
Glazing	Glazing	0,6	0,024	840	1500
	Argon Gaz	0,7			
	Glazing	0,6			

b-Third scenario objectives:

- Simplify construction: Aerated cellular walls integrate thermal insulation, streamlining construction and reducing build times.
- Improve thermal insulation: These walls naturally insulate well, minimizing the need for extra insulation and enhancing the building's energy efficiency.

2.2.1.4 Fourth scenario:

The changes in this scenario were established at the levels of the external walls, internal partitions, intermediate floor and the glazing.

a-material properties:

Table 13: table showing the characteristics of the component elements used in the 4th scenario.

Component element	Composition	Width (cm)	Conductivity (W/m-k)	Specific Heat (J/kg-K)	Density (Kg/m3)
External walls	Brick air, with concrete block and full mineral insulation, and l/w plaster	30	0.3	840	1600
Internal partitions	Aereated briques	10			
Intermediate floor	Reinforced Concrete slab	20	2	1000	2200
Lower floor on ground	Slab on grade, heated, fully insulated	16	1.4	840	2400
Glazing	Glazing	0,3	0.03	340	2500
	Argon Gaz	0,13			

	Glazing	0,3			
	Argon gaz	0,13			
	Glazing	0,3			

2.2.1.5 Fifth scenario:

The changes in this scenario were established at the levels of the external walls, internal partitions.

a-<u>material properties:</u>

Table 14: table showing the characteristics of the component elements used in the 5th scenario.

Component element	Composition	Width (cm)	Conductivity (W/m-k)	Specific Heat (J/kg-K)	Density (Kg/m3)
External walls	Masonry heavy weight dry	30	1.5	240	2000
Internal partitions	Masonry Heavy weight dry	10	1.5	240	200
Intermediate floor	Reinforced Concrete slab	20	2	1000	2200
Lower floor on ground	Slab on grade, heated, fully insulated	16	1.4	840	2400
Glazing	Glazing	0,3	0.03	340	2500
	Argon Gaz	0,13			
	Glazing	0,3			

	Argon gaz	0,13			
	Glazing	0,3			

2.2.2 passive and active strategies:

2.2.2.1 sixth scenario:

In this scenario, we opted for a combination of passive and active strategies, we combined the passive materials of the fifth scenario with active strategies powered by PV panels.

The active strategies used in this scenario are the following:

-Air conditioning, Heating, mechanical ventilation, dehumidification and humidification.

a-Calculation methodology:

To simulate the thermal comfort by combining active and passive strategies in the coworking space, we need to calculate the number of PV panels required to produce sufficient power for all space devices. (devices ensuring active strategies, and others…). In order to do that we have to:

- **First**: determine the power of each device.

To determine the power of each device, we adhered to national norms, which specify the power based on the space's surface area/volume, and usage. The following are the norms:

-Power for air conditioning: 5kw/h according to standard recommendations.

(Standard recommendations: 100w per m² for well insulated spaces), according to: hellowattt.fr)

$P = 100w \times 1m^2$, $P = 100w \times 50\ m^2$ P= 5 kw

-Power for heating: 5 kw/h according to standard recommendations

(Standard recommendations: 100w per m² for well insulated spaces according to: hellowatt.fr)

$P = 100w \times 1m^2$, $P = 100w \times 50\ m^2$ P= 5 kw

-Power for lighting (LED for lighting type):

For offices, it is recommended to have an illumination level of around 300 to 500 lux.

Power (in watts) = Recommended Lux × Area (in m^2) ÷ Luminous Efficacy (in lumens per watt according to: lenalighting.fr)

| P= 400lux×50m² ÷100lm/W |

P= 200 w

-Power for other devices: (Laptops)

Typically, a laptop consumes between 30 and 100 watts when charging, we estimate an average of 50 watts. The accommodation capacity of a coworking space of 50m² is of 12 people, which means 12 laptops.

Power (in watts) = Power required to charge one laptop x number of laptops

| P = 50 w x 12 |

P= 600 w

- **Second:** Estimate operating hours.

- For air conditioning: air conditioning is usually used during 3 months (summer months), for an average of 3 hours per day, for a well-insulated space.
- For heating: heating is usually used during 3 months (winter months), for an average of 3 hours per day for a well-insulated space.
- For lighting: Lighting is usually used during 6 months of cold season, for an average of 4 hours per day for a well-lit space.
- For other devices use: laptops using a power of 50 w per hour, in average take 1 hour to get fully charged.

  It is estimated that the coworking space is used on average 2 hours per day, throughout the whole year.

- **Third:** Calculate annual energy consumption.

| Annual energy consumption: power x hours of use x days of use |

- For air conditioning:

| Annual energy consumption = 5kw x 3h x 91,5 |

AEC= 1372,5 kw/y

- For heating:

Annual energy consumption = 5kw x 3h x 91,5

AEC= 1372,5 kw/y

- For lighting:

Annual energy consumption = 0,2 Kw x 4hx 183

AEC= 146,4 Kw/y

- Other devices:

Annual energy consumption = 0,6 Kw x 2h x 365

  AEC= 438 Kw/y

- **Fourth:** Calculating the required power by dividing the annual energy consumption by 0.85. (0.85 in an energy conversion factor).

The annual energy consumption for our coworking space is the sum of every device's annual energy consumption.

-Coworking space:

AEC = 1372,5 + 1372,5 + 146,4 + 438

AEC = 3329,4 KW/ year

Required Power = AEC / 0.85 (conversion factor)

Required Power = 3329,4 / 0.85 Required Power = 3916,9 peak watt.

- **Fifth**: Calculating the number of PV panels by dividing the required power by 260.

(260 is the nominal power of a PV panel)

Number of PV panels = Required Power / 260

Number of PV panels = 3916,9 / 260

Number of PV panels: 15

3 Simulation Results:

In all simulations' results carried out, we observe 3 main parameters in each scenario carried out:

the operative temperature: It is a concept in the field of thermal comfort that describes a uniform temperature perceived by an occupant in a given environment, incorporating both air temperature and mean radiant temperature to offer a more comprehensive measure of thermal comfort.

The relative humidity: It is a measure of the amount of water vapor present in the air compared to the maximum amount of water vapor the air can hold at a given temperature. It is expressed as a percentage.

the PMV index: The PMV (Predicted Mean Vote) index is a key measure in thermal comfort, predicting the average comfort level of a large group of people on a 7-point scale from cold (-3) to hot (+3). Developed by P.O. Fanger, this index helps in evaluating and designing indoor environments to ensure occupant comfort.

The 7-point scale used for PMV is as follows:

+3: Hot

+2: Warm

+1: Slightly warm

0: Neutral

-1: Slightly cool

-2: Cool

-3: Cold

3.1 Standards and recommendations:

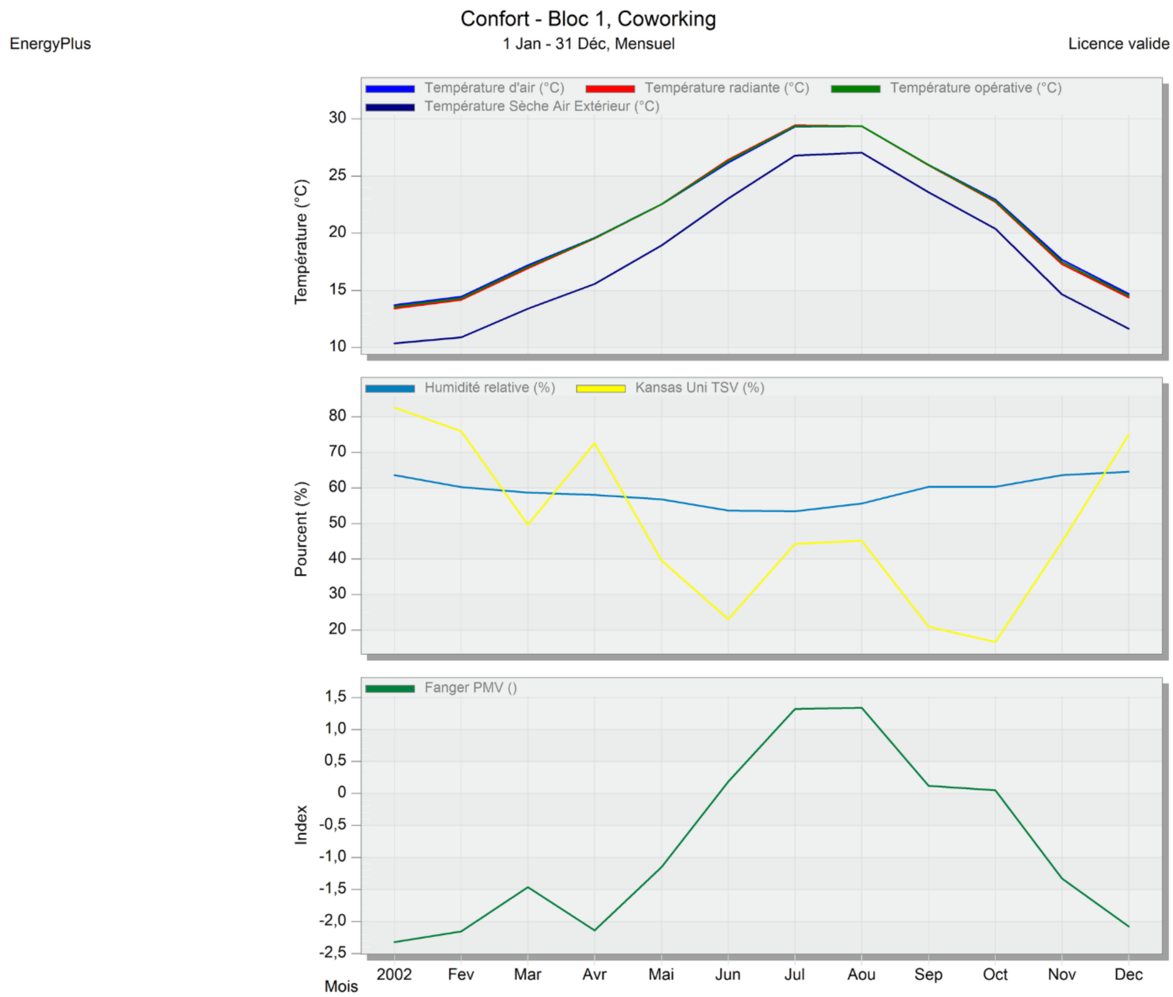
- Temperature: according to the Sozoklay diagram the comfort temperature falls within a range that extends from [20 °C _ 24 °C].

-Relative humidity: according to the Sozoklay diagram the comfort relative humidity percentage falls within a range that extends from [30 % _ 60 %].

-PMV index: according to the 7-point scale from cold (-3) to hot (+3), the value of 0 marks the thermal comfort.

3.2 Evaluation and analysis:

3.2.1 First scenario:



Mois	2002	Fev	Mar	Avr	Mai	Jun	Jul	Aou	Sep	Oct	Nov	Dec
Température d'air (°C)	13,73	14,44	17,19	19,61	22,55	26,19	29,32	29,37	25,98	22,95	17,68	14,70
Température radiante (°C)	13,42	14,17	16,94	19,55	22,53	26,43	29,43	29,37	25,96	22,73	17,29	14,38
Température opérative (°C)	13,58	14,30	17,07	19,58	22,54	26,31	29,38	29,37	25,97	22,84	17,49	14,54
Température Sèche Air Extérieur (°C)	10,38	10,90	13,40	15,56	18,94	23,03	26,80	27,05	23,59	20,40	14,66	11,65
Humidité relative (%)	63,62	60,25	58,70	58,00	56,74	53,62	53,39	55,61	60,32	60,26	63,57	64,54
Kansas Uni TSV (%)	82,60	76,00	49,63	72,63	39,53	23,06	44,22	45,12	20,95	16,59	44,85	75,03
Fanger PMV ()	-2,32	-2,15	-1,46	-2,14	-1,15	0,19	1,32	1,34	0,12	0,05	-1,33	-2,08

Figure 46: First scenario results *Source: Design Builder.*

Table 15: table of temperature, humidity and PMV index ranges, of the first scenario..

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	29.38	22,54	19.58	13.58
Relative humidity %	53.39	56.74	58	63.62
PMV index	1.32	-1.15	-2.14	-2.32

Operative temperature:

We found that the maximum operating temperature during the hot season exceeds the comfort range of [20 C° _ 24°C]. In the cold season, all operating temperatures fall outside this comfort range, indicating uncomfortable indoor conditions. And that is due to the thermal properties of the materials used.

PMV index:

The PMV index for the hot season ranges from (-1.15) to (1.32), which is far from the ideal value of (0) that indicates total comfort. In the cold season, the PMV index ranges from (-2.32) to (-2.14), approaching (-3), which indicates that it is too cold and thus uncomfortable for indoor conditions**.**

3.2.2 Second scenario:

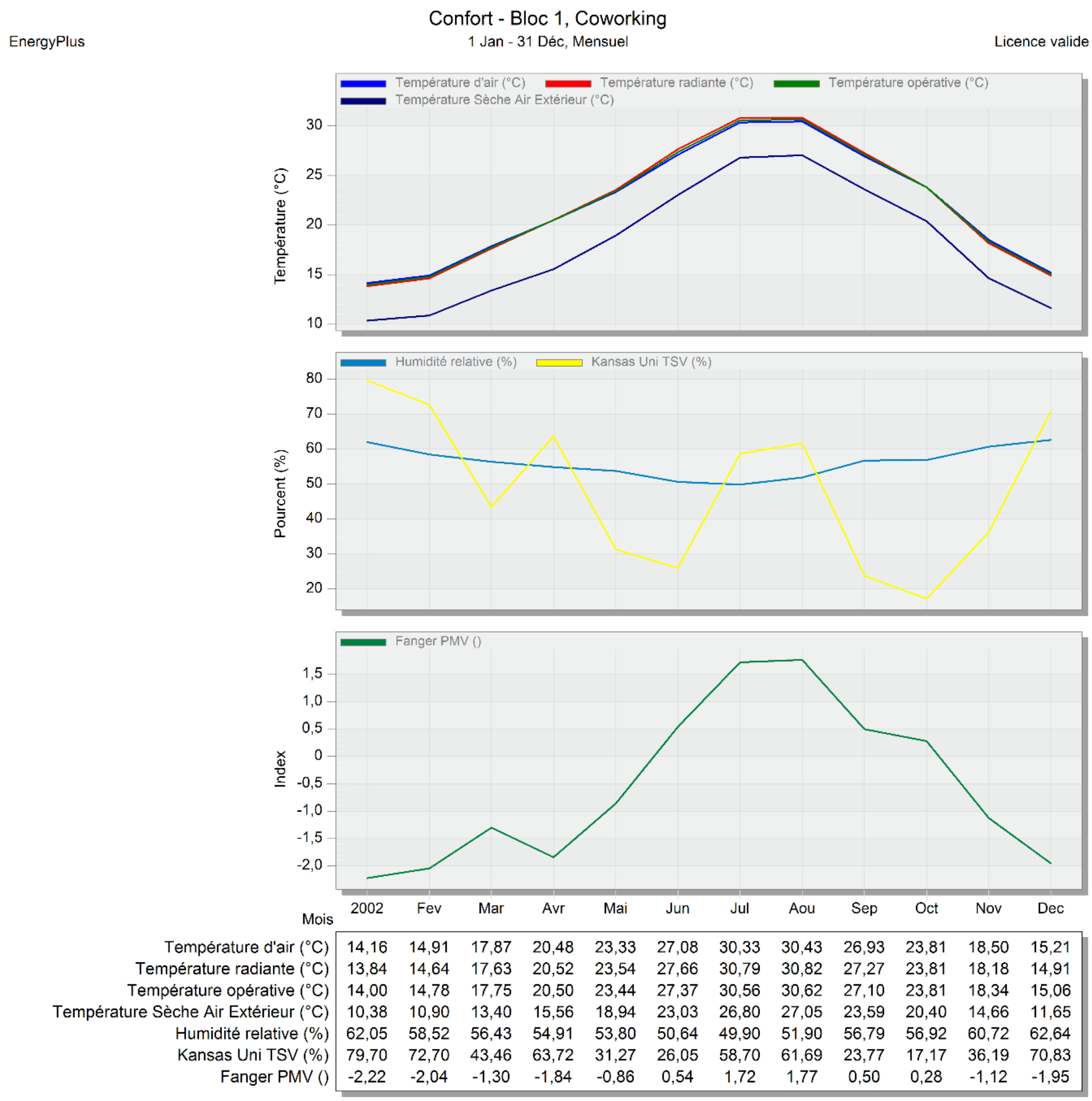


Figure 47: Second scenario results *Source: Design Builder*

Table 16 : table of temperature, humidity and PMV index ranges, of the second scenario.

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	30.62	23.44	20.50	14.00
Relative humidity %	51.90	53.8	54.91	62.05
PMV index	1.77	-0.86	-1.84	-2.22

Operative temperature:

We found that the maximum operating temperature in the hot season reached 30.62 °C, which is too high compared to the outside temperature and is too far from the comfort temperature range [20 °C - 24 °C]. The cold season temperature range in this scenario started to get closer to the comfort temperature range, but yet it's still way too far from reaching all of it.

Explanation:

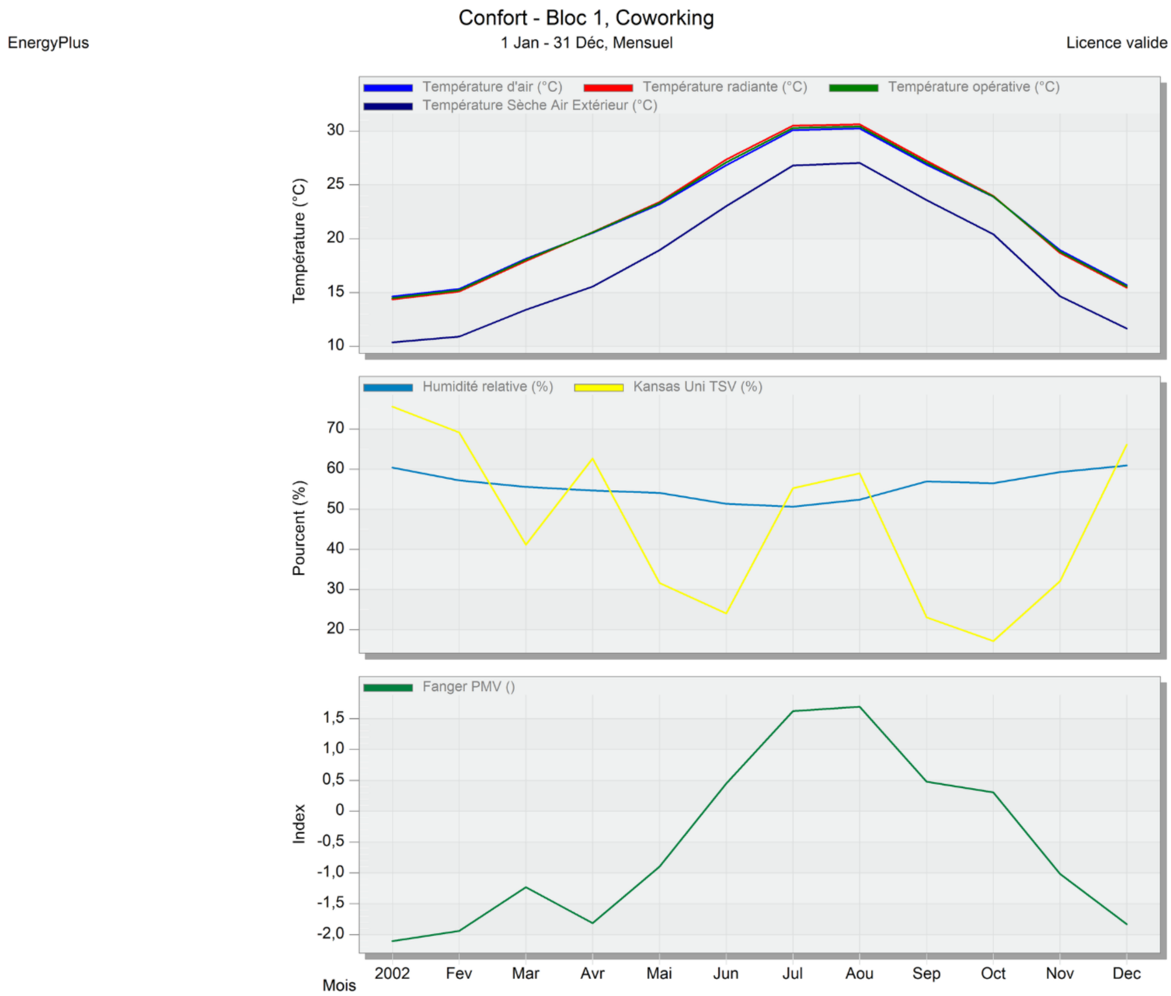
The use of: the glass fiber batt, a heated ad fully insulated floor on ground, concrete cast cellular for intermediate floor and double glazing of 6mm/7mm Arg.

PMV index:

The PMV index in this scenario started to get a little bit closer to the value of 0, compared to the first scenario but it is still so far from indicating comfort.

For the hot season it ranges from (-0.86) to (1.77), which is still far from the ideal value of (0) that indicates total comfort. In the winter season, the PMV index ranges from (-2.22) to (-1.84), approaching (-3), which indicates that it is too cold and uncomfortable for indoor conditions.

3.2.3 Third scenario:



	2002	Fev	Mar	Avr	Mai	Jun	Jul	Aou	Sep	Oct	Nov	Dec
Température d'air (°C)	14,62	15,32	18,13	20,54	23,20	26,83	30,08	30,24	26,86	23,89	18,93	15,69
Température radiante (°C)	14,36	15,10	17,93	20,60	23,42	27,36	30,50	30,61	27,22	23,96	18,66	15,44
Température opérative (°C)	14,49	15,21	18,03	20,57	23,31	27,10	30,29	30,43	27,04	23,93	18,79	15,56
Température Sèche Air Extérieur (°C)	10,38	10,90	13,40	15,56	18,94	23,03	26,80	27,05	23,59	20,40	14,66	11,65
Humidité relative (%)	60,44	57,19	55,58	54,69	54,09	51,39	50,64	52,43	56,98	56,52	59,31	60,94
Kansas Uni TSV (%)	75,65	69,21	41,15	62,68	31,61	24,04	55,27	58,95	23,07	17,09	32,08	66,12
Fanger PMV ()	-2,11	-1,94	-1,23	-1,82	-0,90	0,45	1,62	1,70	0,48	0,31	-1,02	-1,83

Figure 48: Third scenario results Source: Design Builder

Table 17: table of temperature, humidity and PMV index ranges, of the third scenario.

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	30.43	23.31	20.57	14.49
Relative humidity %	52.43	54.09	54.69	60.44
PMV index	1.7	-0.9	-1.82	-2.11

Operative Temperature:

The range of operative temperatures for the hot season [23.31 °C _ 30.43 °C] is above the range of the comfort range [20 °C _ 24 °C]. We note that the maximum Operating temperature for the hot season is way too higher than the outdoor temperature, which indicates uncomfortable indoor conditions, and on the other side the cold season operating temperature is approaching from the comfort range.

Explanation:

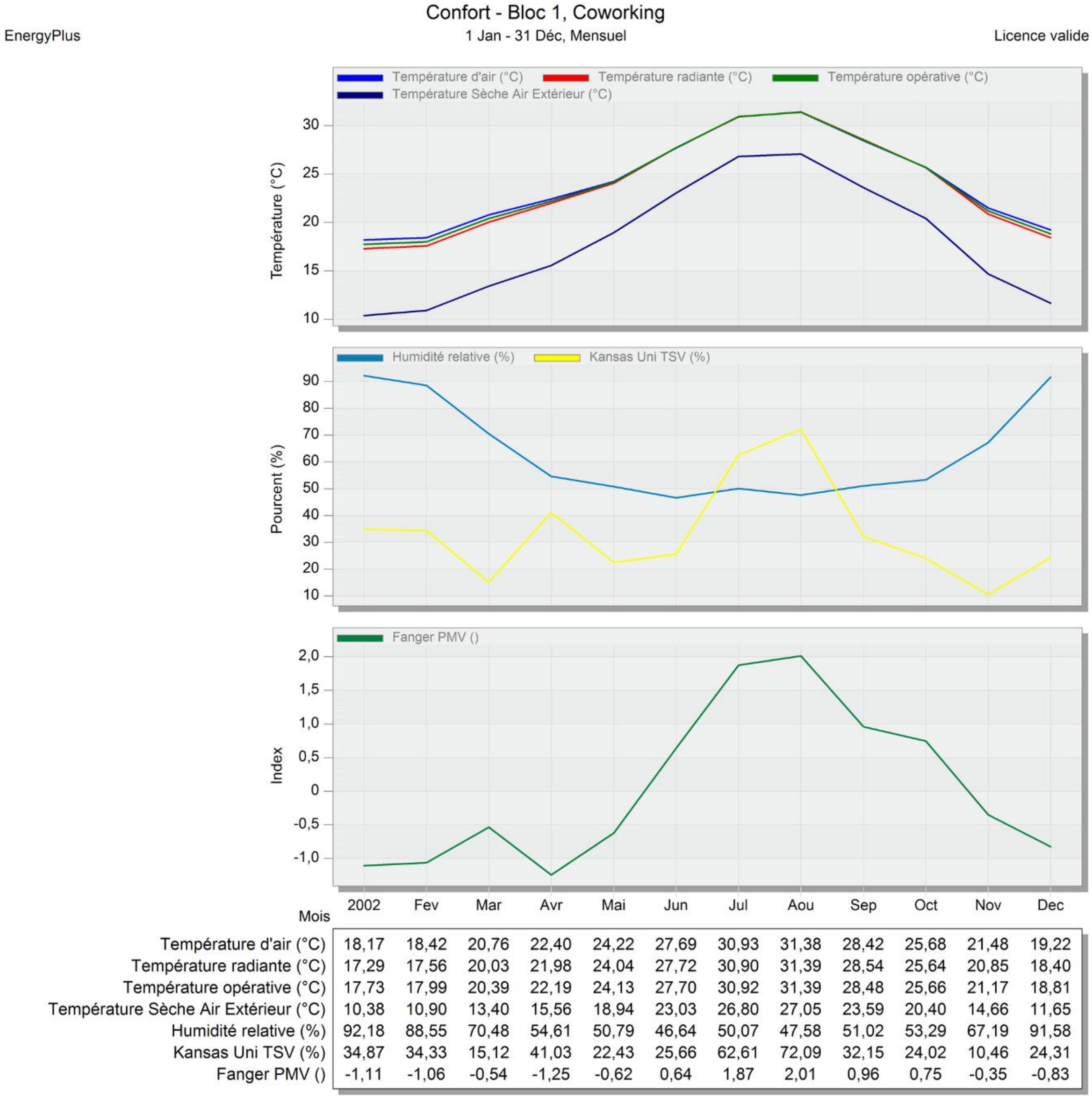
In this scenario, we used aerated concrete cellular for external walls, added sun shadings while keeping the same materials in the previous scenario.

PMV index:

The PMV index in this scenario represent very cold indoor conditions in the cold season, it ranges from (-2.11) to (-1.82), which is closer to (-3) than it is to (0).

For the hot season it ranges from (-0.9) to (1.7), which is still far from the ideal value of (0) that indicates total comfort.

3.2.4 Fourth scenario:



Mois	2002	Fev	Mar	Avr	Mai	Jun	Jul	Aou	Sep	Oct	Nov	Dec
Température d'air (°C)	18,17	18,42	20,76	22,40	24,22	27,69	30,93	31,38	28,42	25,68	21,48	19,22
Température radiante (°C)	17,29	17,56	20,03	21,98	24,04	27,72	30,90	31,39	28,54	25,64	20,85	18,40
Température opérative (°C)	17,73	17,99	20,39	22,19	24,13	27,70	30,92	31,39	28,48	25,66	21,17	18,81
Température Sèche Air Extérieur (°C)	10,38	10,90	13,40	15,56	18,94	23,03	26,80	27,05	23,59	20,40	14,66	11,65
Humidité relative (%)	92,18	88,55	70,48	54,61	50,79	46,64	50,07	47,58	51,02	53,29	67,19	91,58
Kansas Uni TSV (%)	34,87	34,33	15,12	41,03	22,43	25,66	62,61	72,09	32,15	24,02	10,46	24,31
Fanger PMV ()	-1,11	-1,06	-0,54	-1,25	-0,62	0,64	1,87	2,01	0,96	0,75	-0,35	-0,83

Figure 49: Fourth scenario results Source: Design Builder

Table 18 : table of temperature, humidity and PMV index ranges, of the fourth scenario.

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	31.39	24.13	22.19	17.73
Relative humidity %	47.58	50.79	54.61	92.18
PMV index	2.01	-0.62	-1.25	-1.11

Operative Temperature:

The range of operative temperatures for the cold season [17.73 °C _22.19 °C] is starting to get closer to the comfort range [20 °C _ 24 °C]. Meanwhile the range of operative temperatures of the hot season [24.13 °C _ 31.39 °C] is above the comfort range, which indicates uncomfortable indoor conditions.

Explanation:

The materials used in this scenario are the following:

For external walls: Brick air with concrete block and full mineral insulation and l/w plaster

For internal partitions: Aerated bri

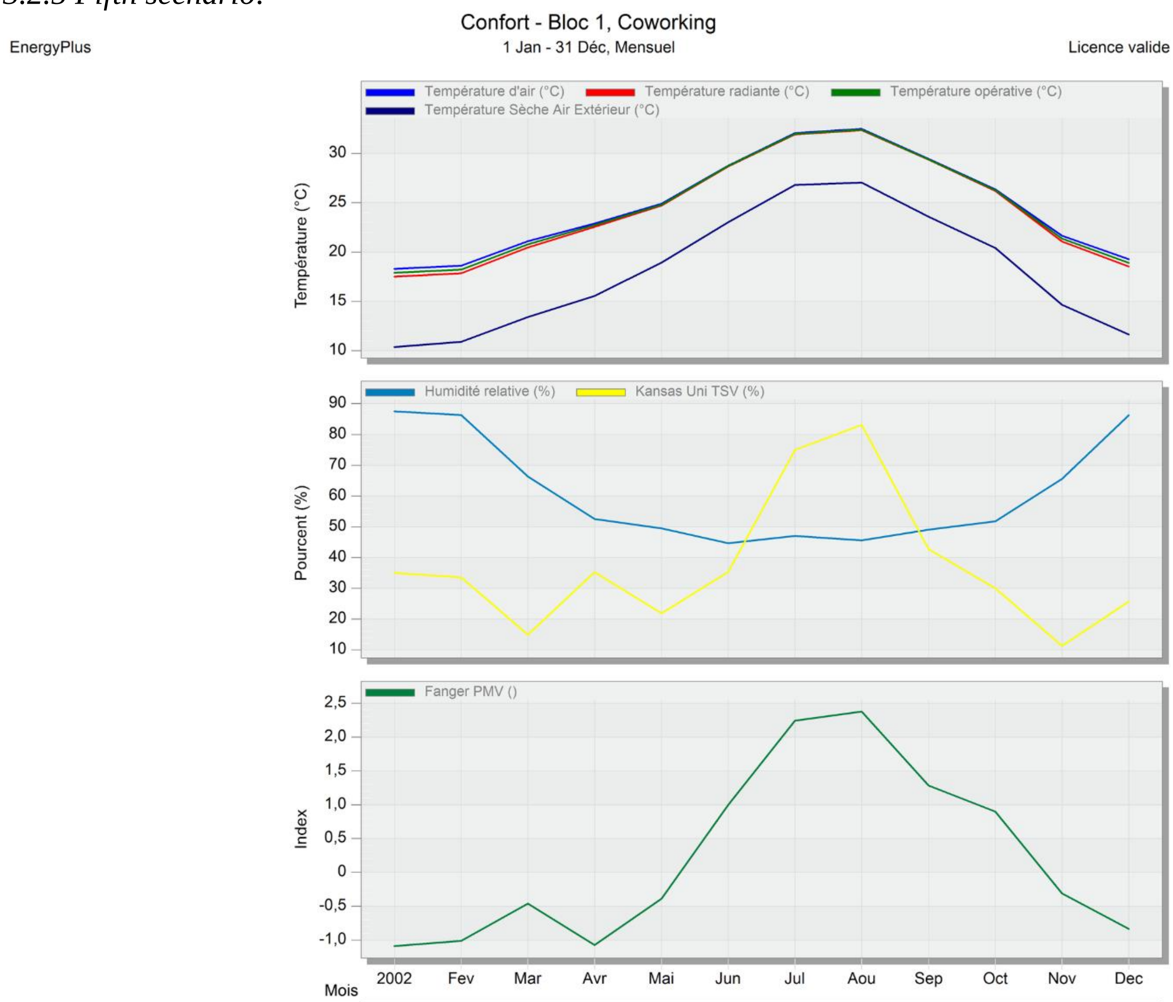
For glazing: Triple glazing 3mm/13 mm Arg

PMV index:

The PMV index range of the cold season in this scenario (-1.25) (-1.11) started to get closer to the value of (0) compared to the third scenario, but the indoor conditions still remain uncomfortable.

For the hot season it ranges from (-0.62) to (2.01), which is still far from the ideal value of (0) that indicates total comfort

3.2.5 Fifth scenario:



Mois	2002	Fev	Mar	Avr	Mai	Jun	Jul	Aou	Sep	Oct	Nov	Dec
Température d'air (°C)	18,31	18,61	21,10	22,90	24,91	28,77	32,06	32,48	29,44	26,35	21,66	19,28
Température radiante (°C)	17,51	17,84	20,46	22,55	24,71	28,67	31,92	32,35	29,36	26,20	21,07	18,53
Température opérative (°C)	17,91	18,23	20,78	22,73	24,81	28,72	31,99	32,41	29,40	26,27	21,37	18,90
Température Sèche Air Extérieur (°C)	10,38	10,90	13,40	15,56	18,94	23,03	26,80	27,05	23,59	20,40	14,66	11,65
Humidité relative (%)	87,54	86,33	66,33	52,48	49,44	44,62	46,99	45,54	49,06	51,78	65,56	86,23
Kansas Uni TSV (%)	34,94	33,52	14,90	35,22	21,88	35,29	75,00	83,11	42,72	29,95	11,23	25,69
Fanger PMV ()	-1,09	-1,01	-0,46	-1,07	-0,39	1,00	2,24	2,38	1,28	0,90	-0,31	-0,84

Figure 50: Fifth scenario results Source: Design Builder

Table 19 : table of temperature, humidity and PMV index ranges, of the fifth scenario.

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	32.41	24.81	22.73	17.91
Relative humidity %	48.54	49.44	52.48	87.54
PMV index	2.38	-0.39	-1.09	-1.07

Operative Temperature:

The range of operative temperatures for the cold season [17.91 °C _ 22.73 °C] is starting to get closer to the comfort range, compared to the previous scenario [20 °C _ 24 °C]. Meanwhile the range of operative temperatures of the hot season [24.81 °C _ 32.41 °C] is getting more above the comfort range compared to the previous scenario, which indicates uncomfortable indoor conditions.

Explanation:

In this scenario the following materials have been used:

External walls: Masonry heavy weight dry

Internal Partitions: Masonry heavy weight dry

PMV index:

The PMV index range in this scenario (-1.09) (-1.07) keeps approaching to the value of (0) compared to the third scenario, but the indoor conditions still remain uncomfortable. Meanwhile in the hot season the range (-2.38) (-0.39) is getting further from the value of (0)

3.3 Passive strategies Synthesis:

The passive strategies used in the last scenario made sure to improve indoor thermal comfort in the cold season, these strategies contributed in improving operative temperatures and pushing them closer to the comfort range.

Cold season comfort range:

First scenario: [13.58 °C _ 19.58 °C]

Fifth scenario: [17.91 °C _ 22.73 °C]

Comfort temperature range:

[20 °C _ 24 °C]

3.4 Active and passive strategies combination:

3.4.1 sixth scenario:

In this last scenario the passive strategies used in the fifth scenario were combined with the active strategies powered by 15 PV panels.

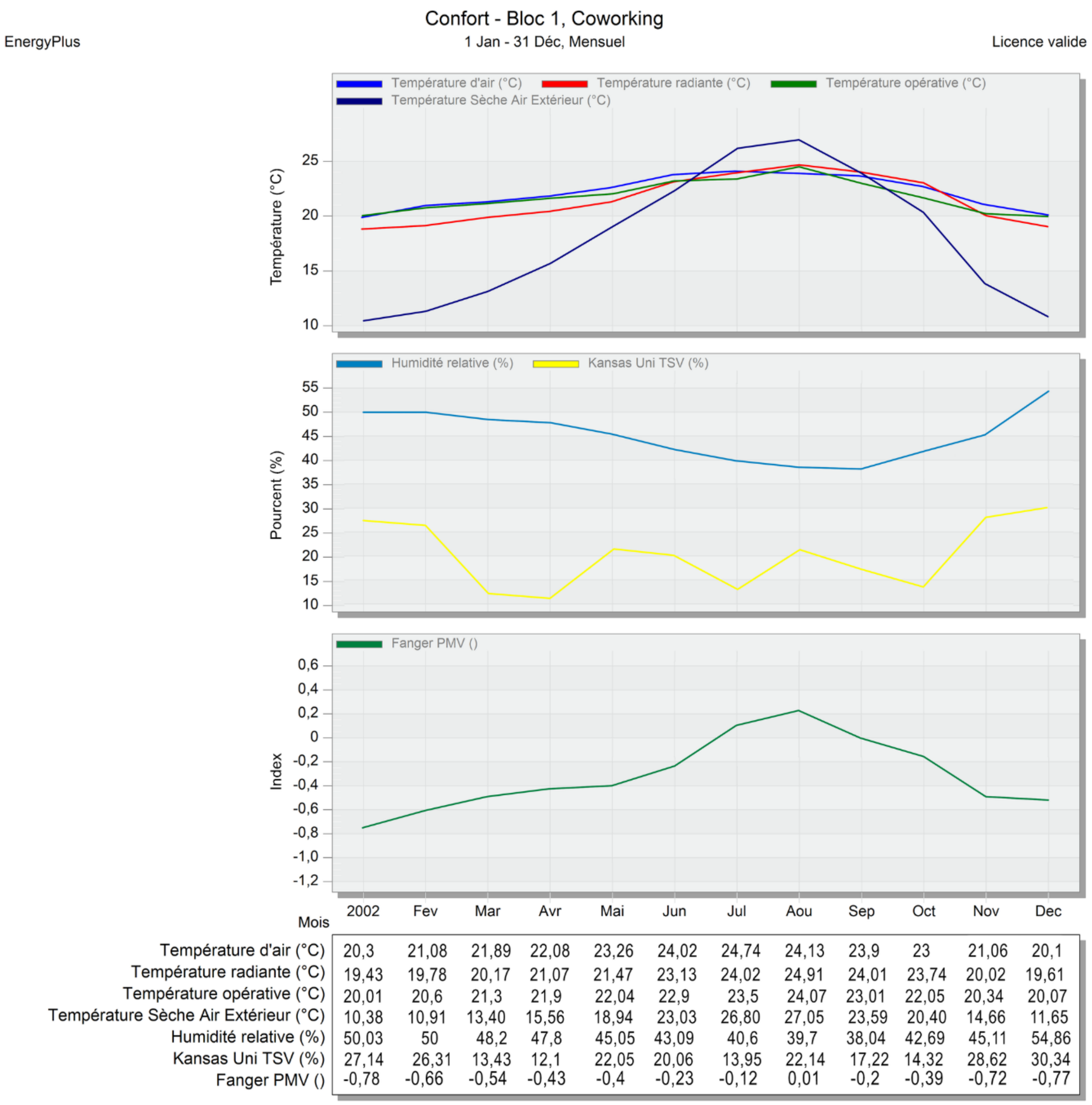


Figure51: Sixth scenario results, Source: Design Builder

Table 20: table of temperature, humidity and PMV index ranges, of the sixth scenario.

	Hot season		Cold season	
	T Max	T Min	T Max	T Min
Operative temperature °C	24.07	22.04	21.9	20.01
Relative humidity %	39.7	45.05	47.8	50.03
PMV index	0.01	-0.4	-0.43	-0.78

Operative Temperature:

The range of operative temperatures for the cold season [20.01 °C _ 21.9 °C] falls within the comfort temperature range.

The range of the operative temperature for the hot season [22.04 °C _ 24.07 °C] falls within the comfort temperature range.

PMV index:

The range of PMV index for the cold season (-0,78) (-0.43) is close to the value of (0).

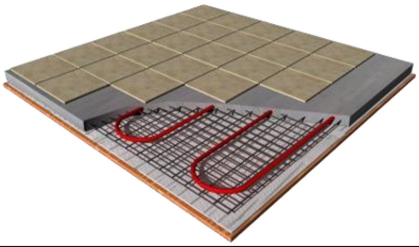
The range of PMV index for the hot season (-0.4) (0.01) is close to the value of (0).

This significant improvement is possible thanks to the combination of passive and active strategies powered by PV panels.

Synthesis:

-Passive strategies used:

Table 21: Table showing the materials used in the sixth scenario

External walls	Masonry heavy weight dry (duty red clay bricks)	
Internal partitions	Masonry Heavy weight dry (duty red clay bricks)	
Intermediate floor	Reinforced Concrete slab	
Lower floor on ground	Slab on grade, heated, fully insulated	
Glazing	3mm 13 mm Arg	

-Active strategies used: Generating power by 15 PV panels.

4 Conclusion:

This chapter delves into the role of dynamic thermal simulation in the design of an incubator center. Initially, it underscores the crucial role of dynamic thermal simulation in projects focused on renewable energy integration. This method allows for a comprehensive assessment and enhancement of a building's thermal and energy efficiency, ensuring superior occupant comfort and reduced environmental impact. In addition to that, the selection of Design Builder Version 6 software was driven by its superior precision and adaptability, which aligned perfectly with our project requirements. To guarantee the validity and accuracy of the simulation outcomes, we meticulously defined parameters such as local climate conditions and the specific functions of the buildings.

The modeling of a primary area facilitated a comprehensive examination of various scenarios. Each scenario was meticulously crafted to evaluate different combinations of materials and systems, aiming to enhance thermal comfort conditions.

The use of passive and active scenarios had let us to reach thermal comfort in the coworking space throughout the whole year.

Through this research we have come to confirm the following hypothesis:

- Solar and wind are Blida's city RE potentials, since the city is situated in north Algeria, it is well exposed to both sun and wind.
- The use of passive and active strategies that take advantage of solar potential, makes it possible to improve thermal comfort.

Finally, we hope that the urban intervention, and the startup incubator project will contribute to revalorize the university campus, support future architectural projects to take advantage of Blida's city RE potential, and integrate them in buildings in order to ensure comfort without the need to hurt the environment.

General Conclusion:

This master's thesis integrates three contemporary themes: sustainability, innovation, and economic growth. Each concept is woven into the fabric of the entire project, which is based in the city of Blida, specifically in Ouled Yaich commune, with a focus on the university campus area.
The project is structured into three main sections, each expanding across different scales: urban intervention, startup incubator design, and thermal comfort simulation. The initial sections focus on a theoretical framework that addresses global themes, such as renewable and non-renewable energies, the impact of greenhouse gases, and how various countries are managing these challenges. This leads to the development of general and specific research questions, particularly related to Algeria's sustainable development goals and strategies for ensuring thermal comfort in buildings using renewable energy solutions.
The "state-of-the-art" chapter plays a crucial role by compiling key information on sustainable development, renewable energy, and the contribution of startup incubators to economic growth. This chapter concludes with an example analysis that analyzes the spatial distribution, hierarchy, and the various functions that a startup incubator can encompass.
In the third chapter, the thesis offers an in-depth look at Blida, examining its strategic location within the Algiers metropolitan area, its architectural heritage, and its climatic characteristics. The AFOM analysis (Strengths, Weaknesses, Opportunities, and Threats) of the intervention area in Ouled Yaich highlights weaknesses such as the area's seasonal vitality and lack of space-energizing services, while also identifying strengths like proximity to the university and good accessibility via multiple road networks.
Based on the findings from the AFOM analysis, the urban intervention was designed to address the identified weaknesses, threats, and risks, with the ultimate goal of creating a high-quality, functional space for its occupants, by injecting leisure and educational services like: cultural center, research laboratory, startup incubator…
The motivation behind selecting a startup incubator as my graduation project stems from the increasing desire among many individuals, particularly young people and students, to innovate and create their own businesses. While they are passionate about launching services that can benefit others, they often face significant challenges, such as lack of financial backing or educational resources. This is where startup incubators play a crucial role. These incubators provide essential support to startups by offering office spaces, coworking environments, mentorship, and facilitating access to investors and sponsors. Additionally, they offer educational guidance and monitoring to help individuals with innovative ideas turn them into successful businesses.
In the final phase of the project, we conducted a simulation of thermal comfort within a coworking space oriented towards the east and south. The simulation was divided into two parts: first, applying passive strategies to enhance thermal comfort, followed by the integration of active strategies, such as solar panels. Ultimately, this approach demonstrated that thermal comfort could be effectively achieved by utilizing a combination of passive techniques and renewable energy sources.

In conclusion, I hope that increased awareness of climate change will encourage further action. It has become essential to educate architecture students on eco-friendly design practices and integrate concepts of bioclimatic and green architecture into workshop curricula. This would ensure that the next generation of architects is equipped with the knowledge and skills to design sustainably and contribute to a more environmentally conscious future.

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Abbreviations list

GHG: Green House Gases

Buildings-GSR: The "Global Status Report for Buildings and Construction" (GSR) is an annual report that assesses the progress of the buildings and construction sector in reducing energy consumption and greenhouse gas emissions

CDER : Centre de Développement des Energies Renouvelables, est un centre de recherche, issu de la restructuration du Haut-Commissariat à la Recherche, qui été créé le 22 mars 1998.

CNERIB : Centre National d'Etudes et de Recherches Intégrées du Bâtiment.

DC: direct electric current.

AC: alternative electric current.

TEP: Tonne équivalent pétrole: amount of energy contained in a ton of crude oil.

APRUE : Agence nationale pour la promotion et la rationalisation de l'utilisation de l'Energie.

PDAU : le plan directeur d'aménagement et d'urbanisme

POS : le plan d'occupation des sols

AADL : Agence d'amélioration et du développement du logement.

LSP : le logement social participatif

LPP : le logement public promotionnel

LPA : le logement promotionnel aidé