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GreenBuilding

Minimising Energy Consumption for Green Buildings repecting present uses and public needs

Output 5.2: Report on new/revised procedures for the energy building refurbishment MPC

Prepared by the Management Company of BorjCedria Techno Park

With the contribution of the Jordanian University of Science and Technology and the Greater Irbid Municipality

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List of abbreviations

ANME: National Agency for Energy Management

STEG: Tunisian Company of Electricity and Gas

EBR: Energy Building Refurbishment

EP: Energy performance

EPL: Energy performance levels

EPS: Extruded Polystyrene boards

ES:Emission Sectors

EX: External Surface

JEEBC: Jordan Energy Efficient Building Code

JGBC:Jordan Green Building Council

JGBG: Jordan Green building guide

JNBC:Jordan National Building council

OEE: Optimizing Energy Efficiency

PUR: Polyurethane

RSS: Royal Scientific Society

TCJ: Thermal Comfort

UCW: Uninsulated Cavity Walls

USW: Uninsulated Solid Walls

1 Introduction

During the last decades, the building energy refurbishment procedures have been well improved in terms of inventing new procedures or revised ones in the European Union (EU) and worldwide, specifically with the development of technological aspects relating to ensure the energy efficiency of a building.

In this context, and in a direct connection to the output 5.1, the output 5.2 aims to develop two reports on the new/revised procedures for the energy building refurbishment, the first is about the EU procedures while the second is around the MPC procedures, with focus on the technological use in strengthening the energy efficiency of a building. Centred on this output description and target value, a total number of two new or revised procedures are expected to be derived.

The sole Activity 5.2.1 under this output is to identify and evaluate new and revised procedures for the building energy refurbishment, and all the PPs are called to assess their best practices in order to compare them and elaborate the report ensuring a high level of knowledge transfer.

The report covers the best practices in energy building refurbishment in Tunisia, Jordan, Algeria and Morocco, with focusing on the technologica procedures and methods in addition to some success stories in new and existing building's energy refurbishment.

2 Identification of new/revised procedures for energy building refurbishment

2.1 Best practices of building's energy efficiency in Tunisia

The following section is based on the research study published on May 13, 2018 by Malik Jedidi (1).

2.1.1 Introduction

Improving the energy efficiency of buildings is an important source of energy savings in developing countries, given the fact that buildings represent an important energy demand in these countries. Managers often view energy expenditure as a fixed cost over which they have no control. However, appropriate techniques for the use and control of energy make it possible to achieve annual savings of around 10 to 15% in buildings in the tertiary sectors (banks, hotels, office buildings).

Tunisia accelerated its action in the energy efficiency area from the start of the 2000s by diversifying its energy mix. This diversification aims to cope with the growing national energy deficit, which exceeded 4 Mtoe (million tonnes of oil equivalent) in 2015, reaching a rate of 56 %.

The main characteristics of the energy sector in Tunisia are as follows:

- A sharp increase in demand for electricity and great importance given to carbon energies by national authorities;
- The continued construction of new gas power station (97 % of current electricity production) in order to meet growing demand and save the country from blackouts;
- Quasi-monopoly of electricity production by the public sector (81%).

Several studies have been carried out on buildings in order to determine the influence of different parameters on the energy balance. The Building energy diagnosis constitutes the realization of a complete assessment of the energy situation. It has three objectives [ajouter une référence]:

- Optimization of energy consumption, representing the correction of malfunctions or design errors by improving the management of equipment and / or by improving its performance;
- Identifying opportunities to use renewable energies instead;
- Improving occupants comfort.

2.1.2 Thermal insulation

The thermal envelope of a building is the area that separates the heated interior volume of the building from the exterior environment. It is around this envelope that the heat exchanges operate which will influence the heating or cooling needs of the building. The sources of heat loss in a building are multiple; they are estimated at the following portions: Walls 25%, window 13%, roof 30%, thermal bridges 5%, soil 3%.

The roof, walls and windows represent the main sources of losses. A good insulation of the walls and glazing can significantly reduce the energy losses caused by these parts.

a-Wall insulation :

In a study carried out in Tunisia (1), Figure 1 gives the values of the building's energy requirement when using a thermal insulator of the expanded polystyrene type with thermal conductivity λ = 0.042 W / m.K. It was noted that the insulation of the exterior walls and of the roof with a Polystyrene (thickness of 7 cm) gave respectively a energy consumption reduction rate of 21% and 35%.

This difference is explained by the fact that the insulation of the roof allows the reduction of the energy needed for heating and for air conditioning; on the other hand the insulation of the exterior walls only allows the reduction of the need for heating (1).

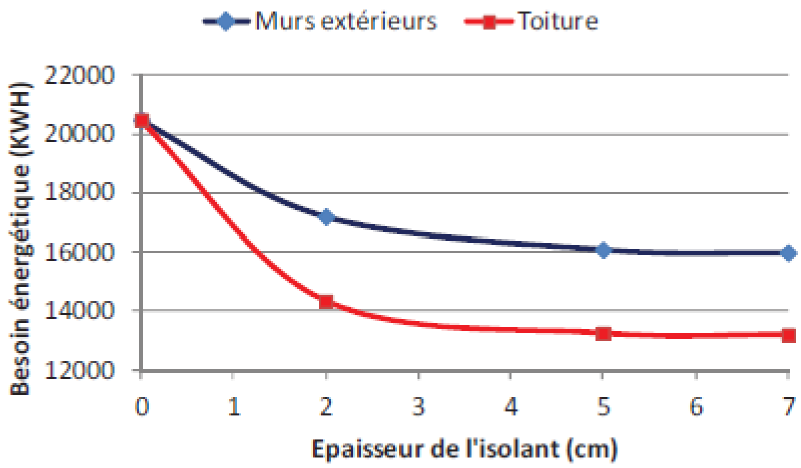


Figure 1 : Annual energy needs in terms of the insulation thickness:

b- Solar protection

Based on the study mentioned before (1), the chosen sun protection is that of roller blinds in fabric, with a transmission factor of 0.2. Knowing the importance of the sunlight (figure 2), the blinds are placed on the east, south and west facades, and are regulated facade by facade according to the minimum temperature of the rooms facing these facades.The annual solar gain is thus reduced by 20%, which translates into a decrease in the demand for cooling by 30% but also by an increase in the demand for heat by 7% (Table 1). This increase is undoubtedly due to less heat storage in the building.

Table 1: Annual building energy needs with solar protection

Energy needs (KWH)	Without solar protection	With solar protection	Compared to the initial building
Heating (KWH)	9300	9985	7 %
Air-Conditioning (KWH)	11180	7830	-30 %
Total needs (KWH)	20480	17815	13 %

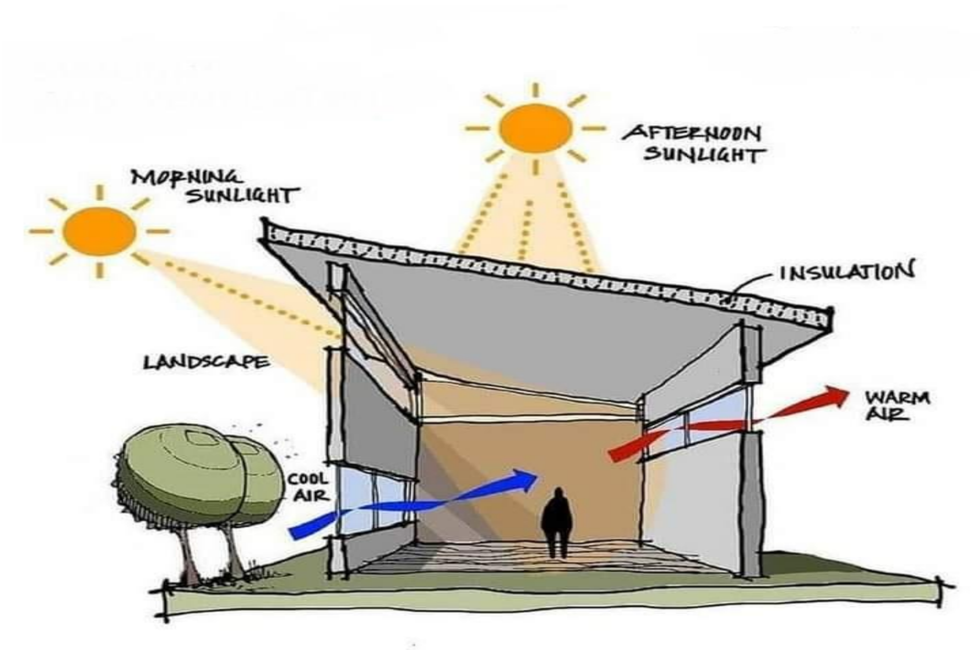


Figure 2: sunlight effect (www.07sketches.com)

2.1.3 Orientation

The building orientation is a main element in identifying the energy needs and any possible gains.

Continuing with the study (1), a case study was carried out on a building which is located in the city of Tunis, at latitude of 36 ° 50'N, longitude of 10 ° 14'E and an altitude of 3.00m. As shown in the following figure, the building has a total surface area of 80 m² and a volume of 240 m³.

The entrance to the building faces north (figure 3). Glazed surfaces represent 10% of the floor area (which represents approximately 6.67% glazed area per facade). Single-glazed windows have an U coefficient = 6.32 W / m².K and a solar factor of 0.85. The dimensions of the different rooms in our building are given in Table 2.

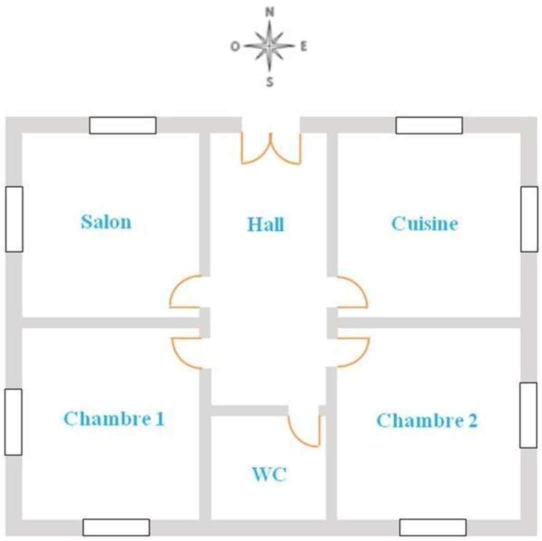


Figure 3: Buildings plan and orientation

Table 2: Dimensions of the rooms

Rooms	L (m)	W (m)	H (m)	A (m²)	V (m³)
Room 1	4.00	4.00	3.00	16.00	48.00
Room 2	4.00	4.00	3.00	16.00	48.00
Salon	4.00	4.00	3.00	16.00	48.00
Kitchen	4.00	4.00	3.00	16.00	48.00
Hall	6.00	2.00	3.00	12.00	36.00
WC	2.00	2.00	3.00	4.00	12.00
TOTAL				80.00	240.00

The original North-South orientation building has been modified and oriented East-West as shown in Figure 4.

(a) (b)

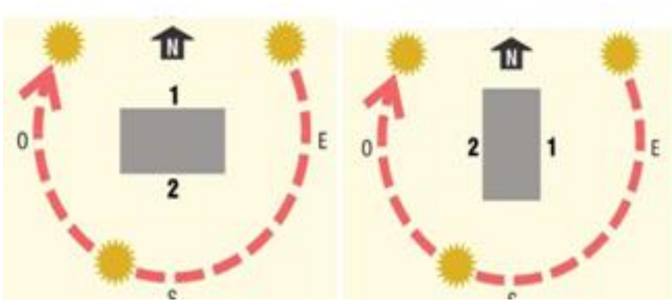


Figure 4: Orientation (a): North-South (b): East-West

Figure 5 gives the results of the influence of the orientation of the building on its energy balance. We note that the demand for heating and air conditioning have been increased by 5% and 11% respectively for a total increase in thermal consumption of 3%. Indeed, for the facade facing north, it receives a little sunlight in the morning and evening. With the modified situation, it is oriented to the East and it receives solar contributions only in the morning, but in a more important way. We should therefore heat less in winter but cool more in summer.

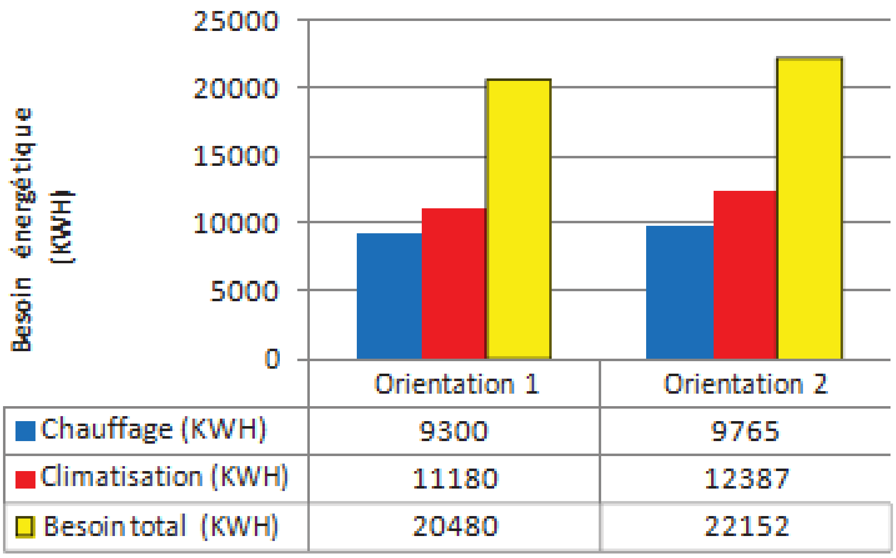


Figure 5: Annual energy needs in terms of building orientation

For the south-facing facade, it receives significant solar gain in the middle of the day. With the modified situation, it is oriented to the West and the sunshine occurs later. It is therefore necessary to heat more in winter. In summer, the supplies at the end of the day will be stored in the building overnight and returned in the morning, so it will also be necessary to cool more.

2.1.4 Thermal characteristics of the materials

The energy efficiency of a building depends on the materials used during the construction, as shown in the case study (1) where the uninsulated exterior walls are of 15 cm thick hollow brick with an exterior plaster of cement mortar and a plaster interior.

The partitions are in 10 cm hollow brick with a plaster coating on both sides. The low floor consists of a layer of stone 20 cm thick followed by 10 cm of concrete, covered with tiling (the underlay is made of cement mortar 2 cm thick).

The roof is made of concrete-slabs with a thickness of 20 cm and a cement mortar screed and an interior plaster coating.

The thermal characteristics of the materials used are presented in Table 3.

Table 3: Thermal characteristics of the materials

Materials	λ (W/m.K)	Capacité thermique (KJ/Kg.K)	Densité (Kg/m3)	Ep (m)
Hollow brick	0.34	0.84	1920	0.15
Hollow brick	0.35	0.84	1920	0.10
Exterior plaster	1.15	1.34	1800	0.01
Plaster	0.57	1.34	720	0.01
Concrete	2.30	0.84	2240	0.10
Rock	1.75	1	2350	0.20
Concrete-slabs	2.30	0.84	2240	0.04
Slabs	0.60	0.88	1000	0.16

Types of construction materials

The building envelope plays a role of thermal separation between the interior and exterior environment since it allows the storage of heat in the building and then distributes it to the interior and exterior air. Figure 6 gives the building's energy requirement for some building materials. We note that the use of a double wall 30 cm thick allows a gain of 22% while the replacement of the hollow brick wall (e = 15cm) by another hollow brick wall but of different thickness (e = 10cm) allows a drop in energy performance of 11.20%. For a stone wall 45 cm thick, there is a decrease in energy consumption which can reach 11.70%. (1)

The results also show that the energy need for air conditioning is greater than that for heating, which leads us to choose materials that allow passive cooling and lower the need for heating. (1)

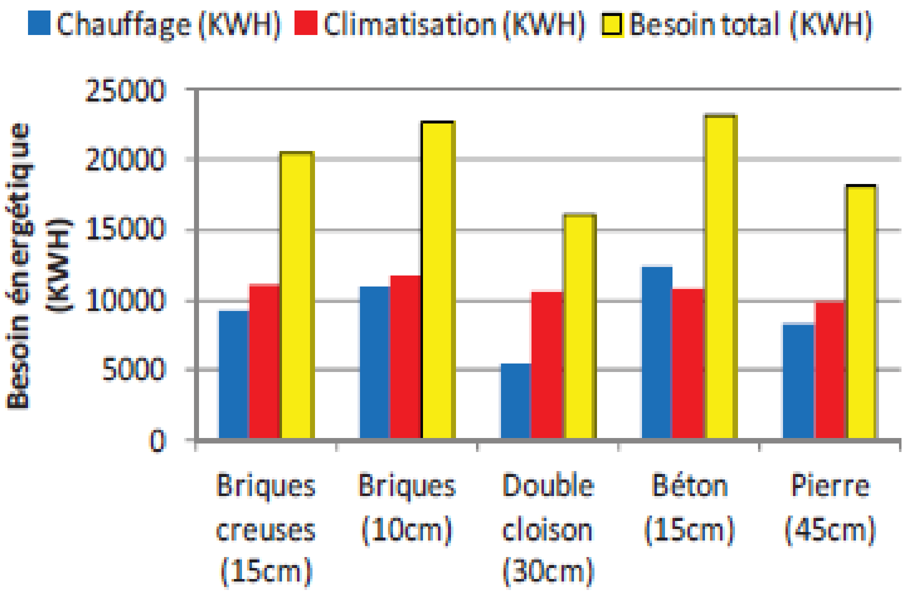


Figure 6: Annual energy needs in terms of the construction materials

2.1.5 Energy needs identification

Improving the energy profile of a building must definitely pass by an energy needs identification in order to know the real needs and the possible energy gains.

Based on the study of building's energy efficiency in Tunisia (1), the annual energy needs of the building described before are shown in figure 7. The values are around 9300 (KWH) for heating and 11 180 KWH for air conditioning, for a total annual need of 20 480 KWH.

Knowing that the total area of the building is 80 m^2, the energy ratio is 256 KWh/m^2. We got this result if we consider that the air-conditioning system has a coefficient of performance COP=2 and the efficiency of the heating system is μ=0.6.

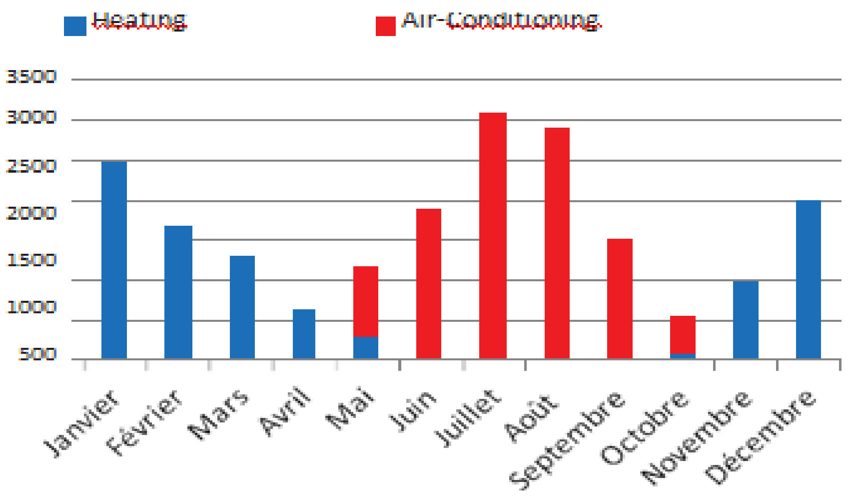


Figure 7: Energy needs

2.1.6 LED Lighting

Known from a very long time, the LED technology was mainly used in electronics for its low electricity consumption, it has seen very strong growth recently thanks to development of the lighting market LED.

The development of the LED lamp market is mainly due to the substantial drop in manufacturing costs thanks in particular to successive technological improvements. (18)

Benefits of the LED lighting

The use of the LED would generate up to 90% energy savings compared to incandescent lamps and even have reduced consumption compared to other "low consumers" such as the compact fluorescent lamps.

The lifetime of LED bulbs is much longer than that of other technologies (40 000 h versus 8 000 h for compact fluorescent bulbs and 1000 h for incandescent bulbs).

The environmental risks associated with the end of life of these products are also limited, unlike fluorescent bulbs, they do not contain mercury.

The quality of light from the bulb's compact fluorescent is in fact frequently criticized for its coldness, while that of LEDs has evolved to offer a range that meets all types of needs. LED lamps provide lighting immediately, while the slow lighting of CFL bulbs remains a reason for dissatisfaction of consumers. (18)

Tunisian context:

The total number of lighting points in residential areas exceeds 17 million points, with a total of 10 million inhabitants.

Tunisia is one of the pioneering developing countries in terms of energy efficiency policy and grants aid to market players such as the application of minimum customs duties and the suspension of TAV (taxes added value) on equipment and products used for control of energy and which have no equivalent manufactured locally As part of the program to phase out the market for incandescent lamps, a consumption tax of 10% has been introduced on this type of lamp since 2008. It rose in 2009 to 30% to reach 50% in 2011.

Under the impact of the various campaigns carried out by state organizations Many households and professionals have been made aware of energy saving and the lifespan of LBCs (halogen and fluorescence). (18)

Challenges:

Still very little developed in Tunisia, LED lighting suffers from a lack of notoriety and very few people are aware of the various benefits of using LED lamps. (18)

Sales of LED lamps are still very low compared to other LBCs.

There are two types of products in the LED lamps market in Tunisia:

- Products that have a very high price which constitutes a buying brake for the consumer.
- Chinese brands that sold at more competitive prices and which are generally of lower quality with a more limited lifespan. (18)

2.1.7 Glazing

Glazed surfaces

Based on the mentioned study on a building in Tunisia (1), the results of the annual energy needs for heating and air conditioning as a function of the percentage of the glazed surfaces of the building are shown in the next figures.

Note that the use of a single glazing with a heat loss coefficient $U = 6.32 W / m^2.K$ did not give an energy gain for all the facades including the southern one.

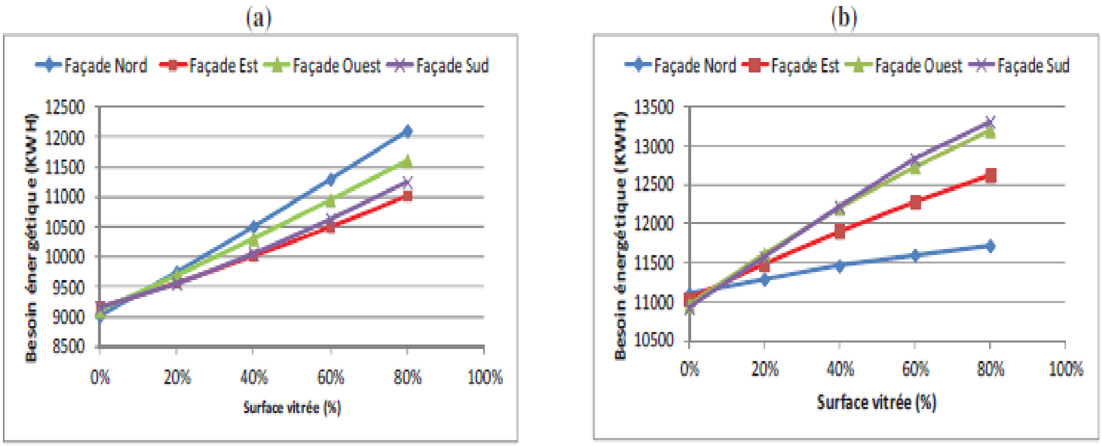


Figure 8: Single glazing

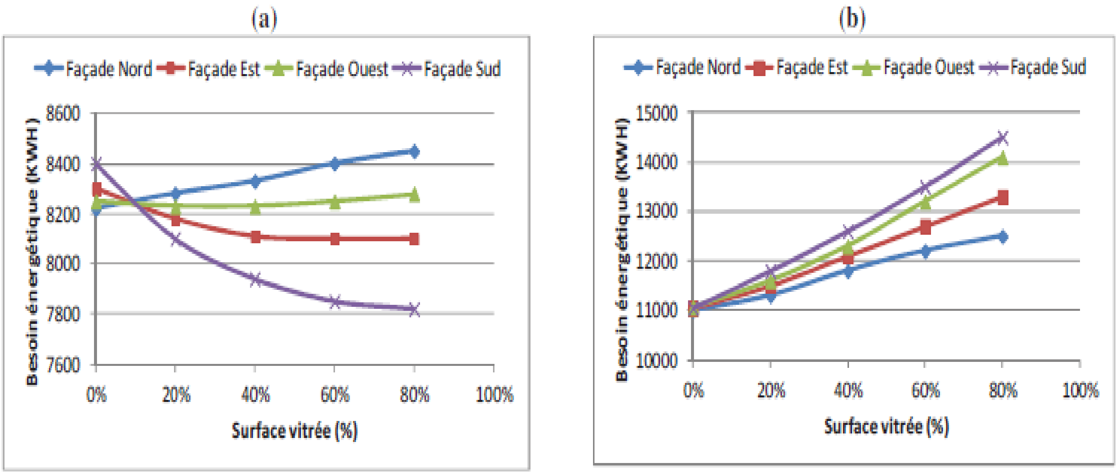


Figure 9: Double glazing

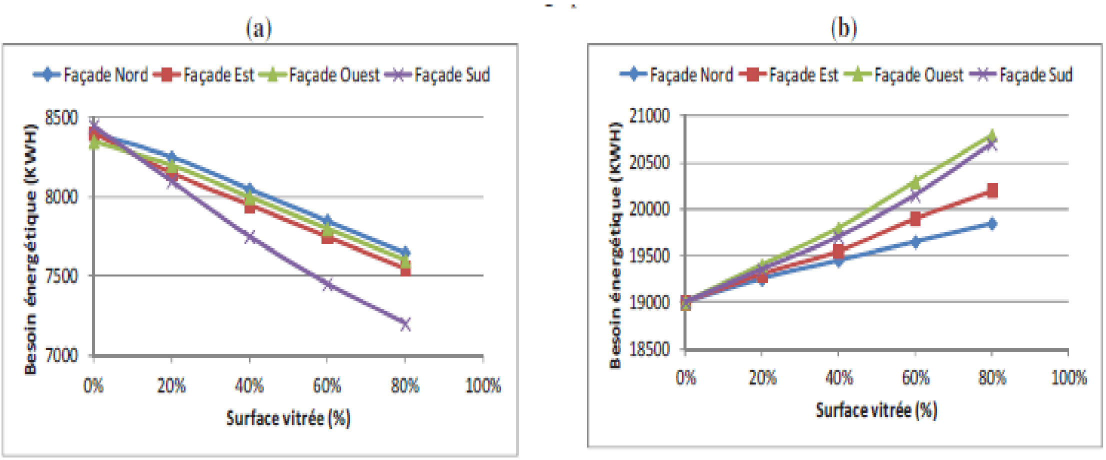


Figure 10: low emitting double diode

(a): Energy needs on heating

(b): Energy needs on air-conditioning

For double-glazed windows, we note that it is absolutely necessary to avoid placing them on the north facade, otherwise its energy needs will explode simultaneously with the increase in the glazed surface. For the other facades, an energy gain in heating was recorded in proportion to the increase in glazed surfaces, especially for the south facade where the gain is significant and stabilizes beyond half of the surface of the facade. For the east and west facades, the gain increased slowly to reach its maximum for a percentage of 40%.

For the low-emission double glazing, there is a heating gain of 22.64 % for the south facade, for the other three facades, the gain was 1% on average for 20 % more glazed area.

Window types

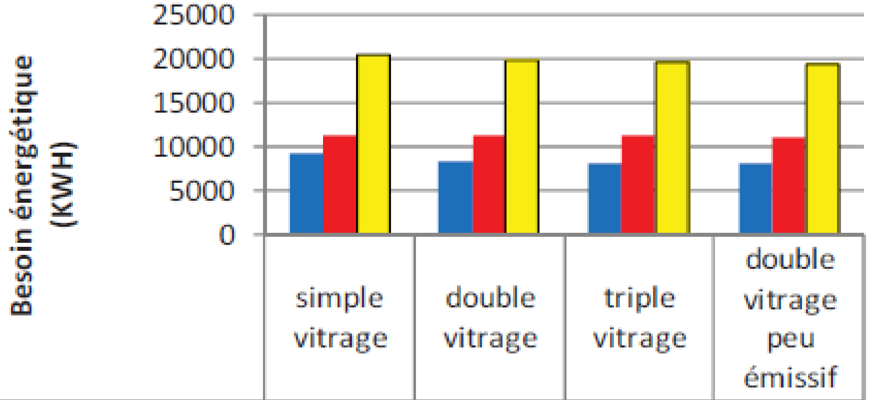
Table 4 shows the different characteristics of the glazing to be installed in order to see their influence on the building's energy needs.

Table 4 : Characteristics of the windows

Windows	Coefficient U (W/m².K)	Solar factor	Dimensions (m)
Simple glazing	6.32	0.85	0.80 x 1.00
Double glazing	3.24	0.75	0.80 x 1.00
Triple glazing	2.17	0.70	0.80 x 1.00
Low emitting double glazing	1.76	0.60	0.80 x 1.00

The results of the annual energy requirement as a function of the type of windows in the building are shown in figure 11.

Note that the quality of the glazing influences the total energy requirement of the building. In fact, the use of low-emitting double-glazed windows provided an energy gain of 5.46 % while the use of triple glazing provided a 4.97 % gain.



	simple vitrage	double vitrage	triple vitrage	double vitrage peu émissif
Chauffage (KWH)	9300	8379	8184	8215
Climatisation (KWH)	11180	11340	11290	11160
Besoin total (KWH)	20480	19719	19474	19375

Figure 11: Annual energy needs in terms of windows types

Consequently, the energy gain is not proportional to the number of glazing that constitutes the window but rather to its thermal quality.

We also note that the use of a window with a loss coefficient (U = 1.76 W / m².K) three times lower than that of single-glazed windows (U = 6.32 W / m².K) brought a gain very modest compared to the investment cost, however the low-emissivity double-glazed window will be retained as the optimal case for our building.

<u>Vital cube medical centre</u>

Vital Cube is a medical and office centre located at the "Berges du Lac 2" of Tunis, an area with a large number of clinics and wellness centres.

The building was designed by ARK-architecture (Bilel Khemakhem) and AUDA (Mohammed Khemakhem and Nejib Saadallah) with a total area of 7.000 m².

The project was realized between 2015 – 2018 and it was nominated for the “Carthage Architectural Days Awards” and the "Archdaily Building of the Year Awards 2021". (8)

For this specific type of project which will welcome patients in search of recovery, we wanted the concept to have a positive contribution to the psychology of operators. This is how we were inspired by Nature.

Three main elements were chosen to reflect on the mass of the project: WATER, VEGETATION and SUN, dividing it into three cubic pavilions. (8)

Figure 12: VITAL CUBE medical Centre

Figure 13: The three main elements

An atrium, flooded with natural light, connects the three pavilions.

The interior circulations follow two perpendicular visual axes which pierce all levels in a spirit of openness and escape, offering a permanent connection with the outside.

The main entrance to the project, completely glazed on four levels, maintains visual continuity from the street to the central atrium. Its transparency gives the reception hall a pleasant and serene atmosphere. (8)

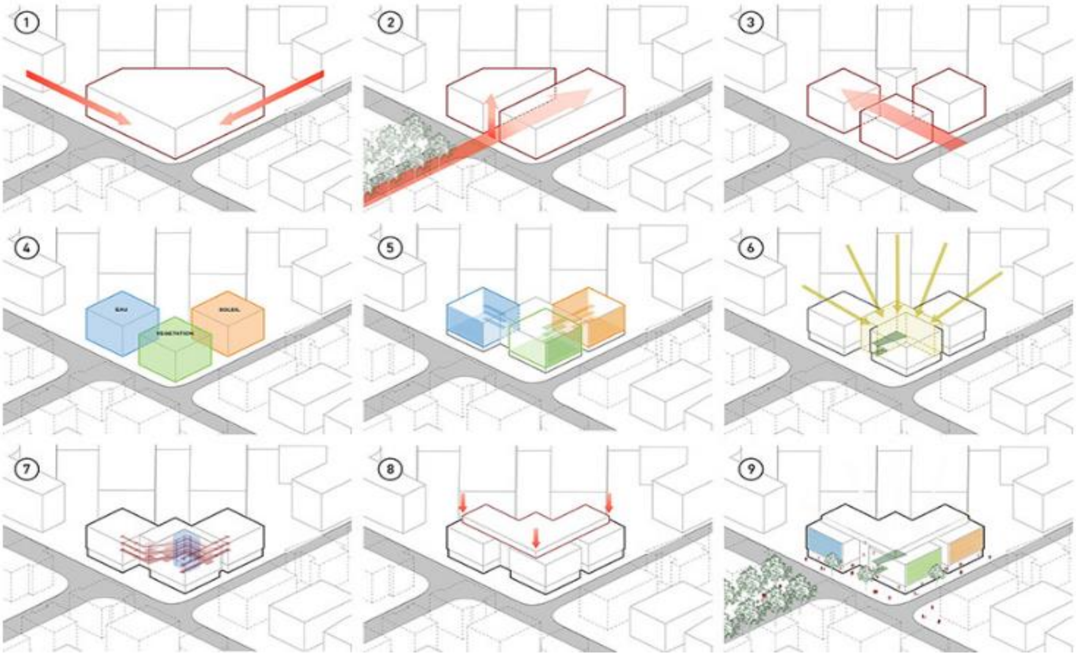


Figure 14: Dividing the building into three cubic parts

Figure 15: Front view

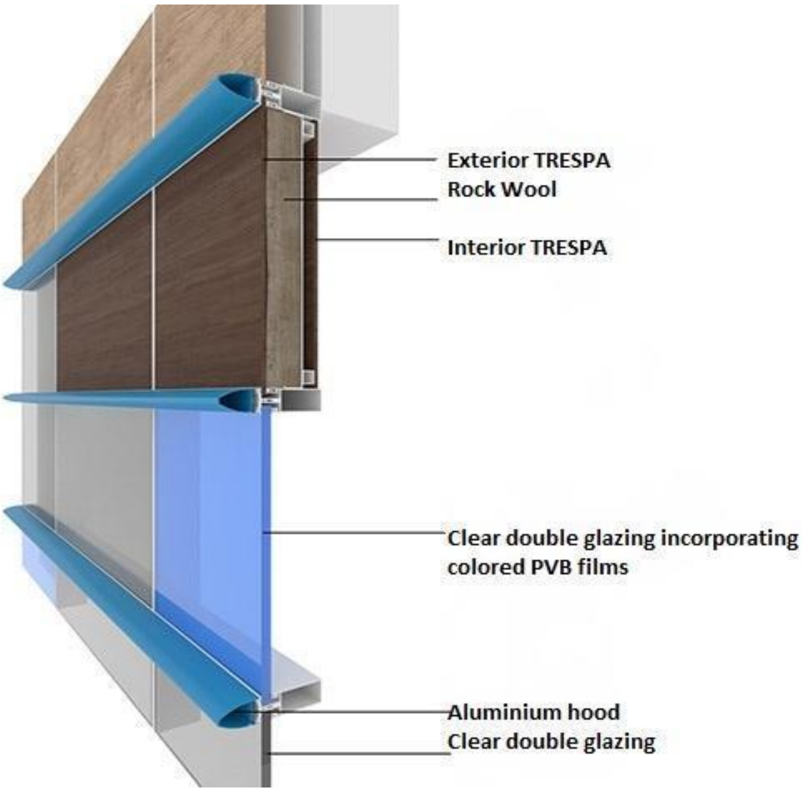


Figure 16: Glazing characteristics

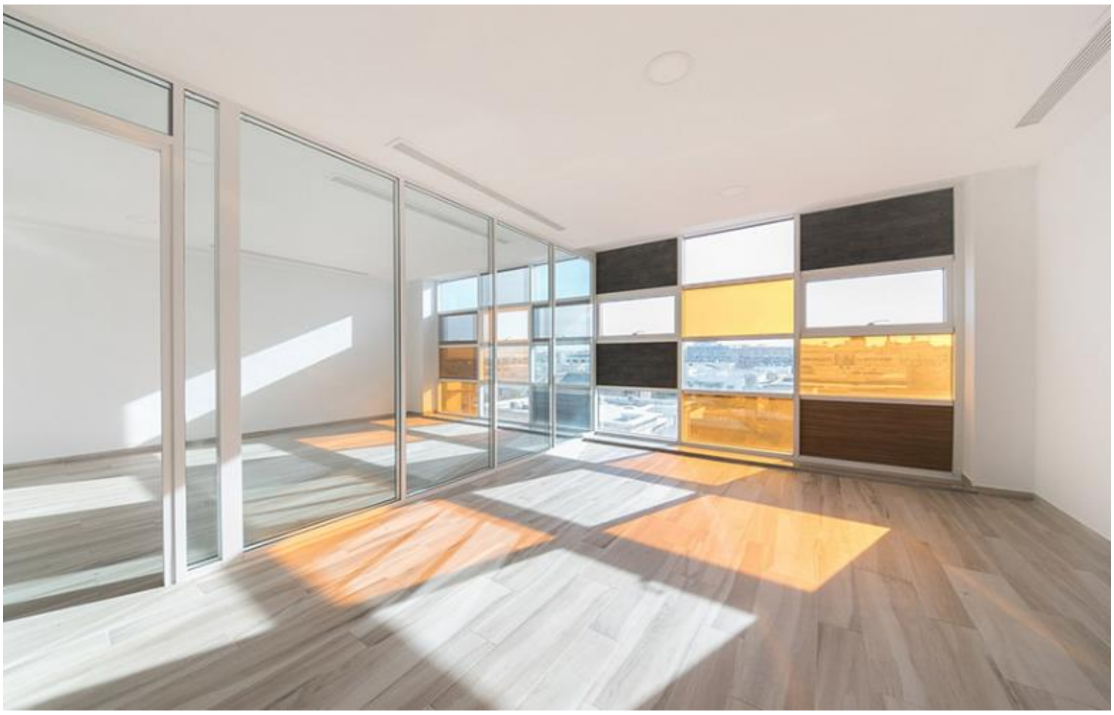


Figure 17: : Interior views of the building

The facades adopt a subtle play of colour modules, carefully contrasted, alternating opaque wood-look "TRESPA" HPL panels, with transparent and colour glass panels. The elements are carried by an aluminium structure with horizontal blue, green and yellow covers, referring to the elements of nature and marking the exterior distinction of the three cubes.

Functionally, the project includes a commercial ground floor and mezzanine, two floors dividing into 22 medical offices with surfaces between 60 m² and 120 m² and an independent upper floor operated by a clinic juxtaposed to the project.

Arranged in 11 consultation rooms, a radiology room and an ultrasound room. Due to its different operation, this floor was treated differently from the outside.

Finally, through the dialogue it maintains with the external environment, the delicate expression of nature and the comings and goings of patients seeking convalescence, the project becomes a living organism: it receives and gives life. This is how it becomes ... VITALCUBE. (8)

Figure 18: VITAL CUBE

2.2 Nationally Appropriate Mitigation Actions Building (NAMA Building)

2.2.1 Context

In 2012, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Department for Business, Energy and Industrial Strategy (BEIS) of the United Kingdom established the NAMA Facility.

The NAMA Facility supports developing countries and emerging economies that show an ambition to play a leading role in the field of climate protection. The Facility makes the necessary funding available for these countries to begin implementing their NAMAs (Nationally Appropriate Mitigation Actions).

NAMAs are voluntary climate protection measures, which are embedded in these countries' national development plans. They are an important instrument for the achievement of nationally determined contributions (NDCs) under the Paris Agreement.

The NAMA Facility main objective is to ensure that the Developing countries and emerging economies carry out ambitious voluntary Nationally Appropriate

Mitigation Actions, thereby contributing to the implementation of the Paris Agreement and justifying their position as role models in the field of climate protection. (3)

2.2.2 NAMA Building

By signing the Paris Agreement, Tunisia has undertaken, within the framework of nationally determined contributions, to reduce the carbon intensity of its gross domestic product by 41% by 2030 compared to 2010.

These efforts are based on five sets of measures (known as “NAMA” for “Nationally Appropriate Mitigation Actions” or nationally appropriate mitigation measures).

One of these sets of measures is dedicated to the building sector, as households currently account for 27% of the country’s energy consumption. Population growth and rising living standards will cause this percentage to rise to around 35% by 2030.

In the context of the NAMA Building, the Tunisian government has already created a framework intended to increase the use of renewable energies and the dissemination of energy efficiency measures to households. These include the PROSOL programs, which promotes the use of solar thermal energy, and PROSOL ELEC, which has supported the installation of photovoltaic installations since 2010.

Despite the growth of the market, these programs are not yet able to reach all segments of the population and realize their full potential. In addition, a thermal insulation promotion program (PROMO ISOL) is planned, but it could not be launched yet due to low capacity and insufficient financial support. (3)

The project promotes the use of thermal insulation and solar energy in the building sector by extending the PROSOL and PROSOL ELEC programs to low-income households and launching PROMO ISOL.

The program approach is based on the following three components:

-Financial component: the current program to promote photovoltaic installations (PROSOL ELEC) must be extended to low-income households.

-Technical component: the legal framework of the three technologies must be improved under the NAMA Building in Tunisia.

-Communication: communication relating to the three programs must be strengthened in order to raise awareness among the actors concerned and to support the development of the Tunisian market for renewable energies and energy efficiency.

2.2.3 PROSOL ELEC: Promotion of solar roofs in Tunisia

The PROSOL ELEC is part of the National Program of Mastery of Energy and it is intended for customers wishing to have an installation of solar photovoltaic (PV) to cover their needs in electricity. In the region of Sfax, in 2019, there were 7014 photovoltaic installations totaling 19159 kWp, which is about 27 % of the national photovoltaic production. (19)

The general conditions to be eligible to the PROSOL ELEC program are as follows: (19)

- The use of electricity must be of the residential type
- The metering reference must be in the name of the applicant
- The premises must be owned by the applicant himself
- The premises must have a consumption history equivalent to the power of:
    - 1 kWp if the annual consumption is >= 1800 kWh
    - 2 kWp if the annual consumption is >= 3600 kWh
    - 3 kWp if the annual consumption is >= 6400 kWh
    - The installed power must be less than the subscribed one

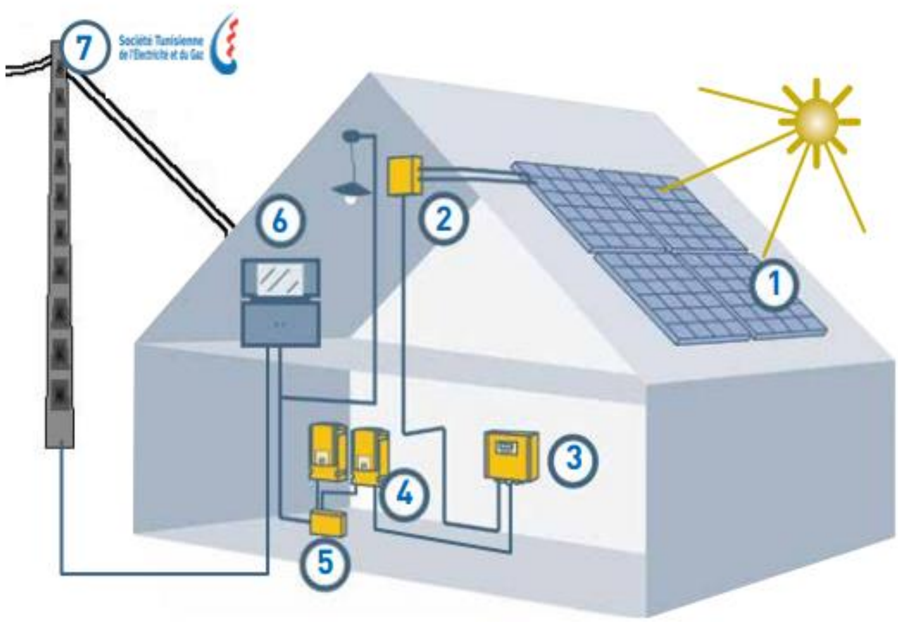


Figure 19: PROSOL ELEC model (19)

1- A set of photovoltaic cells

2- Connection boxes for photovoltaics generators

3- Direct Current box (DC)

4- Inverter

5- Alternating Current (AC) cabinet

6- Bidirectional counter

7- STEG low voltage network (LV)

The electrical energy produced by the photovoltaic installation will be consumed directly by the customer while the surplus will be injected into the grid STEG:

- If the electrical energy supplied is greater than that delivered ---> STEG will charge the difference.
- If the electrical energy delivered is greater than that provided ---> STEG will postpone the statement to the next billing.

In the case of an extension, the subscriber who already benefits from a photovoltaic installation (with or without credit) also has the right to extend the power of his solar system, provided that he does not exceed the subscribed power. Eventually, he will have the possibility of access to a second PROSOL ELEC loan, in accordance with the terms and conditions membership set by the STEG. (19)

Rentability of the program

The average annual production of a photovoltaic system in Sfax is around 1650 kWh for an installed power of 1 kWp. The following figure shows the savings which are calculated on the basis of the current electricity tariff for BT STEG consumers. (19)

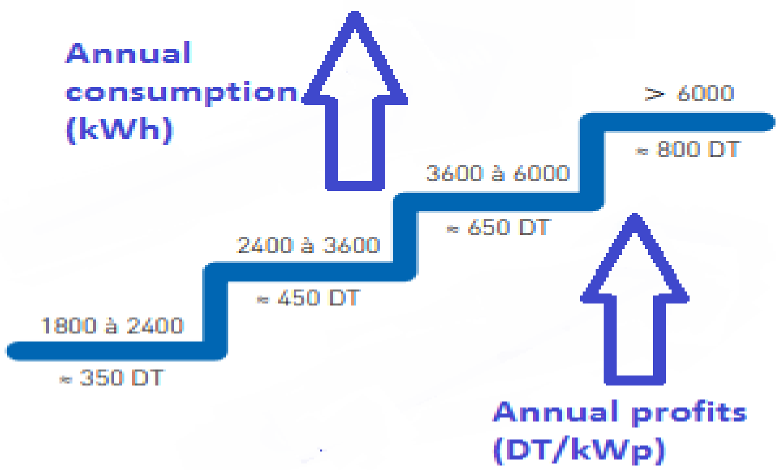


Figure 20: PROSOL ELEC Profi

2.2.4 PROMO-ISOL: Promotion of the thermal insulation in Tunisia

PROMO-ISOL is an incentive program for thermal insulation of the roofs of existing and new residential buildings. (20)

The program addresses several obstacles, such as insufficient access to finance, lack of technical and institutional capacities and low household awareness. In addition to reducing greenhouse gas emissions, the program aims to produce other positive effects on society and the economy. Thus, its objective is to reduce household energy expenditure, create skilled jobs and reduce subsidies in the energy sector. (20)

The funding mechanism put in place consists of:

- An investment bonus financed by the Energy Transition Fund (FTE) of 8 DT per m2 of insulated roof for existing housing and 6 DT per m2 of insulated roof for housing under construction
- A bank loan on favorable terms granted by the FTE (5%interest rate) in an amount which can reach 2400 DT. (20)

2.3 Best practices of building's energy efficiency in Morroco – Sunimplement Project

2.3.1 About the project

Figure 21: Ecobuilding sunimplement (5)

The Sunimplant project is a groundbreaking eco-building that was combined with hemp and solar panels as construction materials. It is designed to be totally independent of the electricity grid, being self-sufficient. This is the first of a kind in Morocco. (4)

This revolutionary eco-building was built in 2020 and it combines a hemp construction and a solar energy system for total independence from the electricity grid.

The unprecedented ecological detached house was designed by students of the Morocco National School of Applied Sciences incorporation with experts from the National School of Architecture, both based in Tetouan, Morocco, and experts from the Fraunhofer Center for Silicon Photovoltaics in Germany.

The very concept of 'Sunimplant' was presented at the World Solar Decathlon Africa 2019, a biennial international competition organised by Morocco's Solar Energy and New Energies Research Centre, the Mohammed VI Polytechnic University, Morocco's Ministry of Energy, Mines, Water and the Environment and the United States Department of Energy. The competition aims to encourage student teams to design and construct buildings powered by renewable energy, while optimizing key considerations such as affordability, resilience and occupant health. The 2019 edition was held in Ben Guerir, the capital of the Rehamna province in Morocco. (4)

2.3.2 Description and characteristics of the building

The building was designed to show how rural areas could be revived and developed. In addition, this design could also be used in urban applications.

The eco-building covers 90 square meters and has a double skin facade using massive adobe walls, formulated with a mixture of hemp, earth, pozzolana and lime, all materials of local origin.

On the other hand, the façade exposed to the outside uses biocomposites incorporating hemp fibres that have been produced by vacuum injection technology. This spherical and aerodynamic structure carries 24 semi-flexible photovoltaic panels subsidised by DAS-Energy, an Austrian research and development centre and a production plant with a capacity of 55 MW per year.

The facade also uses biocomposites incorporating technical hemp fibers that have been produced by vacuum injection technology. The structure also has a spherical and aerodynamic outer skin composed of 24 semi-flexible photovoltaic panels. (5)

Sunimplant can produce a capacity of 55 MW per year. It is worth mentioning that the building is located in the Ben Guerir region.

"The challenge was to create a hemp composite using organic bio-resins and avoiding technical fibres or synthetic components. The eco-building is ahead of its time and reflects a turning point not only in North Africa, but also in hemp construction, which does not have comparable prototypes in the world," says Monika Brümmer, the German architect who led the project and also the co-founder of Adrar Nouh, a cooperative that promotes the use of indigenous hemp stalks for rural development and sustainable employment in the Moroccan Haut-Rif. "Although the building was designed to stimulate rural development, the technology also has applications in urban areas," she says. (5)

The panels are exposed on all sides of the structure to capture sunlight and have a maximum loss of 40% for the less exposed PV panels.

Curved bio composite panels made of hemp wool are also installed to increase the performance of the PV panels by protecting their back side against the extreme climatic conditions of the semi-arid region of Ben Guerir, where temperatures are considerably high.

In addition, the infrastructure is also equipped with high-performance glazing from Saint-Gobain, a French glassmaker.

The construction of the eco-building cost around $120,000 (over MAD 1.2 million), less than half the price of standard buildings. "Even better performance could have been achieved if the original plans to install hemp earth panels for the interior walls and floors, as well as other minor modifications, had not been abandoned due to financial constraints," says Monika Brümmer, the architect. (5)

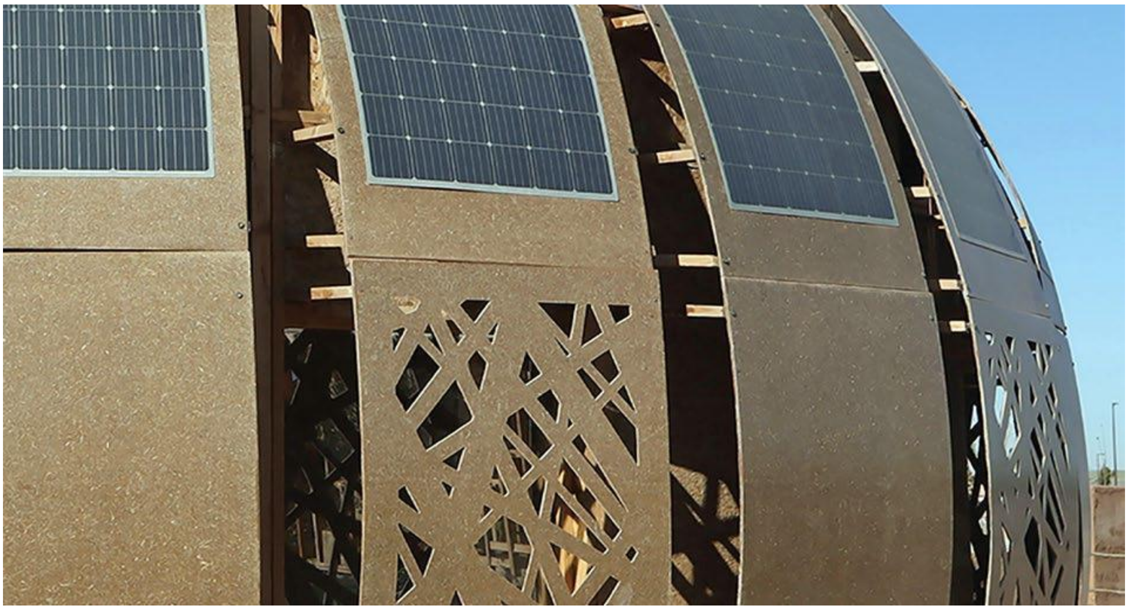


Figure 22: Sunimplement ecological building (5)

2.4 Best practices of building's energy efficiency in Algeria – Mashrabiyas: Sustainable architecture

2.4.1 Description

The Mashrabiyas building is the new Swiss embassy building in Alger that was completed in 2013 and combines a blend of Algerian and Swiss architectural traditions. (6)

Figure 23: The swiss embassy building in Alger (7)

The simple, elegant building combines Swiss architecture with Algerian construction and utilisation techniques as well as local materials. The combination of Algerian and Swiss traditions makes the new building perfectly suited to the local climatic conditions. The carefully planned building is an example of sustainable construction.

2.4.2 Approaches and procedures

A building that combines tradition and sustainability

The three-storey pavilion was designed by one Algerian and two Swiss architects. The outer shell represents Algerian culture and is reminiscent of a mashrabiya, the decorative wooden lattice work used in traditional Islamic architecture for lattice panels in mosques or for window grilles. (6)

The extensive irregular latticework in front of triple-glazed windows produces plenty of shade. This provides a natural way of keeping the temperature cool inside the pavilion, thus reducing the need for air conditioning.

The special pattern produces the most shade when the sun is at its strongest. As well as cooling the building, the exterior facade with its special structure also provides protection against earthquakes. This is indispensable as the embassy is located in an earthquake zone.

Figure 24: The interior of the building (7)

The building materials used for the facade are also sustainable: the concrete consists of white granular material from the Algiers area and was poured on site in collaboration with local facade specialists. The lattice is made of galvanized steel. This prevents rusting and increases the structure's lifespan. The lattice motif and the local building culture are echoed inside the embassy. For example, the pavilion floor is made of cement using traditional local methods. (6)

2.5 Izzat Marji Headquarters Green Building

Emphasizing its commitment towards the national efforts aimed at promoting the spread of green buildings across the Kingdom, IzzatMarji Group (IMG) has occupied a one-of-a-kind and state of the art headquarters in King Abdullah II Street, Amman, Jordan. The 8,700 square meter Green building is the first in Jordan to receive the Jordan Green Building Guide Certificate with the highest level “A”, and the first commercial building in Jordan to receive Platinum rating under the Leadership in Energy and Environmental Design (LEED) certificate provided by the U.S. Green Building Council (USGBC).

The building comprises 10 floors that include showrooms, staff offices, a training center, and parking. Moreover, the building features innovative renewable energy and energy efficiency systems that completely covers its electrical consumption, through PV systems that work on converting solar energy into electric power. It is also worth mentioning that IMG HQ is a Net Zero Energy Building. Given the Energy efficient equipment used, and the use of PV systems in the building, carbon dioxide emissions are expected to decrease by approximately 310,500 kilograms per annum. Other main features include capturing rainwater and achieving 58% saving in water, and providing excellent indoor environmental quality that facilitates occupant's productivity by providing a comfortable HVAC system and increased ventilation levels which reached 30% above standard requirements.

As part of the responsibility towards environment and sustainability, the building is used as an educational tool that allows students form schools, universities, as well as professionals from both private and public sectors to explore the green features of the buildings through guided tours and awareness sessions held in a dedicated training hall inside the building.

IMG’s HQ building includes several innovative and replicable measures considering:

• High efficient building envelope, with Thermal Bridge free construction, with a U-value for external walls of 0.27 W/m2 .K

• High efficient windows with a U-value of 1.5 W/m2 .K

• Reducing waste by implementing a waste management program during construction and operation

• Reducing the water used through rain water harvesting system, and the use of high efficient fixtures (Infrared mixers, Dual flush, waterless urinals)

• LED lighting, with occupancy sensors and lighting controls

• CO2 sensors to ensure the indoor air quality

• Implementing the use of Solar PV systems on the facade, roof, and parking in an innovative manner

• Use of solar water heaters

• Efficient use of the wasted heat from equipment through using the wasted heat in heating fresh air.

In addition, the building has been selected as Middle East Region Innovative Energy Project of the Year Award for 2019 by the Association of energy Engineers (AEE), Green Commercial building of the year 2019 - MENA Green Buildings Award by

Emirates Green building council, and National Energy Globe winner of Jordan by Energy Globe Foundation.

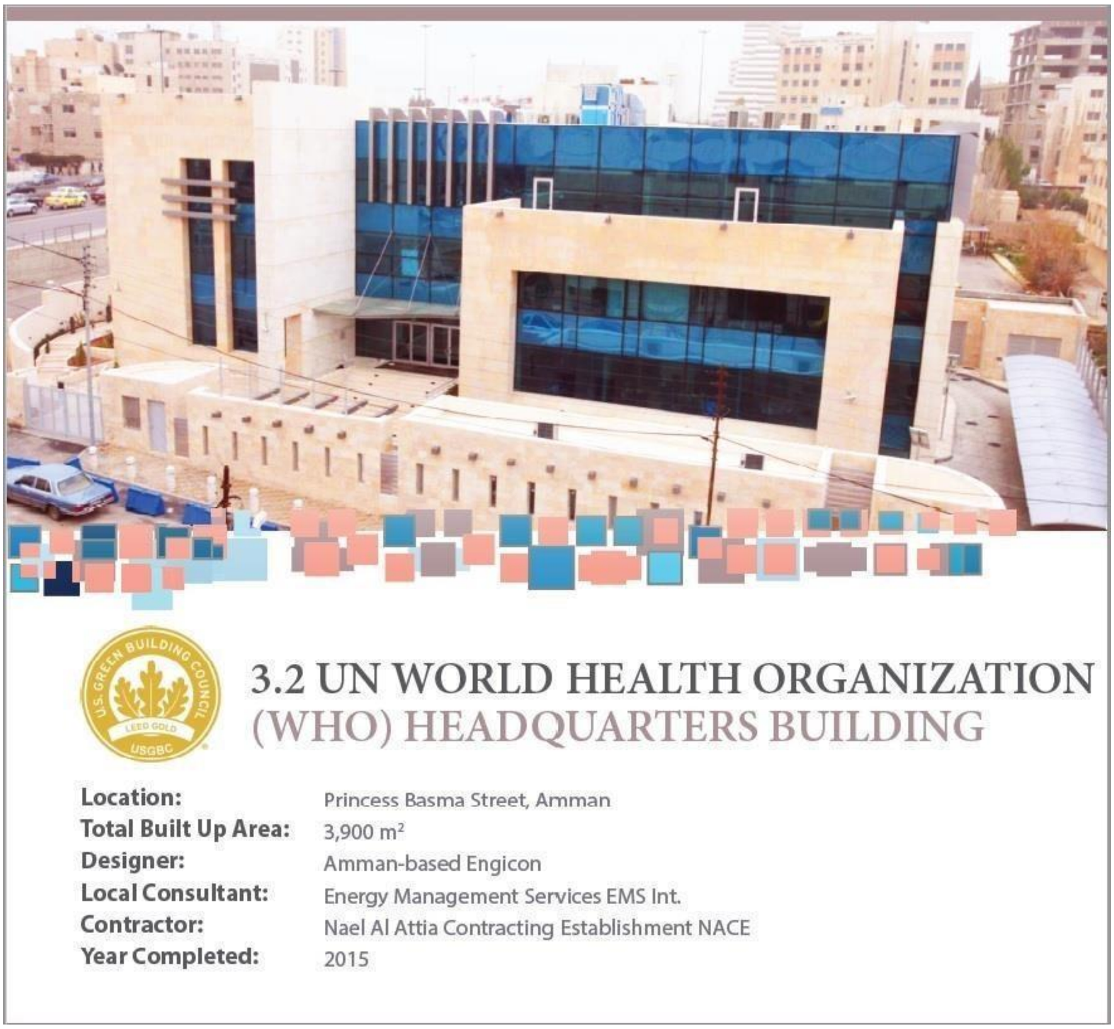


Figure 25: Headquarters building

Benefits and Awards

Due to embedded green components and aspects, UN World Health Organization (WHO) Headquarters Building achieved the following:

Figure 20: WHO Green Building Benefits and Awards

22.5% Reduction in energy consumption

60% Reduction in potable water consumption

79.2% Waste management diverted from landfill

75% Reduction in the building waste

30.5% Locally/regionally sourced materials and 54% FSC wood

74'942 Kg/year reduction in CO_2 emission

- **Higher indoor quality** and comfort level
- **Higher occupant satisfaction** and safer indoor environment
- **Conservation of resources** through recycling
- **Total harmony** with the neighborhood and community
- **Cost effectiveness** and lower maintenance cost
- **5% additional cost, recovered in less than 7 years** of occupation
- **The first Leadership in Energy and Environmental Design (LEED) Gold Certification for a green building not only in Jordan but in the entire Region**
- **LEED Gold 2011** (LEED BD+C: New Construction V2 - LEED 2.2)

The Story Behind

World Health Organization (WHO) is a world known organization that is dedicated to build a better, healthier future for people all over the world with their primary role being to direct and coordinate international health within the United Nations' system. WHO's decision of establishing their head quarter building was well equipped with a vision of an energy efficient and a health/comfort enhancing structure, which lead this office building to implement green building strategies and obtain their LEED certification.

Information regarding this building was obtained from Eng. Mazen Malkawi and Eng. Samar Bahous

Key Green Strategies

WHO building included a wide collection of green components and considered several green aspects to be implemented over the entire lifecycle of the building, which all served the building to be acknowledged as a green building, from these components and aspects, we have selected the following to share with you:

Sustainable Sites

1. **Located in a commercial and urban area,** close to public and private transportation systems.

2. **Secured bicycle racks** – for 5% of full time occupants.

3. **Car & van pools** – 1 car pool and 1 van pool near basement entrance.

4. **Low emitting vehicles** LEV and fuel efficient vehicles FEV dedicated parking spaces.

5. **Covered parking spaces** – 50% of parking spaces placed under cover and under building and light composite material of efficient solar reflectance index (SRI) were provided for outdoor parking spaces.

6. **Minimal paved areas** allowed for 50% of the site to be restored with native vegetation.

Indoor Environmental Quality

1. **Smoke-free** environment.

2. **Reduction of indoor pollutants** through using only very low or no-wood, paints and sealants.

3. **Removal system of dirt** airborne particulates.

4. **Thermal comfort** through a low solar heat and proper ventilation.

5. **Visual comfort** by open floors plans and optimal exterior daylight.

Innovation & Design

1. **Curtain walls** of adequate amount and certain glazing characteristics fixed on elevations, to guarantee optimum use of solar heat and lighting.

2. **Optimum openings design,** allowing natural day light and views.

Awareness, Education and Community Outreach

1. **Became a topic** of several scientific research and academic papers.

2. **Included in many publications** that show-case success & benefits of public green buildings.

Photos from the project




2.6 Best practices of building's energy efficiency in Jordan

2.7.1 Introduction

Jordan faces major challenges including ensuring energy supplies. The country depends on foreign energy sources (9). It imports more than 95% of its energy needs, which mainly consist of natural gas and oil, from neighboring countries (10). Residential and public buildings in Jordan account for around 46% of the total electricity consumption and are considered the largest portion of energy usage in 2017 (11). As buildings become energy efficient, they will have a high potential to reduce energy use on a large scale. Greenhouse gas emissions from buildings are likely to be significantly reduced compared to the other major Emission Sectors (12)(ES). All the facts mentioned above underscore the urgent need to enhance energy efficiency in buildings in Jordan.

The levels of Energy Performance (EP) in most of the current buildings in Jordan are below the requirements of the local energy-saving building code (13). Although the local thermal insulation law has been mandatory since 2009, people in Jordan used to ignore it to avoid the additional costs associated with it resulting in many ineffective buildings. Transforming Jordan's built environment through a sustainable approach is imperative to conserving energy.

Efforts began in 2009 to develop a building classification system that would reduce energy and water demands and provide a more efficient and healthier environment. The Ministry of Public Works and Housing has the Jordan National Building Council (JNBC) division responsible for developing building codes (BC) in Jordan. The Technical Committee for the Guide to Green Buildings in Jordan was established in 2009 to develop the green building classification system in Jordan with the help of professionals in the public and private sectors under the leadership of the technical arm of the Center for Sustainable Building and Building In the Royal Scientific Society (RSS) (https://www.rss.jo/). International references from leading sustainability rating systems have been used as references such as LEED and BREEAM, with a focus on local conditions in Jordan regarding energy and water scarcity. The Jordan Green building guide (JGBG) was released in 2013 and is now available for everyone to use. An incentive program for green building accreditation in Jordan based on the JGBG classification system was approved in 2015 (14).

2.7.2 Motion sensor system

The installation of a motion sensor system ensure that when a resident enters into the building, the lighting at the entrance to the building will be on only for a period of 3 minutes, the inhabitant rides the elevator and exits in one of the floors and the lights in this the floor will only be lit for 3 minutes. If the total period Lighting the lamps after installing the system is equal to 3 * 2 = 6 minutes, and by comparing 18 minutes the electricity consumption in the case of the ladder machine with 6 minutes, the electricity consumption after installing the motion and light sensors system. (6/ 18 = 33%), meaning that the electricity consumption decreasesto 33%, which gives a saving of 67% on the electricity bill at the very least, not to mention the long life of the bulbs and saving the amounts required to purchase the owners and replace the damaged stair lighting switches. The following figure shows the motion sensor system.

Figure 26: motion sensor

2.7.3 Improvement of the thermal performance of the building envelope

The building envelope protects against environmental influences on the building. The components of the building envelope, including the exterior walls and the roof, affect the amount of energy required to cool and heat buildings. They directly affect building heat loss in winter and heat gain in summer, which relates to the energy required to achieve the required thermal comfort levels for building occupants.

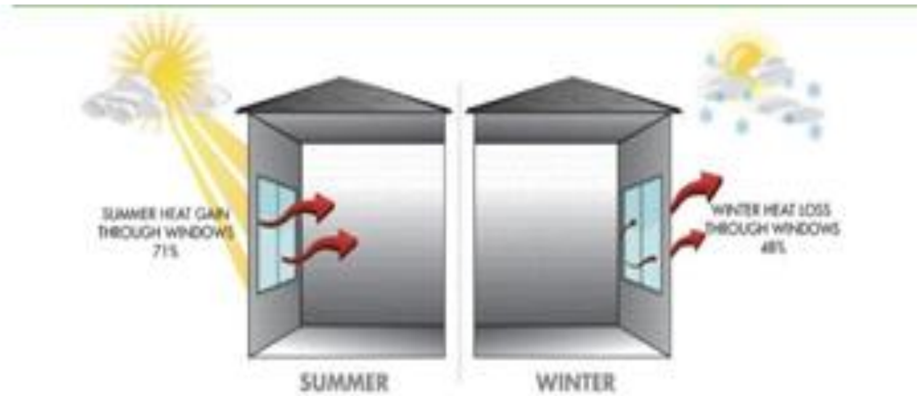


Figure 27: Building heat loss in winter and heat gain in summer

The refurbishment of the building to achieve a reduction in energy consumption means increasing the building's thermal resistance. Increasing the thermal resistance of exterior walls and ceilings are usually achieved by adding thermal-insulating material to the construction layers. This will result in a lower overall U-value (heat flow rate across a unit area of building envelope per unit temperature difference between indoor and outdoor air (W / m2. K)).

The following subsections are the best practices to be done to improve the thermal performance of the building envelope. The data and images contained therein are taken from “Your Guide to Building Envelope Retrofits for Optimizing Energy Efficiency (OEE) & Thermal Comfort in Jordan (TCJ)” paper published by “Jordan Green Building Council”.

a- Adding thermal insulation to building’s external walls

Thermal insulation is the reduction of heat transfer between objects in contact with heat. The most important aspect of the insulation material is its performance to resist the passage of heat throughout the life of the building. (15)

Rockwool, polystyrene, and polyurethane are the common thermal insulation materials used in the Jordanian construction sector [9]. The figure below shows these materials and their thermal resistance values [10]. Polystyrene is the most common insulation material; It is considered the best choice in the Jordanian market due to its thermal performance, emissions, and reasonable price compared to other insulation materials (15)

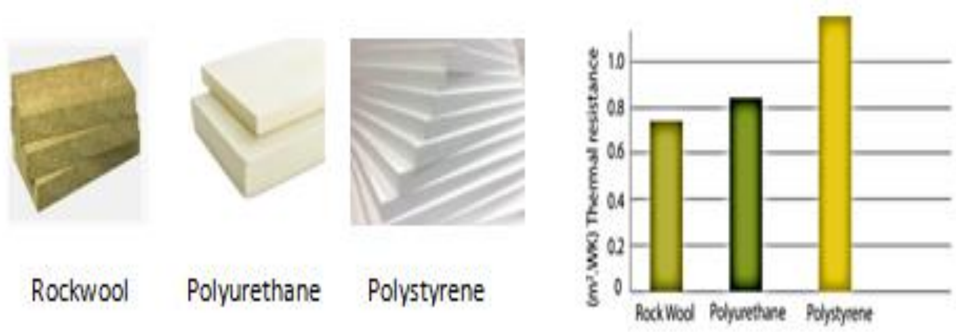


Figure 28: Insulation materials and its thermal resistance

The requirements of the local thermal insulation law are mandatory. However, people used to ignore thermal insulation in buildings (14). The figure below shows a typical insulated external wall compatible with the Jordanian building code (15).

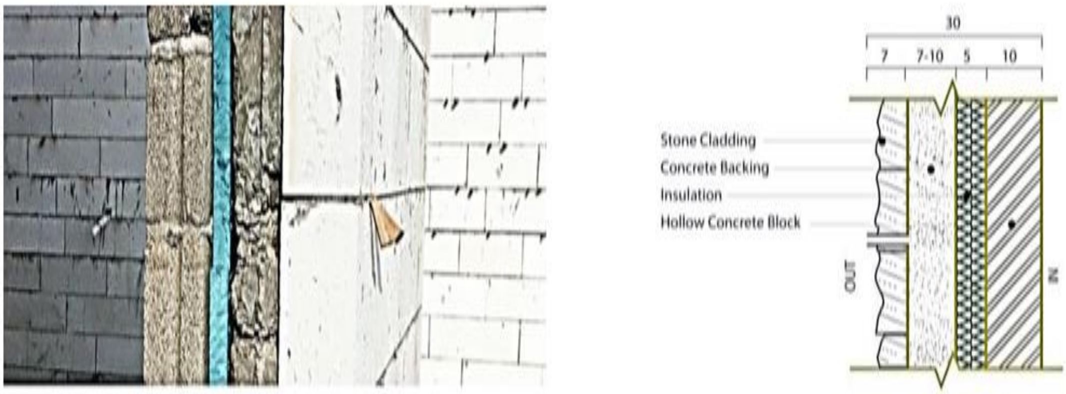
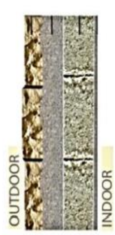


Figure 29: Typical insulated external wall - compatible with the jordanian building code

The external walls of buildings in Jordan differ in wall thickness, the number of layers, building materials, and exterior cladding. In most cases, there is no thermal insulation in existing buildings except for newly built structures. Concrete masonry is the most common building material for vertical walls, in general, exterior walls can be grouped into two main types: Uninsulated Solid Walls (USW) and Uninsulated Cavity Walls (UCW). The next table shows illustration images, the thickness, and the U-value for both types (16) (U-value is the heat flow rate across a unit area of a building envelope per unit temperature difference between indoor and outdoor air (W/m². K)).

Table 5: Walls types and characteristcs

Wall Type	Uninsulated solid walls	Uninsulated cavity walls
Thickness (mm)	260	310
U value (W/m².K)	2.55	1.99
U value maximum limit according to Jordan building code (W/m².K)	0.57	0.57
Illustra	 	 

The aim of modifying existing wall structures is to comply with the minimum requirements for thermal transmittance (U-value) for exterior walls in accordance with Jordan Energy Efficient Building Code (JEEBC), as it requires a maximum value of

0.57 W/ m².K). The thermal performance of existing exterior walls is improved in the most efficient and easy way by adding a layer of thermal insulation material to the wall composition. This insulation can be added to the internal or external surface of the wall (16).

Thermal Insulation Added to Internal Surface of External Wall: This option is implemented by adding a layer of thermal insulation material to the existing inner surface of the external wall, then covering it with a suitable finish material such as gypsum boards, or wood panels or plaster (16).

Thermal Insulation Added to External Surface of External Wall: This option is implemented by adding a layer of thermal insulation material to the existing external surface of the wall and protecting it with the desired cladding or finish material, such as mechanically fixed stone, cladding panels or cement based mortar as render topcoat with backing mesh [8]. Common solutions for improving thermal performance of the external opaque walls [8] is shown in the below Figure.

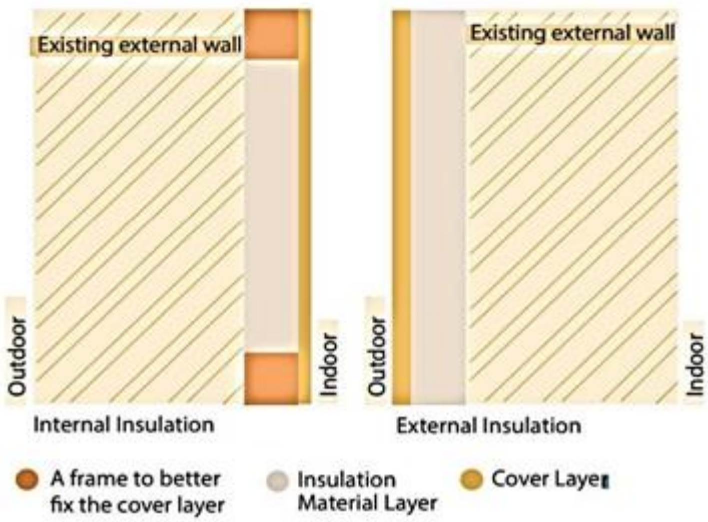


Figure 30: Common solutions for improving thermal performance of the external opaque walls

Table 6 below summarizes the treatments for the refurbishment of the building's external walls, to comply with the Jordan Thermal Insulation Building Code requirements. The calculations of improved U-Values were prepared to assume three different insulation materials: Extruded Polystyrene boards (EPS), Polyurethane foam (PUR), and Rock Wool boards (Rockwool) with minimum thickness needed to comply with Code. As mentioned previously, the data are taken from "Your Guide to Building Envelope Retrofits for Optimizing Energy Efficiency & Thermal Comfort in Jordan" paper published by "Jordan Green Building Council".

The next table shows the improved U value after applying the thermal insulation to the external wall with different insulation materials.

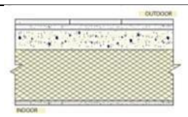
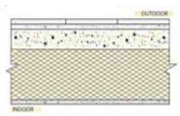
Table 6: The improved U-value

Insulation material	EPS		PUR		RockWall	
Wall type	Solid walls	Cavity Walls	Solid walls	Cavity Walls	Solid walls	Cavity Walls
Suggested insulation thickness	45	40	35	35	55	50
Improved U-value	0.52	0.55	0.57	0.52	0.56	0.55
Improvement %	79	72	78	74	76	72

b- Adding thermal insulation to building's roof

The most common type of roof construction in Jordanian buildings is reinforced concrete roof (15). Table 7 below shows two common roof compositions and their thermal characteristics (16).

Table 7:Thermal characteristics of common roofs compositions

Roof type	Uninsulated fat reinforced concrete roof with tiles	Uninsulated fat reinforced concrete roof
Thickness (mm)	522	424
U value (W/m².K)	0.8	1.02
U value maximum limit according to Jordan Building code	0.55	0.55
Illustration images		

The aim of retrofitting existing roof structures is to comply with the minimum requirement for thermal transmittance (U-Value) of external roofs as per Jordan Energy Efficient Building Code. This code requires a maximum value of 0.55 W/m².K which is not met in many existing buildings. the most efficient and easy way to enhance the thermal performance of an existing roof is tby adding a layer of thermal insulation material to the roof/slab composition. This Insulation could be added to the internal or external surface (16).

Thermal Insulation Added to Internal Surface of Roof/Slab (Cold Roof): This option is implemented by adding a layer of thermal insulation material to the existing inner surface of the roof, then covering it with a suitable finish material such as gypsum boards, or wood panels or false ceiling panels (16).

Thermal Insulation Added to External Surface (EX) of Roof/Slab (Warm Roof): This option is implemented by adding a layer of thermal insulation material to the existing external surface of the roof and then covering it with a waterproofing membrane. A protective cover is preferably installed on top; this could be a layer of poured concrete or tiles. Metal mesh could be used to protect thermal insulation panels from breakage if needed when the roof is used heavily (16).

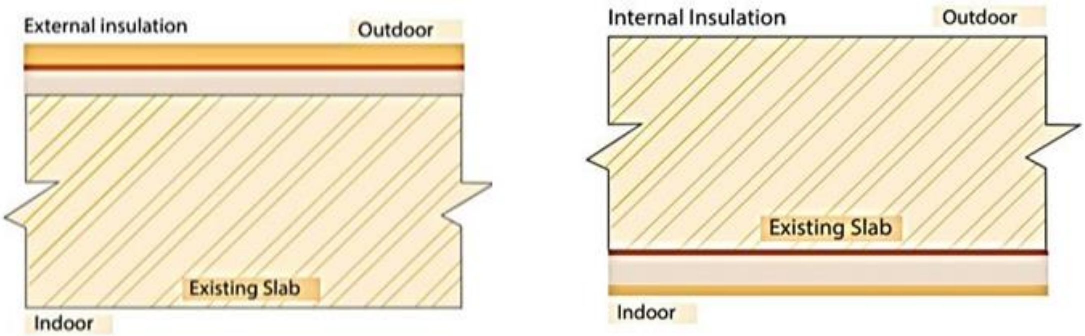


Figure 31: Proposed solutions for improving thermal performance of the roof

Table 8 summarizes the treatments for the refurbishment of the building's roof, to comply with the Jordan Thermal Insulation Building Code requirements. The calculations of improved U-Values were prepared to assume three different insulation materials: Extruded Polystyrene boards (EPS), Polyurethane foam (PUR), and Rock Wool boards (Rockwool) with minimum thickness needed to comply with Code.

Table 8: Improved U-value

Insulation material	EPS		PUR		RockWall	
Insulation solution	External	Internal	External	Internal	Internal	Internal
Suggested insulation thickness	25	30	20	20	30	35
Improved U-value	0.51	0.49	0.53	0.55	0.54	0.52
Improvement %	50	52	51	46	47	50

c- Installing double glazing windows and skylights

Windows play a significant role in providing natural light and natural ventilation to buildings. But, they are considered as source of heat loss in winter and heat gain in summer since they are rarely designed with proper shading and the majority of existing buildings in Jordan have single- pane windows with hollow aluminum frames which are resulting in high heat transmission and weak air tightness (14) (15) (16).

Glazing	Thermal Characteristics
Single glazing with Metal Frame	U-value= 5.7 W/m²K
Clear	SHGC = 0.82

Figure 32: Solar heat gain coefficient

The previous figure shows the traditional single-pane window existed in most buildings in Jordan and its thermal properties (16).

Improperly installed or poorly made windows, doors, and skylights, significantly increase the energy needed for heating and cooling in a building since they are considered the main source for heat loss in winter and heat gain in summer. Thermal Transmittance (U–value) is the rate of heat flow through a unit area of building envelope assembly per unit of a temperature difference between the inside and outside air (W/m².K). The lower the U-value, the better the glass thermal performance is. Replacing Single Pane glazed Surfaces with Double-glazing Units (Insulated Glass) is highly recommended (Figure 31). This could save up to 30% of the heating load. It is also worth mentioning that although triple glazing units are more efficient but not cost- effective in the context of Jordan in terms of climate and cost (16).

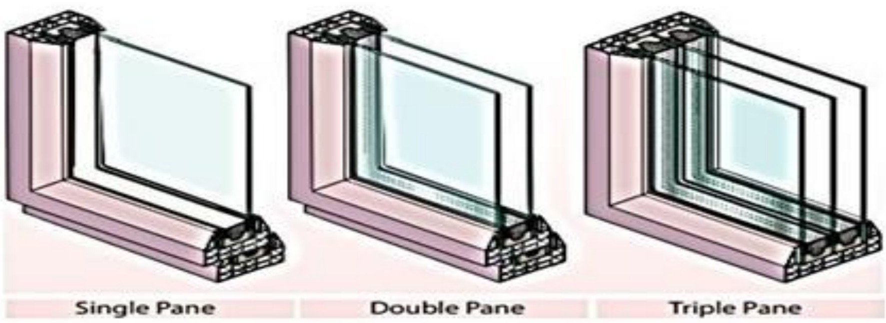


Figure 33: Single, double and triple pane windows

According to a study conducted on a residential building in Amman/Jordan, double glazed windows can save energy up to 59% compared to single glazed windows considering thermal transmittance (Figure 32) (16).

Double-Glazed with 12 mm spacing and PVC frames	U-Value [W/m²k]
Double glazing	2.8
Double with low E (E=0.2)	2.3

Figure 34: The proposed double pane window and its thermal properties

d- Reducing heat gain by introducing shading devices

Shading Devices aim to control sunlight by allowing it to enter the building when it is needed for heating in winter as well as preventing it from entering the building in summer. It also controls glare and reduces heat gain through the solar radiation when entering the building, and therefore reducing the energy demand of the building .Figure 10 next shows some proposed solutions for external shading according to a local study(16).

Besides manufactured external shading devices as shown in Figure 33, there are other ways to prevent sunlight from entering the interior space of a building such as interior shading devices, building self-shading by the design of the building's mass and vegetative shading.

Figure 35: Proposed solutions for external shading according to a local study

Vegetative shading is achieved by planting trees or creepers to filter the sunlight entering the building (14) (16).

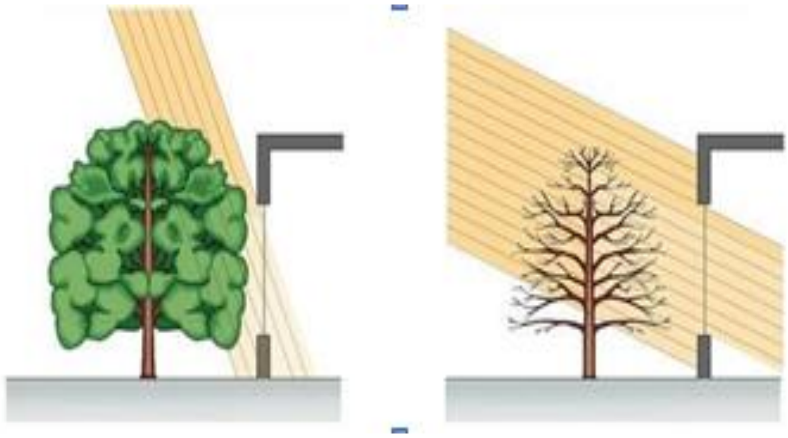


Figure 36: Vegetative shading achieved by planting trees

e- Growing roof to reduce heat gain

The green roof represents excellent solutions to improve the environment, capable not only of creating new places that can be used but also rehabilitating urban areas, as well as reducing the energy needs of buildings, mitigating the effects of pollutants and taming climate factors. Ceilings are one of the sources of heat increase inside the buildings because they absorb heat and transfer it inside. Due to its relatively large flatness compared to the façades in medium and low-rise buildings, and its exposure to near vertical and direct sunlight during the day. Therefore, protection from heat radiation must be provided, especially in summer. The roof planting is used to reduce energy consumption, as plants insulate the roof, reduce (carbon) pollution with the air, and contribute to its purification from dust, in addition it absorbs noise , provides a quiet environment and uses rainwater to irrigate its components. Green roofs may consist of trees, plants or shrubs. The depth and density of the planting layer are divided into two different types:

1- Green roofs can be dense or low in density on a large scale. Intensive roofs are thicker (more than 15 cm deep)that allows for the growth of a variety of plants, trees and shrubs. But they are heavy on the surface, more expensive, and require more maintenance and irrigation.

2- The other type covers a light layer of vegetation and is less than 15 cm thick. It is intended for shrubs and herbs that do not require much depth in the soil to grow

Figure 37: Green roof mode

2.7.4 Paint colours to reduce heat gain

The use of light colors in painting the house contributes to saving energy, as it reflects the light, which contributes to increasing the efficiency of lighting inside the rooms and reduces the intensity of the sun rays falling on the house, for example, light in red gives the feeling of heat, while light in white or blue gives a feeling of cold. The lighter the color the greater the applicability of reflectivity, as darker-colored walls absorb more light and reflect less, and therefore, the lighting required for rooms with dark walls is much more than for those with lighter walls.

2.7.5 Replacing traditional light bulbs with energy efficient bulbs

Replacing conventional lighting fixtures with efficient fixtures can save a significant amount of energy.Table 9 below compares a 60 watt (W) traditional incandescent with energy- efficient bulbs that provide similar light levels .

Table 9:Comparisons between traditional incandescent, halogen incandescent, CFLs and LEDs

	60W Traditional Incandescent	43W Energy-Saving Incandescent	15W CFL		12W LED	
			60W Traditional	43W Halogen	60W Traditional	43W Halogen
Energy Saved (%)	–	~25%	~75%	~65%	~75%-80%	~72%
Bulb Life	1000 hours	1000 to 3000 hours	10,000 hours		25,000 hours	

The residential sector in Jordan consumes 8,038 GWh/year, which represents around 46% of the total consumption. The highest consumption is in space heating followed by space cooling and lighting as shown in Figure 13 below. The average electricity consumption for a typical household is 245kWh/month. (17).

3 Evaluation of the new/revised procedures for energy building refurbishment

In this chapter, the most common techniques in Energy Building Refurbishment(EBR) were evaluated as well as a table summary of SWOT analysis for the green buildings for the most techniques proposed in this report.

3.1. Evaluation of the study on energy building refurbishment in Tunisia

The study presented the impact that certain choices made during the design of a building can have on its energy balance. The following results can be deduced:

- The change in the North-South orientation of the building in East-West increased the demand for heating and air conditioning respectively by 5 % and 11 % for a total increase in consumption of 3%.

- The replacement of single-glazed windows with low-emissivity double-glazed windows resulted in an energy saving of 5.46%.

- The energy gain is not proportional to the number of glazing that constitutes a window but rather to the thermal quality of the window itself.

- The use of a single glazing with a heat loss coefficient U = 6.32W / m².K did not give an energy gain for all the facades including the southern one.

For double-glazed windows, it is absolutely necessary to avoid placing them on the north facade, otherwise its energy needs will explode simultaneously with the increase in the glazed surface.

- The study of permanent solar protection has shown that the energy needed for heating has increased inversely with air conditioning which has recorded a fall of more than 30%, in the end it arrived at a total energy gain of more than 13 %.

- The building envelope has a significant impact on energy consumption. However, replacing the hollow brick wall (e = 15cm) with a double partition (e = 30cm) resulted in a 22% reduction in energy consumption.

- Insulating the roof with 7 cm thick expanded polystyrene resulted in a 35% reduction in energy consumption. On the other hand, wall insulation is not too profitable for an air-conditioned room.

3.2. Common techniques in Energy Building Refurbishment evaluation

a- Movement sensor for green buildings

Motion sensor is a tangible and visual technology. Reduces electrical energy consumption by 59% of lighting consumption. It aims to rationalize electrical energy consumption. It also works on sufficient lighting for the building when entering automatically.

b- Improve the thermal performance of the building envelope

From the advantages of the thermal performance of buildings to achieve limiting the transfer of heat through the external structural elements of the building envelope, whether in the form of thermal loss from inside the building to the outside in the event of heating the building in winter or in the form of heat gain from outside to inside in the summer and saving energy used for heating and cooling purposes, and raise the level of thermal comfort and provide a healthy internal atmosphere for the building occupants throughout the seasons of the year.

c- Adding thermal insulation to building's external walls and roof

One of the advantages of these techniques is that they contribute to !!!!!! the consumption of electrical energy, as thermal insulation is achieved by saving energy and saving it by reducing the value of heat gain or heat loss from buildings. Among the technologies used for walls and roofs are rock wool, polystyrene and polyurethane that are common thermal insulation materials, as they are resistant to high temperatures and contribute to protecting the environment.

d- Installing double glazing windows and skylights

One of the advantages of installing double windows in the green building is energy savings of up to 59% compared to the current used windows, as it works to preserve heat and prevent internal and external air leakage. Double glazed windows improve sound insulation by creating a barrier between the building and the outside environment. Double glazed windows are more difficult to break than single pane windows. So it's recommend.

e- Reducing heat gain by introducing shading devices

It is an excellent way to prevent unwanted solar heat from entering the interior space, and it is used to reduce the heat gain of buildings during the daytime period, as it contributes to improving the user's visual comfort by controlling glare, improving the quality of natural lighting and controlling the amount of light that enters the building.

f- Growing roof and paint colours to reduce heat gain

Roof cultivation is one of the techniques that help provide protection from thermal radiation, as it is considered an insulator for the ceilings and reduces energy consumption, and it is easy to apply this cultivation due to its ease and low cost, and it is also distinguished for buildings by saving energy and increasing the aesthetics of surfaces.

Paint colors also contribute to reducing heat gain by using appropriate colors that reflect light, reduce sunlight gain and insulate heat. As the use of paint colors low cost. Therefore, these technologies are recommended to be beneficial for the environment, buildings and save energy.

g- Replacing traditional light bulbs with energy efficient bulbs

It contributes significantly to saving energy, which is reflected in reducing electricity bills, and has a long life compared to traditional lampsTherefore we recommend using the saved lamps because it saves a large percentage of electricity consumption and for its high efficiency for lighting and low cost.

h- Using efficient air conditioning systems

Air conditioning refers to the cooling and drying of air in buildings, and it is an important technology for stabilizing temperature and humidity. The air conditioners used are inverter air conditioner and inverter type air conditioner that help reduce energy. We conclude that the lower energy-consuming air conditioners are better to use and have higher efficiency compared to conventional air conditioners.

i- Hot water supply

This is an innovative technique to convert sunlight into heat to heat water by using a solar panel that helps save water and electricity and is also important for the environment. The use of underground tanks is an unconventional technology that is innovative to conserve water waste and use of wastewater in various activities in the building.

j- Solar panels

Solar panels are considered one of the technologies that have great importance in using the sun to convert it into thermal and electrical energy. Among the advantages, it can be cited: renewable energy source, reducing electricity consumption, reducing bills, preserving the environment from pollution, as well as long-term energy and low maintenance costs.

3.3. SWOT analysis

Jordan, like any other country in the world, suffers from the environmental issues related to climate changes, air pollution, water quality, energy and health. In this analysis, we attended to use our approach related to the environmental issues in relation to energy. In the table below, the SWOT analysis is summarized :strengths, weaknesses, opportunities, and threads.

Table 10:SWOT for environmental issue in Jordan

Strengths	Weaknesses
-Transforming construction into a more efficient and healthy sustainable approach -Raising the energy efficiency of buildings by saving water and electricity -Extending the life of the building -Reducing pollution by using more environmentally friendly natural resources	-Lack of political and energy mechanisms -Lack of good geographic locations for construction -Buildings require a longer time to construct and design -Unavailability of certain environmental conditions and building materials
Opportunities	**Threats**
-Orientation towards sustainable environmental resources -Increasing awareness campaigns and workshops to spread knowledge about green building -Promote projects with solar thermal panels	-High costs -People may not be convinced that green building can contribute to saving water and electricity, so they will not venture to build it -Change in technology/new products and innovations for competitors

Table 11:SWOT analysis for energy issues in Jordan

Strengths	Weaknesses
-Healthy environment in Zero Carbon -Governmental Regulations -Benefits and Low Tax -Reducing pollution in environmentally friendly natural resources	-Lack of awareness from people in Jordan -Lack of experience -Bad infrastructure for Environmental Bases -No tracking systems applied
Opportunities	**Threats**
- Health and safe society. -Increasing number of job opportunities. -Increase the number of funded projects in this topic.	-High costs for infrastructure and materials. -Instability of governmental decisions. -No decision makers in this topic

Table 12: SWOT analysis for financial issues in Jordan

Strengths	Weaknesses
-Profitable return on investment -Good energy potential of buildings -Establishing economic buildings that serve the world	-High cost -Weak institutions at the policy and operational level -Lack of rare materials capabilities
Opportunities	**Threats**
-High demand for investors/beneficiaries -Provides new job opportunities for construction workers -Increasing energy efficiency and using new technology	-Depreciation of long-term investments -Absence of a domestic financing scheme for energy and efficiency measures -High costs of energy technology investment -Inability to finance large projects

4 Conclusions and highlights

The Mediterranean Partner Countries (MPC) face major energy-challenges including the supply, management and transition towards renewable and clean sources and energy efficient measures.

This report described several new and revised procedures for the energy building refurbishment taken in the MPC with a strong focus given on the technological aspects that can improve the energy profile of a building.

The identified best practices for building Energy refurbishment according to the situation of the energy in the popular Buildings in Jordan are: add thermal insulation to building's external walls and roof, install double glazing windows, reduce heat gain by introducing shading devices, replace traditional light bulbs with energy-efficient bulbs, use efficient air conditioning systems, use tank less water heater connected to solar water heating panel, and finally Use solar panels.

All these practices contribute to enhancing the transformation of the buildings into Green ones.

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