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Energy Efficiency Retrofit for Existing Financial Institutions in Egypt
Case Study: CIB Bank

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Abstract. Existing buildings consume a significant amount of energy in electricity that is used in ventilation, heating, cooling, and lighting. The sustainable retrofit strategy is becoming a more common trend in our modern century to improve energy efficiency for existing buildings. The research aims to explore the emphasis of energy retrofit measures for upgrading the energy performance of the existing buildings especially in commercial buildings. The CIB bank in smart village was chosen as a case study to evaluate the energy retrofit strategies that were upgraded in the building, through conducting a survey analysis depending on the simulation for existing banks and financial institutions of GPRS criteria to introduce the solutions into passive and active retrofit measures. The results come out with a theoretical framework for implementing energy retrofit for commercial buildings.

Keywords: Green Pyramid Rating System, Existing Financial Institutions, Energy Retrofit, Energy Efficiency.

1. INTRODUCTION

Energy retrofit measure aims to upgrade existing buildings to improve its performance in terms of energy use and its associated CO2 emissions, to positively affect the building's environmental, comfort and aesthetic conditions. Measures can affect changes to the building's structural elements (fabric), changes to the building's engineering systems providing heating, lighting and power, water, air supply and extract, or its energy supply (services) or changes to the way in which people interact with the building (behavior). Enhancing the building envelope through passive strategies and upgrading the inner system through active strategies can greatly save the energy consumption especially in commercial buildings.

1.1. Research Problem:

The fact that existing buildings comprise the largest segment of the built environment and generally use significantly more energy, that raised the importance to tackle the method for measuring and improving the performance of energy in existing buildings. Retrofitting existing buildings in Egypt face serious challenges and barriers that need to develop a framework to facilitate the retrofitting process.

1.2. Research Aim:

Energy saving has become a major sustainability goal were the research aims to discuss the energy saving of the existing CIB bank institution after retrofitting as an example for further existing commercial buildings to become a resource of efficient and environmentally friendly, and its vital role in reducing energy consumption and carbon emissions. It is also seeking to reduce energy loads and encourage the provision of using energy meters that allow the energy performance to be recorded.

1.3. Research Methodology:

The researcher adopted a qualitative methodology to discuss the criteria, techniques and measures of the energy retrofit in existing buildings by incorporating passive and active retrofit strategies. The building data was collected and analyzed by using the design builder simulation model to cast a shadow for the importance of the energy retrofitting in existing buildings which have been classified according to the GPRS categories into passive and active measures to find out the benefits of the energy retrofit in the selected building. The results come out with a framework which helps owners and operators of commercial buildings to implement retrofit strategies.

2. LITERATURE REVIEW

2.1. Energy Retrofit in Egypt

The Government of Egypt is supporting various solutions to face the energy challenges as the energy use in buildings is the most stressful indicator with 45-50% of the total energy used in all industries [1]. According to the Arab Republic of Egypt Energy Efficiency Implementation report the commercial buildings which are used for commercial activities, such as malls, hotels, banks and office buildings consume 5.003 GWh which is 4.1% of all electricity consumed in Egypt. (36%) of the total energy consumed in commercial buildings is consumed for lighting, (35 to 40%) for cooling, ventilating and air conditioning (HVAC) systems and the rest for other uses [2]. The average of energy consumption for commercial buildings in Alexandria and Cairo is 317 KWh/m^2 in comparison with public buildings which consume 131 KWh/m^2 because commercial buildings have more cooling and mechanical systems than public buildings. Therefore, there is a responsibility for the government and stakeholders to introduce sustainable retrofitting applications and techniques for the existing building especially for commercial buildings sector to save energy and to raise the energy efficiency of buildings performance.

The Egyptian government has already started to take serious steps in developing a strategy of Egypt's vision 2030 and sets its objectives to improve the energy sector and reduce the environmental footprints and greenhouse gases to improve the wellbeing of the Egyptian citizens. On the other hand, the state realized that the construction sector needs a major development and transition in its performance towards a sustainable built environment [3].

Alexandria's government makes the choices for renovating existing structure and constructing new ones through the Environmental Action Plan (EAP). It sets a short term, mid-term and long-term actions to achieve its targets. The target for 2020 is to make 60% of all existing buildings achieve 20% energy consumption reduction, the target for existing city buildings in 2025 are 25% more energy efficient and by 2030 all new buildings will be carbon neutral[4]. This plan needs to be more effectively applied to the city's buildings and the stakeholders must began to take a seriously steps towards its implementation.

2.2 Barriers and Challenges of Sustainable Building Retrofit in Egypt

The gap between the Egyptian laws and rating systems (Green Pyramid, TARSHED) is a large barrier, as the rating systems were not designed to be in harmony with the Unified Building Law nor its executive appendix. In addition to the urgent need for greening some of the regulations of the Unified Building Law especially that is concerning the energy issues.

The high cost of sustainable building renovation is considered the largest barrier in addition to the need for long-term procedures which are seems to be difficult for stakeholders in Egypt. As the Building owners and stakeholders often take into account the actual cost and do not consider the long-term returns. Another barrier that faces the retrofit process in Egypt is the sustainable technologies which are strange for the Egyptian community, in addition to the absence of specializing companies in the Egyptian market.

2.3 Energy Retrofit Rating Systems

The various rating systems set technical criteria that seek to provide technology solutions to the different environmental issues to upgrade both new and existing buildings. There might be common categories between the different universal and national rating systems but their perception and content are different according to the local needs. However, the majority gives a highest importance to the energy category.

The Green Pyramid codes in Egypt provides green credentials for the assessment of buildings in Egypt through raising awareness of the necessity of green buildings according to the Egyptian context and conditions [5]. It is developed for both new and existing buildings as the specific code for greening existing buildings is still under development. The energy category has 30 points that represent 30% from the total points which refer to the importance of energy efficiency in improving the building's performance. The energy efficiency category in GPRS focused on the energy performance through two approaches; active and passive which will be concluded as a result of the analytical study of the CIB bank.

The commercial international bank in cooperation with the housing and building research center developed the rating system GPRS for existing banks and financial institutions to improve the organization's contribution to sustainability and reducing their impact on the environment. Its goal is to enhance energy conservation, reduce energy consumption and improve occupant health and productivity. The CIB bank in smart village was considered to be the first Egyptian bank to acquire the Egyptian Green Pyramids Rating System Certificate (GPRS)[6].

3. DATA COLLECTION AND ANALYTICAL STUDY OF THE RETROFITTING PROCESS FOR CIB BANK IN (SV3).

The CIB's was awarded the GPRS, Golden grade, following inspection by a technical committee of experts from the Ministry of Energy, HBRC, and Ministry of Housing, Utilities, and Urban Development [6].Energy Efficiency achievements in 72 branches and 5 head offices, are 44,968 LED bulbs installed, 32 solar water heaters and 3 Solar panels were installed. CIB bank in smart village (SV3) success in saving energy with almost 40% reduction, by using energy efficiency applications for basic energy requirements in its inner system, in addition to sustainability treatments in the building envelope as shown in fig 1.

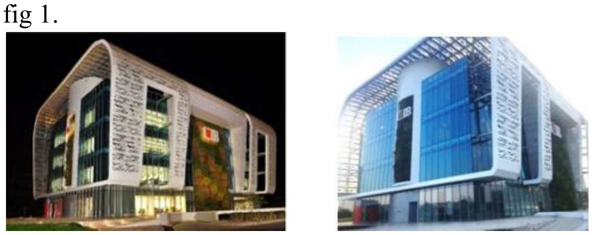


Fig. 1 The Current Situation of CIB After Building Envelope Retrofitting.

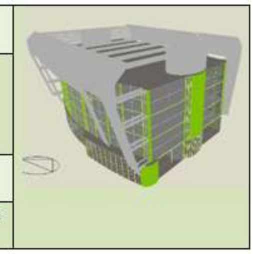
3.1. Building Simulation Process

Simulation process helps to identify the energy audits to know specifically energy consumption usage and calculations that will be used to predict energy savings of interventions to the building envelope or equipment. To facilitate this process a reliable tool must be followed. Design Builder software was used in the analysis as a tool to calculate and evaluate the aspects of building design in the context of energy and environmental performance. The energy consumption for the upgraded scenarios was compared to the energy consumed of the initial base case before treatment as shown in tables 1, 2.

Table 1. The Building Before Treatment (Base Case) Source: (Researcher).

1- Weather data file	Cairo air port	
2- Construction 2-1 wall 2-2 roof 2-3 opening	 R= 0.43 (m^2/W) No insulation R= 0.523 (m^2/W) No insulation Single clear 6mm No shading	
3- System air condition	Fan coil unit	
4- Schedule	All week days expect Friday	

Table 2. The Current Building After Treatment (External Shed and Green Walls). Source: (Researcher).

1-Weather data file	Cairo air port	
2-Construction 2-1 wall 2-2 roof 2-3 opening	Green wall R= 1.95 (m^2/W) Double glass 6-15- 6mm shading	
3-System air condition	Fan coil unit	
4-Schedule	All week days expect Friday	

The energy consumption of the base case was 103.9390 M.w.h and have decreased to 636.337 M.w.h after the retrofit process, the percentage of energy saving is almost 40% as shown in fig 2.

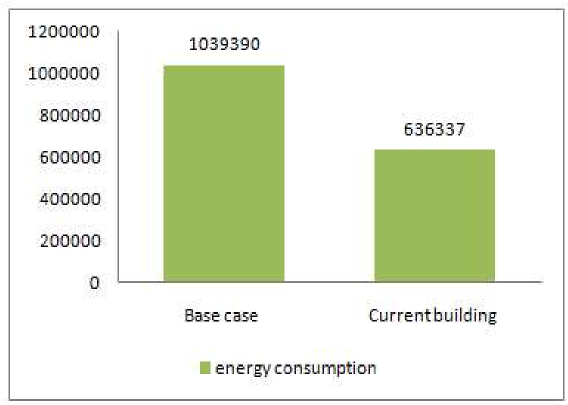


Fig.2 Energy Saving in CIB Bank.Source:(Researcher).

3.2. Energy Retrofit Measures

Upgrading the buildings' operational and physical systems to perform more efficient is an important strategy for energy retrofit in existing buildings. Retrofit measures can be implemented in the building's envelope (passive measures), or to the building basic energy requirements (active measures). The case study is chosen to analysis the GPRS energy credits through the retrofit measures mentioned above as follow:

(1) Building envelope: Passive retrofit measure

A. walls
B. roof
C. openings
D. external shed

(2) Building basic energy requirements: Active retrofit measure

A. Lighting
B. Occupancy sensors
C. Electrical Meters
D. Split units

1. **Building Envelope: Passive Retrofit Measure**

Passive retrofit measures deal with the treatment of building envelop that eliminates the need for heating or cooling, which accounts the highest consumption of building energy use. Retrofitting of the CIB bank was done by using various energy conservation treatments which were upgraded to improve the physical properties of the building envelop. This section illustrates the building envelope treatments through walls, roof, external shade and openings as follow:

Knowing that R-value and u-values are considered the main indicators to measure the passive retrofit. R-value is a material's resistance to heat flow so that the higher R-value, the better in the thermal insulating. However, U-value measures the rate of heat transfer, so materials with a lower U-value will be more energy efficient.

1. A Walls

Thermal performance for walls is an important passive measure, it affected by many factors such as the type and thickness of insulation materials, their locations, the climatic zones that they have been used in.

Green walls play an important role in the CIB bank to improve the thermal performance, increase energy efficiency, reduce indoor and outdoor temperatures, and improve air quality. The Green walls consist of 4 layer of paint isolation for walls and slab, 5cm isolated wood structure and 250mm green wall system thickness.

1. B. Roof

Roof insulation and green roof were upgraded in the building as a passive strategy to improve the roof thermal properties. The following table 3. compares the R and u-value before and after treatment adding 5cm EPS expanded polystyrene.

Table 3. Roof Properties Before and After Treatment Source: (Researcher).

Properties	Before treatment	After treatment
Layers	1. Cement mortar 2. Reinforced concrete slab 3. Sand 4. Mortar 5. Cement tiles	1. Cement mortar 2. Reinforced concrete slab 3. EPS expanded polystyrene 4. Sand 5. Mortar 6. Cement tiles
R	1.91 (m^2/W)	1.95 (m^2/W)
u-value	0.523 (W/m^2)	0.512 (W/m^2)

1. C. Openings

Glazing system of building's openings has protective functions that allows for the exchange of solar radiation, heat, light and air, thus, the double glass was upgraded in the building instead of the single clear 6mm. Double glass consists of two layers of glass with a layer of inert gas between them to reduce the thermal effect. Table 4. shows the physical properties of the glazing before and after treatment.

Table 4. Glass Properties Before and After Treatment Source: (Researcher).

Properties	Before treatment	After treatment
Type	Single clear 6mm	Double glass
SHGC	0.82	0.39
VT	0.88	0.48
u-value	6.14 (W/m^2)	1.6 (W/m^2)

1. D. External Shed

The shading impact is an important passive strategy, it affected by many factors such as the building layout and orientation, the site location and limitation. The external shed that surrounding the building has an impact in mitigating the solar gain; it obscures the sun rays from the roof and façades and reduces the thermal effect to demonstrate a minimum energy performance level. Beside the solar gain mitigating impact, the external shed consists of photovoltaic (PV) components to produce energy.

According to the report of Summit Egypt Company[7] the total PV energy production is estimated to be: 123.32 MWh /a, and the technical data of PV used in the project is:

- Estimated PV project size: 80 kWp, and the grid requirements: low voltage grid –national grid.
- Total number of PV modules is 276
- Roof top panels = (196*1m*2m*13mm*295W)
- Curved façade panels = (80)*1m*2m*9mm*295W
- The peak power is 8142 KWp
- The inverters that are implemented:
  2 inverters each one is 25 Kw (STP 25000-TL 30)
  4 inverters each one is 5 KW (STP 5000-Tl 10)

2. **Building Basic Energy Requirements: Active Retrofit Measure**

Active retrofit measures deal with the building inner systems that provide lighting, heating, cooling, domestic hot water and HVAC. In CIB bank, design was prepared to reduce the electrical consumption not less than 30% using led fixtures, occupancy sensors, solar system, and central solar heater, electrical meters and split units. The following are the treatments of such requirements.

2. A. Lighting

It was found that energy savings could be easily achieved by enhancing the electric lighting system such as using LED light. It is long lasting, cost effective, and mercury free. The use of LED light in the building helps to decrease the electric usage for lighting.

2. B. Occupancy Sensors

Occupancy sensors provide a simple way to automate artificial lighting and control of various devices such as HVAC devices. It helps to minimize the consumption of electricity usage in CIB bank.

2. C. Electrical Meters

Energy meters and sub-meters enable energy consumption auditing for the different parts of the electrical and mechanical systems of the major energy consumption categories. The building installed meters for HVAC, Water, Grey water, PV and electrical meter. All Meters (Electrical, PV, HVAC& Water) are connected to BMS System to achieve the Peak load reduction credit.

2. D. Split Units

The weighted average of all refrigerants and fire suppression systems media has an equivalent Global Warming Potential (GWP) that meets or is less than the requirements of Egyptian Environmental Law. All split units used at the building with refrigerant (407 A) which environmental friend refrigerant that necessary for the Environmental impact credit.

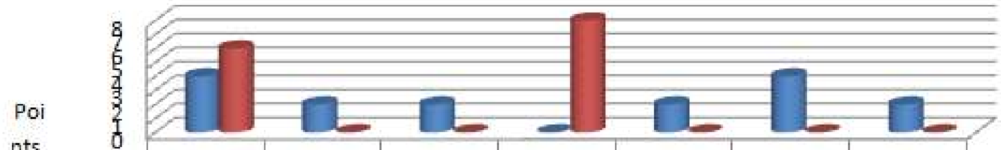
3.3. Results of the Simulation Analysis of the Applied Initiatives to Energy retrofit Measures.

The results of the simulation analysis for the applied initiatives of the GPRS energy credits in the CIB bank according to energy passive and active retrofit measures are shown in table 5.

Table 5. The Applied Initiatives of the Credits to Energy Retrofit. Source: (Researcher).

Credits / Mandatory Requirement	Applied InitiativesPoints		Passive retrofit	Active retrofit
M.1: Minimum Energy Performance Level	Building design depends on the consumption of minimum rate of energy by using: PV, double glass, external shed, central solar water heater, LED lights and occupancy sensors.	M	✓	✓
M.2: Energy Monitoring and Reporting	Monitored the energy consumption by using an electrical meter in the building, besides, using an innovation screen at the ground floor to show current reading for solar system and annual yield reading.	M		✓
M.3: Ozone Depletion avoidance	Using refrigerant (407 A) which is environmental friend refrigerant.	M		✓
M.4: Operation & Maintenance manual	All Mechanical, Electrical and Plumbing (MEP) equipment's in the building have operation manuals to make the maintenance simple.	M		✓
C1: Energy Efficiency Improvement	The building consumes a minimum rate of energy by using PV, double glass, external shed, central solar water heater, LED lights and occupancy sensors.	10	✓	✓
C2: Metering and sub metering	Building is provided with HVAC, Electrical Water and PV meters to enable energy consumption auditing for MEP parts. An innovation screen is installed at ground floor to show current reading for solar system and CO2 reduction and annual yield reading.	2		✓
C3: Peak load reduction	All Meters (Electrical, PV, HVAC and Water) are connected to Building Management System.	2		✓
C4: Renewable Energy Sources	The building covered with solar sheets (Rooftop panels & Curved façade panels) to supply electrical energy to the system with monitoring innovation screen at ground floor that shows current reading for solar energy and annual yield reading.	8	✓	
C5: Environmental Impact	All split units used at the building with refrigerant (407 A) which is environmental friend refrigerant.	2		✓
C6: Optimized balance of Energy and Performance	The indoor air quality in the building adjusted by air quality sensors connected to the variable speed motors for fresh air units.	4		✓
C7: Energy and Carbon Inventories	All MEP equipment's have operation manuals to make the maintenance simple.	2		✓

According to the previous table, it was concluded that there are shared mandatory requirements and credits that combined active and passive retrofit; however, the applied initiatives for active retrofit has the higher benchmarking for energy credits of the GPRS as shown in fig 3.



	Energy Efficiency Improvement	Metering and sub metering	Peak load reduction	Renewable Energy Sources	Environmental Impact	Optimized balance of Energy	Energy and Carbon Inventories
Active	4	2	2	0	2	4	2
Passive	6	0	0	8	0	0	0

Fig 3. Passive and Active Retrofit Benchmarking. Source: (Researcher).

4. RESULTS

The result is to set a framework for owners and operators of commercial buildings in Egypt to upgrade and implement practical and measurable building energy retrofit. The framework combines methods to implement energy retrofit through three main concerns which summarize the active and passive retrofit into building fabric, services and occupant's behavior as shown in fig.4.

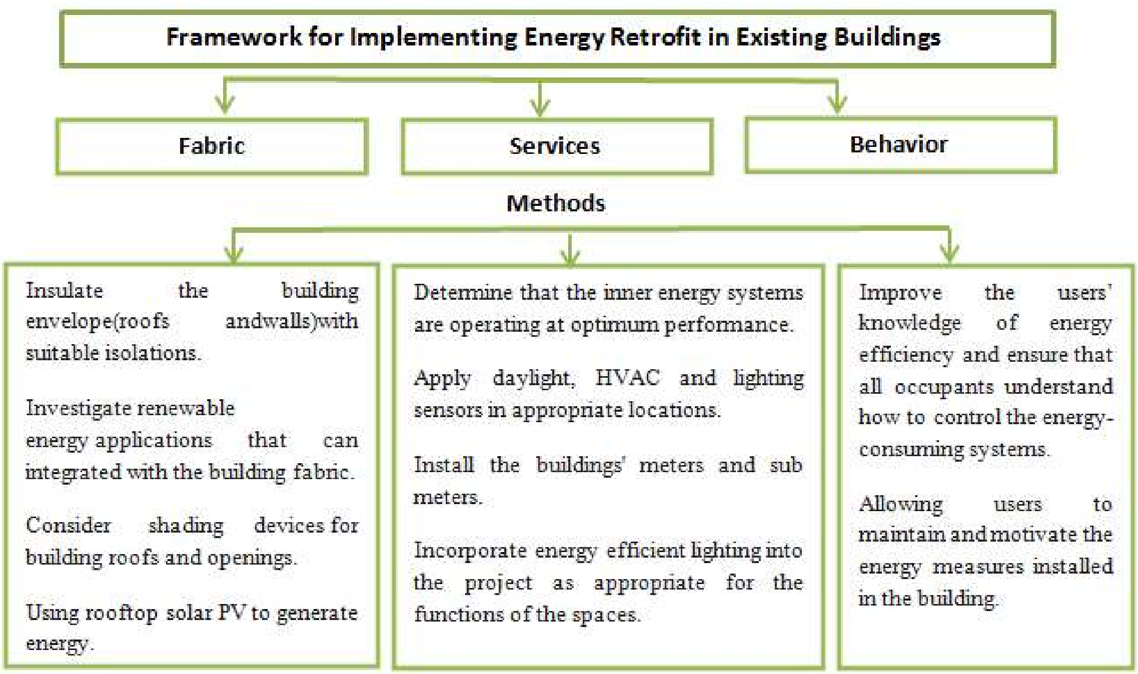


Fig. 4Framework for Implementing Energy Retrofit in Existing Buildings Source: (Researcher).

5. CONCLUSION

The building has introduced several innovations and implementation in energy efficiency retrofit and the lessons learned have emerged as follow:

- The CIB skilled management is a key factor for the successful retrofit strategy.
- The improvements of minimizing the energy consumed by the commonly used building appliances reduce energy demand and optimize the choice of electrical and mechanical equipment's.
- The rating systems of the GPRS criteria helps to find technical ways to reduce energy load, increase efficiency, and maximize the use of renewable energy sources.
- The incorporating of active and passive retrofit strategies in CIB bank is an important factor to raise the energy efficiency in the building.
- The retrofit process creates a more productive environment that improve the staff productivity, health and wellbeing, in addition

to improve the indoor air quality and reduces carbon emissions.

- The social, economic and environmental aspects was greatly improved after the building retrofitting.

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