# Evaluate The Use Of New And Renewable Energy In Tourist Buildings To Reduce Operating Costs Applied Study On Tourist Hotels In Sharm El Sheikh

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**Abstract**:
Egypt is actively working towards developing the use of new and renewable energy sources. This commitment is evident in Egypt's participation in the COP27 climate conference, where it aims to maximize the utilization of solar energy and explore new prospects for green hydrogen. Egypt strives to be at the forefront of renewable energy adoption globally. To achieve these goals, it is essential to focus on two main aspects: developing plans and strategies for incorporating new and renewable energy in newly constructed buildings and enhancing existing facilities by studying how to implement and measure the effectiveness of renewable energy utilization. This involves assessing the expected energy savings and evaluating the efficiency of renewable energy systems in the operational phase.
This research emphasizes the importance of applying the principles and steps of value engineering to evaluate the effectiveness of replacing the current energy system with a renewable system and the potential energy reduction. A case study of a hotel in Sharm- El Sheikh Governorate is discussed in this research. The value engineering approach is applied by gathering information, forming a team to analyze this information, and conducting functional analyses. In this step, the operating costs are studied, revealing that they are high, mainly due to energy consumption and the use of fuel in boilers for water heating, resulting in environmental pollution. The next step in the engineering approach is to provide solutions and innovations, studying their feasibility, cost, and the achieved savings potential.

**Keywords:** Value engineering - new and renewable energy - tourist facilities - changing traditional energy systems with renewable ones.

## 1. INTRODUCTION

Tourism is one of the most important arms of the global economy, as it constitutes a major source of income, foreign currency revenues, tax revenues, and employment, especially since nearly a tenth of the world's population works in it, and hundreds of millions of others earn from it, and it accounts for about 7% of international trade, and 28% of International service exports, as well as representing approximately 20% of the gross domestic product of some countries. The number of international tourist arrivals to Egypt in the first quarter of 2023 increased by 86% compared to the same period last year, and reached 80% of pre-Corona pandemic levels, and the Middle East region witnessed the strongest performance in the first quarter of 2023 as it is the only region Which exceeded 2019 levels by 15%, according to the report of the United Nations World Tourism Organization (UNWTO). Egypt is considered one of the most important and attractive destinations for tourism in the world due to its rich and diverse natural resources and tourist, archaeological and human resources, in addition to its unique cultural heritage. Which enables it to maximize its revenues from the tourism sector, especially since it contributes about 11.3% of the total national income, provides about 13% of the total foreign exchange, and employs about 12.6% of the total Egyptian labor market force. The tourism sector is characterized as a labor-intensive sector, with 3 million people working in professions directly and indirectly related to tourism, representing about 12.6% of the total workforce in Egypt. According to official statements by the Minister of Tourism Ahmed Issa, Egypt contains 210 thousand hotel rooms, and targets... Increasing it to half a million rooms over the next 7 to 10 years, which requires attracting investments worth $20 billion in order to achieve the government's goal of increasing visitor numbers to 30 million tourists annually.

The hotel is one of the parties to the tourism system. Therefore, the hotel was chosen to be the subject of the study and the focus of applying the value management approach for several reasons, including:

Improving the operational and technical level of the hotel is one of the reasons for the success of the tourism system in Egypt by reducing unnecessary operating costs while maintaining the total cost does not increase. This leads to a hotel room at a competitive price that increases the occupancy rate and the number of hotel nights, and then achieves a higher return on investment. Because the hotel is a building with multiple activities and functions, it has multiple activities, including various activities, electromechanical systems, and special systems, which makes it a rich example for researchers and scholars to analyze its elements. Any study to understand the large and influential areas of consumption and the work saved therein will have a very large impact on the private level for the project and on the general level for the state. The difference in the hotel's consumption in general from its operating study makes it a greater opportunity to find new alternatives and ideas to achieve the same required functions, but with high quality, lower cost, and more sustainability and environmental preservation

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## 2. STATEMENT OF THE PROBLEM

3. Increase in energy consumption costs in tourist facilities, especially hotels. As a result of this large increase in costs, which led to a decrease in the profit rate and a reduction in spending on services provided to the end user and a reduction in replacement and renewal expenses, which affected the efficiency of services provided to the end user, which is the tourist..

## 3. RESEARCH SCOPE AND PURPOSE

The designers had to conduct studies on studying hotel projects in the operating phase, as well as targeting the major cost areas in operation and applying the value engineering approach to them to reach the best ways to reduce these costs, which are the costs related to energy consumption in high hotels, by studying the extent of application of one of the new and renewable energy systems, in particular the application Using solar energy in hotels and studying the extent of its effectiveness in all hotels in Sharm El Sheikh Governorate .

## 4. RESEARCH METHODOLOGY

The methodology of this research focused on studying new and renewable energy and the possibility of applying any of them in tourist establishments, especially hotels, regarding improving the energy consumption of hotels and reducing operating expenses, by studying new and renewable energy systems in general and the use of solar panels in hotels in particular. The study was conducted on hotels List of Sharm El Sheikh Governorate. In the theoretical part, many definitions related to the value engineering methodology and its characteristics were explained, in addition to its most important applications in architecture. In the analytical part, the study showed the steps of the value engineering approach that can be used to analyze and study costs and target high cost areas in the operating phase of hotels. A proposed methodology study for improving energy consumption in hotel buildings. Finally, in the applied part, a simulation was conducted of an existing hotel (the Cyrene Island Hotel in Sharm El-Sheikh Governorate), applying the value engineering methodology and a case study in the operating phase, which showed the areas of high cost that lie in energy consumption, and a study of the extent of application of the best new and renewable energy systems that can be applied in The hotel and calculate the amount of savings resulting from this application, which results in increasing the hotel's performance and improving the building's energy consumption.

## 5. APPLYING THE STEPS OF THE VALUE ENGINEERING APPROACH:

1. Collecting information
2. Function analysis
3. Innovation and presenting ideas
4. Evaluation and selection
5. Research and development and preparation of the final report

- **Applying the value management approach**

After we learned in the previous chapter about how to apply the steps of the value management approach to hotel projects with the aim of studying them during the operation stage and studying the highest cost aspects during operation. Targeting these citizens to achieve the highest performance efficiency and appropriate cost.

This chapter presents an analytical example as a case study of a tourist hotel that applies the steps of the aforementioned approach, presenting the results of the study, analyzing them, and judging them as to whether or not they have a real impact that can be implemented on the ground in increasing efficiency and saving and reducing unnecessary operating expenses.

A case study of a tourist hotel in Sharm El Sheikh Governorate (Cyrene Island Hotel) was chosen to be studied and a value engineering report prepared for it - by the researcher - in order to judge the hypothesis of the research presented above.

The chapter deals with defining the hotel, analyzing its components, choosing the field of study, analyzing its item and the functions it performs, then identifying the highest cost areas in operation and targeting them, providing alternatives to reduce this high cost, evaluating the extent to which these alternatives can be applied until we reach the optimal alternative and its development, and then preparing the final report.

Accordingly, the final results of the report are compared with the current situation of the hotel under study, and it becomes clear whether or not it is feasible to apply the value management approach to projects during the operating phase.

**5-1 Introduction to the project: Cyrene Hotel Group (Cyrene Island Hotel).**

**5-1-1 Historical background:**

Serene Tourism Investment Company (an Egyptian joint stock company) was established in the Arab Republic of Egypt - on 7/7/1999, that is, more than 23 years ago. It is a competitive advantage in the field of investment within the framework of the provisions of the Joint Stock Companies Law No. 159/1981, and the articles of association stipulate the licensed areas of activity.

**Assets owned by the company:**

1- Cyrene Island Hotel Group, with an area of 70,752 square meters
2- Number of rooms: 445 rooms
3- The number of floors is three floors
Now, Golden Hospitality, the management company, has decided to work with the company that owns the hotels to fully develop and modernize the hotel.

**Figure** 1 shows a general perspective of the hotel 1999: 2023

**5-1-2 Introduction to the hotel:**

| **Owner** | **Cyrene Tourism Investment Company** |
|---|---|
| Date of contracting with the anagement company | November 2019 |
| Duration of the contract | Ten years starting from the date of the hotel's opening after the completion of the comprehensive development work, which is expected to be completed in the first half of 2025. |
| Hotel location | C3/A & M1+M2 Montazah District - in front of Sharm El Sheikh Airport |
| The project area | 70752m2 |
| Hotel omponents | 1. Number of rooms: 445 rooms<br>2. The number of floors is three floors |
| **project manager** | **GHI Golden Hospitality** |
| Architectural consultant | Zia Architecture |
| Electromechanical consultant | Mac Engineering Consulting |
| Construction consultant | Dr. Hasballah Al-Kafrawy's office |
| General consultant | Zia Architecture |
| General contractor | Co Living Life Development |

## CYRENE SHARM HOTEL
### SHARM EL SHEIKH

## DEVELOPED FRONT PERSPECTIVE

**Figure** 2 shows a general perspective of the hotel after development 1999: 2023, the econdary section of the hotel

## CYRENE ISLAND HOTEL
### SHARM EL SHEIKH


## DEVELOPED FRONT PERSPECTIVE VIEW

**Figure** 3 shows a general perspective of the hotel after development 1999: 2023, the main section of the hotel.

**Applying the steps of the value management approach:**
**5-2-1 Collecting information**
**A- Engineering designs for the project**


**Figure** 4 shows the general location of the hotel

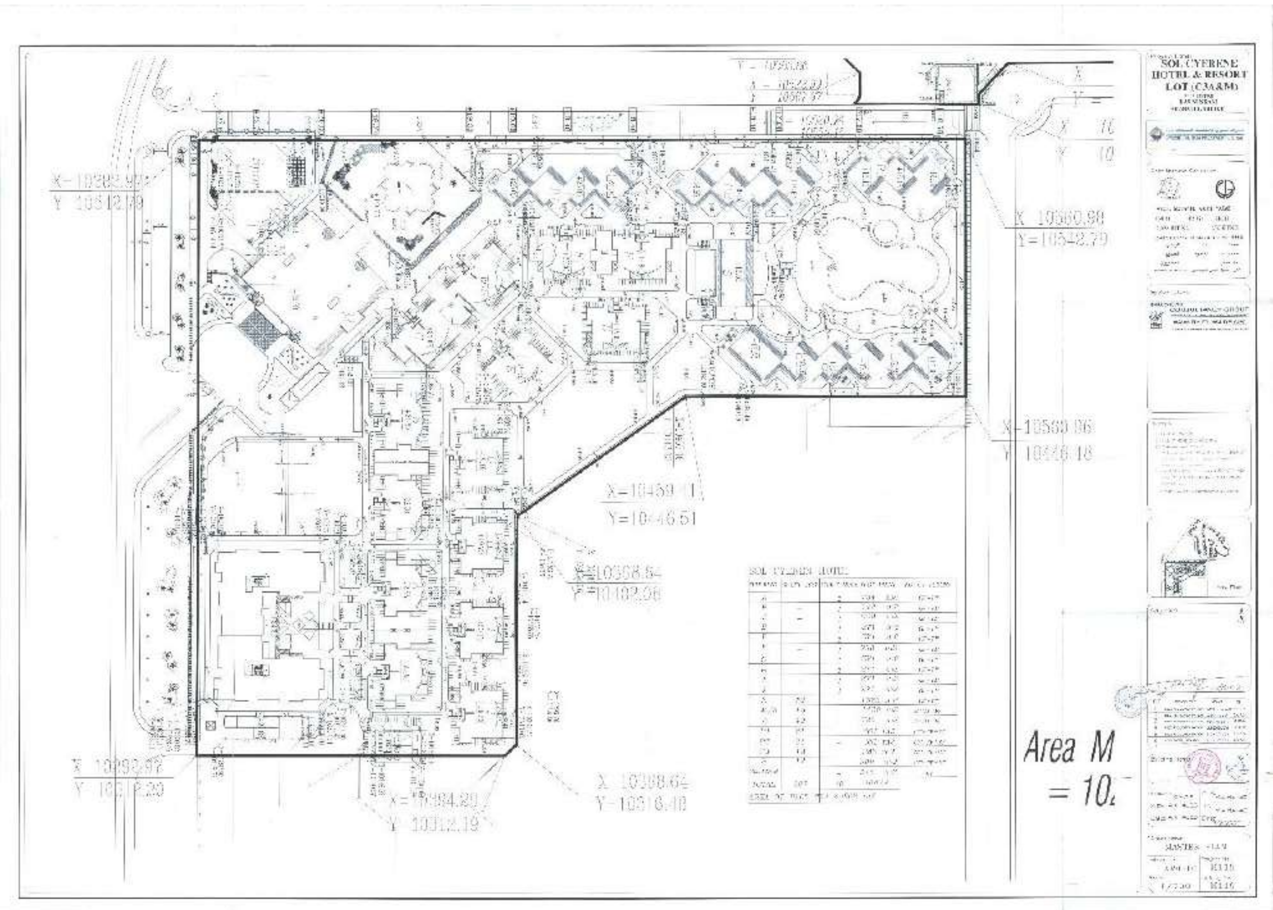


**Figure** 5 shows the general location of the hotel after development 1999: 2023, the main section of the hotel.

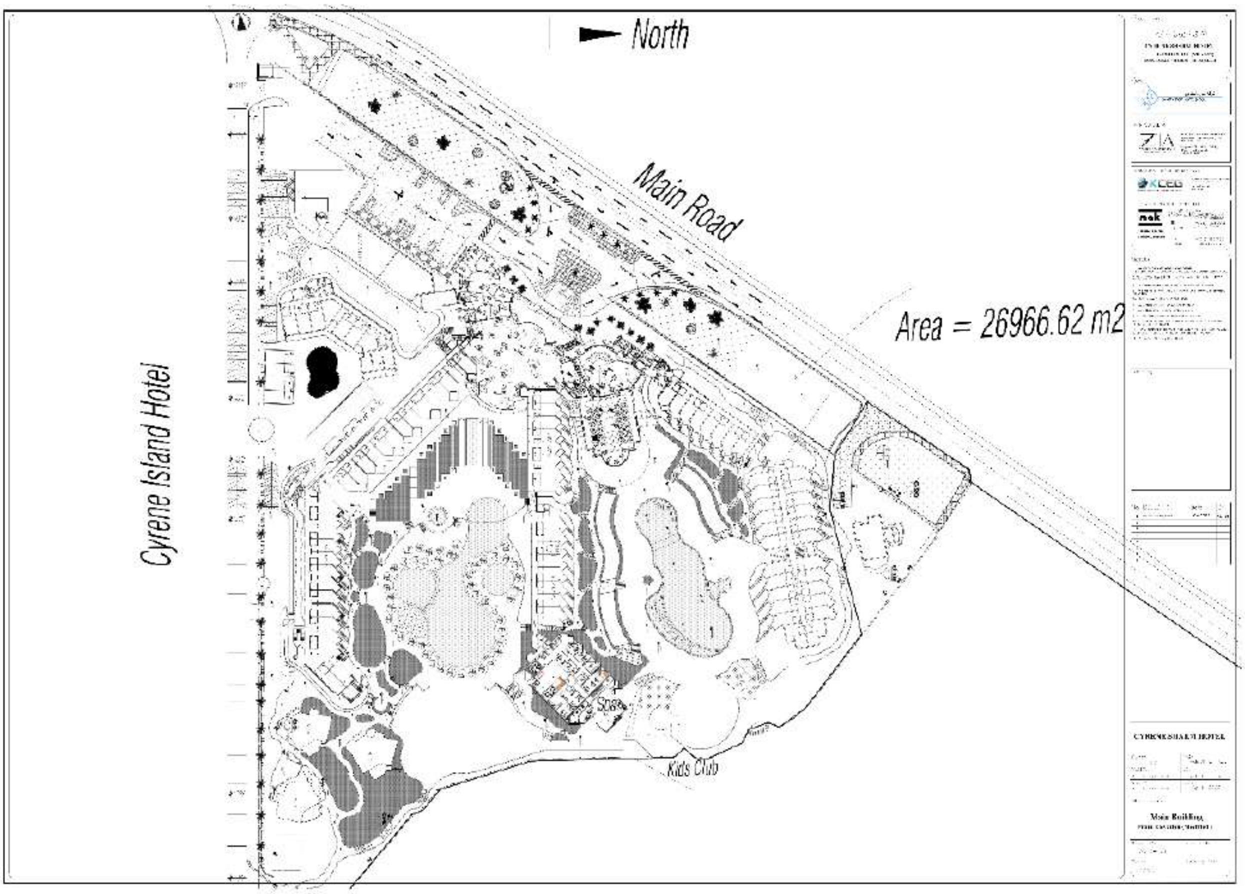


**Figure** 6 shows the general location of the hotel after development 1999: 2023, the secondary section of the hotel.

**B - Analysis of information**

1- Project coordinates 27°58'49.71"N, 34°25'7.98"E

2- A table of spaces and their areas for all hotel elements.

SOL CYRENE HOTEL:

| BUILDING | GUEST ROOM | STAFF ROOM | FOOT PRINT | NO. OF FLOORS |
|---|---|---|---|---|
| A | – | 1 | 784 m2 | GF+FF |
| B | – | 1 | 712 m2 | GF+FF |
| C | – | 1 | 800 m2 | GF+FF |
| D | – | 1 | 271 m2 | GF+FF |
| E | – | 1 | 271 m2 | GF+FF |
| F | – | 1 | 750 m2 | GF+FF |
| G | – | 1 | 271 m2 | GF+FF |
| H | – | 1 | 271 m2 | GF+FF |
| I | – | 1 | 271 m2 | GF+FF |
| J | – | 1 | 271 m2 | GF+FF |
| K | 72 | – | 1575 m2 | GF+FF |
| M/N | 15 | – | 1426 m2 | B+GF+FF |
| O | 42 | – | 785 m2 | B+GF+FF |
| P1 | 24 | – | 461 m2 | GF+FF+SF |
| P2 | 24 | – | 461 m2 | GF+FF+SF |
| P3 | 18 | – | 345 m2 | GF+FF+SF |
| S | 12 | – | 509 m2 | GF+FF+SF |
| ELE.ROOM | – | – | 243 m2 | GF |
| TOTAL | 207 | 10 | 10477 | |
| AREA OF LOT C3A=44239.79 m2 | | | | |

**Figure** 7 shows the land area of the first hotel. The total built-up area Foot Print = 10477 m2

**Figure** 8 shows natural pictures of the hotel from inside the project, the first part.


**Figure** 9 shows the total built-up area, Footprint of the land area in the second hotel = 5400 m2

**Hotel Components**

A – Main Budding
B – Guest rooms & Suites
C – Main Restaurant
D – Specialty Restaurant
E – Main Bar
F – VIP Lounge
G – Caribbean Tent
H – Swimming Pools
I –Pool Bar
J – Diving Center
K- Health Club
L – Electromechanically Budding
M - Cyrene Beach Boutique Hotel
N – Beach Bar
O – Amphitheater

**Figure** 10 shows the horizontal layout and elements of the second hotel

**3- Analysis of hotel operating costs.**

| **Cyrene Hotels Total Expenses For Operation** | |
|---|---|
| Expenses | Cost L.E |
| Payroll Expenses | |
| Salaries & Wages | 3,699,087.10 |
| Social Insurance | 940,268.80 |
| Benefits & Meals (Meals &Bonus & HR Allocation ) | 4,345,140.23 |
| Total Payroll & Related Expenses | 8,984,496.13 |
| Direct Cost | |
| Cost Of Food | 10,241,443.98 |
| Cost Of Beverage | 1,901,910.26 |
| Cost Of Telephone | |
| Cost Of Laundry | 4,493.01 |
| Total Direct Cost | 12,147,847.25 |
| indirect Cost | |
| Electricity | 6,125,842.40 |
| Desalinated water | 2,803,458.00 |
| Treated water | 356,094.00 |
| Fuel | 1,009,269.42 |
| Repair & Maintenance | 2,697,510.31 |
| Operation Expenses Rooms (Cleaning , Guest , Paper Per Guest ) | 685,600.09 |
| Rest of other Expenses | 653,101.01 |
| Operation Expenses F & B (Cleaning , Guest , Paper Per Guest) | 765,116.74 |
| Rest of other Expenses Food & Beverage | 876,500.38 |
| Administration & General | 1,917,950.69 |
| Sales & Marketing | 176,903.95 |
| Total Indirect Cost | 18,067,346.99 |
| | |
| Total Expenses | 39,199,690.37 |

**Table** 1 shows the hotels' annual operating costs of electricity, local water, treated water, and fuel.

It is clear from the analysis of the operating costs of hotels that: -
The operating costs are:
• Expenses (which are the operating expenses of workers operating hotels), which are outside the scope of research.
• Direct costs (which are operating expenses related to food and beverages for operating hotels) and which are outside the scope of research.
• Indirect costs (which are expenses for operating hotels), which are the subject of the study and include the following elements.

- Electricity costs.
- Desalinated water costs.
- Costs of treated water.
- Costs of diesel used for boilers to heat water.

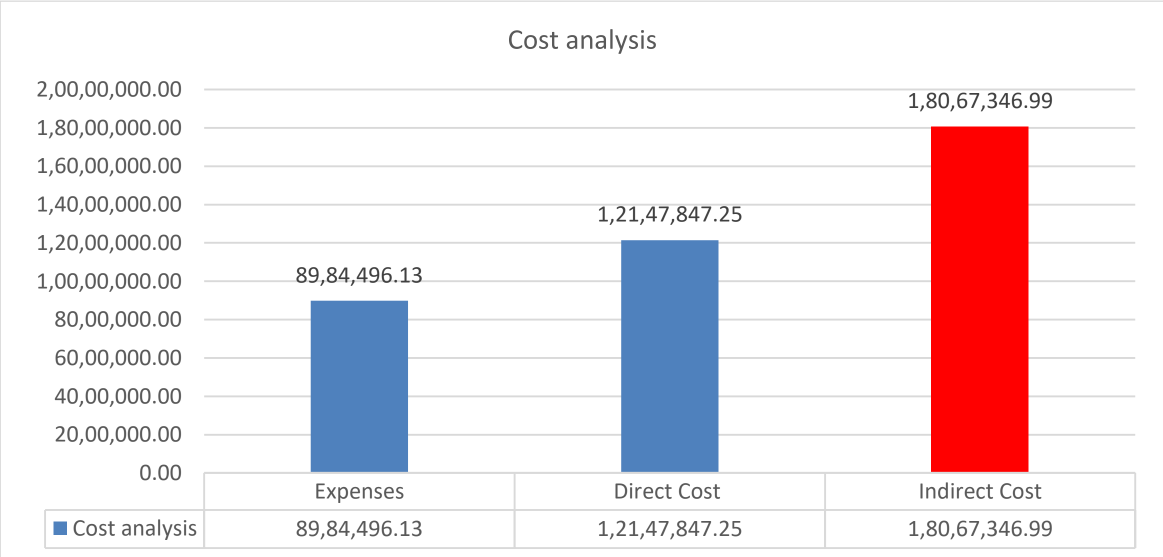


**Table** 2 shows an analysis of the cost components and an explanation of the areas of increased costs

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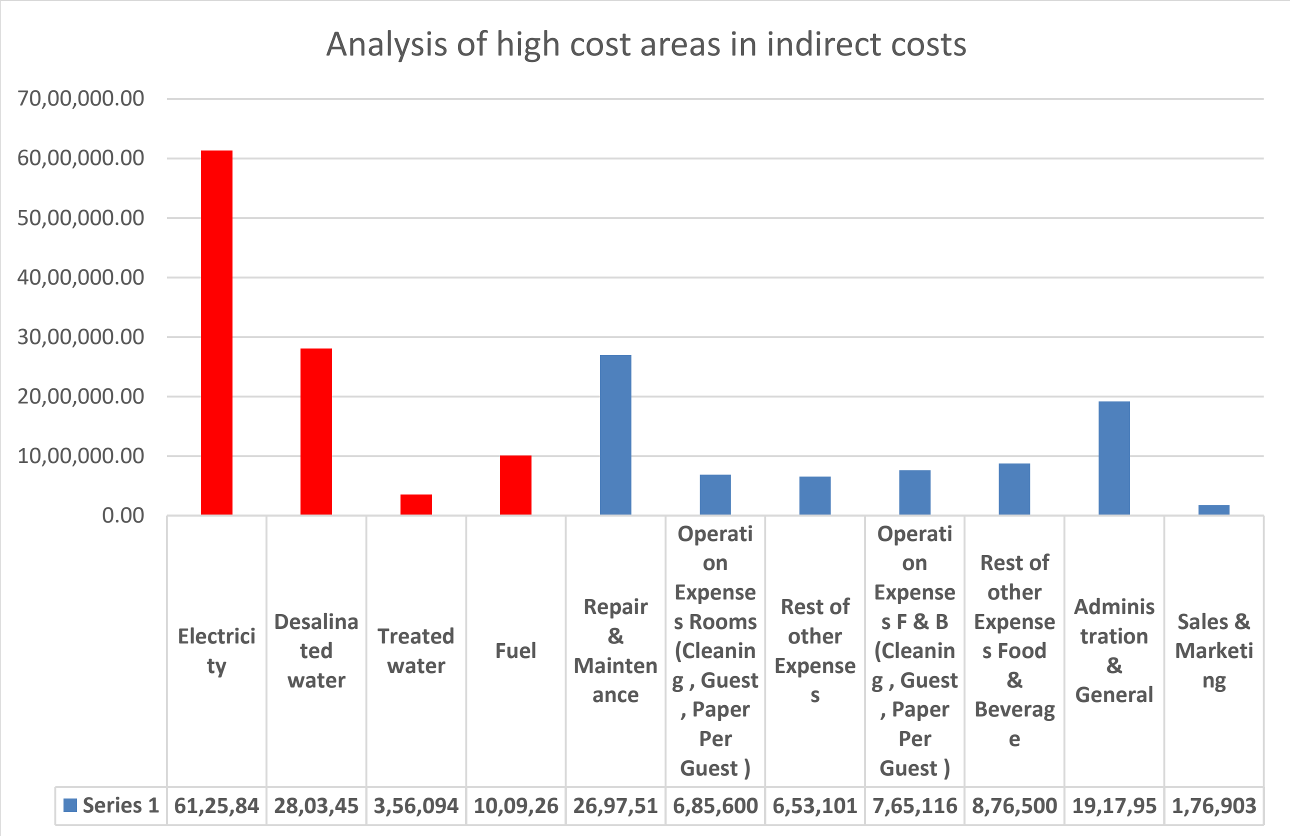


**Table** 3 shows the highest cost areas in indirect costs

**B - Through the previous analysis of costs, it became clear that the elements of the high cost lie in energy consumption in general in the items mentioned.- :**

- Electricity costs.
- Desalinated water costs.
- Costs of treated water.
- Costs of diesel used for boilers to heat water.

The following table shows the extent of the impact of each item on the total costs of the listed items, showing us the items that have the greatest impact on the cost and the possibility of shedding light on them and trying to evaluate them.

| **Cyrene Hotels Total Indirect Cost For Operation** | | |
|---|---|---|
| **indirect Cost** | | |
| **Electricity** | **6,125,842.40** | 33.91% |
| **Desalinated water** | **2,803,458.00** | 15.52% |
| **Treated water** | **356,094.00** | 1.97% |
| **Fuel** | **1,009,269.42** | 5.59% |
| **Repair & Maintenance** | **2,697,510.31** | 14.93% |
| **Operation Expenses Rooms (Cleaning , Guest , Paper Per Guest )** | **685,600.09** | 3.79% |
| **Rest of other Expenses** | **653,101.01** | 3.61% |
| **Operation Expenses F & B (Cleaning , Guest , Paper Per Guest )** | **765,116.74** | 4.23% |
| **Rest of other Expenses Food & Beverage** | **876,500.38** | 4.85% |
| **Administration & General** | **1,917,950.69** | 10.62% |
| **Sales & Marketing** | **176,903.95** | 0.98% |
| **Total Indirect Cost** | **18,067,346.99** | 100.00% |

**Table** 4 shows the percentages on the cost components in indirect costs.

**4- Analysis of electricity consumption rates in kilowatts per month and their equivalent in Egyptian pounds for the year 2018 with traditional energy.**

| | 207 room | 238 room | 207 room | 238 room |
|---|---|---|---|---|
| | Cyrene Island | Cyrene Sharm | Cyrene Island | Cyrene Sharm |
| | K.w | K.w | L.E | L.E |
| january | 135,815.99 | 87,118.48 | 131741.5057 | 84504.92264 |
| february | 92,920.82 | 59,603.59 | 93850.03129 | 60199.62801 |
| march | 165,304.02 | 106,033.43 | 152079.6998 | 97550.75444 |
| april | 204,922.69 | 131,446.62 | 180331.9672 | 115673.0285 |
| may | 310,173.65 | 198,959.32 | 269851.073 | 173094.6062 |
| june | 275,548.56 | 176,749.23 | 236971.7642 | 152004.3399 |
| july | 533,049.99 | 341,922.22 | 607676.9934 | 389791.3346 |
| august | 319,152.91 | 204,719.02 | 360642.7929 | 231332.4959 |
| september | 284,097.44 | 182,232.87 | 323871.0812 | 207745.4673 |
| october | 244,045.54 | 156,541.77 | 305056.9199 | 195677.2187 |
| november | 194,110.91 | 124,511.46 | 246520.8574 | 158129.5574 |
| december | 142,751.41 | 91,567.17 | 184149.314 | 118121.6463 |
| Total K.w | 2,901,893.93 | 1,861,405.19 | 3,092,744.00 | 1,983,825.00 |

**Table** 5 shows the hotels' monthly electricity consumption in kilowatts..

**5- Electricity consumption rates in kilowatts annually and its equivalent in Egyptian pounds for the last seven years (2016-2017-2018-2019-2020-2021-2022-) with traditional government energy**

| Electricity consumption rates in kilowatts annually and their equivalent in Egyptian pounds for the year (2016-2017-2018-2019-2020-2021-2022-) with traditional government energy. | | | Tariff price per kilowatt | No. |
|---|---|---|---|---|
| Value | Quantity in kilowatts | Year | | |
| 2,817,016.68 | 3834798 | 2016 | 0.73 | 1 |
| 3,459,606.55 | 3959818 | 2017 | 0.87 | 2 |
| 6,125,842.40 | 6633966 | 2018 | 0.92 | 3 |
| 6,492,119.90 | 4547531 | 2019 | 1.43 | 4 |
| 2,262,920.85 | 1555865 | 2020 | 1.45 | 5 |
| 3,169,678.27 | 2274919 | 2021 | 1.39 | 6 |
| 6,593,919.95 | 4547531 | 2022 | 1.45 | 7 |
| 30,921,104.60 | 27354428 | Total | | |

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**Table** 6 shows the hotels' annual electricity consumption in kilowatts.

**6 -Analysis of electricity and water consumption rates and their equivalent in Egyptian pounds for the year 2018 per day per hotel room with traditional energy.**

| Element | Daily consumption |
|---|---|
| **Electricity Per Guest** | **30.23** |
| **Water Per Guest** | **14.52** |
| **Fuel Per Guest** | **5.92** |
| **Repair & Maintenance (Per Occupied Room)** | **31.03** |
| **Operation Expenses Rooms (Cleaning , Guest , Paper Per Guuest)** | **4.08** |
| **Rest Of Other Room Expenses Per Guest** | **3.89** |
| **Operation Expenses F&B (Cleaning , Guest , Paper Per Guuest)** | **4.56** |
| **Rest Of Other F&B Expenses Per Guest** | |
| **Electricity Per Room Occupied -Kw** | **52.92** |
| **Water Per Room Occupied -M2** | **2.13** |
| **Diesel Per Room Occupied -Liter** | **2.57** |

**Table** 7 shows the hotels' daily consumption of electricity, local water, and fuel.

**From the previous analysis, we conclude the following:**
o **First**: **The cost of electricity consumption** = 35% of the total indirect costs and 15% of the operating costs, which is a very large rate and is the second highest cost in the operating stage in general and the highest cost in the indirect costs in particular.
o **Second**: **The cost of desalinated water consumption** = 15% of the total indirect costs and 7.5% of the operating costs, which is the third highest cost in the operating stage in general and the second highest cost in the indirect costs in particular.
**- Proposed alternatives as a result of the previous analysis: -**
- **First:** Study the possibility of applying one of the new and renewable energy methods to target reducing energy consumption, especially (solar panels).
- **Second:** Study the possibility of using these panels to generate green hydrogen to contribute to the desalination of seawater and reduce the costs of purchasing desalinated water.

**5-2-2 Function analysis:**
The hotel functions are analyzed by analyzing the highest cost areas in the operating stage and targeting them, identifying the primary, secondary, and permanent functions, as well as the highest goal, the influential function, and the field of research and study, as shown in the following diagram**.**

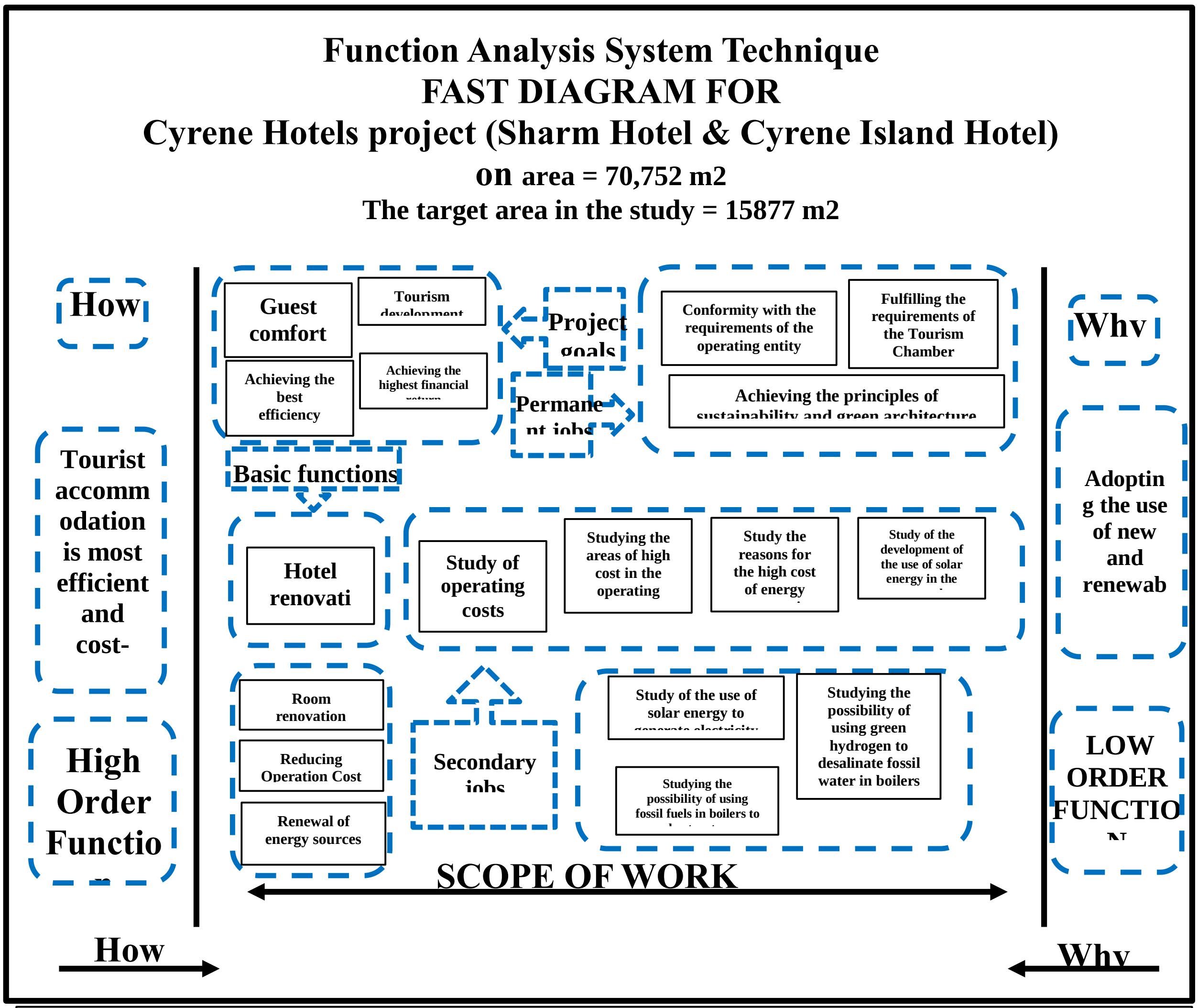


**Figure** 11: shows the FAST analytical chart for the study case blanks (Source: Researcher)

**Where jobs were studied, analyzed and identified to reduce operating costs by studying the following works:**
- Studying the use of solar energy to generate electricity and reduce operating costs.
- Studying the use of green hydrogen to desalinate drinking water as well as treat agricultural water.
- Studying the use of green hydrogen as an alternative to fossil fuels used in boilers used to heat water.

When studying and analyzing these functions, it becomes clear that the primary goal and basic function of all the previous items is to reduce operating costs to make guests' accommodation more efficient and less expensive. This leads us to identify the secondary functions that must be performed by each of the aforementioned items.

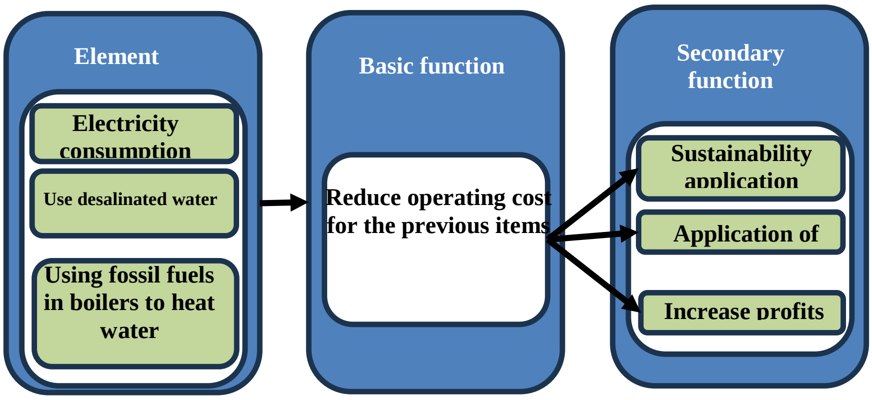


**Figure** 12: shows the primary and secondary functions performed by the elements (Source: Researcher)

**In general, alternative energy sources must be achieved in proportions acceptable to the owner and operator of hotels:**

1. Ensuring no power outages and ensuring continuity without major operating problems
2. There are no negative effects on the equipment in the hotels.
3. Ease of installation and maintenance.
4. The construction costs should not be high and the feasibility of construction should not exceed seven years so that the new method achieves feasibility and profits.
5. Or will studying the total cost be profitable?
6. The new approach should take into account the application of sustainability concepts
7. To be consistent with the principles of green architecture, reduce environmental pollution, and reduce carbon dioxide emissions.

### 5-2-3 Innovation and presenting ideas

This step aims to present all the ideas related to each business item and record them on a regular basis that allows them to be easily evaluated and judged.

| Defects | Advantages | The idea and a brief explanation | No. | Element | |
|---|---|---|---|---|---|
| - Not achieving self-sufficiency in energy<br>- It is not feasible to use this system at night due to the high costs of storing the current in batteries | - Producing clean energy that does not pollute the environment<br>- Achieving a financial return after recovering capital by selling the generated energy to the government network | **Use of solar panels**<br>- Using solar panels on an area of 15,877 square meters for the purpose of studying the production of 2,796,160 kilowatts annually and studying the feasibility of using this system and the extent of the savings it achieves during the operation phase. | 1 | Use of solar panels | Use of new and renewable energy |
| - The novelty of the idea, with the lack of many previous experiences, with the lack of experienced personnel in this field, as well as the high costs of production and maintenance, as this method is limited to entities and major factories only. | - Producing clean energy that does not pollute the environment<br>- Achieving a financial return after recovering capital through the savings that will be achieved in water desalination and the availability of water in the surrounding environment. | **Using green hydrogen in producing desalinated water**<br>Hydrogen fuel needs renewable energy to be green, which requires a massive expansion in renewable energy generation to operate electrolysis plants that break down water into hydrogen and oxygen. Green hydrogen is also difficult to store and transport without a pipeline. | 2 | Using green hydrogen in producing desalinated water | |
| - The novelty of the idea, with the lack of many previous experiences, with the lack of experienced personnel in this field, as well as the high costs of production and maintenance, as this method is limited to entities and major factories only. | - Producing clean energy that does not pollute the environment<br>- Achieving a financial return after recovering capital through the savings that will be achieved in water desalination and the availability of water in the surrounding environment | **Using green hydrogen in boilers as an alternative to fossil fuels**<br>Hydrogen fuel needs renewable energy to be green, which requires a massive expansion in renewable energy generation to operate electrolysis plants that break down water into hydrogen and oxygen. Green hydrogen is also difficult to store and transport without a pipeline. | 3 | Using green hydrogen in boilers as an alternative to fossil fuels | |

**Tabe** 8: Shows alternatives to using traditional energy for the case study (Source: Researcher)

**5-2-4 Evaluation and selection**

**Examination of ideas:**

The goal of this step is to analyze and study all the ideas that were previously mentioned in the ideation stage, where the idea is judged completely and its value index is analyzed if it increases or reduces quality and cost in what is called the initial selection of ideas.

| the cost | the quality | The idea and a brief explanation | No. | Element | |
|---|---|---|---|---|---|
| ↓ | ↑ - - | **Use of solar panels**<br>- Using solar panels on an area of 15,877 square meters for the purpose of studying the production of 2,796,160 kilowatts annually and studying the feasibility of using this system and the extent of the savings it achieves during the operation phase. | 1 | Use of solar panels | Use of new and renewable energy |
| ↑ - - - | ↑ - - | **Using green hydrogen in producing desalinated water**<br>Hydrogen fuel needs renewable energy to be green, which requires a massive expansion in renewable energy generation to operate electrolysis plants that break down water into hydrogen and oxygen. Green hydrogen is also difficult to store and transport without a pipeline. | 2 | Using green hydrogen in producing desalinated water | |
| ↑ - - - | ↑ - - | **Using green hydrogen in boilers as an alternative to fossil fuels**<br>Hydrogen fuel needs renewable energy to be green, which requires a massive expansion in renewable energy generation to operate electrolysis plants that break down water into hydrogen and oxygen. Green hydrogen is also difficult to store and transport without a pipeline. | 3 | Using green hydrogen in boilers as an alternative to fossil fuels | |

**Table** 9: Shows the alternatives to using traditional energy for the case study (Source: Researcher)

- means an increase in quality or cost when implementing this idea. ↑
- It means stability in the level of quality or cost when implementing this idea. -
- means a decrease in quality or cost when implementing this idea. ↓

**Possibility of saving on energy consumption (electricity consumption):**

It is clear from previous studies of the hotels under study that the average hotel consumption of electricity from 2018-2022, that is, over a period of 7 years, is 4,224,718.90 kilowatts annually. That is approximately the equivalent of 6,125,842.40 EGP annually.

**-Proposed alternative:**

After reviewing the drawings, a site visit to the project, forming a value engineering team, and holding many meetings, it was found that the Foot Print for hotels, which is equal to the area of the roof floor, as shown in the following pictures from nature, = 15,877 m2, and this area is considered unused, as shown in the pictures. It is a flat surface exposed to light and heat throughout the day, which is reflected in an increase in the building temperature as well as an increase in electrical energy consumption in air conditioning and refrigeration work. Which makes it worthy of study and research to try to find alternatives to exploit that surface, enhance the function it performs, and raise the efficiency of the building in general, at a lower overall cost, and the study will also be a reason for making a profit.

**Figure** 13 shows natural pictures of the hotel from inside the project, the second part.

**Figure** 14 shows natural pictures of the hotel from inside the project, the second part

**Figure** 15 shows natural pictures of the hotel from inside the project, the second part.

**Figure** 16 shows natural pictures of the hotel from inside the project, the second part.

After research, study, and the value engineering team decided to study the use of solar energy, communication was made with one of the most important companies implementing the project, which is Al-Nasr Company, and communication was made with the specialized team to study the site and areas. After the study, the content of the technical and financial offer was as follows- :

**- Implementing a solar power station in the first hotel with a capacity of 1000 kilowatts.**
**- Implementing a solar power station in the second hotel with a capacity of 562 kilowatts.**

Grid-On stations are solar systems that generate electricity only when they are connected to the government electricity network. They are a group of cells with a capacity of no less than 5 kilowatts in accordance with the conditions of the New and Renewable Energy Authority and government electricity distribution companies. They are connected to a current transformer (inverter) and in This system automatically disconnects in the event of a power outage, the station is connected to the electricity network, and the consumption of surplus energy generated from photovoltaic cells is exchanged with national electricity distribution companies under long-term contracts, measured by a double meter, and reviewing the station's specifications.

**There are no batteries with a relatively short lifespan, and this reduces the station's costs and operational expenses due to the availability of the government network and the possibility of connecting with it.**

The operating cost of photovoltaic power plants is approximately 90% less than the high cost of operating photovoltaic power plants.

Conventional electrical energy. Because photovoltaic power plants do not consume water, points, or gas. In large connected stations, the operational cost is limited to the workers' wages and the value of the usufruct of the project land. In the case of a home station, the operating cost is limited to spraying the panels with water to clean them: In homes where the monthly consumption exceeds 500 kilowatt-hours and where the subscriber is subject to high-value consumption brackets, a station connected to the network with a Net Metering system can be installed.

**How the connected station works :**

The panels absorb sunlight, produce DC electricity, and pass through the inverter, which converts it into 380 volts AC power. In the case of large connected stations, a medium voltage transformer is made to convert 11,000 volts, for example, before connecting to the network. Then the resulting electrical current flows during the day to the national grid. Through a double electricity meter.

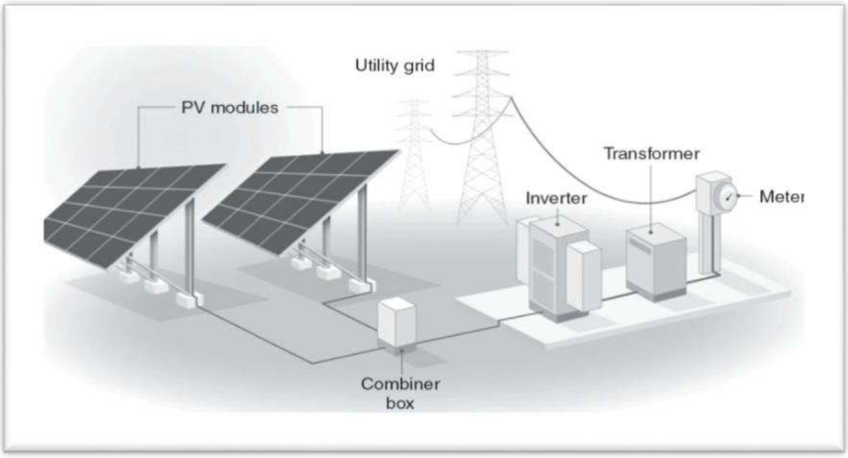


**Figure** 17 shows how the On-Grid station works

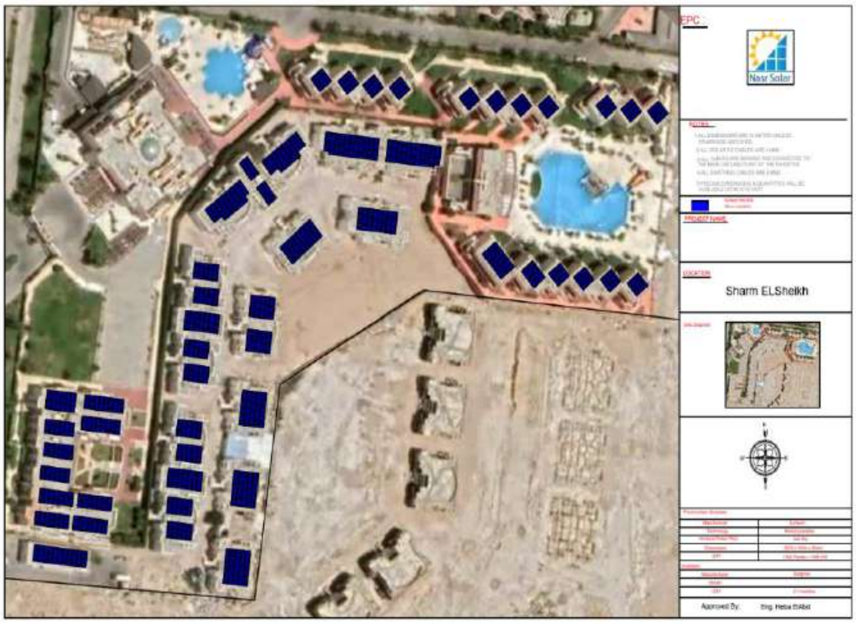


**Figure**. 18 shows the station layout of the 1000 kW On-Grid system on the first hotel


**Figure** 19 shows the layout of the 562 kW On-Grid system station at the first hotel

**The technical offer to establish two stations with a capacity of 1000 kilowatts and 562 kilowatts**

| The technical offer to establish two stations with a capacity of 1000 kilowatts and 562 kilowatts | | | | |
|---|---|---|---|---|
| Class statement | Type | country of origin | Quality level | Warranty |
| Solar panels<br>Number of panels for the two hotels = 2826<br>The capacity of one panel is 540 watts<br>Board size = 113.3 * 225.6 mm<br>Half Cut Cells | Quantum<br>JA Solar<br>LONGI<br>Suntec<br>Jinko | China | Class A | 25 years |
| 9 inverters, 50 kilowatts<br>14 inverters, 33 kilowatts<br>8 inverters, 40 kilowatts<br>2 inverters, 20 kilowatts<br>1 inverter, 10 kilowatts | SUNGROW<br>Huawei<br>Growatt | China | Class A | 5 years |

| | | | | |
|---|---|---|---|---|
| Total power is 1562 kilowatts<br>Three stages | | | | |
| 6mm tinned copper cables for DC | HIS<br>KPE | Germany<br>Turkey<br>Italy | Class A | |
| MC4 Connector | Ip68 | China | Class A | |
| Fixing structure made of 2 mm galvanized iron according to the engineering design of BeNeshty company | | Egypt | Class A | 20 years |

**Table** 10 shows the technical proposal for constructing two stations with a capacity of 1000 kilowatts and 562 kilowatts.

**Consequences of implementing the proposed alternative:**

| The cumulative total of the station price | The price of establishing the station | The cumulative total value of invoices annually | Total value of bills annually | The price of a kilowatt in Egyptian pounds | Performance Ratio | Total generation of solar power plant (kW) | No. |
|---|---|---|---|---|---|---|---|
| 27,486,200.00 | | 4,278,300.00 | 4,278,300.00 | 1.50 | 100% | 2,852,200.00 | 1 |
| 27,486,200.00 | | 8,658,509.11 | 4,380,209.11 | 1.55 | 99.4% | 2,835,086.80 | 2 |
| 27,486,200.00 | | 13,142,891.39 | 4,484,382.29 | 1.59 | 98.8% | 2,817,973.60 | 3 |
| 27,486,200.00 | | 17,733,755.07 | 4,590,863.67 | 1.64 | 98.2% | 2,800,860.40 | 4 |
| 27,486,200.00 | | 22,433,453.07 | 4,699,698.00 | 1.69 | 97.6% | 2,783,747.20 | 5 |
| 27,486,200.00 | 27,486,200.00 | 27,244,383.67 | 4,810,930.60 | 1.74 | 97.0% | 2,766,634.00 | 6 |
| 27,486,200.00 | | 32,168,991.11 | 4,924,607.44 | 1.79 | 96.4% | 2,749,520.80 | 7 |
| 27,486,200.00 | | 37,209,766.15 | 5,040,775.05 | 1.84 | 95.8% | 2,732,407.60 | 8 |
| 27,486,200.00 | | 42,369,246.72 | 5,159,480.56 | 1.90 | 95.2% | 2,715,294.40 | 9 |
| 27,486,200.00 | | 47,650,018.43 | 5,280,771.71 | 1.96 | 94.6% | 2,698,181.20 | 10 |
| 27,486,200.00 | | 53,054,715.23 | 5,404,696.80 | 2.02 | 94.0% | 2,681,068.00 | 11 |
| 27,486,200.00 | | 58,586,019.92 | 5,531,304.70 | 2.08 | 93.4% | 2,663,954.80 | 12 |
| 27,486,200.00 | | 64,246,664.76 | 5,660,644.84 | 2.14 | 92.8% | 2,646,841.60 | 13 |
| 27,486,200.00 | | 70,039,431.98 | 5,792,767.22 | 2.20 | 92.2% | 2,629,728.40 | 14 |
| 27,486,200.00 | | 75,967,154.34 | 5,927,722.36 | 2.27 | 91.6% | 2,612,615.20 | 15 |
| 27,486,200.00 | | 82,032,715.66 | 6,065,561.32 | 2.34 | 91.0% | 2,595,502.00 | 16 |
| 27,486,200.00 | | 88,239,051.33 | 6,206,335.66 | 2.41 | 90.4% | 2,578,388.80 | 17 |
| 27,486,200.00 | | 94,589,148.79 | 6,350,097.47 | 2.48 | 89.8% | 2,561,275.60 | 18 |
| 27,486,200.00 | | 101,086,048.07 | 6,496,899.27 | 2.55 | 89.2% | 2,544,162.40 | 19 |
| 27,486,200.00 | | 107,732,842.17 | 6,646,794.10 | 2.63 | 88.6% | 2,527,049.20 | 20 |
| 27,486,200.00 | | 114,532,677.58 | 6,799,835.41 | 2.71 | 88.0% | 2,509,936.00 | 21 |
| 27,486,200.00 | | 121,488,754.67 | 6,956,077.08 | 2.79 | 87.4% | 2,492,822.80 | 22 |
| 27,486,200.00 | | 128,604,328.07 | 7,115,573.41 | 2.87 | 86.8% | 2,475,709.60 | 23 |
| 27,486,200.00 | | 135,882,707.11 | 7,278,379.04 | 2.96 | 86.2% | 2,458,596.40 | 24 |
| 27,486,200.00 | | 143,327,256.10 | 7,444,548.99 | 3.05 | 85.6% | 2,441,483.20 | 25 |
| | | 143,327,256.10 | The total amount paid for bills is in Egyptian pounds | | | | |
| | | 27,486,200.00 | Total paid for the solar power plant | | | | |
| | | 115,841,056.10 | Total savings in case of constructing the station | | | | |

**Table** 11 shows the results of applying the alternative

**A table showing the costs if a traditional energy source is used and an alternative is not created**

| Total value of bills annually | The price of a kilowatt in Egyptian pounds | Current average electricity consumption in kilowatts | |
|---|---|---|---|
| 6,337,078.34 | 1.50 | 4,224,718.90 | 1 |
| 6,527,190.70 | 1.55 | 4,224,718.90 | 2 |
| 6,723,006.42 | 1.59 | 4,224,718.90 | 3 |
| 6,924,696.61 | 1.64 | 4,224,718.90 | 4 |
| 7,132,437.51 | 1.69 | 4,224,718.90 | 5 |
| 7,346,410.63 | 1.74 | 4,224,718.90 | 6 |
| 7,566,802.95 | 1.79 | 4,224,718.90 | 7 |
| 7,793,807.04 | 1.84 | 4,224,718.90 | 8 |
| 8,027,621.25 | 1.90 | 4,224,718.90 | 9 |
| 8,268,449.89 | 1.96 | 4,224,718.90 | 10 |
| 8,516,503.38 | 2.02 | 4,224,718.90 | 11 |
| 8,771,998.49 | 2.08 | 4,224,718.90 | 12 |
| 9,035,158.44 | 2.14 | 4,224,718.90 | 13 |
| 9,306,213.19 | 2.20 | 4,224,718.90 | 14 |
| 9,585,399.59 | 2.27 | 4,224,718.90 | 15 |
| 9,872,961.58 | 2.34 | 4,224,718.90 | 16 |
| 10,169,150.43 | 2.41 | 4,224,718.90 | 17 |
| 10,474,224.94 | 2.48 | 4,224,718.90 | 18 |
| 10,788,451.69 | 2.55 | 4,224,718.90 | 19 |
| 11,112,105.24 | 2.63 | 4,224,718.90 | 20 |
| 11,445,468.39 | 2.71 | 4,224,718.90 | 21 |
| 11,788,832.45 | 2.79 | 4,224,718.90 | 22 |
| 12,142,497.42 | 2.87 | 4,224,718.90 | 23 |
| 12,506,772.34 | 2.96 | 4,224,718.90 | 24 |
| 12,881,975.51 | 3.05 | 4,224,718.90 | 25 |
| 231,045,214.40 | The total amount paid for bills is in Egyptian pounds | | |

**Table** 12 shows the consequences of not implementing the alternative

**The value report resulting from proposing alternatives:**

❖ The annual increase in the price of electricity is 3%, to be taken into account while calculating the total cost
❖ Price of a kilowatt of electricity = 1.5 L.E
❖ The annual depreciation rate for solar panels = .06%, and the deduction of the depreciation rate was taken into account in the calculations for the station's ability to generate electricity.
❖ The size of the station in kilowatts = 1562 kilowatts
❖ Execution price of kilowatt capacity = 17650 L.E
❖ Total cost of the alternative (cost of constructing the station) = L.E 27,486,200.00
❖ In the previous study, the initial cost of supply and installation of the station was calculated.
❖ The age of the replacement was calculated to be a major element in the evaluation, which is estimated at 25 years for the panels, with a guarantee for that from the implementing company.
❖ The study showed that the average generation of electricity by the station in kilowatts over the life of the station = 2,646,841.60 kilowatts, to achieve the project's sufficiency of 63% of the project's energy needs, which is estimated at a value of L.E. 4,278,300.00 in the first year, and an average value of L.E. of 5,733,090.24 annually over the life of the project.
❖ The study showed that the recovery period for the capital for establishing the alternative cost of constructing the station is six years. This is the amount paid over six years if the station is not built.
❖ The study indicated that the total cost paid to the electricity company over the life of the project in the event that the project is not implemented is 231,045,214.40 L.E., and that after implementing the alternative, an amount of 143,327,256.10 L.E. can be saved, meaning a saving of 62% of the operating costs over the life of the alternative.
❖ Achieving a net profit after six years after recovering the capital over a period of nineteen years, amounting to L.E. 116,082,872.43, meaning an average net profit of L.E. 6,109,624.86 annually.

**CONCLUSION:**

In light of the above analysis, simulation and comparison between applying the proposed alternative and not applying it within the case study (Cyrene Island Hotel - Sharm El Sheikh).

The results showed that establishing a solar energy station has a major role in saving the annual energy consumption costs of the hotel subject of the study, which are detailed as follows:-.

 The study showed that the average generation of electricity by the station in kilowatts over the life of the station =

2,646,841.60 kilowatts, to achieve the project's sufficiency of 63% of the project's energy needs, which is estimated at a value of L.E. 4,278,300.00 in the first year, and an average saving of a value of L.E. 5,733,090.24 annually over the life of the project. .

 The study showed that the recovery period for the capital for establishing the alternative cost of constructing the station is six years. This is the amount paid over six years if the station is not built.

 The study indicated that the total cost paid to the electricity company over the life of the project in the event that the project is not implemented is 231,045,214.40 L.E., and that after implementing the alternative, an amount of 143,327,256.10 L.E. can be saved, meaning a saving of 62% of the operating costs over the life of the alternative.

 Achieving a net profit after six years after recovering the capital over a period of nineteen years, amounting to L.E. 116,082,872.43, meaning an average net profit of L.E. 6,109,624.86 annually.

Based on the above, we can conclude that using the proposed alternative, which is establishing a solar energy station, has an effective role in improving thermal performance and reducing the demand for cooling energy in tourist hotels in Sharm El Sheikh.

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