
SOLAR ENERGY APPLICATIONS IN FLOATING HOTELS FROM MANAGERS POINT OF VIEW

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Abstract

This research aims to study solar energy applications in floating hotels. In order to achieve this aim, the current research adopted a deductive approach using the personal interviews with managers who are working in floating hotels in Luxor and Aswan sample of the research and with engineers who working in solar energy companies. A total of 52 personal interviews were conducted with the manager's which represent sample of the research. The findings of the filed study showed that the level of awareness of managers with solar energy applications is poor and there is no strategic vision from hotel management of using solar energy applications. The results also showed that the high prices of solar technology and the lack of space needed to place solar cells on floating hotels are considered the main obstacles for the use of solar energy applications.

Keywords: Solar Energy Applications, Floating Hotels, Luxor and Aswan.

تطبيقات الطاقة الشمسية فى الفنادق العائمة من وجهة نظر المديرين

المخلص

يهدف هذا البحث إلى دراسة تطبيقات الطاقة الشمسية في الفنادق العائمة. من أجل تحقيق هذا الهدف، اعتمد البحث الحالي على منهج استنتاجي باستخدام المقابلات الشخصية مع المديرين الذين يعملون في الفنادق العائمة في الأقصر وأسوان عينة من البحث ومع مديري شركات الطاقة الشمسية. تم إجراء ٣٨ مقابلة شخصية مع المديرين ومساعدى المديرين الذين يمثلوا عينة البحث وعدد ٧ مقابلات شخصية مع مديري شركات الطاقة الشمسية. أظهرت نتائج الدراسة المقدمة أن مستوى وعي المديرين بتطبيقات الطاقة الشمسية ضعيف وليس هناك رؤية استراتيجية من إدارة الفنادق لإستخدام تطبيقات الطاقة الشمسية. كما أظهرت النتائج أن ارتفاع أسعار تكنولوجيا الطاقة الشمسية والإفتقار إلى المساحة اللازمة لوضع الخلايا الشمسية في الفنادق العائمة تعتبر عقبات رئيسية أمام استخدام تطبيقات الطاقة الشمسية.

الكلمات الدالة: تطبيقات الطاقة الشمسية، الفنادق العائمة، الأقصر وأسوان .

Introduction

The critical role that energy plays in virtually all human activities is widely acknowledged. It constitutes a relatively modest share of Gross Domestic Product (GDP) in most countries (Voser, 2012). Without a reliable and affordable source of energy, governments, institutions and individuals would find it difficult to realize their social and economic aspirations. Planners, especially those in the developed countries have long recognized the importance of energy as a veritable resource for improving human welfare and driving industrial growth (International Energy Agency (IEA) and World Bank on fossil-fuel., 2011).

Hotels are found in many countries to be among the most energy-demanding building categories (Xydis *et al.*, 2009). Substantial amount of energy is consumed in providing comfort and services to guests, many of whom are familiar with, and ready to pay for exclusive amenities and entertainment, the energy utilization and its attendant waste generation vary substantially among different types of hotels, and is affected by hotel size, class/category, the number of rooms, customer profile (guests visiting for business/on vacation), location (rural/remote or urban), climate zone, as well as by the types of services/activities and amenities provided to guests (Bohdanowicz *et al.*, 2001).

Solar energy, radiant light and heat from the sun, is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaics, concentrated solar power (CSP), concentrator photovoltaics (CPV), solar architecture and artificial photosynthesis (IEA, 2011). Active solar technologies encompass solar thermal energy, using solar collectors for heating, and solar power, converting sunlight into electricity either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP) (Royal Society of Chemistry, 2012).

Research Questions

- What are the current methods on which floating hotels depend on electricity generation and quantities and cost of biofuels used?
- What are the opinions and attitudes of managers towards the use of solar energy application on floating hotels?
- How the application of the SWOT model (Strengths-Weaknesses-Opportunities-Threats) contributes to proposals for the advancement of solar energy applications?
- What are the benefits of applying solar energy applications and the obstacles that facing applying of the solar energy applications in floating hotels?

Aims of the Research

- Statement of the reality of electricity generation currently in floating hotels in terms of financial cost, type and quantities of biofuels used.
- Study the opinions and attitudes of managers towards the use of solar energy application in floating hotels.
- Study SWOT analysis model to evaluate the factors that influencing on using solar energy application in floating hotels.
- Study the benefits of applying solar energy application and the obstacles that facing using of solar energy application in floating hotels.

Review of Literature

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat (**Ellabban et al., 2014**).

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, and artificial photosynthesis (**IEA, 2011**).

Solar PV systems convert sunlight into electricity. Solar PV allows a hotel to produce electricity without noise or air pollution, from a clean renewable resource: the sun. In the Pacific, solar PV is the most widespread renewable energy technology in use, and has been used for over 30 years. Like SWH systems, solar PV today is a proven technology with many suppliers and installers . Solar PV can be used as either an alternative energy source or a supplement to a main grid connection. Solar PV can also be a viable option for electricity cost savings and upgrading of electricity reliability for hotels in rural areas and on islands, which are not connected to the main FEA utility grid (**IREA, 2014**).

Solar Energy Applications

Solar Power and Solar Thermal

The following Table 1 shows the differences between solar power and solar thermal.

Table1: The Difference between Solar Power and Solar Thermal

System	Solar Power	Solar Thermal
Picture		
Energy	Electricity	Heat/Hot water
Application	Power supply for any application.	Heat or hot water applications (e.g. laundry, shower, kitchen appliances, heating systems, pool heating, wellness and spa facilities).
Continue:		
Continued Table1: The Difference between Solar Power and Solar Thermal		
Generating Technologies	Photovoltaic module (solar/PV cells).	Solar collector (solar absorber).
Types of Generators	Polycrystalline modules; Monocrystalline modules; Thin-film modules	Flat plate collector; Evacuated tube collector; Swimming pool absorber.
Working Principle	Solar cells absorb sun radiation and release electrons that generate electricity. if connected to an electric circle.	Sun radiation heats up the water running through the solar collectors, which generate heat.
How to Identify	Thin panels with a shiny surface in blue, brown or color.	A glazed box with black or blue flat plate collectors or glass tubes connected to a manifold.
Efficiency	The solar panels have an efficiency rate between 15-20% depending on the module type and	The solar thermal collectors have an efficiency rate of up to 50%, depending on the

	installation conditions (e.g. location, inclination, orientation).	temperature of the hot water, the quality of the components as well as the installation and location of the system.
Interface to Hotel	Inverters	Not applicable
Connection Point	The solar power system is connected to either the mains or sub-distribution board of the hotel.	The solar thermal system is connected to the hot water system of the hotel.
Storage	Batteries	Hot water storage tank
Back-up / Supplementary Energy	Public grid or generator	Boiler or electric heaters
Connection	Wiring	Piping with insulation

Source: Karina et al., (2018).

Utilization of Solar Energy for Cooking

Cooking with solar energy is not new or novel idea. According to the Halacy and Halacy (1992) the first scientist who was done experiment with solar cooking was a German physicist named Tschirnhausen (1651-1708). He used a large lens to focus the sun's rays on a boiled water in a clay pot. That experiment was published in 1767 by Swiss scientist (Schwartzter and silva, 2003).

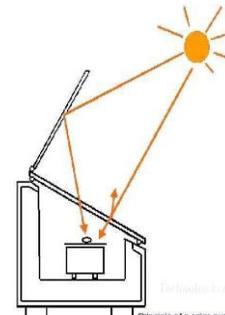


Fig.1: Box solar cooker
Source: Schwartzter and silva, 2003

A mirrored surface having high reflectivity is used to concentrate light coming from sun on a small cooking area, but it is depend on geometry of cooking surface. Solar cookers are typically designed to achieve temperature 650 to 4000 on a sunny day. Solar cookers concentrate sunlight on cooking pan. Interaction between receiver material and sunlight converts sunlight into heat energy. Pots and pan used for cooking must be in black color only. It is most important to insulate the cooker

simply by using glass lid on pot .It minimize convection loss of heat energy in the solar cooker (**Harish *et al.*, 2016**).

Benefits of Investing in Solar Energy Application

In 2011, the IEA said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. These advantages are global. Hence the additional costs of the incentives for early deployment should be considered learning investments; they must be wisely spent and need to be widely shared"(IEA, 2011). Italy has the largest proportion of solar electricity in the world, in 2015 solar supplied 7.8% of electricity demand in Italy in 2016, after another year of rapid growth, solar generated 1.3% of global power (**Ren21, 2016**).

The use of solar cooking has many advantages; No use of any fuel, no pollution, no smoke formation, energy is available every day, solar energy does not contribute to global warming, acid rain, maintainace free and long lasting. There are also some disadvantages; more time is required for cooking i.e. 1.5 to 3 hrs, initial cost is high, cooking should be affect due to presence of cloud, solar cookers are large and bulk to carry (**Harish *et al.*, 2016**).

Obstacles of Applying Solar Energy Application

The most significant barriers to the widespread implementation of large-scale of solar energy are primarily social, technical, economic and political. From social obstacles; Lack of information dissemination and consumer knowledge and awareness, Perception of costs and aesthetics (**Kannan and Vakeesan, 2016and; Da Silva, 2016**).

(Zhang *et al.*, 2012; Karakaya and Sriwannawit, 2015) mentioned that from technical obstacles the following; Inadequate installation space and service infrastructure, Lack of necessary scientific and technical knowledge and skills in the workforce, Lack of data and research and development.

Also (Karakaya and Sriwannawit, 2015; Gabriel Cle-Anne., 2016; Timilsina and Shah, 2016; Silva and Izael, 2017) stated that from economic obstacles long payback period and investment risks, limited access to capital and lack of purchasing opportunities, inadequate knowledge of costing systems, High initial construction/installation and maintenance costs.

Some researchers stated that there are some political obstacles such as lack of Government policy and financial support and incentives, prioritization and dependence of modern of traditional energy sources and lack of coordination between ministries, agencies and institutions (Ince *et al.*, 2016; Kannan and Vakeesan, 2016 and Zuboy and Margolis, 2016).

Research Methodology

The population of this research consisted of 38 general managers and assistant general managers of five and four stars floating hotels in Luxor and Aswan and 7 managers of solar energy companies. Five and four stars floating hotels were chosen for many reasons. Firstly, they are considered full service operations, Providing integrated services to guests in addition to the consumption of large amounts of energy; they target high level of income market, Secondly, high consumption of biofuels for operation of diesel engines for floating hotel from Luxor to Aswan. According to Chamber of Tourist Establishments guide (Establishment Hotels Chambers Guide, 2016), there are 222 five and four stars floating hotels in Luxor and Aswan, the number of five and four star floating hotels that already work are 65 floating hotels 29.27%. The researchers contacted with the

managers and assistant managers of the 21 floating hotels 32.30% mentioned to explain the aims of the research.

The questions of personal interviews were divided into three parts: The first part which consists of three questions aimed to study the opinions and attitudes of managers towards the use of solar energy application. The second part which consists of four questions aimed to study management responsible for the adoption of solar energy applications. The third part which consists of three questions were related to study of SWOT analysis and the benefits of using solar energy applications in floating hotels, as well as study the obstacles that facing using of solar energy applications.

Results and Discussions

The following sections present the response of the managers. **The First Part consists of Three Questions aimed to study the Opinions and Attitudes of Managers towards the use of Solar Energy Application in Floating Hotels.**

When managers were asked about *their awareness with solar energy applications*, their answers were that the majority of those who work in floating hotels that the most commonly used solar energy applications are solar cells to generate energy in fixed hotels and some government institutions, but not used in floating hotels in Luxor and Aswan. The personal interviews also showed that many managers are aware of the use of other solar applications at an average level due to the scarcity of other applications such as solar thermal and use of solar energy for cooking. Some respondents also stated that employees do not have full awareness of renewable energy sources, and how is it used, and are in dire need of raising their awareness and knowledge. This consider one of the obstacles that face the use of solar energy, this result agreed with **(Kannan and Vakeesan, 2016 and; Da Silva, 2016)** which stated that Lack of information

dissemination and consumer knowledge and awareness are consider from the obstacles of application of solar energy.

When managers were asked about *the importance of using solar energy applications for the tourism industry in general and for floating hotels in particular* their answers were that, solar energy is a silent product which solar cells do not cause any noise when it convert sunlight into usable electricity. They also stated that the use of solar energy applications does not result in any emissions and harm to the environment. It is also a means of tourist attraction for tourists who have environmental awareness of the importance of encouraging investment in solar energy applications.

When managers were asked about *their expectations of the level of success of solar energy applications in floating hotels* their answers were that the level of success of using solar energy applications may be average in general due to some obstacles that hinder the success of these applications if they are overcome. Especially in floating hotels between Luxor and Aswan. They also mentioned that the nature of the climate in the provinces of Luxor and Aswan is a key factor in the successful use of solar energy applications, where temperatures in the summer reach 41 Degrees Celsius, increasing the brightness of the sun. This results in the conversion of large amounts of sunlight into energy or in other applications such as solar thermals.

The Second Part which consists of Four Questions aimed to study Management Responsible for the Adoption of Solar Energy Applications

When managers were asked about *the commitment of the hotel management towards the adoption of solar energy applications*, their answers were that the management of many floating hotels does not have any responsibility for the use of renewable energy applications and the use of solar energy technology. They also said that the hotel management does not

involving hotel staff in the energy management plan, and there is no hotel training programmes for energy efficiency and renewable energy. Some of the managers mentioned that involving hotel staff in the energy management plan (EMP) is not only essential for the hotel energy plan to be successful; it is also a method to give them ownership of the plan and promote a joint effort to achieve the objectives. As long as the hotelier explains to staff members that energy efficiency and renewable energy are now part of the hotel's environmental and business strategy plan, and if the hotel provides the necessary training to its staff to be able to implement any new energy-related requirements, staff members will be able to contribute to the hotel's efforts for a more sustainable business. To increase effectiveness and participation of staff, the hotel should review the roles of staff and adjust job description if needed and as well as training, consider adjusting salary scales where new responsibilities have been added.

When asked about *the commitment of senior management to set a strategic vision to invest in the use of solar energy applications in floating hotels*, their answers were that, the majority of floating hotel departments don't have any strategic plan to invest in renewable energy especially solar energy application due to the lack of suitable floating hotels for solar energy applications in the governorates of Luxor and Aswan, and the existence of many obstacles that hinder it. Some of managers mentioned that many companies failed to study the feasibility of the application of solar energy and find solutions to overcome these constraints.

When managers were asked about *the commitment of the senior management to train the staff in order to invest in the future in the use of solar energy technology in floating hotels* their answers were there is no commitment from senior management with training programs for employees.

Some of managers mentioned that it is strongly recommended to actively involve the hotel's staff members, and for the hotel to provide its staff with information and training on the actions to be taken to support the hotel's EMP. The hotel management should also invite its staff to provide their feedback and ideas on how to save more energy. Staff information and training is an effective way to improve the way energy is used in the hotel. Although it may cost some time and money to inform and train the hotel staff, the resulting benefits will show up in a very short time because staff behaviour has a direct impact on energy consumption, just like guests' behaviour. Changing the way people use energy should not imply any reduction in comfort or convenience for staff or guests, and should not mean excessive restrictions.

When managers and engineers of solar energy companies were asked about *solar energy applications that could be applied in floating hotels* their answers were as follows:

- **Water Heating:** The most common use for solar thermal technology is for water heating. Hundreds of thousands of hot water systems are in use throughout the world.
- **Solar Photovoltaic Energy:** Solar PV systems convert sunlight into electricity. Solar PV allows a hotel to produce electricity without noise or air pollution, from a clean renewable resource.
- **Solar Heating of Buildings:** Collecting the solar radiation by some element of the building itself i.e. solar energy is admitted directly into the building through large South-facing windows. And using separate solar collectors which may heat either water or air or storage devices which can accumulate the collected solar energy for use at night and during inclement days.
- **Solar Cooking:** It consists of a well-insulated metal or wooden box which is blackened from the inner side. The solar radiations entering the box are of short wavelength. As higher wave-length radiations are unable to pass through the glass covers, the re-

radiation from the blackened interior to outside the box through the two glass covers is minimised, thereby minimising the heat loss. The solar cooker requires neither fuel nor attention while cooking food and there is no pollution, no charring or overflowing of food and the most important advantage is that nutritional value of the cooked food is very high as the vitamins and natural tastes of the food are not destroyed. Maintenance cost of the solar cooker is negligible.

▪**Solar Electric Power Generation:** Electric energy or electricity can be produced directly from solar energy by means of photovoltaic cells. The photovoltaic cell is an energy conversion device which is used to convert photons of sunlight directly into electricity. It is made of semiconductors which absorb the photons received from the sun, creating free electrons with high energies.

The Third Part which consists of Three Questions were related to study of SWOT analysis and the benefits of using Solar Energy Applications in Floating Hotels, as well as study the Obstacles that facing using of Solar Energy Applications.

The results of the personal interviews with the sample of the research showed that the results of SWOT analysis on floating hotels were as follows:

Strengths

- ✓ Geographical location of floating hotels in terms of the fall of the sun radiations on floating hotels throughout the journey from Luxor and Aswan.
- ✓ The appropriate infrastructure for solar energy applications is available in floating hotels.
- ✓ There is enough space to install solar cells in floating hotels.

Weaknesses

- ✓ Personal interviews showed that, it is not permissible to place solar cells on the surface of the sun deck, because it has the majority of the facilities and entertainment provided by the hotel such as swimming pool and Jacuzzi and because the vast majority

of customers spend most of the time on sundeck, the use of solar energy application hinder the benefit from this.

✓ Also, if its pillars are designed on the surface of the floating hotels as a wall to install solar cells on it, the success is met with a handicap of technical obstacles such as Edfu Bridge. And one of the managers mentioned that on the surface of the floating hotels there are tandems that are lowered when passing down the Edfu Bridge to prevent friction when installing solar cells, these obstacles must be addressed. Where the passage of the bridge Edfu between Luxor and Aswan height hinder it.

✓ Decision-makers worry about financial risk because they are new projects.

✓ Lack of conviction among the decision maker of the feasibility of generating energy from solar energy in floating hotels.

Opportunities

✓ State supports for hotels that investing in renewable energy technologies.

✓ Progress in solar technology is continuing to make it economically more efficient. In addition to the low cost of installing solar energy supplies, the cost of solar energy will continue to fall below the cost of conventional or fossil-fuel electricity.

✓ High temperatures in Luxor and Aswan governorates.

✓ Encourage domestic manufacturers to manufacture renewable energy technology with high efficiency and low cost.

✓ Provide local approved maintenance centers for renewable energy systems and provide free maintenance for the project for five years of installation.

Threats

✓ There are some technical obstacles that hinder the use of solar energy applications.

✓ High prices of solar energy technologies.

- ✓ The return on investment in solar energy is realized in the long term.
- ✓ The fluctuation of biofuel prices restricts investment decisions in solar energy.
- ✓ Unusual sunlight affects the total dependence on solar energy production.

When managers were asked about *the benefits that results of using solar energy applications in floating hotels* their answers were that solar energy technologies bring numerous significant benefits, in addition to the aforementioned ones, that could be summarized as follows: Stabilization of energy expenses of hotels, solar energy offers independence from unreliable grid-connections, meeting the sustainability demands of many hotel guests, tourism relies on a clean environment and solar energy serves as a basis for protecting natural heritage, taking responsibility and actively engaging toward protecting the environment and costs of conventional energy sources is highly unpredictable, and could hike again in the future.

When managers were asked about *the obstacles that facing the investment in solar energy applications in floating hotels* their answers were as follow: Financial factors, investment fund shortage and unsure payback time, lack of experienced engineers to support and promote energy projects, lack of specific information and follow up, low feasibility, viability and quality of products, difficulty of integrating solar collectors in floating hotels, where aesthetics and traditional architecture play a dominant role, this results agreed with which stated by (Zhang *et al.*, 2012; Karakaya and Sriwannawit, 2015).

Recommendations

Based upon both the literature reviewed and the field study findings, recommendations could be divided two aspects as follows:

- ❖ Raising the level of awareness of the employees and managers of floating hotels of the importance of using solar energy applications for power generation, through the Ministry of Electricity and in cooperation with the Ministry of Tourism and the Establishment Hotels Chambers.
- ❖ The enactment of a set of rules and laws that encourage floating hotel management to use solar energy applications such as reducing taxes on renewable energy generation and tax deductions on imported solar energy companies to save investment costs.
- ❖ Supporting and financing floating hotel owners by providing loans with the lowest rates to encourage investment in the use of solar energy applications.
- ❖ Solar companies should provide space for solar cells without affecting the facilities and services available at the sundeck on the floating hotels.

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