

SOLAR WATER HEATING SYSTEM IN LIBYAN BUILDINGS

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

(قُلْ إِنَّ صَلَاتِي وَنُسُكِي وَمَحْيَايَ وَمَمَاتِي لِلَّهِ رَبِّ الْعَالَمِينَ * لَا شَرِيكَ لَهُ وَبِذَلِكَ أُمِرْتُ وَأَنَا أَوَّلُ
الْمُسْلِمِينَ)

(Say, "Indeed, my prayer, my rites of sacrifice, my living and my dying are for Allah, Lord of the worlds * No partner has He. And this I have been commanded and I am the first of the Muslims).

صَدَقَ اللَّهُ الْعَظِيمُ

DEDICATION

This thesis is dedicated to my beloved father and mother. I also, dedicate this work to my beloved brothers, sisters and my entire family members for tremendous love, care and courage during the cause of my studies and journey to produce this thesis.



PTTA UTHM
PERPUSTAKAAN UNIVERSITI TEKNIKAL AMINAH

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ABSTRACT

Solar energy is a clean and abundant energy resource that can be used to supplement several energy needs. Solar energy can be utilized as a form of heat, such as solar water heating, and as electricity, such as solar photovoltaic. Solar water heating systems are commonly referred to in the industry as Solar Domestic Hot Water systems. The challenges (increasing demand for energy, sustainable development, low competitiveness, reducing environmental impacts) and the opportunities (value added, job creation, transfer of knowledge and technology acquisition) that North African countries are experiencing today in this field, call for collective action across the whole region, oriented towards tangible results, including Libya faces challenges in providing energy in light of the continuing power outages. The objectives of this research are to identify the current practices of solar water heating system in Libyan buildings, to identify the factors that hinder the application of solar water heating system in Libyan buildings, to suggest on the application of solar water heating system in Libyan buildings. Questionnaires were used to collect the data from contractors and consultants in the construction industry. Ranking and analysis of variance (correlation) were used to analyse the data collected with the use of version 21 SPSS. It was found that the application of renewable energy in construction project is very low. However, the factors that hinder of solar water heating system in Libya were lack of consultant's initiatives, lack of financial commitment, and lack of commitment design team, lack of government interest to promote solar water heating system and high tax on solar energy by government. The result of this finding implicate that the construction industry in Libya need to improve its approach in using solar water heating system by understanding its current practices and finding ways to solve of the factors that hinder.

ABSTRAK

Tenaga solar adalah sumber tenaga yang bersih dan banyak digunakan sebagai tambahan kepada beberapa keperluan tenaga. Tenaga solar boleh digunakan sebagai satu bentuk haba seperti pemanasan air solar dan juga bekalan elektrik seperti solar photovoltaic. Sistem pemanasan air solar biasanya digunakan dalam industri sebagai sistem Solar Air Panas Dalam Negeri. Cabaran (peningkatan permintaan untuk tenaga, pembangunan lestari, daya saing yang rendah, mengurangkan kesan alam sekitar) dan peluang (tambahan nilai, kewujudan pekerjaan, pemindahan pengetahuan dan pemerolehan teknologi) yang negara-negara Afrika Utara alami hari ini dalam bidang ini telah memanggil tindakan kolektif di seluruh rantau ini dengan tumpuan ke arah hasil yang ketara, termasuk Libya yang turut menghadapi cabaran dalam menyediakan tenaga cahaya kepada gangguan kuasa berterusan. Objektif kajian ini adalah untuk mengenalpasti amalan semasa sistem pemanasan air solar dalam bangunan di Libya, untuk mengenalpasti faktor-faktor yang menghalang penggunaan sistem pemanasan air solar dalam bangunan di Libya dan seterusnya mencadangkan beberapa aplikasi sistem pemanasan air solar dalam bangunan di Libya. Borang soal selidik digunakan untuk mengumpul data daripada kontraktor dan perunding dalam industri pembinaan. Peringkat dan analisis varians (korelasi) telah digunakan untuk menganalisis data yang dikumpul dengan menggunakan SPSS versi 21. Didapati bahawa penggunaan tenaga boleh diperbaharui dalam projek pembinaan adalah sangat rendah. Walaubagaimanapun, faktor-faktor yang menghalang sistem pemanasan air solar di Libya adalah disebabkan kurangnya inisiatif daripada pihak perunding, kurangnya komitmen dalam kewangan dan dalam pasukan rekabentuk, kekurangan minat daripada pihak kerajaan untuk menggalakkan sistem pemanasan air solar dan juga pengenaan cukai tenaga solar yang tinggi daripada kerajaan. Hasil dapatan ini mengaitkan bahawa industri pembinaan di Libya perlu memperbaiki pendekatannya dalam penggunaan sistem pemanasan air solar dengan memahami amalan semasa dan mencari jalan untuk menyelesaikan faktor penghalang.

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LIST OF ABBREVIATION

SDHW	Solar Domestic Hot Water
SWH	Solar Water Heating
ECA	Economic Commission for African
SHW	Solar Hot Water
PV	Powered by Photovoltaic
FPC	Flat Plate Collectors
ETC	Evacuated Tube Collectors
SEF	Solar Energy Factor
SF	Solar Fraction
KNUST	Kwama Nkrumah University of Science and Technology
SWHS	Solar Water Heating System
BIM	Building Information Modelling
IBS	Industrialized Building System
EE	Energy Efficient
RE	Renewable Energy
EWB	Electric Water Heating

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Solar energy is a clean and abundant energy resource that can be used to supplement several energy needs. Solar energy can be utilized as a form of heat, such as solar water heating, and as electricity, such as solar photovoltaic. Solar water heating systems are commonly referred to in the industry as Solar Domestic Hot Water (SDHW) systems (Atchison, 2009).

Consumers often ask if there is enough sunlight in the world to support solar applications such as water heating. In fact, there is enough solar energy to deliver an average of 2500 kW/h of energy per year. This means that a solar water heater can provide enough solar energy to meet about one half of the water heating energy needs for a family of four (Atchison, 2009).

Water heating is one of the most cost-effective uses of solar energy, providing hot water for showers, dishwashers and clothes washers. Every year, several thousands of new solar water heaters are installed worldwide. Solar water heating is an accepted technology and is increasingly being used as one of the cost-effective means of heating water in residential and public buildings such as hotels, laundries, restaurants, hospitals and health centers (Bennett, 2008).

Solar water heaters, also called solar domestic hot water systems, can be a cost-effective way to generate hot water for homes. It uses sunlight as its energy source which makes it possible to be used in any climate. There are two types of solar water systems active and passive (Chiras, 2002).

An active solar collector system can produce about 80 to 100 gallons of hot water per day, a passive system will have a lower capacity. Solar water heating (SWH) or solar hot water (SHW) systems comprise several innovations and many mature renewable energy technologies that have been well established for many years (Chiras, 2002).

The SWH system is a part of sustainable energy phenomenon. It becomes necessary due the potentialities that were embedded in it. According to the Economic Commission for African (ECA) under the United Nations Decade of Sustainable program that was air marked between 2014 and 2024, it has potential opportunities in the medium and long term as well as existing barriers and perspectives (UNDS, 2013).

Construction industry is one of the most important sectors in socio-economic development of Libya. This is caused by high rate of urbanization which exposes this country to various issues, which are also associated with environmental and natural resources depletion (Eltaief, 2011). This implies that, due to the increase in population, more construction for housing is required and thus the degree of energy consumption has increased.

Due to the increase in global energy demand, the design of energy efficient building is a matter of great concern among scientists and researchers (Alam, *et al.* , 2012).

1.2 Problem Statement

The challenges (increasing demand for energy, sustainable development, low competitiveness, reducing environmental impacts) and the opportunities (value added, job creation, transfer of knowledge and technology acquisition) that North African countries are experiencing today in this field, call for collective action across the whole region, oriented towards tangible results, including Libya faces challenges in providing energy in light of the continuing power outages (Kramer, 2006).

The idea of sustainability, or ecological design, is to ensure that actions and decisions today do not inhibit the opportunities of future generations. Currently, most

of the commercial and industrial hot water demands in Libya are met mainly by the use of electric heaters (Hinrichs and Kleinbach, 2012). Therefore, there is need to device an alternative of getting hot water without much reliance on electricity.

Unfortunately, cut off electric almost daily, the rising energy cost, environmental concerns, and the depleting nature of the current primary energy sources in use have made electric heaters less attractive (Asif and Muneer, 2007).

This is because the primary energy sources of electric energy utilised are mainly the fossil fuels. Therefore it is understood that producing this form of energy is expensive and sometimes disappointing (Barry, 2011).

Solar can be used as a clean alternative energy to reduce electrical production and is promising in the effect to establish environmentally friendly for electrical system. It is important to implement this form of energy source because country like Libya has many hours in a day, but the using of solar water heating system not familiar. Libyan people have not realized yet about the benefits of using solar water heating systems. It is important to study about producing hot water using solar water heating system and proving about energy saving of solar water heating system.

1.3 Research question

- a. What are the current practices of solar water heating system in Libyan buildings?
- b. What are the factors hindering the application of solar water heating system in Libyan buildings?
- c. What are the ways to promote the application of solar water heating system in Libyan buildings?

1.4 Research objectives

The aim of this research is to identify the current practices of solar water heating system in Libyan buildings. This can be obtained through the following objectives:-

- a. To identify the current practices of solar water heating system in Libyan buildings.
- b. To identify the factors that hinder the application of solar water heating system in Libyan buildings.
- c. To suggest on the application of solar water heating system in Libyan buildings.

1.5 Significance of Research

Solar water heating system is the key element of green construction and since it can be considered as a new technology in Libya, this research is significant in order to help Libyans, both people and government, and other similar countries to apply solar energy. The result of the research can contribute new knowledge in construction industry by giving possible ways of implementing the solar water heating system techniques. The study intends to provide an inquiry into the current practices of solar water heating in the Libyan construction industry because it contributes to the infrastructural development which is significant to the development of its economy. If there is a failure in the construction industry, it manifests into weak infrastructure which affects productivity and the economy as a whole.

1.6 Scope of the Research

The research work focuses on the current practices of solar water heating system in Libyan buildings. The research is to identify the main factors that are affecting the application of solar water heating in Libyan buildings. The case study for this

research consists of the public buildings in Bani Walid city of Libya. The contractors, consultants and clients are the potential respondents of this research.

1.7 Organizational Chapters of the Research

This research work structured into five (5) chapters. Details and specific explanation to every section will be discussed below:

CHAPTER 1: INTRODUCTION

In this chapter, background, aim, significant and the scope of the study will be discussed.



CHAPTER 2: LITERATURE REVIEW

Literature review is on solar water heating system and solar water heating system in Libyan building.



CHAPTER 3: RESEARCH METHODOLOGY

The chapter discusses the research process, design and approach. Also it includes the targeted respondent considered in the research.



CHAPTER 4: DATA ANALYSIS AND DISCUSSION

The data presentation and Analysis of the result will form the main body of this chapter. The discussion and summary will be the conclusion of this chapter.



CHAPTER 5: CONCLUSION AND RECOMMENDATION

Summary of the findings of this research will be highlighted. Conclusion and General Recommendations relevant to the findings are to be drawn.

Figure 1.1: Organization of Chapters

Chapter 1: Introducing the subject to be discussed in the opening of this chapter. It consist of background of research which includes the research problem, research questions, research objectives, scope and significance of research, organization of the chapters and conclusion.

Chapter 2: Literature review will look at the previous writing during the past within the solar water heating system in Libyan building. The chapter focuses on identification of the research gaps that have not been discussed by previous researchers or need to be discussed more. The chapter closes with a conclusion.

Chapter 3: The third chapter discusses the research method and methodology. Discussions focus on the research methodology used in this study. It covers the research design, the scope of the study, sampling studies, research instruments, data collection and data analysis methods.

Chapter 4: This chapter presents the collected data and analyses it. The chapter also discusses the result from the survey and findings of the survey. The chapter discusses the main results of the analysis. The discussion in this chapter answers the research question and gives some recommendations for further research.

Chapter 5: This is the last chapter in the research. It summaries the entire research work conducted and the conclusion. The recommendations are given in this chapter for possible actions to be taken. The chapter will end by highlighting furthermore gabs to intensify research on them.

1.8 Expected Outcome

The expected outcome of this research is the identification of current practices of solar water heating system in construction industry in Libya and its factors that hinder. This research will incorporate the ideas and the experiences of the contractors, consultants and clients in order to meet the objectives of this research. The outcome will reveal the current practices of solar water heating system in Libyan buildings. It will also assist in revealing the major barriers affecting the application of solar water heating system. The study will contribute to the development of the economy and highlight the significance of implementing solar water heating system by the public authority.

1.9 Summary

Introduction of the research subject matter was explained above. The explanation in it comprises the problem statement that established to justify the gap of the research. Research aim and objectives, the question to be answered in the research, the significant and also the scope of the research were fully explained. This is necessary for the subsequent chapters to be discussed with justice. The chapter serves as bedrock that will accommodate the literature review which follows in the next chapter.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Libya is a country located in North Africa on the southern coast of the Mediterranean Sea. It is a member of a number of organizations and regional and international groupings, including the United Nations, the African Union, the Arab Maghreb Union, and the League of Arab States, the Non-Aligned Movement, the Organization of Islamic Cooperation, the Organization of Petroleum Exporting Countries (Adepoju, 2006).



Figure2:1 Location of Libya in the world (Source: www.geo-Libya.yoo7.com).

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