ACTIVE ENERGY EFFICIENCY TECHNOLOGY SOLUTION FOR AL HAMRA MALL

INTRODUCTION

Al Hamra shopping Mall covers an area of 36,000 m^2 and is part of the 5,000,000 m^2 Al Hamra village Real estate project in Al Hamra area of Ras Al Khaimah (RAK) city of United Arab Emirates (UAE). Operation of the mall is associated with high electrical consumption and since the mall is located in a hot, dry and humid climate, about 70% of the energy consumption is attributed to HVAC system used for the mall. However, the hot climate also provides an opportunity of vast solar energy resource which can be harnessed to offset the high cooling energy demand/cost.

Active energy cooling systems operate on the same principle like conventional cooling systems except that the electrically driven compressors used in pressurizing the refrigerant are replaced with a heat source used in evaporating the refrigerant from an already pressurized absorbent-refrigerant mixture. The heat source can be provided by waste heat from combined heat and power plants, gas turbine plants or solar thermal energy. A solar assisted absorption cooling system can effectively be used to reduce energy demand and cost.

OBJECTIVES

Main objective

To theoretically model and simulate a solar assisted active energy efficiency technology solution based on absorption cooling principle

Specific objectives

- To theoretically approximate and simulate the detail dynamic cooling load trend of Al Hamra Mall on the existing state of operation
- To estimate the cost effectiveness of the proposed solution as compared to the existing system

LITERATURE REVIEW

Buildings consume about 30% of the primary global energy use [D. Urge-Vorsatz et. al., 2007; Lina Yang and Yuguo Li, 2008]. The percentage is higher in hot, dry, and humid climates because of the high demand for cooling required for thermal comfort of occupants in buildings. Air conditioning of buildings is responsible for a large percentage of the green house and ozone depletion effect due to the harmful gases released into the atmosphere from refrigerants of conventional cooling systems [T. Tsoutsos et. al., 2009]. However the use of solar energy provides an opportunity to mitigate the aforementioned problems through passive and active energy efficiency technology solutions [M. Santamouris et. al., 2007]. According to T. Tsoutsos and M. Karagiorgas [2006], the cooling load of large buildings can be met by use of solar assisted absorption cooling. This is because it has demonstrated a promising market potential [T. Tsoutsos et. al., 2009]. It can be used in stand-alone systems to improve the indoor air quality of buildings and also reduce energy consumption/cost. Several solar assisted air conditioning systems are available and can lead to remarkable primary energy savings [A. Argiriou et. al., 2005; H. M. Henning, 2007]. These include; single-effect, double-effect, and triple-effect absorption systems.

PURPOSE OF RESEARCH

According to T. Tsoutsos et. al. [2009], by 2007, there were only 81 large scale solar cooling systems installed in the world and only 7 in Asia particularly in China. Basing on the dry, humid, and hot climate of UAE, there is a high demand for cooling throughout the year and this has been met largely by use of conventional air conditioning systems which are associated with high energy costs, green house and ozone layer depletion effect. This therefore implies there is a huge gap in research and implementation of large scale solar cooling systems in UAE and this can avert the energy problems associated with the conventional systems as well as ensuring thermal comfort of people. The research will aim at designing cost effective and environmentally friendly active energy cooling system which utilizes the vast solar energy resource in UAE to meet cooling demands of large buildings.

METHODOLOGY

Literature review

A review of related researches will be conducted to establish current status of active energy efficiency technology solutions and methods used in calculating dynamic cooling loads of large buildings. This will help in selecting the most appropriate solar assisted absorption cooling system to be designed and also obtain the best method to use in estimating the cooling demand

Data collection

Available hourly weather data of the mall for one year will be reviewed. This will include temperature, relative humidity, wind speed and direction, and solar irradiation. Information about structure and usage of the mall will be considered. This will include construction materials, orientation, size, and geometrical characteristics, existing HVAC system, electrical appliances used, and people using the mall at a particular hour of the year.

Data analysis

The data collected will be used in Energy Engineering Solver program (EES) and Transient system simulation program (TRNSYS) to estimate the dynamic cooling loads of the mall and optimizing the designed solar assisted absorption cooling system. The cost of existing system will be estimated by considering energy cost bills and the approximate cooling load calculated. The cost of proposed system will be estimated and a comparison with the existing system will be made by calculating a payback time of the proposed system.

EXPECTED OUTCOME

The research will stipulate a complete procedure for designing solar assisted absorption cooling systems for large buildings. The designed cooling system will be important in reducing energy consumption/cost and utilization of the enormous and environmentally sustainable renewable solar energy resource to meet the dynamic cooling load of large buildings.

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MASTER'S THESIS PROJECT WORK PLAN - 2010						
	March	April	May	June	July	August
Proposal writing, presentation to the supervisor, and approval						
Proposed starting date for Master's thesis project	15st					
Getting acquainted with simulation softwares: TRNSYS and EES						
Reviewing related researches						
Monthly status report presentation to the supervisor		1st				
Working on Introduction/background, Objectives, and Methodology of report						
1/3 of thesis report presentation to the supervisor		30th				
Monthly status report presentation to the supervisor			3rd			
Collection and recording of relevant data						
Monthly status report presentation to the supervisor				1st		
Analysis and discussion of results and recording						
2/3 thesis report presentation to the supervisor				28th		
Monthly status report presentation to the supervisor					1st	
Final report writing and editing						
Monthly status report presentation to the supervisor						1st
Presentation of final results and report						30th