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Assessment of practices and technologies of energy saving and renewable energy sources in hotels in Crete

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ABSTRACT

This study aims to assess the state of the art of practices and technologies of energy saving and renewable energy sources in hotels. This will contribute to determining the potential of efficient and sustainable energy technologies integration. Hotel managers were interviewed face to face and information sessions were provided. Special energy and environmental awareness campaigns, sectoral tourism programs for climate change mitigation and adaptation, supportive policies and hotel energy investments and renovation programs are some recommendations elicited from the results of this study.

1. Introduction

Tourism and environment should be managed in an integrated and interdisciplinary way [1]. Growing global environmental concerns are dictating the adoption of environmental friendly policies for tourism industry. Although there are some very well-known tools aiming at environmental protection and sustainability, i.e. EMAS, ISO 14001, eco-labels, etc. [2], the question of how to achieve sustainable tourism remains an object of debate. It is clear that for tourism to be sustainably developed, environmental impacts need to be kept below critical threshold levels, which can only be achieved if these can be quantified [3]. Dalton et al. [4] support that Green House Gas (GHG) emissions produced by hotels can be reduced by: implementation of energy efficiency measures and/or production of power by renewable energy supply initiatives and technologies.

Hotels are ranked among the largest energy consumers in tertiary building sector. Compared to demolition and reconstruction, renovation is usually financially attractive and also offers great opportunities for promotion of energy efficient measures, exploitation of renewable energy sources (RES) and rational use of energy (RUE) in the hotel sector [5]. There is a lot of room for cost reduction and competitive prices achievement in hotel energy consumption. Growing awareness of environmental factors in hotel design and operation, is leading to the introduction of elements and processes with less environmental impacts, which help to create conditions favorable to the optimization of energy resources and the introduction of Renewable Energy Technologies (RETs) [6]. Furthermore, the adoption of energy saving applications in hotels shall give them a comparative advantage of environmental performance [7].

Electricity is the primary form of energy used in hotels mainly for air-conditioning, space and water heating, lighting, lifts, kitchen equipment, etc. [7] while natural gas, diesel and coal, only play a minor role [8]. Ali et al. [9] report that electricity used for running air conditioning systems corresponds approximately to 30% or more of total expenditures of energy consumption. According, however, to Santamouris et al. [10] air-conditioning systems increase the annual energy consumption by 29–77%, depending on the type of system. Daskalaki and Balaras [5] report that in European hotels, 61% of the energy is consumed by space heating, cooling and ventilation, 25% by services and 15% by hot water production.

About half of the European hotel buildings are located in the Mediterranean countries. An important characteristic of the Mediterranean hotels is that they are located in areas with high

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seasonal energy demand loads and frequently high energy cost and low security of energy supply (i.e. islands) [5]. On the other hand, there is a high potential for energy saving and application of RES. Nevertheless, there is a poor RES application in hotels according to HOTRES project. An exception is the thermal solar investments for sanitary hot water production [6].

The reasons for the extremely low profile scheme of RETs penetration in the hotel sector are [5,6]: 1. Financial factors, investment fund shortage and unsure payback time, 2. Lack of experienced engineers to support and promote energy projects, 3. Lack of specific information and follow up, 4. Low feasibility, viability and quality of products, 5. Difficulty of integrating solar collectors in hotels located in the islands, where aesthetics and traditional architecture play a dominant role.

Energy consumption in hotels is among the highest in absolute values in the non-residential building sector. Karagiorgas et al. [7] report annual figures of 215 kWh/m^2 in Italy, 287 kWh/m^2 in Spain, 280 kWh/m^2 in Greece and 420 kWh/m^2 in France. In Singapore mean energy consumption is 427 kWh/m^2 [11]. In Athens, average annual total energy consumption in audited air-conditioned hotels is 298 kWh/m^2, in hotels with split unit heat pumps is 218 kWh/m^2, while in naturally ventilated hotels corresponding value is 168.7 kWh/m^2 [10].

Annual final energy demand in Hellenic hotels is estimated at 4.2 TWh, representing 28% of total energy demand in tertiary (non-residential) building sector, the fuel breakdown is 18% for oil and 82% for electricity. In France, total energy consumption of the hotel sector is 13.25 TWh, representing 18% of the total energy demand in the tertiary sector. In Spain, energy demand in hotels represents 35% of total demand in the services sector [5].

Priority should be given to control energy use in guestrooms using popular room key-cards to ensure that practically all electrical appliances are turned off when guestrooms are unoccupied. In this case, annual energy savings were estimated at 170,972 kWh/year (1147 kWh/room·year) for a medium size Mediterranean hotel. If a room key-card control is used (used as an entrance key), the payback period is 1.5 years [5].

Santamouris et al. presented several scenarios to reduce energy consumption levels for 158 Hellenic hotels operating all year round by using different simulations. Annual average energy consumption in Hellenic hotels was 273 kWh/m^2, one of the highest among all categories of buildings. Thermal insulation can reduce annual thermal energy consumption by reducing heat losses during winter and cooling load during summer. For insulated buildings, thermal energy consumption can be up to 20% less than the energy consumption in non-insulated buildings [10]. Energy co-generation of heat and power (CHP) in combination with absorption chillers, compared to renewable energy technologies and demand side measures (DSM) is a solution examined in practice for a “green” large hotel [12]. Khemiri and Hassairi estimate that energy saving potential should reach 50% for hotels in the Mediterranean [13].

Energy-saving related measures studied by specific software for energy management in hotels (XENIOS) for medium size Mediterranean hotels were [5]: 1. Installation of solar collectors for sanitary hot water production, 2. Installation of solar collectors for swimming pools, 3. Hot water production, 4. Solar cooling, 5. Chiller cooling with seawater, 6. Installation of zoning and controls in the elevator system, 7. Use of energy efficient equipment in the administration offices, 8. Reduction of the energy consumption for lighting in specific areas, 9. Daylight control in specific areas, 10. Room key-card control.

The hotel sector in Greece is highly important comprising 8689 hotel units. They include 339,540 rooms and 644,898 beds. Crete has the largest Greek tourist capacity with 1381 hotels, 66,411 rooms and 124,784 beds [14]. Due to the importance of tourism for the economic growth of Greece and the high number of hotels in Crete, we have decided to investigate the energy saving and RES state of the art and to localize the factors of integration of these technologies in Cretan hotels under the ENERCYREGIO Interreg IIIC project [15]. We aimed at providing information and awareness for hotel managers and formulating and prioritizing policy actions and investments.

2. Materials and methods

This section provides information concerning the questionnaire design, the information material used, as well as the sample selection and implementation of the research.

2.1. Questionnaire design

The questionnaire addressed to hotels consisted of 5 parts. Also a specific information session had been prepared and implemented during each interview in order for all respondents, to have a minimum understanding level and, thus, being able to reply to questions.

The first part was comprised of questions which refer to the characteristics of the hotel, like categorization (stars), floor area, number of rooms, number of beds, annual stays, etc. The second part contained information about energy awareness of the hotel operator and electricity supply reliability. The third part contained information about the building envelope, such as the existence of shading devices, double glazing windows, etc. The fourth part aimed at recording any energy saving technologies and renewable energy source practices at the hotel and the intention to install them: questions were addressed about clever keys linked to electricity management, efficiency and the maintenance of air-conditioning units, cleaning of air conditioning filters and installation of thermal solar heaters. The fifth part addressed the environmental and energy image of the hotel.

2.2. Information material

The information material consisted of a two-part leaflet with pictorial information. The first part included photos and schematics of RES. The interviewer showed those pictures and explained about solar heaters, photovoltaics, shallow (solar) geothermy and bioclimatic designs. These are RES practices that can be applied in a hotel building. The second part included photos and plans of double glazing insulation techniques, fixed sunshades, Venetian blinds, inverter technology of air conditioning and energy saving classes of the split units, smart keys and cards linked to energy saving, maintenance of air-conditioning units and filter washing.

In order to convince hotel managers of the economic and energy/environmental advantages of the proposed RES and energy saving technologies and interventions, quantitative data – adapted to local conditions and to the operational mode of Crete – have been simultaneously presented during the interview [16].

1. The system of clever key cards linked to electricity switching off, results to the room/apartment achieving 15% electricity saving, which equals to 24 € per season of operation. Given that the installation of such systems is subsidized at 40%, the payback period is 3 years (for seasonal operation).
2. The cost of an air-conditioning unit with inverter technology and A energy class is 25% more expensive (aprox. 230 €) and achieves an electricity saving of 55% which corresponds to 70 €/yr while its payback period is 3 years.
3. The annual maintenance cost of the air conditioning units is 20 € per hotel room and corresponds to an electricity saving of