

Issues Regarding Sustainable Electricity Management in Hotels on Islands

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Abstract. The aim of this work is to analyze several issues concerning the contribution to energy sustainability on islands that appropriate management of the electrical energy in hotels may enable. Accordingly, possible energy efficiency measures, as well as renewable energy applications are mentioned.

In addition, some standards and sustainability indicators related to the assessment of adequate energy management are described, also including examples of some islands and hotels in their commitment to increase their levels of energy sustainability.

Finally, the management potential that hotels may have inside the context of a smart grid development on islands is discussed; concluding that the role of hotels, and tourism facilities in general, should go beyond simple energy saving measures, that is, they should become more involved in the whole island electrical energy management, easing the overall increase of energy efficiency in both scopes, hotels and islands.

Key words: Sustainability, renewable energy, sustainable islands, sustainable tourism, energy efficiency, energy and electricity management.

1. Introduction.

Due to the particular characteristics of islands – isolated territories, frequently small - the issue of sustainability acquires more relevance when they are compared with other areas or territories in mainland regions, given their relative fragility in terms of economic and energy dependence from abroad. Moreover, not only the sustainability options for islands depend on the measures that may be taken in this regard by their populations, but these options also rely on what the rest of the world does in order to assure a sustainable planet, particularly when the consequences of the climate change are taken into account [1]. As a result, the inherent vulnerability of islands to the use of fossil fuels as the primary energy for their electricity needs makes it essential the analysis of the different energy options, and the key sectors where investments could make a worthwhile contribution to the proper and efficient access to electricity on islands [2,3].

Additionally, islands are forced to face this situation in the middle of very high fossil fuel price volatility, which has been caused by several reasons, such as political decisions in the oil-producing countries (geopolitics), associated technology development (which has led, for

instance, to use the hydraulic fracturing or ‘fracking’ as a method to obtain oil and gas at relatively low cost in some regions, particularly in The United States of America), together with the adoption of energy efficiency programs by the oil-consuming countries in order to reduce their energy needs, giving priority to fossil fuel savings in particular. Furthermore, despite the recent decrease in the oil prices, this fact has been understood as a transitory period since, although the technology improvements have reduced the cost of extracting new oil, this kind of oil is usually of lower quality and still more expensive to obtain than that obtained using traditional methods in traditional oil sites. Not to mention that the available fossil fuels are finite in essence, even though this availability may be extended more than previously foreseen. Thus, the investments in renewable energy around the world, not only have not been reduced, but they have also been increased [4].

Moreover, the concern about the climate change due to the excess of greenhouse gas emissions to the atmosphere is also worth mentioning, since in the last Climate Conference of Parties (COP21, held in Paris in December 2015) the settings of an appropriate framework were established to promote a shift towards a ‘decarbonized’ economy [4]. The threats of the climate change need to be tackled seriously as they have been widely described in different literature [e.g.: 5-7].

On the other hand, in general, the most important economic sector on islands is the tourism, accounting for more than 20 % of their Gross Domestic Product (GDP) in many cases [8]. Moreover, some islands can reach more than the 70% of their GDP, as it is the case of The Canary Islands [9]. Thus, it is interesting to study how the tourism sector may play a key role in pursuing the energy sustainability on islands. This fact has been acknowledged by the World Tourism Organization (UNWTO) and the International Renewable Energy Agency (IRENA), which have reached an agreement in order to promote the energy efficiency, including the use of renewable energies, in the tourism sector on islands. This agreement was reached in 2014, during the Third UN Conference on Small Island Developing States, organized by the United Nations in Samoa [10].

In this regard, it is also important to consider the concept of sustainability, as it was defined during the World

Commission on Environment and Development (WCED) held in 1987, which states that the sustainable development is the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” [11]. The final report of this meeting, called ‘Our Common Future’, represented one of the first statements leading to a serious concern about the environment protection from human activities; later, the social implication, also contained in the sustainability definition of the WCED report, was also given its justified importance, leading to the concept of ‘Corporate Social Responsibility’, which basically refers to the social commitment of companies beyond their economic and technical interests [11]. Finally, sustainability for a company essentially consists of being capable to generate economic profits for long time, while considering and managing the impact that its activities may have on the society and the environment [11]. Thus, nowadays, companies – including hotels and resorts – can show evidence of their sustainability commitment through what is called ‘sustainability reports.’

2. Hotel Energy Needs and Energy Efficiency Options.

The energy consumption in hotels situated on islands does not differ too much compared to those located in mainland regions. Thus, the average energy needs of a typical hotel, in terms of electricity consumption, are depicted in Fig. 1.

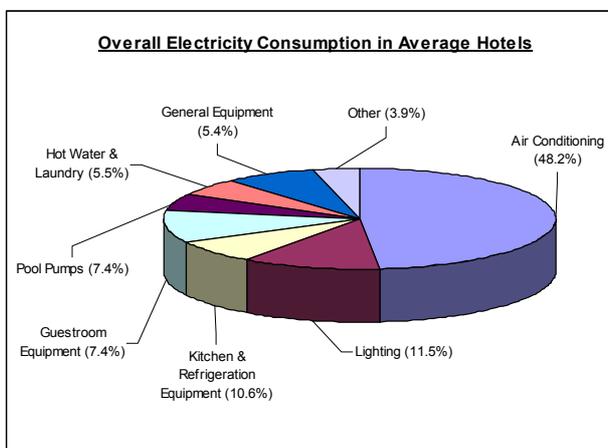


Fig. 1. Electricity consumption in average hotels [12].

Of course, the percentages depicted in Fig. 1 may change for each particular case, mainly depending on the region of the world where the hotel is situated. Thus, in average, a hotel located in Sweden consumes the 48 % of its energy needs in space heating, and just the 4 % in space cooling; whereas a hotel in Hawaii would consume a 45 % of its total energy needs in space cooling [13]. These figures show that, although the air conditioning can be mostly used either for cooling or heating, the percentage of the total energy consumption that the air conditioning represents does not differ too much from each other. Moreover, what is relevant is that air conditioning is by far what consumes more energy in an average hotel. On

the other hand, the figures for other kinds of consumption do not differ too much for different hotels either.

Additionally, the percentages depicted in Fig. 1 are more likely to represent the energy consumption of relatively large hotels, with high levels of energy needs, where the options for savings are estimated between 25 % and 30 % [14]; whereas in the smallest hotels the facility consuming more energy is usually the water heating system [8].

A consequence of the consumption pattern, that the average hotel shows, is that the air conditioning represents the amount of energy consumption where more savings, in terms of energy and energy operation costs, can be achieved. In this way, several approaches can be considered in order to reduce the energy consumption of a hotel and, thus, increase its efficiency:

- The implementations of low consumption and efficient lamps, as well as an efficient design of the lightning system as a whole, taking into account the activities for which the different areas of the hotel have been intended. Just changing incandescent bulbs by compact fluorescent light, reductions in energy consumption have accounted for 75 %, not to mention the longer operational lifetime that fluorescent light holds [15].
- In general, the use of efficient equipments, electrical and mechanical devices, including their appropriate maintenance, as well as the maintenance of the whole installations, together with an efficient operation, would lead to rapid investment returns [16].
- Different approaches to automation, such as home automation devices like occupancy sensors in rooms, linked to more efficient regulations in air conditioning flow levels, as well as to the operation of lighting, can considerably reduce the energy needs [16].
- The involvement of personnel and guests in the efficient management of a hotel has also been considered of importance in the success of energy efficiency measures, with examples of 15 % reduction in energy needs, in only seven years, by implementing the adequate energy management, together with the appropriate hotel staff participation [14].
- Another important issue to consider when building a new hotel is the use of sustainable architecture techniques, such as proper building orientation, efficient use of natural light, natural cooling and heating, use of adequate materials, etc. However, if it is an already built hotel, minor refurbishing, such as setting isolating materials or replacing windows or glasses with more efficient ones, would improve the overall hotel energy efficiency in most cases [14].
- Finally, the use of renewable energy, in order to supply part of the hotel energy needs, is commonly worth considering, both in terms of operational costs and energy savings. Additionally, emissions of greenhouse gases are also reduced due to savings in the use of fossil fuels.

In general, the reduction of energy consumption, by using most of these measures, oscillates between 15 % and 20 % in many cases, reaching more than 45 % in energy reduction in some cases [14].

On the other hand, in spite of the reasons that hotel owners have to implement energy efficiency measures, such as savings in operational costs, meeting demands from environmentally aware customers, and showing a better image to increase the hotel position in the tourist market, for instance [16], there are also some barriers against such implementations that should be overcome. Examples of some of these hurdles are the fact that the initial investments may be too high in some cases, so hotel owners may have difficulty in their access to financing, particularly in small islands and for small resorts. Additionally, reluctance to the use of renewable energy, instead of diesel or propane gas, could also arise due to the way some technologies work, not able to supply the required amount of energy when needed, such as wind and solar energy, so some storage system may be necessary, leading to a more complex system as a whole. Furthermore, if there are no appropriate regulations and guarantees with regard to grid electrical energy exchanges, the management of situations with lack or surplus of energy inside the hotel may become difficult in some cases [8].

Besides, the lack of skilled personnel in some islands, who is needed to deal with the appropriate management and maintenance of the new installations, together with some difficulty in the access to the necessary equipment, are also drawbacks for those islands to make technological improvements in their hotels. Finally, in some cases, hotel owners have the preconceived notion that spending high amounts of energy is necessary to assure the necessary comfort levels for their guests [8,14].

A. Regulations aiming to achieve energy efficiency around the world.

The standards compliance, with regard to efficient energy operation and management in hotels, together with appropriate regulations and economic support by local and national governments in order to promote energy savings in buildings – and particularly in tourism facilities – would be strong drivers towards tourism sustainability. Whereas regulations are commonly mandatory, standards are usually voluntary; in this way, hotels can improve their position in the tourism market holding energy efficiency standards as sustainability credentials for attracting tourism concerned with environmental issues.

A number of standards are available for hotels to be accomplished. Some of them are international worldwide standards and others are more specific to certain regions, some of them could be applied to whatever organization, and others are more specific for certain companies to be applied, but all of them give directions on how to improve the different sustainability parameters.

One of the most important regional standards is the European Eco-label, aiming to implement an adequate environmental policy that can be also applied to hotels; it has acquired European-wide recognition [17]. Another relevant international standard is provided by EarthCheck, which provides eco-tourism certifications in a wide spectrum of environmental friendly issues related to tourism and tourist destinations, including hotels, considering their management and design [18]. There are also standards established in specific countries, as it is the case for Ecotourism Australia, which also issues eco-certifications for hotels (Climate Action Business Certifications) in Australia; these certifications acknowledge that the certified hotels meet certain requirements on environmental sustainable practices [19].

In general, it is considered that the first practical international acknowledgement about the consequences that human activities may have over the earth sustainability, mainly through their influence on the climate change, took place in 1987, when the World Commission on Environment and Development warned about the problem of sustainability in its final report 'Our Common Future'. Then, environmental issues were given consideration to take part of the culture and general management of companies, resulting in the development of 'Environmental Management Systems' (EMS), such as the 'Eco-Management and Audit Scheme' (EMAS), which was a non-compulsory set of guidelines and action plans, developed by the European Commission, that could be implemented by companies in almost every aspect of their businesses in order to protect the environment from their activities [11]. The worldwide international standard for EMS is the ISO 14001. Both procedures are quite similar, although EMAS is more demanding [20].

However, it was realized that the approach to sustainability should be put in practice taking everything into consideration, that is, including social issues and economic aspects, together with the already considered environmental issues. This concern led to the concept of 'Corporate Social Responsibility' aiming companies to consider sustainability in a holistic way. In this way, the 'Global Reporting Initiative' (GRI) is widely used in order to publish the level of the involvement that a company has in terms of sustainability [11].

Finally, and taking only into account the energy management, the standard ISO 50001 is the most acknowledged international standard intended to achieve a sustainable energy management in any organization. It gives an effective procedure to increase the energy efficiency of the company and, at the same time, takes into account the protection of the environment; all of this without diminishing the productivity of the company [21]. It is based on a continuous improvement process, which involves all the personnel at the company [21]. This process is represented in Fig. 2.

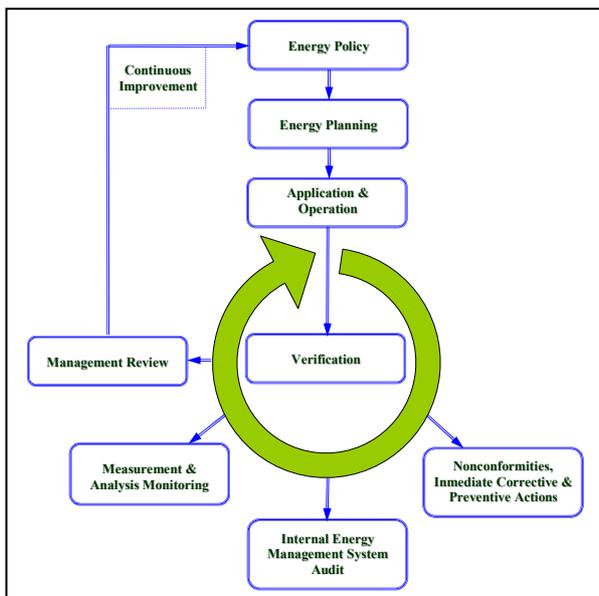


Fig. 2. Schematic model of the energy management standard ISO 50001 [21].

3. Sustainability Indicators with regard to Hotels Energy Consumption.

Whenever measures are implemented – in this case to improve energy efficiency and sustainability in hotels and islands – it is necessary to consider certain variables or indicators with the purpose of measuring the effects that those implementations cause. This can be further used to check if the results have met the objectives, or if others measures are needed to stay closer to the desired goals. Thus, indicators are particularly useful when different scenarios need to be assessed and compared.

Accordingly, and with regard to hotels, some indicators are worth mentioning in relation to energy management, environmental issues and sustainability in general. Some of these indicators are the energy consumption (per tourist activity and source), amount of renewable energy used compared to non-renewable, direct and indirect gas emissions, carbon footprint per tourist activity, levels of polluting light (lighting pollution at night), levels of polluting noise coming from the use or generation of energy, etc. [22].

4. Sustainability through the use of renewable energies in hotels on islands.

When considering energy sustainability actions for certain hotel, the first step is saving as much energy as possible without comprising the quality of the services offered to guests. This is achieved by setting appropriate energy efficiency measures and it has been already discussed. The second step would consist of using renewable energy sources to supply the remaining needs of energy after having applied the efficiency measures. Of course, reaching a 100 % renewable system in a hotel is rather difficult to achieve while keeping the installation costs at a reasonable rate; however, a properly designed mix of several kinds of renewable energy facilities,

considering the energy resources of each island, as well as taking into account the applications for which the energy is going to be used, can lead to a highly sustainable and profitable energy system for the hotel.

A. The use of electricity as a tool towards energy efficiency enhancement in hotels.

Electricity is a means of clean, safe and easy to manage energy that has become essential in the industrial development throughout the past century. However, it must be obtained from some primary energy in order to be appropriately used; thus, if the electrical energy related industry needs to be sustainable, that primary energy should be renewable. In this regard, islands are usually granted with several kinds of renewable energy, depending on their geographical characteristics.

In some cases, it is more efficient not to transform the primary energy into electricity whenever it is possible to use the energy from the primary source directly in the process. An example of this is the case of heating or cooling systems fed by a geothermal facility, being the main driver of the installation a thermal system – following a thermal cycle –, so the consumption of electricity is mainly spent in the compressor of the heat pump (if it is necessary in the installation), reaching savings of 30 % - 60 % compared to systems working only with electrical energy [23]. Additionally, it is also possible for air conditioning the use of solar energy through evacuated tube collectors, or even using high efficiency flat plate collectors. Flat plate collectors are also useful for water heating applications.

In general, if heating or cooling is required, and the chosen renewable source delivers heat or even cold (sea water for air conditioning, for instance), it would not make sense to transform that heat energy to electrical energy to be used for electrical heaters or coolers, so energy transforming losses are avoided. Another example of this direct use of energy is biomass, which is commonly used for district heating renewable installations, burning it in biomass boilers, although electrical applications are also possible. However, the efficiency of power generation with biomass can be of 20 % or even less, specially in installations at small scale; conversely, the efficiency of biomass power generation facilities increases when a co-generation process takes place, reaching efficiencies of 80 % or even more [24]. In the last years, a growing number of islands are adopting what is called ‘modern biomass energy’ (methane, biological fuel oil, ethanol, etc.), reaching efficiencies in power generation of about 60 % - 90 %, also emitting less polluting gases to the atmosphere [25].

Anyway, there are several factors to be considered when analyzing the best option and, depending on the regulatory framework, the efficiency and cost of the technology, the energy needs and the resource potential, whether using or not electricity as the main energy vector becomes challenging and requires deeper consideration [26].

On the other hand, much of the renewable energy is usually transformed in electrical energy, as it is the case of high temperature geothermal systems, wind and some solar systems, hydropower, biomass in some cases, and several means of sea energy (tides, sea currents, sea temperature gradients, sea waves, salinity gradients) [25]. Sea energy is still undergoing research to become fully competitive on the market; however there are already demonstration projects installed on some islands, showing a promising future for this kind of energy [25].

B. Examples of sustainable energy commitment in some hotels on islands around the world.

The energy sustainable development on islands is uneven. This may be due to their different regulatory frameworks, differences in the awareness of their populations, different accessibility to technology or just different renewable energy potential.

Regarding hotels, they usually follow the same pattern of sustainability attitude adopted by the island as a whole. An example of this general involvement is the Danish island of Samsøe, when in 1997 it won a Danish contest aiming to make the island 100 % renewable in 10 years [27]. Since then, although not very successful at the beginning, the project became very active in promoting the participation of islanders in renewable energy installations, such as wind, solar and biomass facilities, leading to energy and economic benefits [27]. Following the success of the project, tourism interested in the development of renewable energy on the island started to increase, becoming it part of the attractiveness of the island [27].

Tourism represents the second main economic sector in Samsøe, after agriculture, and the accommodation in the island consists of different lodging types, such as, hotels, summer cottage rentals, bed and breakfast lodges, etc. [28], which can benefit from the renewable energy produced on the island in terms of electricity and heat, (if they are connected to the electrical grid or to a district heating system respectively), from some individual renewable energy facilities that they may have, as well as from sustainable architecture measures, such as the use of isolation materials; however, no special actions or facilities seem to have been developed specifically in the tourist sector with regard to energy.

On the other hand, in the Pacific, The Fiji Islands have released recently a framework document on guidelines for their green – sustainable – development [29]. Knowing that the small island developing states (SIDS) in the Pacific are among the most threatened islands by the effects of the climate change, the document is a comprehensive agenda leading to a sustainable future for the archipelago. In relation to energy, there is a strong commitment to development of renewable energies in the archipelago, fostering the independent power producer through adequate regulations, such as feed in tariff or a similar pricing framework; also enhancing energy efficiency in buildings, as well as the production of biofuels on the islands [29].

Regarding energy and tourism, there are already examples of energy efficiency actions in many hotels and resorts on The Fiji Islands, including the development of renewable energies [29]. An example of this is the 412.36kWp photovoltaic facility installed at Radisson Blu Resort Fiji Denarau Island, which can reach a production of 597 MWh of electrical energy per year [30].

The archipelago of Hawaii is also worth mentioning, being by far the state of the United States of America that consumes more energy from fossil fuels, also possessing the highest electricity rate of the whole country, so appropriate measures have been taken to foster the development of renewable energies in the archipelago, with support of both the federal government and the state government [31]. Besides, the renewable potential of the islands is high and varied, mainly wind, geothermal and hydro, but each island has its own energy potential [31]. Accordingly, hotels take part of this renewable energy development with a variety of instances [32].

With regard to standards, the Terceira Mar Hotel, located in the Portuguese Terceira Island in the archipelago of The Azores, adopted the EMAS standard several years ago, together with the ISO 14001, making investments in new efficient equipment and in a centralized automated management centre in order to monitor the energy consumption of the hotel, reducing the electricity consumption per room by 38.11 % in only one year (from 2003 to 2004) [33].

5. Smart grids and hotels as essential contributors to the future energy management on islands.

During the last decades, a new concept about how a power system should be managed has emerged, leading to changes in traditional paradigms regarding power system operation and management. Thus, utilities have just been mainly concerned about reducing their operational costs, taking it for granted that the electricity demand was always there, given the high inelasticity of the demand curves of electrical energy. Nevertheless, strong concern about energy efficiency, as well as the appearance of new distributed electrical energy generation, has led to the concept of smart grids, where utilities are just, although essential, components of a complex meshed network of energy exchanges.

Utilities have noticed and reacted to these shifts in paradigms, so they have started to provide their customers with services, apart from just supplying electrical energy [34]. Accordingly, they are implementing smart metering devices, offering energy efficiency solutions and reaching agreements with renewable energy producers, among other actions.

On the other hand, hotels, and tourist resorts in general, are commonly huge electrical energy consumers and, when they take part of relatively weak power grids, such as those usually found on islands, the importance of how

they manage their internal electricity systems is evident from the point of view of the whole grid operation and management. In this way, many hotels have already implemented automation systems in order to achieve an efficient management of their energy [35]; this is of most importance since these inner automation systems ease the integration with the external grid [36]. Besides, due to the intermittent characteristics of some renewable energies, i.e. wind and sun, it would be almost impossible to feed all the energy needs of a hotel only with renewable energy, unless costly storage systems were included in the hotel facilities; in this regard, according to research, the implementation of smart charge/discharge systems for electric vehicles, in the context of smart grids, would facilitate the integration of renewable energies [37]; thus, the fact of including appropriate charging ports, in the parking lots of hotels, would also ease the management of the self-supply energy systems of those hotels.

Although detailed grid stability studies are necessary prior to the implementation of smart grids in weak grids, preliminary research has concluded that the settlement of microgrids is likely to have a positive impact on islands [38]. Of course, all of this must be tailored to each particular case, adapting the available technology to reach the best cost-benefit ratio [39].

6. Conclusions.

This work shows how the tourism sector, particularly the facilities associated with hotels, can definitely contribute to the energy sustainability on islands. This can be done by the appropriate management of the electrical energy that those facilities use. In this way, apart from the possibilities for the reduction of energy consumption in hotels that appropriate energy efficiency measures can generate, they may also result in reductions regarding expenditures in upgrading the power system on islands. Moreover, the electrical installations of the hotels in certain areas of the islands could also contribute to a more efficient use of the existing grid and a better management of the power system as a whole, when considering a smart grid environment.

According to the studies performed, most of the hotels committed to sustainability have only based their energy management on trying to reduce their energy consumptions by means of several strategies, including different levels of automatization in their installations. At the same time, investments in one or several means of renewable energy facilities are also made to supply part of their energy needs. However, there is no evidence of close cooperation between hotels and utilities in order to achieve a more efficient electrical energy management on the islands. Thus, the development of microgrids and/or smart grids, where hotels and utilities could work together for a common energy efficient management, is still necessary to be encouraged if higher levels of energy efficiency are desired on the islands. This would comprise appropriate regulations in order to foster mutual benefits, as well as extensive use of information technologies (IT), all intended to achieve a more optimal operation of the whole system.

Therefore, in order to achieve these improvements in terms of energy efficiency and sustainability, rigorous, extensive and particularized studies must be done to match each case to the adequate solutions – i.e. considering the characteristics of each island together with those of its hotels, - which include the use of the available renewable energy resources in their optimal proportion. Thus, preliminary energy studies comprising the analysis of the present situation, the available options and the investment needed to reach a certain result, are essential in the process of becoming sustainable with regard to the energy management, with islands and hotels working together.

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