Sustainable technologies in Greek tourist accommodation; Part 2: A quantitative review

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Abstract

This paper is the second part of a review on sustainable technologies pertinent in Greek tourist accommodation. The first part was a qualitative review while the current paper is a quantitative review. Namely, this paper provides figures and data that describe the quantitative picture of sustainable hotels in Greece. The topic is unique because the analysis presented herein has been largely fragmented in various reports, webpages and the records of relevant organizations. The reason we focus on Greek reality is the importance of tourism for the Greek economy. This review will help first hoteliers to benchmark their businesses to a the ideal sustainable reference point and second policy makers to obtain a quantitative overview of hotel sustainability in Greece and provide insight as to the measures that should be established for the promotion and improvement of sustainability in Greek hotels and the subsequent design of useful measures and policies.

Keywords: Greece; green technologies sustainable hotel; quantitative; review;

1. Introduction

European policies for tourism focus around a fully integrated environmental management with three distinct but sometimes also interconnecting pillars: energy, water and waste management which will result in resource conservation and sustainability. Careful auditing of resource consumption, collection of all relevant information and its dissemination, participatory procedures and responsibility sharing among all stakeholders are some of the prerequisites that will ensure that tourism will grow without negative implications for the environment and the local communities that foster it.

Agenda 21 includes tourism as one of the sectors that need separate attention for the pursuit of sustainability with a particular focus on information exchanges, awareness, the implementation of innovative practices, the direction of structural forms into sustainable forms of development and the incorporation of environmental pillar into tourism. As far as the energy pillar is concerned, energy efficiency and its rationalization of usage should be promoted through energy efficiency technologies and the penetration of renewable energy sources as well as the encouragement of demand side management schemes which will contribute to cost internalization through smart

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economic instruments which will penalize polluters and squandering consumers. Until Agenda 21, European policies included tourism only as a dimension of the environment which had a significant impact on it through its related activities.

Greek tourism accounted for 7.5% direct contribution to GDP in 2016. Its total contribution to GDP that year was 18.6%. Its direct contribution to employment was 11.5 while its total contribution to employment was 23.4% in 2016. The World Travel Tourism Council estimates a direct contribution to GDP equal to 4.5% per annum for the next decade, a total contribution to GDP equal to 4.6% per annum, a direct contribution to employment equal to 2.9% per annum and a total contribution to employment equal to 3.4% per annum (World Travel & Tourism Council 2017). Greece has 9,730 hotels with 788,553 beds. From them, 444 hotels were ranked as 5 star (namely, 4.58% of them with 137,210 beds), 1,412 hotels were ranked as 4 star hotels (namely, 14.51% of them with 203,203 beds), 2,472 hotels were ranked as 3 star (namely, 25.40% of them with 185,560 beds), 3,990 hotels were ranked as 2 star (namely, 41.00% of them with 210,365 beds) and 1,412 hotels were ranked as 1 star (namely, 14.51% of them with 52,215 beds), (Hellenic Institute of Tourist Research and Forecasting, 2016).

The dissemination of both qualitative and quantitative information on the state of the art is necessary for Greek hoteliers because this will enable them to position and benchmark their own businesses in the industry and show them the available possibilities for sustainable development and the way that needs to be covered by them in order to become competitive and viable in the long-run. Kapiki (2012)finds that the benefits from an eco-friendly hotel include a satisfactory decrease in the level of operating costs and a significant increase in the volume of reservations (up to 30%). Last but not least, tourists themselves and tour operators will be facilitated and they will become aware of the level of environmentally sustainable solutions that are to be expected in Greek hotels. A survey of 1,300 U.S. travelers by TripAdvisor.com has revealed that two-thirds of tourists, consider the environment when choosing hotels, transportation and meals (Bender 2013).

The current study has collected data from statistical services, fragmented literature, surveys and reports from relevant organizations. The collection took place either with desktop work or visits to the organizations. Our study is similar to the structure of Chan et al. (2017).Their study deals with hotels in Honk Kong and their data and information have been collected with a survey questionnaire.

The rest of this review is divided in four sections: Section 2 surveys quantitative data about the hotels that have adopted energy saving tools in Greece. Accordingly, Section 3 deals with quantitative data about the water saving technologies, Section 4 deals with the waste management practices, Section 5 with the food and beverage sector, Section 6 with hotel structure and smart applications and other Section 7 with miscellaneous applications towards sustainability that do not belong strictly under any of the aforementioned parts. Section 8 offers the concluding remarks. All sections are the quantitative counterparts of the first paper in this two part paper.

2. Energy conservation and efficiency solutions in Hotels; Quantitative evidence from Greece

Energy conservation and efficiency is a sector in which Greek hotels have made larger progress than the rest of the sectors examined in the paper. Before going into much detail about the numbers achieved by Greek hotels, it is useful to have an overview of the size of the sector, because this size also determines the size of the benefits that will be reaped from the adoption of the ecological measures.

Overall, Greece had about 10,000 hotels with 412,830 rooms and 788.210 beds in 2016 (Statista 2018). The hotel dynamic has increased by 52% between 1990 and 2015 (ITEP). The country is dominated by old, medium sized hotels, 2 start hotels. Thus, most hotels are old buildings which have been constructed in 1960-1980. About 80% of Greek hotels have less than 50 rooms, while there are only 367 hotels with more than 300 beds. Also, there are 87 Greek hotel chains and 6 non Greek hotel operators. Hotel accommodation is not evenly accommodated all over the country. The majority of them, namely 85% of the beds are distributed in Crete, South Aegean, Central Macedonia and the Ionian Islands (Pwc 2016). Although hotels constitute only 0.26% of buildings in Greece, they are responsible for 29% of energy consumption in the private sector.

Large hotels publish their environmental missions, goals and achievements on statements that have published on the internet. From those statements we have collected the information that energy consumption in luxurious energy efficient hotel resorts ranged from 14.41- 17kWh of per guest night. Karagiorgas et al. (2007) has studied a sample of 28 hotels in 2003 in balanced spatial manner and ranking (mount, city and coast, 14 four star hotel and 14 five star hotels). According to their results, the Deluxe category hotels had an average total energy consumption of 68.15 kWh per guest night. The A category had an average total energy consumption of 41.54 kWh per guest night. The B category produced an average total energy consumption of 17.59 kWh per guest night. The electricity was prevalent in their energy mix at 45%, 60% and 38% respectively (The penetration of gas is low. According to Maleviti et al. (2011), the penetration of gas will be about 20% by 2020). The differences of consumption per guest night are vast and cannot be directly compared because the measurements refer to different years and different infrastructures and facilities. The gold sustainable benchmark of energy consumption is 24Kw/GN (Chasapis).

Total energy consumption consists of a fixed part which represents electricity consumption in areas that are not influenced by the number of occupied rooms (e.g. lights in reception, kitchen, laundry etc.) and a variable part which depends on room occupancy rate. The fixed component of energy consumption is about 45%. According to Karagiorgas et al. (2007), energy consumption allocation in the aforementioned representative sample of Greek hotels is the one shown in Table 1.

Table 1. Energy consumption allocation in a representative sample of Greek hotels

Service	Heating-Ventilation-Air condition	Domestic Hot Water	Laundry	Catering	Shared Lighting	Electric room	Lift
2 lunches	10%	5%	20%	90%	20%	-	60%
2 baths	-	15%	15%			30%	
Bar use	10%	5%	5%	10%	15%	-	30%
Stay room	60%	-	60%	-	5%	70%	
Leisure	20%	75%	-	-	60%	-	10%
TOTAL	100%	100%	100%	100%	100%	100%	100%

Source: Adapted from Karagiorgas et al. (2007).

The services of the sampled hotels are shown in the first column of Table 1 and the allotment of energy consumption takes place through all energy consuming activities (in the rest of the columns). For example the highest energy consumption in ventilation and air condition tales place while the tourist is in his/her room. The highest energy consumption for the preparation of hot water takes place for leisure and not for baths, as would one expect. According to Chasapis (undated), the consumption of hot water corresponds to 50-70lt daily and this requires 1.74-2.43kWh per person per day. This corresponds to a daily consumption of oil by 0.17-0.24 lt per person per day. Continuing with Table 1, the highest energy consumption in laundry occurs because of the laundry needs generated by the room stay, namely the change of bed linen and towels. The highest energy consumption in catering occurs for the preparation and consumption of the lunches, the highest energy consumption in shared lightning takes place for leisure, electricity consumption is the highest when the tourist stays in room and the energy consumption from the lift occurs in the two meals.

Apart from some fragmented statements about mean energy consumption per guest night and the cost allotment in a sample of representative hotels, information is also fragmented for the rest of the facets of energy conservation and efficiency in Greek hotels. Thus, Maleviti et al. (2011) have found that efficient lighting was used in most cases. This is further specified by Velissariou and Gerolymos (2012) as being equal to 65.50%, while based on another survey by Gaglia et al. (2007), this amount is 50%.

This is one of the easiest and low cost investments. In another survey on Dodekanese islands, a high number of hotels there (namely 65.50%) have solar water heaters, but only 5.70% have installed solar systems, 43.70% use electrical devices with high energy efficiency, 89.70% use electronic devices with certified low energy consumption, 44.80% have installed lights operating with automatic handling (Velissariou and Gerolymos 2012).

Other types of energy saving and energy efficiency solutions take place through insulation and construction corrective interventions. Thermal insulation of the hotel walls reduce energy consumption by 20.1% (CO_2 emissions by 4.85%), thermal insulation of the hotel roof will reduce energy consumption by 12% (CO_2 emissions by 5.7%), the replacement of heating with natural gas will reduce energy consumption by

8.6% % (CO_2 emissions by 3.8%) and double glazing with new energy efficient frames will reduce consumption by 7.8% (CO_2 emissions by 1.03%). These results have been produced from a case study of a 4 star hotel that was constructed in 1970 with 238 beds by Papadopoulos and Boemi (undated). Last, based on some older survey by Karagiorgas et al. (2006), only 6% of the hotels had been found to have installed some type of renewable energy systems. Tables 2 and 3 show the renewable energy penetration in five big hotels in Crete and 18 large hotels in Greece. The results were collected from a survey in Altener II programme. Table 4 contains the questions that hotel representatives had to answer and they are based on 2000. Understandably, new progress has been performed since that time, but unfortunately no updated data are available. Most hotels state that they have installed solar heaters, some of them state that they have installed photovoltaic panels and only of them states the existence of bioclimatic architecture. In none of them is reported the generation of wind energy, geothermal energy, wave energy, biodiesel energy etc. Given the new progress that has been made by the tourist sector based on the sparse evidence we receive from literature and desktop research, new primary research is necessary.

Table 1. Measures for energy saving in Greek hotels

Measure	Statement	% of saving	Duration of investment (yrs)	Mean cost of saving
Thermal insulation of walls	Application to all non-insulated buildings dated before 1980	Thermal energy: 38-44% Cooling energy: 5%	30	31.9 €/m^2
Roof insulation	Application to all non-roof insulated buildings dated before 1980	Thermal energy: 5-8% Cooling energy: 2%	30	27.1 €/m^2
New central heating systems	Application to all buildings which have an old system of central heating	Thermal energy: 15-17%	25	1700-6000€/building (for a hotel 500-5000 m^2)
New central heating systems with natural gas	Application to 15% of buildings with old systems found in zones B and C and based on natural gas availability	Thermal energy: 19-21%	25	1300-6000€/hotel (for a hotel with a surface 500-5000 m^2)
Thermostats	Application to all buildings that do not have thermostats,	Thermal energy: 5%	20	800-2600 €/hotel (for a hotel with a surface 500-5000 m^2)

Measure	Statement	% of saving	Duration of investment (yrs)	Mean cost of saving
	based on national regulations			
Ceiling ventilators	Application on 50% of the air-conditioned buildings with a coverage of 50%-70% of their surface	Cooling energy: 60%	10	48 €/ventilator
High efficiency lamps	Application to all buildings which do not have them	Thermal energy: 20% Electricity: 60%	10	0.6 €/m^2
BMS (Building Management Systems)	Application to 10% of the air conditioned buildings dated before 1980, to 30% dated before 1980-2001 and to 50% of the buildings dated between 2001-2010	Thermal energy: 20% Electricity: 30%	10	14.5 €/m^2

Source: Adapted from Gaglia, A.G. (2007). Building resources, the potential for energy saving and pollution reduction in domestic and tertiary sector in Greece-measures, (In Greek), In: WWF (2010). Green measures in Greece

Table 2. Renewable energy sources penetration in tourist industry, based on results from Altener II Programme

Hotel	Number of beds	Operation Period	Address	RES technologies used in the hotel	Technical features of the RES technologies used in the hotel				Reasons in favor of the investment	Barriers for the low penetration of RES in the hotel sector	RES technologies that are more appropriate for tourist units
					Installation year	Collector area m^2	Number of boilers	Total capacity lt			
Knossos Royal Village	840	Seasonal	Anissaras, Hersonissos, Crete	Solar heaters for hot water production	1998	1000	12	44,000	1) Need for upgrading the boiler room, 2) Energy saving, 3) Financial support by 50% from the national operation program for energy environmental reasons	1) Problems in the central heater systems, 2) Architects must be better informed about the way of the solar systems into the building incorporation	1) Except solar heaters, it is possible to use photovoltaics in a small scale for covering the peak load, 2) New hotels must employ bio climatic architecture
Robinson Club Lyttos Beach	649	Seasonal	Hersonissos, Crete	Solar heaters for hot water production	1997	546	9	35,000	1) Energy saving, 2) Environmental reasons, 3) Financial support by 50% from the national operation program for energy	Problems in the central heater systems that had been previously installed	1) Solar heaters, it is possible to use photovoltaics, 2) Steam can also be produced from solar energy when the appropriate surfaces become available

Hotel	Number of beds	Operation Period	Address	RES technologies used in the hotel	Technical features of the RES technologies used in the hotel				Reasons in favor of the investment	Barriers for the low penetration of RES in the hotel sector	RES technologies that are more appropriate for tourist units
Hersonissos Maris	216	Seasonal	Hersonissos, Crete	1) Solar heaters for hot water production, 2) Photovoltaics for electricity production	1) 2000 2) 2000	1) 238 2) Power: 20 kWp	5	9,000	1) Environmnetal profile, 2) Energy saving, 3) Financial support by 50% for the solar system and 70% for the photovoltaic from the national operation program	1) Bureaucracy, 2) Delays in the investment to get the financial support from national and European programs, 3) License procedure is very slow, 4) Need for correct and timely information	1) Solar systems, 2) Photovoltaics
Mirabello	322				2000	160	2	6,000	1) Environmental profile, 2) Energy saving, 3) Financial support by 50% for the solar system and 70% for the photovoltaic from the national operation program	1) Luck of information, 2) Some RES technologies are still expensive	1) Solar systems, 2) Photovoltaics, 3) Wind generators

Hotel	Number of beds	Operation Period	Address	RES technologies used in the hotel	Technical features of the RES technologies used in the hotel				Reasons in favor of the investment	Barriers for the low penetration of RES in the hotel sector	RES technologies that are more appropriate for tourist units
Mirabello village	251	Seasonal	Ag.Nikolaos, Crete	Solar heaters for hot water production	2000	190	5	8,500	1) Environmental profile, 2) Energy saving, 3) Financial support by 50% for the solar system and 70% for the photovoltaic from the national operation program	1) Luck of information, 2) Some RES technologies are still expensive	1) Solar systems, 2) Photovoltaics, 3) Wind generators

Table 3. The hotels which answered the questionnaire for renewable energies in tourism plants

Hotel name	Cat:	Nu of beds	Nu of room	Nu of Em	Electrical energy kWh	GAS (lt)	Diesel (lt)	LPG (lt)	Yr of Insta	RES	Address	S.O
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Shivas Apartment Hotel	A	48	30	7	40,000	-	5,000	-	2000	Solar heaters (6), Boiler (300lt)	Odigitrias st., Sibas, Dimos Tympakiou, Heraklion, Crete	No
Sani Club	Lux	410	205	130	872,000	-	40,000	-	2000	Central solar heater system, Collector area: 300m^2, Boiler (7.5lt)	Kasandra, Chalkidiki	Yes
Sani Beach Hotel	Lux	932	490	220	2,172,800	-	-	114,350	2000	Solar heaters (6), Boiler (300lt)	Kasandra, Chalkidiki	Yes
Porto Sani Village	Lux	300	103	100	1,212.000	-	-	50,250	-	-	Kasandra, Chalkidiki	Yes
Grecotel Lakopetra Beach	A	385	193	95	1,000,000	5,000	15,000	-	1988	Solar heaters (3), Collector area: 5m^2, Boiler (450lt)	Lakopetra Achaia	Yes
Bella Maris	Lux	324	147	60	-	50,000	-	-	-	-	Anisaras Hersonissou, Heraklion, Crete	Yes
Candia Maris	Lux	-	260	-	-	-	30tn	140,000	-	-	Amoudara Gazi Hersonissou, Heraklion, Crete	No

Hotel name	Cat:	Nu of beds	Nu of room	Nu of Em	Electrical energy kWh	GAS (lt)	Diesel (lt)	LPG (lt)	Yr of Insta	RES	Address	S.O
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
Creta Maris	Lux	1078	547	-	-	200,000	25tn	-	-	-	Hersonissos, Heraklion, Crete	Yes
Silva Maris	A	472	305	-	-	-	100,000	-	-	-	Eleftheriou Venizelou 193, Hersonissos, Heraklion, Crete	Yes
Porto Elounda de Luxe - Resort	Lux	470	225	200	1,520,000	39,684	78,000	-	-	-	Elounda Lasithiou, Crete	No
Elounda Mare	Lux	160	80	150	74,800	17,283	47,950	-		-	Elounda Lasithiou, Crete	Yes
Big Blue Apartments and Studios	A	50	15	3	-	-	-		a)1990, 1993, 1998, 2000, b)1999	a) Solar heaters (5), Collector area: 28m^2, Boiler (1,000lt) b) Photovoltaics: Collector area: 2.1m^2, Power: 225W	Myrtos Ierapetra, Crete	Yes
Grecotel Creta Palace	Lux	710	366	230	2,626,990	53,829	136,075	-	a)1998, b)2000	a) Central solar heater, Collector area: 300m^2, Boiler (15,000lt)	Mysiria, Rethimno, Crete	Yes

Hotel name	Cat:	Nu of beds	Nu of room	Nu of Em	Electrical energy kWh	GAS (lt)	Diesel (lt)	LPG (lt)	Yr of Insta	RES	Address	S.O
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
										b) Photovoltaics: Under construction		
Grecotel Rithymna Beach	Lux	1056	556	328	3,000.000	78,719	116,000	-	a)1981, b)2000	a) Solar heaters (70), Collector area: 240m^2, Boiler (14,000lt), Central solar heater, Collector area: 400m^2, Boiler (20,000lt) b)Photovoltaics: Under construction	Adelianos Campos, Rethimno, Crete	Yes
El Greco	B	573	307	170	1,500,000	7,896	74,773	-	1990	Central solar heater system, Collector area: 400 m^2 400m^2, Boiler (25,000lt)	Campos Pigis, Rethimno, Crete	Yes
Grecotel Agapi Beach	A	614	318	150	1,384,000	70,000	71,540	-	1997, 2000	Central solar heater, Collector area: 335 m^2, Boiler (17,000lt)	Gazi, Heraklion Crete	Yes
Chrysi Ammoudia	A	351	172	85	480,000	20,000	-	-	a)1998, b)1995	a) Solar heaters (20), Collector area: 80m^2, Boiler (4,000lt),	Anisaras Hersonissou, Heraklion, Crete	Yes

Hotel name	Cat:	Nu of beds	Nu of room	Nu of Em	Electrical energy kWh	GAS (lt)	Diesel (lt)	LPG (lt)	Yr of Insta	RES	Address	S.O
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]
										Central solar heater, Collector area: 70m^2, Boiler (3,500lt) b) Passive systems (Bioclimatic Architecture), Building orientation, Shading, Building color, Double glasses		

Notes: [2]: Cat= Hotel category, [3]: Nu of beds= Number of beds, [4]: Nu of room=Number of hotel rooms, [5]: Nu of em=Number of employees, [6]: Electricity consumption in kWh, [7]: Gas consumption in lt, [8]: Diesel consumption in lt, [9]: LPG, liquid propane consumption in lt, [10]:Years of installation, [11]: RES= Available renewable energy source types in the hotels, [13]: Seasonal Operation of the hotel

Table 4. Questionnaire completed by Greek hoteliers and their answers in percentages in 2000

Question	Answer percentage
Hotels that perform energy audits	53%
Occupation of permanent technical staff	88%
-Engineers	35%
Usage of some type of RES in the hotel	53%
RES Technology applied in the sampled hotels	
- Solar heaters	88%
- Central Solar heater systems	76%
- Photovoltaics	88%
- Small hydro	29%
- Wind generators	59%
- Biomass	41%
- Passive systems	41%
- Geothermal systems	35%
What is the necessary prerequisite for the establishment of Solar systems and photovoltaics in your hotel?	
- Available surfaces	82%
- Sunlight sufficiency	88%
What is the necessary prerequisite for the establishment of wind generators in your hotel?	
- Available space	29%
- Wind sufficiency	6%
What is the necessary prerequisite for the establishment of small hydro in your hotel?	
- Available space	-
- Hydraulic energy sufficiency	-
What is the necessary prerequisite for the establishment of biomass in your hotel?	
- Available space	-
- Biomass sufficiency in the district	-

Question	Answer percentage
What is the necessary prerequisite for the establishment of geothermal systems in your hotel?	
- Available space	18%
- Geothermic energy availability	18%
My opinion is that the necessary investment on RES is cost effective	94%
My opinion is that the necessary investment on RES is not cost effective	6%
I believe that the implementation of RES could attract new categories of customers	100%
I am informed about the potential financing opportunities from national funds	82%
I am informed about the potential financing opportunities from European funds	29%
I consider the shortage of information as the most important barrier for the adoption of RES in my hotel	71%
I consider the technical barriers as the most important barrier for the adoption of RES in my hotel	18%
I consider the high cost as the most important barrier for the adoption of RES in my hotel	59%
I consider the institutional barriers as the most important barriers for the adoption of RES in my hotel	12%
I consider other as the most important barrier for the adoption of RES in my hotel	18%

3. Water conservation and efficiency solutions in Hotels; Quantitative evidence from Greece

Water consumption in Greek hotels is also characterized by high variability depending on the facilities each hotel offers and the measures it has taken against water squandering. Based on information found from the webpages of large hotels, water consumption for 2016 was reported to be 0.517m^3 per guest night (Giannoulis Hotels and Resorts, 2017), 0.417 m^3 per guest night (Rhodos Royal, 2016), 0.240 m^3 per guest night (TUI Kerkyra Golf Hotel, 2017). Besides the sustainability reports of individual large hotels, the study on Dodekanese islands (Velissariou and Gerolymos 2012) states that 50.60% of hotels take measures of water consumption savings and 35% are willing to assume them. Also, 36.80% of the hotels control leaking in their pipelines.

The installment of water saving taps, showers and toilet flushing is also stated in the sustainability reports of some large hotels and is published online. The Hellenic Company of Water Saving (2018) has estimated a cost reduction of 1€ per night if water

provision is reduced from 13 to 4.5 lt per minute and from 14 to 9 lt per minute. This translates into 127 €/room/semester and the investment cost is covered within a month. Maximum water provision in the hotel should not exceed 10lt/minute. Water reduction mechanisms in the showers of a representative hotel of 100 rooms (with 75% occupancy) can reduce water consumption by 2,700m^3/year. Together the cost of water and the cost of gas for hot water production amounts to 7,300€/year. This saving contributes to a reduction of CO_2 emissions by 9,800k/year. This investment equals to 500€ and pays back by 1400% (Travelife undated).

Another form of water saving (and energy saving as well) takes through the reduction of laundries. Towels constitute 40% of the total laundry volume in a hotel. Prolonging the usage of the same towel for more than one days, in a representative hotel of 100 rooms (occupancy rate 75%), could reduce towel laundry by 12,300k/year, reduce washings by 610 times (in 20 kg capacity washing machines), reduce drying by 1,220 times (in 10kg capacity drying machines), reduce detergent and laundry chemicals by 7.5% and reduce water and power bills by 1,650€/yearly (Travelife undated). Analogous savings occur when bed linen change every 3 days. Again with the same assumption of a 100 room hotel, this prolongement reduces the bed linen by 27,300k/year, reduces the detergent and laundry chemicals by 15% and the cost of water and power bills by 3,700€/year (Travelife undated). However, no aggregate data exist on how many Greek hotels have adopted the practice for towel non-change on a daily basis.

4. Waste management in hotels; Quantitative evidence from Greece

It has been estimated that in the European Union, 7% of the garbage is produced in hotels while 7-10% is about plastic garbage. Every year about 2.5-3.5 m tones plastic garbage comes from the hotel sector (Μυλωνάς 2018). Data for waste management in Greek hotels are more scant, in comparison with the data collected for their energy and water saving technologies. Only in one hotel website did we find reported the size of the daily produced garbage per guest night. That was 4.1 kg of garbage per guest night (Grecotel Royal Rhodes 2016). Tsakona (2015) states that in some tourist regions in Greece, the waste produced by tourists is of much higher volume than that produced by locals and this poses a great burden particularly for the islands which are regarded as closed systems. In the Dodecanese islands survey, 41.40% of the hotels reported that they have practiced recycling materials such as paper, ink, plastics, glass etc, while waste management is practiced only by 17.20% of the hotels, 12.60% of them have biological purification systems for their effluent and 33.30% of them use ecological cleaning materials (Velissariou and Gerolymos 2012).

The Greek Hotel Green reports a percentage of waste recycling to reach 45%, while according to Tsakona (2015), 52% of hotel waste is recyclables, 45% are organic and 3% are other categories. For corroboration reasons, it is worth reporting special cases of hotels such as Sani Resort in Chalkidiki (800 rooms, 15 restaurants and bars) in a 7 year implementation of recycling programmes, they state they have achieved a 40% recycling rate. Further they expand on an analysis of this percentage and they reveal that in 2014 the resort recycled 225 tones of waste (138 tones of glass, 47 tones of paper, 13 tones of plastic, 4 tones of cans, 2 tones of batteries and electrical equipment and 21 tones of cooking oils. They also composted 200kg of organic waste every day. Another example by Hilton Hotel Athens (508 rooms) states that they compost 0.7tonnes of food

waste per week and reduces food waste by 90%. Last, Athenaeum Intercontinental Athens (559 rooms) states that they recycle 50 tones of glass annually, 60 tones of paper, plastic and aluminium and 6 tones of cooking oils. Not least, according to Tsakona, about 100 hotels in Greece recycle soap (Tsakona 2015). A recent initiative has started the treatment and drying of food waste from hotels for the production of animal food in Greece (Lambrou 2018).

5. Food with a low environmental footprint in hotels; Quantitative evidence from Greece

Food enhances the tourism product, but can also be the reason for traveling to a destination. Recently a new tendency is cultivated in large hotels to establish a local cuisine where tourists will be to acquaint themselves with local gastronomy, culture and history. This tendency is also an ambassador of Greek agriculture which is characterized by small quantities of unique agricultural products that contain a taste which corresponds to local soil quality, the microclimatic conditions, farmers' practices, local history and a short supply chain which is environmental friendly because it does not entail long distance transfers from overseas. However, only large hotels consciously promote this tendency, have established a corner with local breakfast and lunches in their dining rooms, they have established biological gardens close to the hotel from where the ingredients for some of their dishes originate. These hotels usually have gained green certifications. Foremost, these hotels organize excursions to local producers of various agricultural products such as fruit, vegetables, olive oil, wine, bread and thus tourists also acquire gastronomic knowledge.

However, the aforedescribed situation flourishes only in large luxurious hotels or chain hotels and not the average Greek hotel which still has a long distance to cover on this and the cuisine does not have personality. According to SETE (2009), food in tourism does not have a stable quality in all gastronomic scope and suffers from insufficient marketing. The opening of new markets into the Greek tourism, such as the Arab world or Chinese people and others, causes the demand for new products or more qualitative products. With the recent huge numbers in tourist arrivals, maybe the Greek agriculture will solve its orientation problem of market finding if it focuses on supplying tourism with high quality, unique products in small batches that will also have short supply chains. Thus, together with tourism will also flourish the long afflicted Greek agriculture.

Depending on the type of tourism practiced, a different emphasis is laid on food. The practiced tourism type reflects the personality, the needs, the education, the income and many other demographic characteristics of the tourist. In both relaxation holidays for sunbathing and swimming and urban tourism for sightseeing and relaxation, food is ranked third, after swimming possibilities and sunbathing or sightseeing and relaxation. The nationalities that show high interest for Greek food are the Turkish, British, Scandinavians, Germans and the Russians. In luxury tourism, tourists are familiar with a lot of various international tastes already but they are usually accustomed to their home tastes and they look for them even when on holiday. Older tourists, usually seek low fat food, no sugar, no salt etc. Alternative tourism is usually practiced by the Swedish or German people in Greece. This type of tourists often they do not eat meat and care a lot about the welfare of animals (Stergiou 2017).

The number of Green certified hotels might be a good proxy for the number of hotels that offer sustainable cuisines. For example in the Green Hotels programme, the environmental criteria encompass besides energy and waster saving, waste management and various other among which is the use and promotion of local products and the cooperation with certified suppliers as well as a recent hotel certification such as ISO 14001, EMAS, Eco Label etc. However, when it comes to the prerequisites of the food dimension, it refers only to the food hygiene and safety but not the supply. Also, the relevant site presents the ten most popular green hotels, but does not reveal their number for all Greece.

According to SETE (2009), the Greek hotel cuisine needs improvement because very few hotels offer local cuisine and fewer of them combine this with smart solutions such as their own vegetable or fruit gardens. Cooks are not highly qualified and staff changes take place very often which is not favorable for the establishment of a long-run learning effect. The quality of ingredients used suffers from a lack of gastronomic culture. The staff does not have wine knowledge either. For American or Continental breakfast, hoteliers buy cheap imported ingredients. Prices are pressed downwards and this has an impact on food quality. Food and wine production places should be accessible for tourists to visit. Nowadays there are a few wineries where tourists are allowed to go on an educational excursion. In Porto Caras (Halkidiki) there is a small train which takes tourists for a tour within the hotel ground and towards the winery of the Porto Caras Hotel (Kioumourtzi 2010). The same could be possible for cheese or pasta making factories, furnaces and olive press factories and could provide tourists with an educational experience.

6. Hotel construction and improvement, Bio-climatic architecture and smart IT applications in hotels; Quantitative evidence from Greece

The improvement in hotel construction and the adoption of bio-climatic designs in new hotel infrastructure, reduces energy consumption for cooling, warming and other amenities that demand energy. Improvement in construction is applicable to old hotel buildings, while the bioclimatic opportunity is available to new infrastructures. Most Greek hotels are old buildings which have been constructed between 1960-1980. Old buildings lose energy by 25% from their walls, 25% from the aeration through windows and doors, 18% through their window frames, 12% from the chimney, 13% from the roof and 7% from the floor and basement. Gaglia et al. (2007) report these figures in a slightly different, but more detailed and comprehensive way in Table 1, also divided between thermal energy and cooling energy savings. This table also informs of the duration of investment in years and the mean cost of saving per square meter. Thus, hoteliers can acquire both a holistic view and a more individual one of the energy sustainable measures that are feasible for their hotels.

Thus, Gaglia et al. (2007) suggest that thermal insulation of walls reduces thermal energy consumption by 44% and cooling energy by 5%. Roof insulation reduces thermal energy consumption by 5-8% and the cooling energy by 2%, new central heating reduces thermal energy by 15-17%, thermostats reduce that by 5%, ceiling ventilators are the most effective in cooling energy reduction by 60% and high energy efficiency lamps reduce thermal energy consumption by 20% and electricity by 60%. Last, building energy management systems reduce thermal energy by 20% and electricity by 30%.

The superiority of the bioclimatic building in its energy efficiency performance is revealed by the vast difference in its energy consumption as compared to the conventional structure. A conventional building consumes 20lt oil/m^2, while a bioclimatic building consumes 1.5lt oil/m^2. This means a 90% energy saving in the bioclimatic hotel.

The bioclimatic hotel room of the future is perceived as a cell which is self adapted to the climatic conditions of its environment. It was designed by the Greek Chamber of Civil Engineers and was presented in a tourist exhibition in 2012. The pilot bioclimatic tourist room has the potential of high elasticity of transformation between its indoor and outdoor space. The usage of water and a roof from natural materials as well as outdoor shadowing provide a natural cooling effect for the sleep area in the room. There are reflections and sounds of water and cooling currents of wind. There are cooling installations based on geothermal procedures under floor which satisfy the energy demands of the hotel room (Balis 2017).

As far as smart IT technologies in Greek hotels are concerned, again those are present only in large, many star hotels both in Greece and worldwide. Social media and the official webpages are not adequate to serve all the modern needs in a hotel. This is the reason that smartphone applications have been developed greatly but luxurious hotels such as Hilton, Marriott, Hyatt etc which cater for the needs of more sophisticated clients . The average hotel usually does not offer an interactive webpage. Conversely, large, many star hotels offer a large variety of smart IT applications. For example, smart catalogues for food ordering are available in many languages and reduce the waiter work load, while they also aim at increasing food loyalty (Karolidou 2015). Smart IT applications also involve check in and check out, reservation and cancelling, food and beverage ordering, Uber taxi invitations, point rewarding systems, entertainment choices etc (Theodorou 2016). Once more, we have failed to find aggregate data on the number of Greek hotels that offer these amenities and our evidence originates from our own research in various hotel webpages.

7. Other sustainable technologies in hotels; Quantitative evidence from Greece

This category of sustainable solutions in Greek hotels encompasses all other sustainable technologies that do not fall directly under any of the above previous groups. Thus, the section contains figures that are worth being reported as examples. For example, the sustainability report of “Sani Green” hotel states that this hotel had adopted stray dogs which their clients further adopted and took them back home. Furthermore, “Sani Green” hotel reports the adoption of its social initiatives about its support to abused women, the organization of hiking locally, biking and farm activities such as apiculture etc. “Sani Green” hotel also report that 70% of their staff are local, 69% of their food products are Greek, the hotel has achieved a water consumption reduction by 7% since 2015 and a daily consumption of energy below the gold sustainable benchmark which is 24Kw/per guest night (Athinorama Travel.gr 2017). Also, the survey on Dodecanese hotels by Velissariou and Gerolymos (2012) provide information to their customers about the green policy of their hotel, while 55.20%, 36.30% of Dodecanese hotels train

their employees to implement green measures and 21.80% of Dodecanese hotels use organic products.

8. Concluding remarks

This is the second part of a two part paper on the state of the art of environmental sustainable technologies in Greek hotels. Due to the large size of the papers, we have separated our research into two papers (parts); The first paper (part) is a qualitative overview, namely it discusses the topic from a qualitative point of view, while the second paper (current paper) discusses the topic from a quantitative point of view. Our ambition for the quantitative paper was to collect therein the most up to date quantitative information on each dimension of the topic examined in the qualitative paper (first paper). However, we realized that most data on any of these matters did not exist and was fragmented and incomplete for most of the subjects. However, we believe we provided herewith the best we could, given the data non-availability.

This paper is the first quantitative review of sustainable technologies in Greek hotels. The sources we have used are the extant literature, reports from special organizations and the data and information that we found on various internet sources. Not all the information we found is updated and for some sections of this paper it was more difficult to find quantitative data.

For example more data and quantitative information was available on energy saving technologies for Greek hotels. Energy conservation and efficiency is a sector that Greek hotels have made larger progress than the rest of the sectors examined in the paper. Thus, less information is available for the progress and adoption of water saving technologies and very little on the rest of the parameters we have examined, namely waste and recycling, food, construction and other.

Therefore, we consider the data on energy conservation and efficiency to be richer, albeit themselves, at some point, are also outdated. Furthermore, in comparison to large hotels, higher rank hotels or hotel chains appear to have made more progress at all sustainability pillars. They are probably in a position to hire specialized staff and can create a green team due to the positive economies of scale they enjoy and the role they play in local communities. These large hotels also are the ones that communicate this information in their webpages and consumers can get informed.

However, there is an urgent need for primary research and recording of data and the quantitative state of the art for the rest of the parameters. For this reason, we provide a questionnaire template which we plan to send all Greek hotels and contribute to the recording of this information in a uniform and official way.

The data and information sought will be of primary importance for policy making and the design of fiscal motives for the hotels to adopt more of the available solutions to promote sustainability in all basic pillars. Last but not least, the adoption of these measures will increase the business value of the hotels, increase their profitability and competitiveness and sustainable operation.

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Chapter two provides a review of the literature relating to the concept of sustainable development and sustainable tourism. The subchapters divide the literature review into four sections. The first section (Chapter 2.2) defines sustainable tourism and discusses the role of the tourism industry in sustainable development.Â This particular study is unable to describe the discussion about the negative impacts of accommodation businesses in-depth and will not provide a detailed review of all sustainable business practices as it would go beyond the realms of this study. It is noted that there is no universal solution for accommodation businesses due to the fragmented structure of the industry.