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# List and classification of the appropriate technologies and solutions available for SME hotels

*WP2 Experience and viability of nZE refurbishment projects - D2.4*

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## THE EU INITIATIVE NEARLY ZERO ENERGY HOTELS (neZEH)

neZEH's scope is to accelerate the rate of refurbishment of existing hotels into Nearly Zero Energy Buildings (nZEB), providing technical advice to hoteliers for nZEB renovations, demonstrating the sustainability of such projects, challenging further large scale renovations through capacity building activities, showcasing best practices and promoting the front runners. The project covers seven (7) EU countries: Greece, Spain, Italy, Sweden, Romania, Croatia, France and has a wide EU level impact.

The expected results are:

- An integrated set of decision support tools to assist hoteliers in identifying appropriate solutions and designing feasible and sustainable nZEB projects;
- A dynamic communication channel between the building sector and the hotels industry, which will enable the exchanging between demand and supply side and the endorsement of the nZEB concept;
- Demonstration pilot projects in 7 countries to act as "living" examples; aiming to increase the rate of nZE renovation projects in the participating countries
- Practical training, informational materials and capacity building activities to support nationally the implementation and uptake of nZEB projects;
- Integrated communication campaigns to increase awareness for the nZEB benefits, to promote front runners and to foster replication; challenging much more SMEs to invest in refurbishment projects in order to achieve nZE levels.

In the long term, the project will assist the European hospitality sector to reduce operational costs, to improve their image and products and thus to enhance their competitiveness; contributing in parallel to the EU efforts for the reduction of GHGs.

neZEH started at May 2013 and will end at April 2016 and is co-financed by the Intelligent Energy - Europe (IEE) programme.

### PROJECT PARTNERS

Technical University of Crete, Renewable and Sustainable Energy Systems Lab (ENV/TUC) <i>Project Coordinator</i>	Greece
United Nations World Tourism Organization (UNWTO)	EU/Int.
Network of European Regions for a Sustainable and Competitive Tourism (NECSTouR)	EU
Federation of European Heating, Ventilation and Air-conditioning Associations (REHVA)	EU
Agency of Braşov for Energy Management and Environment Protection (ABMEE)	Romania
Creara Consultores S.L. (CREARA)	Spain
ENERGIES 2050 (ENERGIES 2050)	France
Energy Institute Hrvoje Požar (EIHP)	Croatia
Istituto Superiore sui Sistemi Territoriali per l'Innovazione (SITI)	Italy
Sustainable Innovation (SUST)	Sweden

### PROJECT COORDINATOR

Associate Professor Theocharis Tsoutsos, Renewable and Sustainable Energy Systems Lab.  
School of Environmental Engineering, TECHNICAL UNIVERSITY OF CRETE (ENV/TUC)

### WP2 LEADER

Federation of European Heating, Ventilation and Air-conditioning Associations (REHVA)

### DELIVERABLE EDITOR

Federation of European Heating, Ventilation and Air conditioning Associations (REHVA)

Authors: Anita Derjanecz (REHVA), Andrei Liţiu (REHVA), Zoltan Magyar (Budapest University of Technology and Economics, Hungary),

Work team: REHVA, TUC, CREARA

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# 1. Introduction

This deliverable presents the appropriate technologies and solutions that ensure nearly zero energy consumption of hotels and explains the ranking methodology according to the key ranking aspects.

The purpose of the document is the determination of the most relevant technologies for SME hotels to reach a nearly zero energy (nZE) operation, considering constraints and specificities of the sector and classification and ranking of technological and other solutions, based on material assessed in WP2, and on the experience already acquired by UNWTO during the HES project. It also presents this information in a form suitable for integration into the HES e-toolkit update, and for use in other WPs and Tasks in accordance with requirements set out in the full Project Document.

The energy consumption of the different end-user systems was presented, highlighting that the heating, cooling and DHW functions are the most important energy consumers.

The main energy saving solutions were gathered and ranked based on the Hotel Energy Solutions (HES) project<sup>1</sup> reports [1] [2] and based on REHVA experts' experience written in REHVA guidebooks [3] [4] [5] [11] [12]. The description of each relevant technology and solution are described in a separated document (as an additional deliverable) "D2.4c Assessment of existing technologies to support nZEB renovations".

HES project's aims were to increase energy efficiency by 20% and renewable energy sources contribution by 10% in European small and medium hotels (SME hotels). The HES energy saving solutions were adjusted and improved with other technologies and solutions such as free cooling, micro hydropower, hybrid ventilation, micro CHP, inflector window insulator etc. The relevant technologies and solutions were gathered in the following five groups: energy management, reduction of heating and cooling demands, equipment efficiency, system efficiency and renewable energy.

The financial investment, the potential energy saving and the climatic zones are the most important aspects for taking the right decision and for selecting the most suitable technologies and solutions for a given hotel. The investment size, such as equipment and installation costs, and the potential energy savings were the first and second ranking aspect, while the five EU climatic zones was the third. Each technology was classified by these three ranking criteria in order to point out the most appropriate technologies for the hoteliers. In the first and second ranking the low/medium/high classification was introduced, because the energy prices and investment costs vary from one country to another. In the third ranking (climatic zone), each technology got a priority number, which expresses the feasibility and the energy saving potential of the given technology taking into

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<sup>1</sup> The **Hotel Energy Solutions** is an UNWTO-initiated project in collaboration with a team of United Nations and EU leading agencies in Tourism and Energy. The project delivers information, technical support & training to help Small and Medium Enterprises (SMEs) in the tourism and accommodation sector across the EU 27 to increase their energy efficiency and renewable energy usage. <http://hotelenergysolutions.net/en>

consideration the given climatic zone and its characteristics.

Following to this work and closely linked to it, a tool has been developed (described in “D2.4.b Ranking of technologies and solutions available for SME hotels”) which focuses in providing a country specific ranking of technologies and solutions. The particular tool utilises the results of this work, in terms of technologies listing and ranking aspects. Building on that, it incorporates local parameters, such as local prices of technologies and climate data (heating and cooling degree days), to provide a country-specific ranking of the technological solutions.

## 2. Energy saving technologies and solutions

The energy consumption of SME hotels depend on many parameters, such as geometry of the hotel building (A/V ratio), heat transfer coefficients of the hotel building structures ( $U$ ,  $W/m^2K$ ), the type and the age of the equipment of the heating, cooling, domestic hot water and air conditioning systems, the control of the HVAC systems, the type of the lamps (incandescent, CFL, LED, etc.), the energy efficiency of cooking equipment, and others (elevator, TV, printer, refrigerator, etc.), and also depend on what kind of facilities are offered by the hotel for the guests (spa elements, indoor and outdoor swimming pool, etc.).

A good study [6] - quoted also in the HES Training Manual - has been assessed regarding the energy breakdown by the different end-user systems in hotels. Although, this study has taken into account hotels located in the United States of America, the results are probably not so different from the hotels' located in Europe. According to [6] in the typical total energy use breakdown by end use in hotels, heating accounts for 31% and cooling for 15% summing up together almost half of the typical total energy consumption of a hotel. Therefore, the reduction of the heating and cooling demands, the efficiency of the used equipment, which serves the heating and cooling systems, and the overall energy efficiency of the systems and their operation are particularly important issues concerning the energy use in hotels.

Besides the heating and cooling energy use, lighting and domestic hot water have also significant energy use accounting for, respectively 12% and 17%. So, lighting and domestic hot water must also be taken into consideration for the energy saving solutions. The energy consumption of the domestic hot water system is one of the key factors in the hotels located in the Mediterranean zone, because in this case the DHW has a bigger part of the total energy consumption, due to the lack of, or minimized heating demand. This specificity has been highlighted in the analysis made by Creara Consultores, neZEH partner, and Balantia Energy Efficient and Sustainable Tourism. They prepared energy audits of 55 hotels located in different zones of Spain. In the analyzed Spanish hotels the average DHW energy demand was 22%, but it can be even 44% in seasonal hotel in Baleares - Mallorca - Cala Bona geographic zones. The heating consumption was generally lower than the DHW demand, the average was 11%, but in a full year used hotel located in Granada, the heating represents 43%. Due to the warmer and longer summer, the value of the cooling degree days is higher, therefore the average cooling energy consumption represents 22%, but in some cases 48%. For the sake of completeness in the Spanish study the heating accounts

for 11%, the cooling for 22%, hot water for also for 22%, kitchen equipment 10%, lighting for 11%, equipment for 21% (TV, computers, printers, elevators, data centers, UPS, etc.) and others (small equipment and appliance) for 4% as it is presented in [Appendix 6](#).

As a consequence, the focus from the potential energy saving point of view is on the heating, the domestic hot water, the cooling and the lighting systems which sum up 65-75% of the total energy use of a typical hotel. The rest 25-35% contains kitchen equipment, refrigerators, TV, office-equipment and other small equipment.

According to the above mentioned, five groups of energy saving technologies and solutions were created to be targeted during nZEH design or renovation project. These groups contain relevant technologies and solutions that can help to reach nearly zero energy consumption in hotel buildings:

- Energy management;
- Reduction of heating and cooling demands;
- Equipment efficiency;
- System efficiency;
- Renewable energy.

## 2.1. Energy management

The most obvious from the above groups of solution is the energy management group, because actions can easily be taken, when the energy production and the technical systems are identified and quantitative information about the energy use of the different energy consumers, e.g. heating, cooling, lighting, domestic hot water, ventilation systems, is available. The best option for achieving high level energy management is to perform energy use monitoring and energy audits and to involve the staff and the guests by presenting them information on how they can participate and what is their impact on the energy efficient operation of the given hotel's technical systems.

## 2.2. Reduction of heating and cooling demands

This group contains the technology and solutions for reducing the heating and cooling demands. By reducing the heating and cooling demands significantly, the total energy use of the hotel will be much lower at the same time. The most relevant retrofitting solutions available for SME hotels for ensuring lower heating and cooling demands (kW) are improving thermal insulation of the building's envelope, using demand controlled air flow rates (e.g. IEQ sensor + VAV system), installing solar shading devices or other exterior works.

## 2.3. Equipment efficiency

Besides the hotel's energy efficient operation and reduced heating and cooling demands, high energy efficiency equipment is important to have. One of the least difficult technologies to apply is energy saving light bulbs, which will offer the same lighting conditions, but with much less electrical power input. The considered energy efficient equipment of the main energy consumers include:

high efficiency boilers and cooling equipment, micro CHP, heat recovery system in the air handling units, energy efficient motors, energy saving light bulbs, and water efficient measures to reduce domestic hot water consumption and its energy need.

## 2.4. System efficiency

The other option for energy savings is the overall technical system's efficiency. The fact that the technical systems of the hotel consist of energy efficient equipment does not guarantee that the systems work properly and energy efficiently. Considering the specific features of the hotels, there are many possibilities to increase the efficiency of the hotel's technical systems. Regarding the lighting system the main energy saving solutions are control of the lighting and the use of key card systems in the guest rooms. In the heating and cooling systems, the regulation of space heating and cooling (especially in the guest rooms) is the most important issue, which has to be addressed and implemented. Low temperature heating systems and thermal insulation of the heating system's elements could also increase the heating system's efficiency. In hotels the domestic hot water and cooling demands are rather high compared to other building types, therefore part of the domestic hot water demands can be covered by the waste heat of the chiller. Furthermore the chiller could function in free cooling mode as well for decreasing the cooling system's energy use.

## 2.5. Renewable energy

In addition to the reduction of the hotel's total energy use, renewable energy sources have high impact on the hotel's primary energy indicator thus in reaching nZEH benchmark values. The renewable energy sources are related to the highest energy consumers of the hotels i.e. heating, cooling, domestic hot water and lighting. The renewable energy sources are 'clean' energies, thus they ensure the sustainability of the energy production and the lowest primary energy use. A study published in 2011, made by WWF [7], stated that "by 2050, we could get all the energy we need from renewable sources". That report demonstrated that such a transition is not only possible but also cost-effective, providing energy that is affordable for all and producing it in ways that can be sustained by the global economy and the planet. The relevant energy production equipment from renewable energy sources for SME hotels include: heat pumps, solar thermal panels and photovoltaic panels, solar powered absorption chiller, biomass boiler, micro hydropower, small scale wind turbines.

# 3. Ranking criteria

One of the most important aims of WP2 is the determination of the most relevant technologies and solutions for SME hotels to reach nearly zero energy operation. The main energy saving solutions were gathered based on the Hotel Energy Solutions (HES) project, on REHVA experts' experience written in REHVA guidebooks [3] [4] [5] [11] [12] and based on EPBD Concerted Actions Documents and Reports [8].

The description of each relevant technology and solution are described in a separated document



(as an additional deliverable) “D2.4c Assessment of existing technologies to support nZEB renovations”.

Three ranking aspects have been taken into account in order to give priority for the selected technologies. The first ranking aspect is the financial investment size, the second is the potential energy saving, while the third ranking contains the classification according to the five European climate zones.

The investment size, such as equipment and installation costs, and also the energy prices [10] vary from one country to another and depend on many local parameters. Therefore concerning the size of the financial investment and the potential energy saving, instead of exact prices (e.g. in EUR), three classifications were introduced i.e. low, medium or high. The classification (low/medium/high) of each technology and solution is based on the REHVA’s experts knowledge, the HES project reports [1] [2], the implemented Hungarian energy retrofitting projects supported by the EU (KEOP and KIOP), the experiences of more than one hundred energy audits, the Hungarian national building energy strategy (NÉeS) and publicly available information from Internet.

The first and second rankings, the size of the investment and the potential energy saving, are necessary to know for determining the return on investment. Based on the investment and the energy savings, which were classified as low, medium or high, and based on the above mentioned references, the typical interval of the return of the investments are: short, medium and long-term ROI. The investment size, the potential energy saving, and the ROI is essential for the planning of energy retrofitting, but it is still not enough, because we have to know the effectiveness of the technology or solution in the given climatic zone, in which the hotel is situated. Therefore all of the technologies and solutions were ranked according to the five EU climatic zones defined in Ecofys report [9]. The methodology was to define the priority of these technologies and solutions taking into account the main climatic factors, such as outdoor temperature, heating and cooling degree days and solar radiation. The aim was to add a classification of each technology and solution, which expresses both the feasibility and the potential energy saving in the given climatic zone, because it varies from one climatic zone to another. The priority number (3 - highly recommended, 2 - recommended, 1 - feasible) for the different solutions expresses how the given technology can be used effectively in the given climatic zone, and how relevant it is for hotels in the given climatic zone.

### 3.1. Ranking aspect 1: Size of the financial investment

The rankings according to the size of the investment of the 40 selected technologies and solutions are based on HES project reports [1] [2], field experience and prices of already implemented investments. Based on the financial investment ranking the stakeholders can select technologies and solutions based on their financial performance. Again, equipment and installation costs vary from one country to another and depend on many local parameters, therefore concerning the size of the financial investment three rankings were introduced i.e. low, medium or high, in favour of exact prices.

### 3.2. Ranking aspect 2: Potential energy savings

The 2<sup>nd</sup> ranking aspect gives information on the potential energy savings of the technologies and solutions, because knowing only the investment size is not enough to take an established decision. The potential energy savings as cost savings depend on the energy prices, which vary among countries, therefore the quantitative energy savings were used for rankings i.e. low, medium or high. The energy saving by using a given technology depends on many parameters of the existing situation, such as the building geometry, the type of the heating, cooling, air conditioning, domestic hot water, lighting, cooking and other equipment, the control of the HVAC systems, behaviour of the consumers, etc. Overall, the potential energy savings depend on the technical systems and equipment efficiencies of a given hotel, so the energy savings could vary significantly, thus the typical cases were considered. Low classification generally means 1-5% energy saving, medium means 5-15% energy saving, and high means more than 15% energy saving, but it depends greatly on the building specificities. The energy saving refers to the energy source used by the given technology. A detailed energy audit for the given hotel can give the exact energy savings.

### 3.3. Ranking aspect 3: European 5 climatic zones

Rankings according to the 3<sup>rd</sup> aspect take into account the climatic zones of Europe. The climatic zones used to rank the technologies and solutions based on climate were the ones proposed in the ECOFYS report: Zone 1 and Zone 2 include the Mediterranean countries, zone 3 and zone 4 comprise in Eastern and Western Central Europe and zone 5 the Northern countries. Concerning Zone 1 and Zone 2, the same nZEH requirement (56 kWh/m<sup>2</sup>a) was presented in D2.3, therefore the classification of the technologies and solutions is the same for Zone 1 and Zone 2. The main climatic factors which have to be considered for the energy savings potential of a certain technology or solution include among others: the outdoor temperature, heating and cooling degree days, solar radiation and the geothermal features. The rankings were 1 - Feasible, when the given technology or solution is available but does not have much potential in the given climatic zone, 2 - Recommended when the technology or solution has average to high potential and 3 - Highly recommended, when the technology or solution has the highest potential in the given climatic zone.

The ranking tables for each of the technologies and solutions group, can be found in Appendices 1 to 5.

## 4. Return on investment based on the ranking criteria

The return on investment (ROI) of the different technologies and solutions can be appraised, based on the first two rankings i.e. size of the financial investment and predicted potential energy savings. Again, because the investment and energy costs vary from one country to another, the energy saving technologies and solutions are classified as short-term, medium-term and long-term ROI.

Typically, the short-term ROI solutions need low investment cost, furthermore some of them have almost zero cost, such as staff training, or information to guests. Other short-term ROI technologies and solutions need investment, such as energy audit, balancing of HVAC systems, regulation space heating, etc., but these have significant energy saving potential. Therefore the ROI period of these investments are very favourable, 1-3 years are expected. All in all, firstly the hotels should implement short-term ROI investments, taking into consideration the 3<sup>rd</sup> ranking as well, i.e. the classification of the technologies by climate zone.

Usually, medium-term ROI technologies and solutions, for example high efficiency boilers, lighting controls, high temperature cooling, etc., need higher investment cost, than short-term ROI solutions. Nonetheless, the combination of medium-term ROI solutions can result significant energy saving for hotels. Typically, the return on investment is 3-8 years.

Generally, long-term ROI solutions need the highest investment cost, for example windows changing, building insulation, geothermal energy, PV panels, etc., however these technologies have the highest potential energy saving. Long-term ROI solutions are essential for achieving nZEB level, because many of the technologies use RES. These technologies and solutions can be part of a comprehensive modernization of hotels. Typically, the return on investment is higher than 8 years.

#### 4.1. Short-term ROI

- Energy consumption monitoring;
- Energy audit of the hotel;
- EU Eco-label for Tourist accommodation services;
- Staff training;
- Information to guests;
- Building envelope air tightness;
- Prevention of high unnecessary air change rate;
- Energy saving light bulbs;
- Water saving taps;
- Key card systems to switch off electricity in guest rooms;
- Thermal insulation of boilers, domestic hot water tanks and pipes;
- Balancing of heating, cooling and air conditioning systems;
- Regulation of space heating and cooling.

## 4.2. Medium-term ROI

- Exterior works to improve summer comfort;
- Inflector window insulator;
- Energy efficiency rating of electrical appliances;
- Energy efficient motors in HVAC applications;
- High efficiency boilers;
- Efficient solutions for active space cooling;
- Efficient ventilation systems, min. 70% efficiency heat recovery;
- Lighting controls;
- Free cooling;
- Utilize waste heat of chiller;
- Hybrid ventilation system;
- Low temperature heating (including acceptable heating energy generation);
- High temperature cooling.

## 4.3. Long-term ROI

- Windows changing;
- Building insulation;
- Installation of sun shading devices;
- Geothermal energy (heat pump);
- Aerothermal energy (heat pump);
- Hydrothermal energy (heat pump);
- Solar powered absorption chiller;
- Micro hydropower;
- Micro CHP;
- Wind energy (small scale wind turbines);
- Biomass boiler;
- Solar thermal;
- Solar thermal for swimming pool;
- Photovoltaic panel.

## 5. Conclusions

The country specific nZEH benchmark values of primary energy for hotels hosting function was presented in D2.3. In D2.3 the validity of the derived nZEH benchmarks was also assessed in comparison to climatic zone nZEH benchmark values. These were inputs for the classification of technologies and solutions for nZE operation.

The classification of the relevant technologies and solutions is necessary from several points of view. First of all the investment size and the potential energy saving of a given technology is extremely important for a hotel owner. Instead of exact prices, three classifications were introduced: low, medium or high, because the equipment cost and the energy prices vary from one country to another. The return on investment (ROI) of the different technologies and solutions can be appraised, based on the above mentioned two rankings i.e. size of the financial investment and predicted potential energy savings. The energy saving technologies and solutions are classified as short-term, medium-term and long-term ROI, which is essential for the planning of energy retrofitting.

The effectiveness of a technology in the given climatic zone is also necessary for taking the right decision, therefore a third ranking was introduced, which expresses both the feasibility and the potential energy saving in a given climate zone. The priority numbers for the technologies in a given climate zone are presented in the following structure:

- 3 - highly recommended;
- 2 - recommended;
- 1 - feasible.

These three ranking aspects and the classification of each technology gives the opportunity to get information about the financial need and the predictable energy saving, and the relevancy in the given climate zone.

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## Appendix 1 Rankings of the energy management group's appropriate technologies and solutions for SME hotels

No.	Technologies and solutions group	Technology and solution	Ranking aspect 1 - Size of the financial investment			Ranking aspect 2 - Potential energy savings			Ranking aspect 3 - European climatic zones				
			Low	Medium	High	Low	Medium	High	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	Energy management	Energy use monitoring	✓			✓			3	3	3	3	3
2		Energy audit		✓			✓		3	3	3	3	3
3		EU Eco-label for tourist accommodation service		✓			✓		2	2	2	2	2
4		Staff training	✓			✓			3	3	3	3	3
5		Information to guests	✓			✓			3	3	3	3	3

## Appendix 2 Rankings of the reduction of heating and cooling demands group's appropriate technologies and solutions for SME hotels

No.	Technologies and solutions group	Technology and solution	Ranking aspect 1 - Size of the financial investment			Ranking aspect 2 - Potential energy savings			Ranking aspect 3 - European climatic zones				
			Low	Medium	High	Low	Medium	High	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	Reduction of heating and cooling demands	Windows changing			✓			✓	1	1	2	2	3
2		Inflector window insulator		✓			✓		3	3	2	2	3
3		Building insulation			✓			✓	1	1	2	2	3
4		Building envelope air tightness	✓				✓		2	2	2	2	2
5		Prevention of high unnecessary air change rate	✓				✓		2	2	2	2	2
6		Installation of sun shading devices		✓			✓		3	3	2	2	1
7		Exterior works to improve summer comfort (green roof, trees, etc.)	✓				✓		3	3	2	2	1



## Appendix 3 Rankings of the equipment efficiency group's appropriate technologies and solutions for SME hotels

No.	Technologies and solutions group	Technology and solution	Ranking aspect 1 - Size of the financial investment			Ranking aspect 2 - Potential energy savings			Ranking aspect 3 - European climatic zones				
			Low	Medium	High	Low	Medium	High	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1		Energy saving light bulbs		✓			✓	3	3	3	3	3	
2		Energy efficiency rating of electrical appliances	✓			✓		2	2	2	2	2	
3		Energy efficient motors in HVAC applications	✓			✓		2	2	2	2	2	
4		High efficiency boilers		✓			✓	2	2	2	2	3	
5	Equipment efficiency	Efficient solutions for active space cooling		✓			✓	3	3	2	1	1	
6		Micro CHP			✓		✓	2	2	2	2	2	
7		Efficient ventilation system (min. 70% energy recovery)		✓			✓	2	2	3	2	3	
8		Water saving taps (to reduce water and DHW consumption)	✓				✓	3	3	3	3	3	

## Appendix 4 Rankings of the system efficiency group's appropriate technologies and solutions for SME hotels

No.	Technologies and solutions group	Technology and solution	Ranking aspect 1 - Size of the financial investment			Ranking aspect 2 - Potential energy savings			Ranking aspect 3 - European climatic zones				
			Low	Medium	High	Low	Medium	High	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	System efficiency	Key card systems to switch off electricity in guest rooms	✓				✓		2	2	2	2	2
2		Lighting controls	✓				✓		2	2	2	2	2
3		Thermal insulation of boilers, domestic hot water tanks and pipes	✓			✓			1	1	1	1	1
4		Balancing of heating, cooling and air conditioning systems	✓				✓		3	3	3	3	3
5		Regulation of space heating and cooling	✓				✓		3	3	3	3	3
6		Free cooling (including night cooling)				✓			2	2	2	2	2
7		Utilize waste heat of chiller	✓				✓		3	3	2	1	1
8		Hybrid ventilation system		✓			✓		2	2	2	2	2
9		Low temperature heating (including acceptable heating energy generation)		✓				✓	1	1	2	2	3
10		High temperature cooling		✓				✓	3	3	2	2	1

## Appendix 5 Rankings of the renewable energy group's appropriate technologies and solutions for SME hotels

No.	Technologies and solutions group	Technology and solution	Ranking aspect 1 - Size of the financial investment			Ranking aspect 2 - Potential energy savings			Ranking aspect 3 - European climatic zones				
			Low	Medium	High	Low	Medium	High	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
1	Renewable energy	Geothermal energy (heat pump)			✓		✓	1	1	2	2	3	
2		Aerothermal energy (heat pump)		✓			✓	3	3	2	2	2	
3		Hydrothermal energy (heat pump)			✓		✓	2	2	2	3	2	
4		Solar powered absorption chiller			✓		✓	3	3	2	2	1	
5		Micro hydropower			✓		✓	1	1	1	1	1	
6		Wind energy (small scale wind turbines)			✓		✓	1	1	1	2	1	
7		Biomass boiler			✓		✓	1	1	2	2	3	
8		Solar thermal		✓			✓	3	3	2	2	1	
9		Solar thermal for swimming pool		✓			✓	3	3	2	2	1	
10		Photovoltaic panel		✓			✓	3	3	2	2	2	

## Appendix 6 Spanish Hotels' Energy Balance Database (Based on energy audit of 55 hotels)

Hotel Num.	Type	Zone	Occupancy	Available days	Rooms	Electricity	Propane (LPG)	Natural Gas	Butane (LPG)	Diesel	Thermal solar contribution	Total kWh	% Equipment	% Lighting	% Cooling	% Heating	% Hot Water	% Kitchen	% Others
1	Seasonal	Baleares - Mallorca - Can Pastilla	77%	214	144	392 246	0	17 681	0	233 465	0	643 392	11%	10%	37%	5%	34%	3%	1%
2	Full Year	Baleares - Mallorca - Can Pastilla	69%	365	61	235 797	0	217 169	0	0	0	452 966	11%	8%	23%	29%	22%	6%	0%
3	Full Year	Granada	72%	365	200	928 263	137 807	0	0	1 033 326	285 488	2 384 884	8%	6%	15%	43%	17%	13%	3%
4	Seasonal	Baleares - Mallorca - Paguera	78%	214	66	233 953	20 449	0	0	77 964	0	332 366	13%	14%	33%	10%	24%	6%	0%
5	Full Year	Baleares - Mallorca - Palma	67%	365	59	358 350	0	179 191	0	0	0	537 541	14%	14%	24%	27%	15%	5%	0%
6	Full Year	0	52%	365	69	1 792 037	156 198	0	0	874 800	0	2 823 035	12%	13%	24%	7%	35%	8%	1%
7	Seasonal	Baleares - Mallorca - Porto Colom	74%	171	155	390 594	78 967	0	0	272 160	0	741 721	18%	7%	24%	4%	43%	2%	3%
8	Seasonal	Baleares - Mallorca - Cala Mayor	84%	214	414	1 238 434	516 284	0	0	0	0	1 754 718	18%	8%	31%	12%	26%	3%	2%
9	Full Year	Lanjarón - Granada - Andalucía	66%	334	141	121 138	33 760	0	0	136 080	0	290 978	12%	11%	13%	12%	39%	12%	1%
10	Seasonal	Baleares - Mallorca - Porto Colom	79%	156	144	674 162	4 051	0	0	25 787	0	704 000	19%	5%	48%	5%	18%	1%	4%
11	Full Year	0	62%	365	141	934 114	0	80 000	0	340 200	0	1 354 314	11%	25%	15%	8%	27%	10%	4%
12	Full Year	Granada	65%	365	121	673 860	0	63 178	0	389 626	0	1 126 664	9%	6%	25%	14%	30%	9%	7%
13	Full Year	La Calahorra - Granada - Andalucía	58%	365	30	233 783	322 377	0	0	0	0	556 160	7%	9%	16%	36%	13%	11%	7%
14	Full Year	Campanillas - Málaga - Andalucía	55%	365	54	460 431	252 631	0	0	0	0	713 062	10%	16%	21%	5%	32%	10%	6%
15	Seasonal	Baleares - Mallorca - Paguera	76%	245	134	460 332	97 770	0	0	204 450	0	762 552	14%	10%	31%	5%	27%	13%	1%
16	Seasonal	Baleares - Mallorca - Can Pastilla	67%	153	101	82 091	0	61 213	0	0	0	143 304	15%	26%	2%	0%	43%	14%	0%
17	Full Year	Baleares - Mallorca - Palma	61%	365	12	194 954	0	97 200	0	0	0	292 154	11%	17%	22%	11%	21%	1%	18%
18	Full Year	Valenciana - Alicante -	75%	365	99	859 640	0	0	0	454 470	0	1 314 110	15%	10%	15%	10%	35%	14%	1%

		Benidorm																	
19	Full Year	Olula del Río - Almería - Andalucía	40%	365	34	523 572	318 493	0	0	0	42 423	884 488	12%	12%	11%	38%	9%	19%	0%
20	Seasonal	Baleares - Mallorca - Palma Nova	84%	177	121	319 478	48 434	0	0	184 495	0	552 407	17%	7%	29%	3%	31%	9%	5%
21	Seasonal	Baleares - Ibiza	84%	150	119	619 413	15 523	0	0	42 642	0	677 578	26%	7%	29%	6%	27%	1%	4%
22	Seasonal	Baleares - Mallorca - Cala Bona	42%	156	113	197 829	15 485	0	0	238 140	0	451 454	17%	6%	16%	2%	44%	3%	11%
23	Seasonal	Baleares - Mallorca - Porto Colom	44%	180	120	321 275	15 742	0	0	44 965	0	381 982	21%	10%	42%	5%	12%	4%	6%
24	Seasonal	Baleares - Mallorca - Playa de Palma	67%	255	93	217 759	0	169 940	0	0	0	387 699	20%	7%	22%	6%	34%	10%	1%
25	Seasonal	Baleares - Mallorca - Playa de Muro	74%	180	200	697 387	62 081	0	0	153 925	0	913 393	11%	13%	36%	4%	15%	7%	14%
26	Seasonal	Baleares - Mallorca - Can Picafort	68%	180	54	111 059	4 501	0	0	32 912	0	148 472	25%	11%	21%	3%	33%	3%	4%
27	Seasonal	Baleares - Mallorca - Santa Ponça	83%	179	143	331 221	72 993	0	0	145 790	0	550 004	16%	5%	31%	3%	28%	13%	4%
28	Seasonal	Baleares - Mallorca - Lluçmajor	95%	171	241	609 980	193 328	0	0	383 298	0	1 186 606	9%	6%	29%	5%	27%	16%	9%
29	Full Year	Granada	74%	365	40	187 884	0	0	0	204 946	0	392 830	24%	11%	3%	29%	23%	8%	2%
30	Full Year	Andalucía - Almería	65%	365	105	991 655	0	0	39 022	306 705	0	1 337 382	14%	9%	19%	14%	23%	15%	5%
31	Full Year	Canarias - Gran Canaria - San Agustín	65%	365	210	1 086 415	0	0	0	243 024	0	1 329 439	18%	13%	23%	7%	22%	17%	0%
32	Full Year	Canarias - Gran Canaria - Costa Meloneras	71%	365	561	7 168 293	2 240 033	0	0	0	0	9 408 326	30%	12%	34%	6%	13%	5%	0%
33	Seasonal	Baleares - Mallorca - Portals Nous	74%	172	170	325 784	215 179	0	0	0	0	540 963	20%	5%	26%	6%	27%	8%	8%
34	Full Year	Andalucía - Cádiz - Rota	83%	365	92	1 068 387	357 886	0	0	0	139 538	1 565 811	18%	6%	22%	21%	13%	18%	0%
35	Full Year	Canarias - Gran Canaria - Playa del Inglés	78%	365	402	2 738 063	172 469	0	0	536 544	0	3 447 076	33%	19%	25%	6%	12%	5%	0%
36	Full Year	Andalucía - Almería -	44%	365	197	1 718 184	1 585 145	0	0	0	0	3 303 329	34%	11%	19%	21%	10%	3%	1%

		Roquetas de Mar																	
37	Full Year	Canarias - Gran Canaria - Playa del Inglés	73%	365	724	3 203 081	220 112	0	0	1 153 764	0	4 576 957	33%	14%	13%	15%	19%	5%	0%
38	Full Year	Canarias - Gran Canaria - Costa Meloneras	60%	365	188	1 711 366	756 052	0	0	0	0	2 467 418	32%	11%	22%	7%	22%	7%	0%
39	Seasonal	Baleares - Mallorca - Can Picafort	63%	180	157	376 460	29 709	0	0	90 396	0	496 565	28%	7%	33%	4%	17%	6%	5%
40	Seasonal	Baleares - Mallorca - Palma Nova	95%	163	185	433 715	24 243	0	0	233 280	0	691 238	27%	5%	25%	3%	26%	4%	10%
41	Full Year	Canarias - Gran Canaria - Playa del Inglés	67%	365	257	2 142 391	1 088 798	0	0	0	0	3 231 189	29%	16%	15%	4%	23%	12%	0%
42	Seasonal	Baleares - Mallorca - Can Picafort	77%	180	100	131 400	70 222	0	0	89 638	0	291 260	13%	9%	20%	3%	27%	24%	4%
43	Full Year	Canarias - Gran Canaria - Playa del Inglés	74%	365	383	1 836 094	0	0	0	452 437	0	2 288 531	15%	17%	15%	10%	15%	27%	0%
44	Seasonal	Baleares - Mallorca - Puerto de Alcudia	56%	180	220	410 817	42 712	0	0	61 955	0	515 484	31%	8%	33%	5%	10%	8%	4%
45	Seasonal	Cataluña - Barcelona - Santa Susanna	92%	188	308	776 237	0	1 069 104	0	197 190	0	2 042 531	15%	5%	21%	13%	18%	4%	24%
46	Seasonal	Baleares - Mallorca - Can Picafort	86%	180	138	303 015	31 998	0	0	60 662	0	395 675	27%	10%	26%	6%	13%	8%	9%
47	Full Year	Andalucía - Cádiz - Los Barrios	44%	365	116	539 812	306 480	0	0	0	0	846 292	30%	16%	7%	6%	27%	6%	8%
48	Full Year	Canarias - Gran Canaria - Costa Meloneras	82%	365	1 136	14 529 046	4 055 736	0	0	0	0	18 584 782	36%	9%	29%	1%	15%	4%	6%
49	Full Year	Andalucía - Málaga - Archidona	75%	365	21	286 720	224 757	0	0	0	0	511 477	14%	14%	13%	19%	5%	34%	1%
50	Full Year	Andalucía - Cádiz - Jerez de la Frontera	61%	365	131	1 189 091	184 698	997 922	0	0	0	2 371 711	15%	7%	13%	22%	10%	18%	16%
51	Full Year	Antequera - Málaga -	44%	365	86	736 288	62 317	0	0	0	0	798 605	35%	15%	16%	17%	1%	8%	9%

		Andalucía																	
52	Full Year	El Ejido - Almería - Andalucía	53%	365	58	785 959	323 483	0	0	0	38 566	1 148 008	26%	9%	19%	10%	10%	21%	5%
53	Full Year	Canarias - Gran Canaria - San Agustín	85%	365	408	1 629 551	152 672	0	0	491 699	0	2 273 922	45%	15%	9%	9%	16%	7%	0%
54	Seasonal	Andalucía - Málaga - Marbella	49%	365	96	444 855	66 621	0	0	0	103 224	614 700	30%	7%	11%	6%	20%	21%	4%
55	Seasonal	Andalucía - Cádiz - Rota	54%	275	220	1 363 400	739 038	0	0	0	239 209	2 341 647	57%	6%	9%	10%	14%	0%	4%
Average													21%	11%	22%	11%	22%	10%	4%

## neZEH TEAM



### Project Coordinator

Technical University of Crete, School of Environmental Engineering  
Renewable and Sustainable Energy Systems Lab, Greece



United Nations World Tourism Organization



Network of European Regions for a Sustainable and Competitive Tourism



Federation of European Heating, Ventilation and Air-conditioning Associations



Agency of Braşov for Energy Management and Environment Protection, Romania



Creara Consultores S.L., Spain



ENERGIES 2050, France



Energy Institute Hrvoje Požar, Croatia



Istituto Superiore sui Sistemi Territoriali per l'Innovazione, Italy



Sustainable Innovation, Sweden

## CONTACTS

### PROJECT COORDINATOR:

Technical University of Crete, Renewable and Sustainable Energy Systems Lab  
Ms Stavroula Tournaki • [stavroula.tournaki@enveng.tuc.gr](mailto:stavroula.tournaki@enveng.tuc.gr) • +30 28210 37861 • [www.nezeh.eu](http://www.nezeh.eu)

### AUTHOR:

REHVA & University of Pécs, Hungary  
Anita Derjanecz • [ad@rehva.eu](mailto:ad@rehva.eu), Andrei Liţiu • [al@rehva.eu](mailto:al@rehva.eu), Zoltan Magyar • [magyar@egt.bme.hu](mailto:magyar@egt.bme.hu)





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