**Strategy Design to Incentivize the Efficent use of Energy in the Hotel Industry on the Canary Islands.**

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**Abstract:** Energy production and consumption represent the most significant sources of CO2 emissions in the world. An isolated island scenario like the case of the Canary Islands, where dependence on fossil fuels is almost complete needs an effective integrative strategy for energy efficiency in order to reduce the carbon footprint. The objective of our work is to design an integrative and sustainable energy transition strategy in the hotel sector of the Islands. To achieve this, we implement a qualitative / quantitative technique called Q methodology. Our study was conducted with a carefully selected group of 31 experts from diverse areas related to the energy sector who were asked to rank-order their degree of agreement or disagreement with 30 key energy discourses (statements). The results of our analysis identify four profiles of stakeholders' mindsets: the "Low-carbon", the "Techies", the "Skeptics" and the "Trusting". A well-defined integrative strategy could be identified which includes self-consumption using renewable energies; simplification of the administrative procedures; promotion of the use of heat pumps, among others. A further interesting consensus result among all four groups reveals experts' uncertainty regarding the post-COVID-19 reality.

**Keywords:** Canary Islands; Energy transition; Q methodology, Hotel industry; Renewable energies; Energy efficiency

## 1. Introduction

Energy production and consumption are the most important sources of $CO_2$ emissions on the planet due to the current extreme energy dependence on fossil fuels [1]. In 2015, the world's primary energy consumption was supplied from 81% fossil sources and 19% renewables. Reducing energy consumption, developing non-polluting energy sources, and improving energy efficiency (EE) are key to mitigating the effects of climate change. In 2018, the European Union heightened its commitments to energy sustainability by 2030, stipulating a reduction of at least 40% in greenhouse gas emissions compared to 1990 with at least 32% of energy consumed coming from renewable energy sources and a 32.5% increase in energy efficiency [2,3]. Under this framework, Spain developed the *Plan Nacional Integrado de Energía y Clima 2021–2030* (PNIEC) [4], which contains the foundation for the energy transition and decarbonization of the economy needed to achieve carbon neutrality by 2050.

The Canary Islands are an isolated system that depends almost entirely on fossil fuel as a primary energy source [5]. The islands' isolation and small size make it difficult to sustainably and reliably supply energy, causing a deep external dependence on fossil fuels and increasing the cost of transporting fuels, among other aspects [6]. However, as reflected in the Research and Innovation Strategy for Intelligent Specialization (RIS-3), there exists a significant potential for the use of renewable energy resources in the Canary Islands. Since the end of the 1980s, the use of renewable energy and energy efficiency in the Canary Islands has been promoted through various energy plans, with the last being the *Plan Energético de Canarias* (PECAN 2006) [7], which was replaced in 2015 by the *Estrategia Energética de Canarias 2015–2025* (EECan25) [8]. Nonetheless, the Canary Islands continues with an energy model far removed from both that proposed in PECAN 2006 [7] and the policies contemplated in the European strategies.

Achieving a sustainable energy transition requires adapting to the geographical, social, and economic circumstances of the country or region at hand. The Canary Islands' economy is highly dependent on the tourism sector, whose direct and indirect effects on the economy are estimated at 35% of GDP and 40.4% of employment [9]. The World Tourism Organization estimated that the lodging sector was responsible for 1% of global $CO_2$ emissions in 2005. In the hotel sector, in particular, numerous studies have shown that hotels have among the highest energy consumption across all building types [10]. Thus, the efficient use of energy in the tourism sector is a strategic element in the design of a sustainable energy strategy in the Canary Islands.

The realization of energy policy objectives is closely related to two types of factors: political-economic and technical. It is essential to establish strategies and an appropriate energy governance model to achieve energy policy objectives. Energy governance is the decisive factor in promoting or hindering the satisfactory development of the mechanisms necessary for energy-saving technologies, the introduction of renewable energy, and emission reduction. Energy governance refers to the process by which a country guides the development of its energy sector to ensure that socioeconomic objectives are achieved, in the broadest sense of the term [11]. This concept emphasizes the role of the policymaking and implementation processes that govern the energy sector, as well as the roles played by the different stakeholders and institutions involved (both public and private).

Successful governance requires setting emission reduction targets and formulating appropriate planning tools to achieve those targets by improving EE and increasing the use of less polluting forms of energy. The first step in establishing an energy transition is to extract the various strategic perspectives on the necessary policies from the involved stakeholders in the hotel industry.

The purpose of this article is twofold. First, it analyzes the preferences of the stakeholders involved in EE and the use of renewable energies in the hotel industry of the Canary Islands. Second, it identifies the main aspects to be considered in the design of an integrative strategy to achieve the decarbonization of the islands' hotel sector. Furthermore, it provides insights into the possible effects of the COVID-19 crisis, which has significantly affected the tourism sector in the Canary Islands.

The strategy of hotels' energy consumption is a basic pillar in the energy governance of the Canary Islands. In order to achieve these objectives, we apply the Q methodology by surveying experts from all areas related to energy consumption in the hotel sector (stakeholders). To our knowledge, this is the first time that this methodology has been used to identify perspectives in the hotel industry. Our work thus makes a novel contribution to the existing literature in the field of energy transition in hotels. The analysis of the results allows us to identify stakeholders' various strategic mindsets, which can be used to propose an integrative and sustainable strategy for energy use in hotels in the Canary Islands.

The structure of this paper is as follows. Section 2 outlines the energy consumption situation in the Canary Islands, particularly with regard to hotels, and reviews the literature on the use of the Q Methodology in the energy sector. Section 3 describes in detail the Q methodology and the case study we conducted. Section 4 presents the results of the survey and determines the different profiles that define the various strategic visions of energy consumption in the Canary Islands' hotels, as well as an analysis and discussion of the results. Section 5 summarizes the possible energy policy measures that can be used to reach an inclusive and sustainable energy transition. Section 6 presents the main conclusions.

## 2. Background

### *2.1. The hotel sector and energy consumption*

Spain, which saw 83.5 million international tourist arrivals in 2019, is the world's second-largest tourist destination behind France and has the second-largest international tourism revenue (after the United States) at $80 billion. [12] It is estimated that the tourism industry contributes around 16% of Spain's GDP. The Canary Islands received 15.1 million tourists in 2019, of whom 87% were international. This makes the islands one of the most important destinations in Spain for international tourism, occupying third place in number of arrivals (15.74%), behind Catalonia (23.2%) and the Balearic Islands (16.38%). In March 2020, the 663 hotel establishments in the Canary Islands offered 62.2% of all hotel and non-hotel lodging spaces.

In Spain, the tourism sector accounts for about 5% of the country's total energy demand. After transport, accommodations represent the most important energy consumption source in the tourism sector, comprising 20% of the total. The hotel sector is responsible for an estimated 1% of the total $CO_2$ emissions in Spain) [13]. According to the ITH, a significant number of Spanish hotel establishments are not very proactive in implementing measures to improve energy consumption and EE to increase their competitiveness. It is estimated that less than a third of hotels have made some kind of investment in renewable energy.

The final energy consumed by hotels can be electric or thermal. The relative weight of each depends on many factors (e.g., situation, category, services offered), but in the case of the Canary Islands, a differentiating factor is the lower use of heating. It is estimated that the electricity consumption of Canary Islands hotels is 65.6% and thermal consumption 34.4% [14]. These figures differ from the consumption rates on the Spanish peninsula, where estimates are 47% and 53%, respectively, according to the Centre for Resource Research and Energy Consumption. With regard to thermal consumption of fossil origin, the fuels used in hotels in the Canary Islands are primarily diesel (57.5%) and propane (39.5%) [14].

In terms of electricity demand, the hospitality sector (accommodations and catering) in the Canary Islands accounted for 15.9% of total electricity demand in 2019, behind domestic use alone (35.7%) and administration and other public services (18.2%) [15]. The most energy consumed in hotels in the Canary Islands is due to air conditioning (30.8%), sanitary hot water (SHW) and swimming pools (22%), laundry and kitchens (21.2%), rooms (10.5%), and general lighting (8%) [14]. The use of renewable-origin electricity in the Canary Islands has grown significantly in recent years, doubling between 2017 and 2019. In 2019, renewable generation reached 1480.6 GWh, representing 15.9% of the total. Of this percentage, 77.5% was generated with wind power and 18.8% with photovoltaics [15].

Boosting renewable energy as a means of reducing external vulnerability and improving environmental protection has been a priority objective of energy policy in the Canary Islands since the late 1980s. A recent example is the PECAN 2006 [7]; however, non-compliance in implementation led to the approval of a new Energy Strategy for the islands in 2017 [8]. This document highlighted the realization of objectives and multiannual spending commitments, making it a more flexible instrument capable of adapting to different circumstances throughout its implementation. The following objectives have been set to be achieved by 2025: to improve primary energy intensity by 28.91% compared to 2015, to increase the share of renewable energy in final energy to 15% (up from 2% in 2015), to increase the share of renewable energy for electricity generation by 45% (up from 8% in 2015), and to reduce $CO_2$ emissions by 21% from the 2014 level.

Among its lines of action, EECan25 includes "boosting savings, energy efficiency and incorporation of renewable energies in companies in the tertiary sector (in particular SMEs), especially those in the tourism sector." EECan25 has been joined by the Preliminary Draft Canary Islands Law on Climate Change and Energy Transition, which was approved in November 2020. This preliminary draft aims to promote green tourism, establishing that hotel and extra-hotel facilities and resorts should develop energy transition plans that aim to minimize their carbon footprints.

*2.2. Q Methodology and subjective perceptions in the energy field*

The Q methodology is a qualitative and quantitative method whose objective is to learn the subjective opinions of a group of individuals on a specific topic to determine the different perspectives on the issue at hand. It consists of surveying experts representing the different stakeholders involved in a problem by asking their degree of agreement or disagreement with different ways of addressing the topic. Subsequently, from this information, specific strategies or policy measures can be designed that integrate the different visions.

Although originally designed to study people's subjective opinions in psychology, numerous researchers from other disciplines have exploited the efficacy of this "hybrid" method. Since its invention by the psychologist and physicist W. Stephenson in 1935, Q has been applied in health studies [16], education [17] [18] [19], transportation [20], environmental studies [21] [22], and political science [23], among other fields. Q has also been used in energy studies, but the number of articles on this topic is still quite limited.

To our knowledge, this methodology has not previously been used in the study of energy consumption in the hotel sector. Thus, our work using Q makes a valuable contribution to the literature on EE in the hotel industry. The reason for the growing academic interest in the use of Q is due to its particular usefulness when dealing with controversial topics, like EE in the hotels of the Canary Islands.

An overview of the application of Q in the energy sector is necessary to establish the foundation for the current study. Q has been implemented in several areas related to renewable energy sources. Stakeholders' opinions regarding wind farms were studied in [24], [25], [26], and [27]. These researchers proved that previous work on wind farm public acceptance using strictly quantitative methods led to poor explanatory findings and thus ineffective policy. Q is the most adequate technique for understanding subjectivity and leads to more correct policy measures. Different perspectives on photovoltaic energy have also been addressed [28] [29] [30] [31] [27] [32]. Previous, solely quantitative research on planning photovoltaic infrastructure led to strictly technical outcomes, where experts' subjective opinions had not been taken into consideration. However, when considering different stakeholders' perspectives on the topic, it becomes clear that policies should consider the subjective opinions of all affected agents in order to reduce conflicts.

Additionally, [33] and [34] applied Q in shale gas exploration studies, and [35] explored opinions on biomass. Perceptions of hydroelectric plants were addressed in [36], whereas [37] analyzed stakeholders' opinions on clean transportation and electric vehicles. Other previous literature involving Q has also focused on more generalized discourses on energy (see, e.g., [34] [38] [39] [40] [41]). Topics where extreme opinions might emerge due to conflicts in the interests of the different stakeholders need to be examined more thoroughly from all angles at once. This is where Q's strengths can elucidate the subjective nuances of stakeholders' mindsets in order to develop more accurate and effective policies. Further advantages of this method compared to other similar techniques are outlined below.

Q is particularly valuable for studying energy governance in the hotel industry for several reasons. First, it has a "horizontal" approach, as participants simultaneously consider all variables that define the topic of research [42]. Another reason that we opted to use Q is that it can yield significant results using small samples, unlike Likert-scale questionnaires. Likewise, it avoids the problem of low response rate, since face-to-face interviews assure a greater response percentage compared with online or email-based surveys [43]. Finally, compared to cluster analysis, where grouping of individuals is also carried out, Q captures the "hidden" nuances of individuals' perceptions and attitudes, adding more richness and detail to the research [44]. All of these reasons make Q the most appropriate tool for analyzing hotel EE.

## 3. Methodology

One of the most accurate ways of defining the essence of Q-methodology was proposed in [45], where the term "qualiquantological" is used to describe the mixed nature of this method. It combines the meticulousness of qualitative methods with the rigor of quantitative methods. The qualitative component takes place during the choice of sample and in the conducting and treatment of the survey by experts. The quantitative component occurs when using statistical methods in the analysis and the subsequent processing of survey data [33].

### *3.1. Concourse and Q-set*

In the first stage, data were obtained that allowed us to comprehend the different perceptions on energy transition for hotels in Canary Islands aimed at the decarbonization of the sector. This process consisted of collecting a population of statements of opinions, called a concourse or shared knowledge set [46]. This procedure is based on the hypothesis that there is a finite number of views on any subject. The population of statements was gathered from professional literature, in-person interviews, press articles, and other sources of information containing tangible or intangible stimuli relevant to the subject. The concourse was considered to cover all aspects of our research question. Subsequently, a final sample, called the Q-set, was extracted from the previously selected population of statements. The definite selection was made after a pilot survey was conducted with five stakeholders (Focus Group) who later took part in the focus group of experts chosen for the final survey (see Figure 1).

The existing literature on the Q methodology indicates that the number of statements must be manageable for both the participants and the researchers. In order not to exhaust the respondents, we chose a number that requires an average completion time of 20 to 40 minutes. Typically, the number of statements varies between 16 and 40 [37] [39] [47]. However, some authors choose up to 80 depending on their target participants. For our study, 30 statements were divided into three thematic blocks, and the number of statements in each block was chosen by relevance to the topic and further readjusted and confirmed by the pilot survey group (Focus Group) (Table 1):

**Block 1:** General measures, taxation, and awareness (thirteen statements);

**Block 2:** Energy-saving measures in air conditioning and SHW (eight statements); and

**Block 3:** Energy efficiency (nine statements).

This choice of categorization was first motivated by the findings in [14], where the opinions of experts in the hotel sector were gathered. The initial survey consisted of five blocks (energy-saving measures in air conditioning, SHW, and illumination were each placed in a separate block). Following this, we asked the Focus Group to contribute to the correct identification of the blocks. After taking the experts' remarks into consideration, we combined energy-saving measures in air conditioning and SHW into one block and added illumination-related energy-saving measures to the EE block.

**Table 1.** Statements used in expert interviews

| No. | Statement |
|---|---|
| | **BLOCK 1: General measures, taxation, and awareness** |
| 1 | In order to improve energy consumption management, the installation of self-consumption energy systems using renewable energies, together with demand management and storage systems, is a priority. |
| 2 | The hotel sector is very proactive in adopting energy efficiency measures. |
| 3 | Regulatory requirements and bureaucratic difficulties hinder the installation of infrastructures for self-consumption of electricity produced from renewable energies. |
| 4 | Private hotel investment in energy transition projects is NOT supported by tax deductions that favor returns on these large investments. |
| 5 | High-tech R&D projects developing new applications or energy flow management systems applicable to the hotel industry should be prioritized. |
| 6 | Bonuses and subsidies for energy efficiency and renewable energy usage projects are sufficient and reach all stakeholders in the tourism sector. |
| 7 | “Green” taxes (eco-taxes) should be imposed on tourists in order to raise funds for the decarbonization of the islands. |
| 8 | “Green” certificates awarded to hotels for using clean electricity and for their efficient use of energy are a decisive factor in customers’ choices when booking a hotel. |
| 9 | Green-room apps (which inform customers about their energy-efficient usage) fail to change customers’ behavior despite the benefits they offer. |
| 10 | Informative energy-saving campaigns that aim to raise awareness among tourists fail to change their behavior. |
| 11 | The European “Next-Generation” funds dedicated to boosting the green economy in the post–COVID-19 era will be sufficient to support the investment projects presented by the tourism/hotel industry. |
| 12 | In the post–COVID-19 reality, projects to decarbonize the hotel sector will be delayed because public spending and investment in other sectors is a priority. |
| 13 | New post–COVID-19 tourists will be more aware of the environmental impacts of their energy behavior in hotel establishments. |
| | **BLOCK 2: Saving measures in air conditioning and sanitary hot water** |
| 14 | In the short term, it is essential to replace the use of diesel with natural gas/Liquified Petroleum Gas (LPG) in the hotel sector. |
| 15 | Short-term reductions in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipment and using petroleum derivatives with heat pumps. |
| 16 | In the short term, it is a priority to boost the use of propane-air (LPG-air) to reduce energy consumption in hotels. |
| 17 | Aerothermal heating systems (with several heat pumps) are the best option for replacing diesel boilers in the medium term. |
| 18 | Cogeneration from renewable sources is the best solution for medium-term energy savings. |
| 19 | Residual biomass boilers (pellets, olive bone, etc.) are a reasonable medium-term solution to reduce energy consumption in hotels. |
| 20 | In the medium term, it is a priority to use low-enthalpy (low-temperature) geothermal energy for sanitary hot water production. |
| 21 | The installation of photovoltaic power panels is the best medium-term solution for reducing energy consumption in hotels. |
| | **BLOCK 3: Energy efficiency measures** |
| 22 | Efficient climate construction does NOT generate significant energy savings. |
| 23 | Air conditioning savings can be achieved by using sensors (smart meters) that disconnect air conditioning or heating when they detect that windows are opened to prevent power wasting. |
| 24 | The use of presence or occupancy detectors for lighting savings is widespread in all hotel establishments. |
| 25 | Outdoor lighting systems (facades, gardens, etc.) must use photovoltaic panels. |
| 26 | Intelligent water leak detection sensors are essential in cases of older, unrenovated hotels. |
| 27 | The installation of showers with flow reducers, thermostats, and timed flow taps is a priority for the reduction of sanitary hot water use. |
| 28 | In order to optimize medium-term energy consumption, it is a priority to install energy management systems for the building (Building Management Systems (BMS)/Environmental Monitoring Systems (EMS)) for better control and to obtain information for decision-making. |
| 29 | It is a priority to reduce the thermal losses of the entire installation through adequate insulation and maintenance. |
| 30 | Hotels must install charging points for electric vehicles. |

### *3.2. P-set (P-sample)*

The second stage entails the selection of survey participants, who are not chosen at random as in other types of surveys. Groups of respondents are selected from all sectors related to the topic. This expert group is called a P-set, and the number of participants can vary between 25 and 40 [48]. The Q methodology is not intended to extrapolate the results of a sample to the entire population but rather to extract opinions only from experts. For this reason, a relatively small group of individuals (N = 31) were selected from a variety of experts in the energy sector. We used snowball sampling to recruit participants. Each previously selected respondent was asked to refer other experts competent in energy issues. Figure 1 visualizes the research design and graphically explains the steps involved in applying the Q methodology in our study.

Following this, experts were categorized into three groups according to their occupational status. Individuals who worked in the energy sector were subdivided into energy supply companies (n = 6), technical enterprises and sector consultancies (n = 4), and energy associations (n = 2). The second group of respondents, who were involved in the hotel industry, were subdivided into hotel maintenance technicians (n = 2), hotel managers (n = 3), and representatives of hotel associations (n = 2). The last group contained experts from public administration and political office (n = 5), NGOs (citizens' platforms for a new energy model) (n = 3), and university academics (n = 4) (see Table 2).

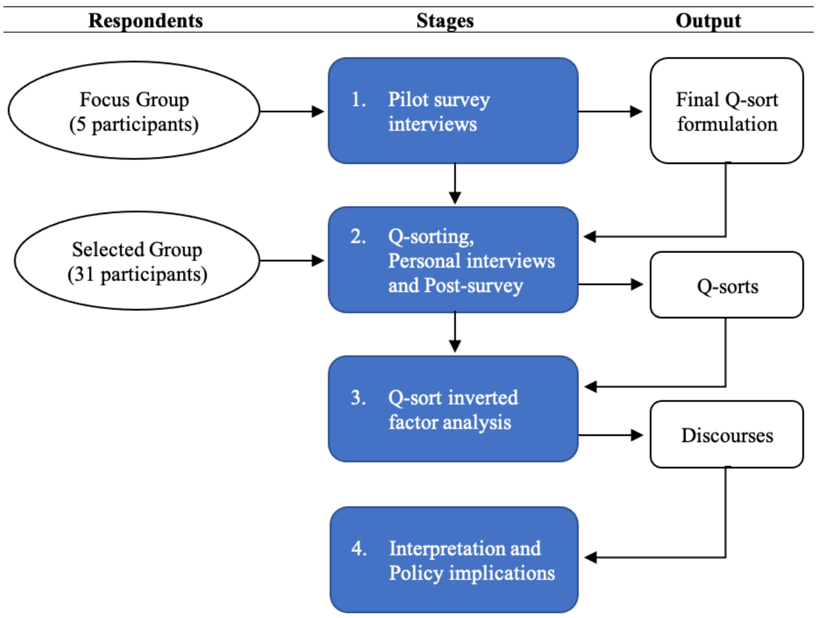


Figure **1:** Research design (Adapted from [41])

**Table 2.** Respondents.

| Id | Category Group | Id | Category Group |
|---|---|---|---|
| | **Energy sector** | | **Other groups of interest** |
| 8 | Energy supply companies | 3 | Public administrations and political offices |
| 12 | Energy supply companies | 13 | Public administrations and political offices |
| 14 | Energy supply companies | 15 | Public administrations and political offices |
| 23 * | Energy supply companies | 21 | Public administrations and political offices |
| 27 | Energy supply companies | 22 | Public administrations and political offices |
| 30 | Energy supply companies | 5 | NGOs |
| 9 | Technical enterprises and sector consultancy firms | 6 * | NGOs |
| 18 | Technical enterprises and sector consultancy firms | 7 | NGOs |
| 24 * | Technical enterprises and sector consultancy firms | 1 | University academics |
| 28 * | Technical enterprises and sector consultancy firms | 2 | University academics |
| 19 | Energy associations | 4 * | University academics |
| 20 | Energy associations | 29 * | University academics |
| | **Hotel industry** | | |
| 16 | Hotel maintenance technicians | | |
| 26 | Hotel maintenance technicians | | |
| 11 | Hotel managers | | |
| 25 | Hotel managers | | |
| 31 | Hotel managers | | |
| 10 | Hotel associations | | |
| 17 | Hotel associations | | |

(*) indicate the participants who load significantly on more than one factor and were excluded from the posterior analysis

Once the P-set was built, participants were told to sort the statements by rank-ordering their opinions in a range of +4 (totally agree) to -4 (totally disagree). This process is called Q-sorting and follows a quasi-normal forced distribution determined by the researcher where a limited number of opinions can be placed in each column ("agree," "neutral," and "disagree") [44] (see Figure 2). The interviews were held in person, and the specific software used to complete the survey was Lloyd's Q Sort Tool [49].

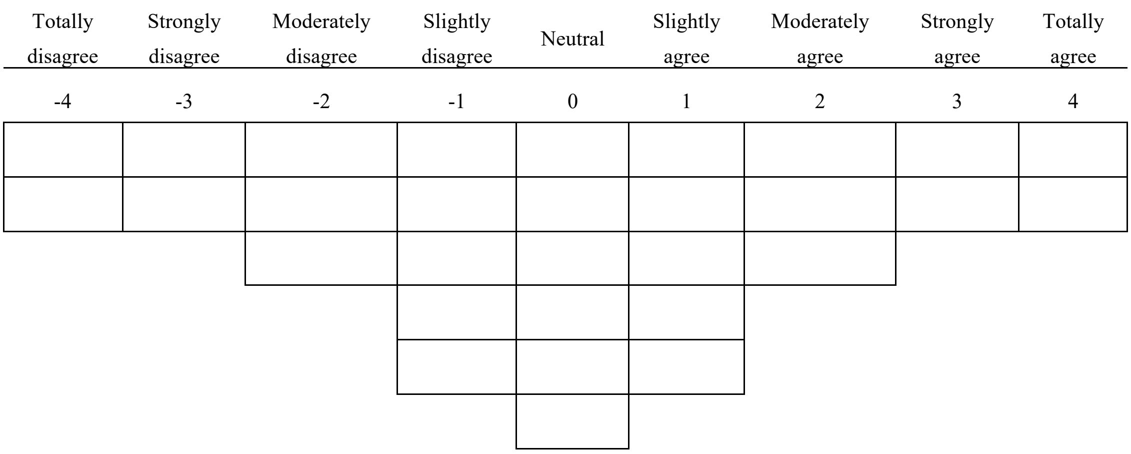


**Figure 2.** Quasi-normal distribution.

## 4. Results

After concluding the Q-sorting process, inverse factor analysis was conducted by exporting the raw data from Lloyd's Q Sort Tool [49] in a PQMethod format into the Ken-Q free software for statistical analysis. The term "inverse" means that factors represent groups of individuals and not groups of variables, as in conventional factor analysis.

### *4.1. Inverse factor analysis*

Initially, principal component analysis was performed with an outcome of eight factors extracted before the rotation [50]. These groups of participants held similar views on possible measures for EE in the hotel industry on the Canary Islands. In order to facilitate interpretation, a Varimax rotation is needed in order to minimize the number of individuals who have high loadings in each factor. Orthogonal rotations like Varimax assume that factors are uncorrelated [51]. "Varimax rotations maximize high- and low-value factor loadings and minimize mid-value factor loadings" [52].

Several criteria must be met for a factor to be retained. First, the Kaiser (K1) criterion should be fulfilled—namely, eigenvalues must be greater than 1 for factors to be retained [53]. Second, a scree test should be examined for breaks and/or discontinuities [54]. This test should show that a few major factors account for the greatest part of the explained variance. The steeper the slope, the greater the part of the variance that is explained by these factors. As the slope flattens, the factors lying in that area account for less variance. Finally, [55] further suggests that at least three individuals should form part of one factor to achieve "minimum coverage of the construct's theoretical domain."

Our analysis before rotation showed that all eight factors had eigenvalues greater than one (Table 3); however, the scree plot flattens at the fourth factor, and the explained variance is small if more factors are added to the analysis (Figure 3). The retention of four factors is also confirmed by the fact that fewer than three individuals were entered in factors five to eight. After the Varimax rotation, six participants (ID: 4, 6, 23, 24, 28, 29) were considered indecisive because they loaded significantly on more than one factor and were thus excluded from the analysis. The total cumulative explained variance after eliminating the six experts was 54%, which is above 50% and is considered acceptable.

**Table 3.** Eigenvalues and explained variance.

| | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 | Factor 6 | Factor 7 | Factor 8 |
|---|---|---|---|---|---|---|---|---|
| Eigenvalues | 9.2316 | 2.9839 | 2.6881 | 2.0039 | 1.7078 | 1.6176 | 1.3707 | 1.3376 |
| % explained variance | 30 | 10 | 9 | 6 | 6 | 5 | 4 | 4 |
| Cumulative % explained variance | 30 | 40 | 49 | 55 | 61 | 66 | 70 | 74 |

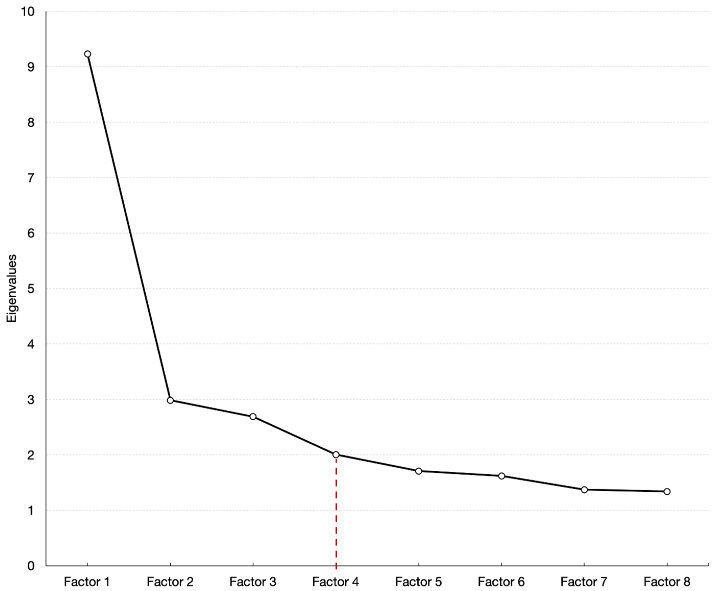


**Figure 3.** Scree Plot.

*4.2 Transforming factors into mindset groups*

Interpreting the Q methodology results was intended to uncover the similarities and differences between the four mindsets as well as the characteristics in the composition of their components. Distinguishing statements were identified and analyzed for each factor. These were the statements that yielded the highest $z$-scores in a given factor (above 0.5) compared to the rest of the factors. Finally, consensus statements (similar $z$-scores among factors) gave us invaluable insights into which topics were agreed upon by all experts. Furthermore, the post-surveys, in which we interviewed participants to identify the motives behind their rankings, helped us define the factors more precisely.

Based on the standardized $z$-scores of each statement, which are comparable across all factors, a composite or “idealized” Q-sort for each factor was generated (see Figure 4). These four composite Q-sorts represent the generalized mindsets of the individuals who fall into each corresponding factor. After a deeper analysis of the factors, we transformed them into the following mindsets: “low-carbon,” “techies,” “skeptical,” and “trusting.”

**Composite Q-sort of Factor 1**

| -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 19 | 22 | 18 | 10 | 12 | 23 | 1 | 15 | 21 |
| 7 | 14 | 6 | 11 | 8 | 20 | 30 | 3 | 17 |
| | | 16 | 25 | 27 | 2 | 28 | | |
| | | | 4 | 26 | 29 | | | |
| | | | 13 | 9 | 24 | | | |
| | | | | 5 | | | | |

(a) Low-carbon

**Composite Q-sort of Factor 2**

| -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 19 | 6 | 16 | 12 | 29 | 26 | 3 | 21 | 1 |
| 22 | 8 | 17 | 13 | 27 | 18 | 30 | 28 | 5 |
| | | 20 | 14 | 25 | 9 | 2 | | |
| | | | 11 | 15 | 23 | | | |
| | | | 24 | 4 | 7 | | | |
| | | | | 10 | | | | |

(b) Techies

**Composite Q-sort of Factor 3**

| -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 30 | 27 | 15 | 13 | 6 | 11 | 17 | 5 | 14 |
| 19 | 24 | 22 | 23 | 10 | 21 | 1 | 4 | 3 |
| | | 2 | 7 | 25 | 20 | 12 | | |
| | | | 26 | 9 | 8 | | | |
| | | | 18 | 16 | 28 | | | |
| | | | | 29 | | | | |

(c) Skeptical

**Composite Q-sort of Factor 4**

| -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|---|
| 21 | 25 | 8 | 26 | 12 | 27 | 18 | 28 | 1 |
| 22 | 7 | 24 | 19 | 6 | 16 | 15 | 2 | 29 |
| | | 10 | 4 | 23 | 5 | 17 | | |
| | | | 9 | 13 | 30 | | | |
| | | | 11 | 14 | 3 | | | |
| | | | | 20 | | | | |

(d) Trusting

**Figure 4.** Composite Q-sorts for four factors and distinguishing statements (green)

4.2.1 Mindset 1: Low-carbon (Immediate decarbonization of the hotel industry)

The composite Q-sort for factor 1 indicates that these experts were completely against imposing "green taxes" on tourists (7) and did not consider biomass boilers a solution for EE in hotels (19). In contrast, they strongly favored systems with heat pumps (17) and considered photovoltaic power panels the best solution in the medium term for reducing energy consumption in hotels (21). This group strongly supported applying existing technological energy solutions in the short term and strongly disliked all alternatives associated with $CO_2$ emissions. They were also against propane-air, although this preference was less strong (16).

Figure 5 shows the distinguishing statements associated with the low-carbon mindset compared with the rest of the factor groups. This group had the highest scores in response to statements 15, 17, and 24 (Table 4). The experts restated their opinions in favor of heat pumps as a short-term solution, this time for reducing air conditioning and SHW consumption (15). According to them, the use of occupancy detectors for lighting saving is widespread among hotels in the Canary Islands (24). Participants in this group gave the lowest ratings to prioritizing R&D projects in the hotel industry (5). Furthermore, they valued less the replacement of diesel with natural gas or LPG in the hotel industry (14) (Table 4). In sum, these experts wanted immediate decarbonization without intermediate steps. The first factor explains 17% of the variance and includes a total of eight experts, three of whom worked in energy supply companies, two in energy associations, two in public administration, and one as a hotel maintenance technician.

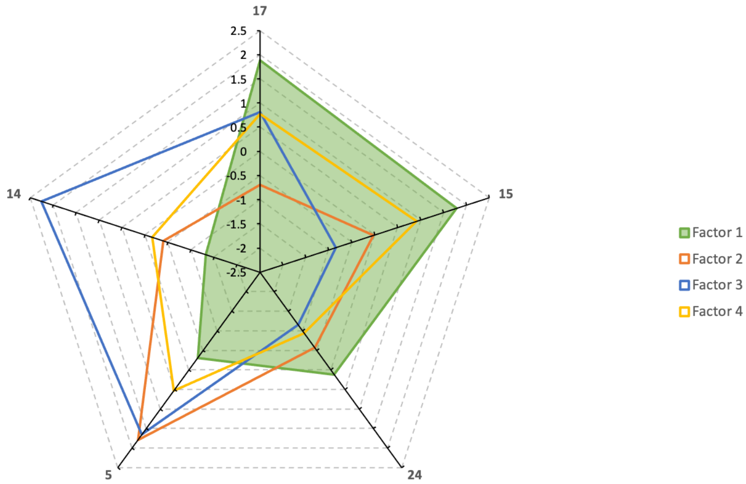


**Figure 5.** Average loadings for the distinguishing statements of Factor 1.

**Table 4**. Distinguishing statements for Factor 1.

| No. | Statement | Q-value | Z-score |
|---|---|---|---|
| 17 | Aerothermal heating systems (with several heat pumps) are the best option for replacing diesel boilers in the medium term. | 4 | 1.88 |
| 15 | Short-term reductions in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipment and using petroleum derivatives with heat pumps. | 3 | 1.78 |
| 24 | The use of presence or occupancy detectors for lighting savings is widespread in all hotel establishments. | 1 | 0.12 |
| 5 | High-tech R&D projects developing new applications or energy flow management systems applicable to the hotel industry should be prioritized. | 0 | -0.31 |
| 14 | In the short term, it is essential to replace the use of diesel with natural gas/LPG in the hotel sector. | -3 | -1.32 |

4.2.2 Mindset 2: Techies (Trust in technology implementation)

The defining characteristic of this group is their interest in the development and implementation of new technologies for improving the energy efficiency of the hotel industry. These participants gave their highest scores to boosting R&D projects (5), installing self-consumption energy systems that use renewable energy together with demand management and storage systems (1), and assessing in depth the installation of building management systems (BMSs) and environmental monitoring systems (EMSs) in hotels (28). It is noteworthy that all experts in this category demanded management systems that used software technologies. Their tendency toward technology is further affirmed by their valuation of intelligent water leak detection sensors in unrenovated hotels above other factors (26) Interestingly, this group was the only one who valued the collection of green taxes from tourists somewhat positively. This suggests that these respondents may also have a stricter nature compared to the rest of the groups, as they believe in penalization for boosting carbon emissions. Figure 6 shows that stakeholders in this group valued the use of heat pumps the least (17) compared to the rest of the factors. They also assigned the lowest priority to using low-enthalpy geothermal energy for SHW production (20). (Table 5). The second factor also explains 17% of the variance and includes nine energy stakeholders: two hotel maintenance technicians, two experts in public administration, two NGO representatives, two university academics, and one individual who worked for a technical enterprise.

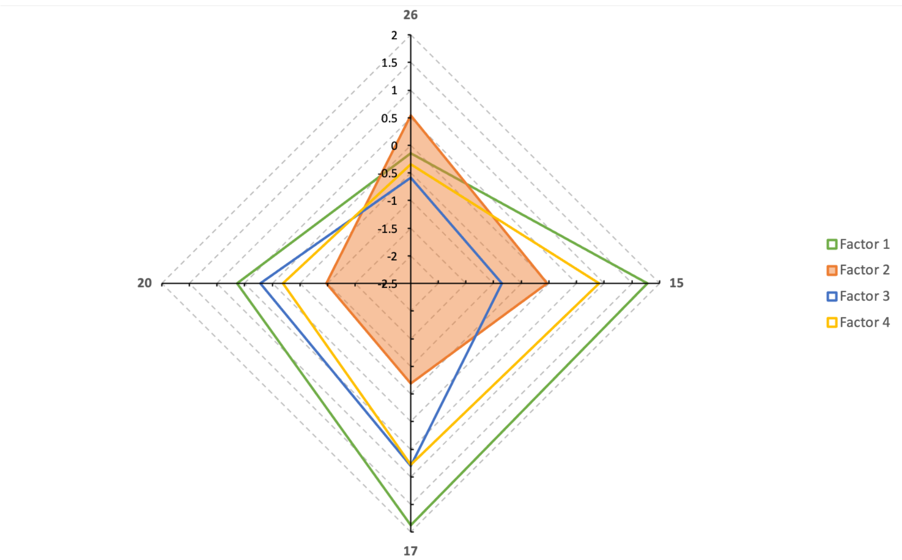


**Figure 6:** Average loadings for the distinguishing statements of Factor 2

**Table 5**. Distinguishing statements for Factor 2.

| No. | Statement | Q-value | Z-score |
|---|---|---|---|
| 26 | Intelligent water leak detection sensors are essential in cases of older, unrenovated hotels. | 1 | 0.54 |
| 15 | Short-term reduction in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipment and using petroleum derivatives with heat pumps. | 0 | -0.03 |
| 17 | Aerothermal heating systems (with several heat pumps) are the best option for replacing diesel boilers in the medium term. | -2 | -0.69 |
| 20 | In the medium term, it is a priority to use low-enthalpy (low temperature) geothermal energy for sanitary hot water production. | -2 | -0.98 |

#### 4.2.3 Mindset 3: Skeptics (Lack of trust in receiving financial help; pragmatic)

This group expressed clear skepticism toward public institutions and their helpfulness and supportiveness. This can be observed by their low trust that they would receive tax deductions for energy transition projects (4). Furthermore, their lack of faith in institutions is strongly expressed by their total agreement that bureaucratic difficulties hinder the installation of green infrastructures (3). Likewise, they expressed skepticism about receiving sufficient "Next-Generation" funds to recover after the COVID-19 pandemic (11). This suggests that respondents in this group are pragmatic and cautious with regard to spending money. Their responses indicate that they would rather avoid investments that will take a long time to recover. Expensive investments like infrastructure for electric vehicles (30) were not favored by this group. The use of residual biomass boilers (19) and the installation of showers with flow reducers, thermostats, and timed flow taps (27) were not among their priorities compared to the rest of the groups. Energy-saving measures to reduce SHW use by means of heat pumps (15) were valued least, and they held low opinions of the proactivity of the hotel industry in adopting EE measures (2). Their practical nature is further evidenced by the fact that they most strongly supported the replacement of diesel with natural gas or LPG (14)—one of the less costly options for energy transition (Figure 7) (Table 6). This factor explains 9% of the variance and contains four stakeholders from four different categories: two hotel managers, one employee of an energy supply company, and one employee of a technical enterprise.

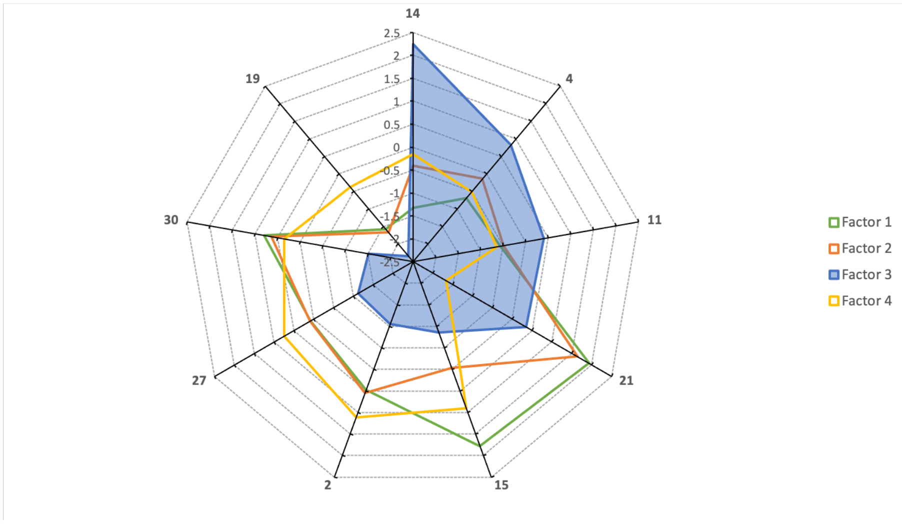


**Figure 7:** Average loadings for the distinguishing statements of Factor 3

**Table 6**. Distinguishing statements for Factor 3.

| No. | Statement | Q-value | Z-score |
|---|---|---|---|
| 14 | In the short term, it is essential to replace the use of diesel with natural gas/LPG in the hotel sector. | 4 | 2.25 |
| 4 | Private hotel investment in energy transition projects is NOT supported by tax deductions that favor the returns on these large investments. | 3 | 0.82 |
| 11 | The European "Next-Generation" funds dedicated to boosting the green economy in the post-COVID-19 era will be sufficient to support the investment projects presented by the tourism/hotel industry. | 1 | 0.4 |
| 21 | The installation of photovoltaic power panels is the best medium-term solution for reducing energy consumption in hotels. | 1 | 0.35 |
| 15 | Short-term reduction in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipment and using petroleum derivatives with heat pumps. | -2 | -0.85 |
| 2 | The hotel sector is very proactive in adopting energy efficiency measures. | -2 | -1.05 |
| 27 | The installation of showers with flow reducers, thermostats and timed flow taps is a priority for the reduction of sanitary hot water use. | -3 | -1.12 |
| 30 | Hotels must install charging points for electric vehicles. | -4 | -1.52 |
| 19 | Residual biomass boilers (pellets, olive bone, etc.) are a reasonable medium-term solution to reduce energy consumption in hotels. | -4 | -2.34 |

### 4.2.4 Mindset 4: Trusting (Trust in hotel management and tourists)

This group is characterized by trust in the hotel industry and tourists, reflected in group members' strong agreement that the hotel sector is very proactive in adopting energy efficiency measures (2). Respondents in this factor trusted that energy-saving campaigns aiming to raise awareness among tourists were successful (10). They also believed that green-room apps had the capacity to change tourists' energy-saving behavior. All of this indicates that these respondents have a strong belief in tourists' sustainable behavior while staying in hotel establishments. Additionally, these individuals held favorable opinions of high-tech R&D projects' ability to create new energy-saving applications (5) and BMS and EMS technologies' abilities to optimize energy consumption (28). It is interesting that this group was not in favor of photovoltaic energy (21, 25) but agreed on the use of heat pumps (17) and propane-air (16). The experts belonging to this group rated the use of residual biomass boilers higher than all other factors (19). They also considered important the installation of showers with flow reducers, thermostats, and timed flow taps (27) and assigned a high priority to performing adequate maintenance to avoid thermal losses in the system (29) (Figure 8) (Table 7). This factor explains 11% of the variance and includes four energy stakeholders: two hotel association representatives, one individual working in public administration, and one employee of an energy supply company.

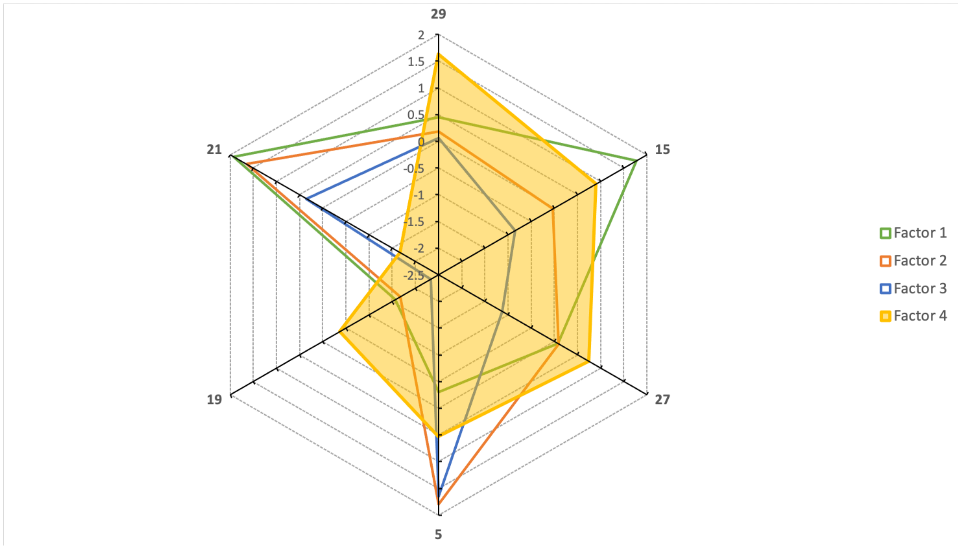


**Figure 8:** Average loadings for the distinguishing statements of Factor 4

**Table 7**. Distinguishing statements for Factor 4.

| No. | Statement | Q-value | Z-score |
|---|---|---|---|
| 29 | It is a priority to reduce the thermal losses of the entire installation through adequate insulation and maintenance. | 4 | 1.63 |
| 15 | Short-term reductions in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipment and using petroleum derivatives with heat pumps. | 2 | 0.9 |
| 27 | The installation of showers with flow reducers, thermostats and timed flow taps is a priority for the reduction of sanitary hot water use. | 1 | 0.74 |
| 5 | High-tech R&D projects developing new applications or energy flow management systems applicable to the hotel industry should be prioritized. | 1 | 0.53 |
| 19 | Residual biomass boilers (pellets, olive bone, etc.) are a reasonable medium-term solution to reduce energy consumption in hotels. | -1 | -0.37 |
| 21 | The installation of photovoltaic power panels is the best medium-term solution for reducing energy consumption in hotels. | -4 | -1.67 |

*4.3 Consensus statements among all factors*

Consensus statements in Q indicate topics on which experts had similar ratings and demonstrated agreement. It is evident that the post–COVID-19 reality is an unclear area for respondents across factors. The ratings on statements 12 and 13 varied between -1 and +1, which translates into neutrality, lack of knowledge, and doubt (see Table 8). There was uncertainty with regard to whether public spending would be used to decarbonize the hotel industry. Participants also expressed doubts that post–COVID-19 tourists would be more aware of their environmental impact during their stays. The general conclusion drawn from both consensus statements indicates skepticism and uncertainty regarding the post–COVID-19 reality. Section 5 provides a deeper analysis of the consensus among the factor groups in order to offer a better understanding of the various mindsets and the views that they have in common.

**Table 8**. Consensus statements

| | | Z-score | | | |
|---|---|---|---|---|---|
| **No.** | **Statement** | **Factor 1** | **Factor 2** | **Factor 3** | **Factor 4** |
| 12 | In the post-COVID reality, projects to decarbonize the hotel sector will be delayed because public spending and investment in other sectors is a priority. | 0.116 | -0.27 | 0.43 | 0.277 |
| 13 | The new post-COVID tourist will be more aware of the environmental impacts of his energy behavior in the hotel establishment. | -0.7 | -0.38 | 0.05 | -0.133 |

*4.4 Interpretation of results*

The 25 experts who we retained for analysis are presented in Table 9 by sector group, sector subgroup, and the specific factor in which they are considered. Nine belonged to the energy sector, seven to the hotel sector, and nine to other sectors. In the latter group, five belonged to public administrations, two were representatives of citizens' platforms for a new energy model, and two were university academics.

**Table 9**. Associations of respondents to specific factors.

| **Respondent Group** | **"Low-carbon"** | **"Techies"** | **"Skeptical"** | **"Trusting"** | **Total** |
|---|---|---|---|---|---|
| **Energy sector** | | | | | |
| Energy supply companies | 3 | | 1 | 1 | 5 |
| Technical enterprises and sector consultancy firms | | 1 | 1 | | 2 |
| Energy associations | 2 | | | | 2 |
| **Hotel industry** | | | | | |
| Hotel maintenance technicians | 1 | 1 | | | 2 |
| Hotel managers | | 1 | 2 | | 3 |
| Hotel associations | | | | 2 | 2 |
| **Other groups of interest** | | | | | |
| Public administrations and political offices | 2 | 2 | | 1 | 5 |
| NGOs | | 2 | | | 2 |
| University academics | | 2 | | | 2 |
| **Total** | 8 | 9 | 4 | 4 | |

Table 9 can be read either vertically or horizontally. The vertical reading gives the composition of each factor depending on the sector group to which the respondents belong. Of the low-carbon mindset, 62.5% were representatives of the energy sector, of whom the majority (three out of five) belonged to energy companies and the rest worked in energy associations. This reflects their commitment to rapid decarbonization of the sector and avoidance of the intermediate term. Next, 66% of techies were representatives of other stakeholders. It is noteworthy that all NGOs and university academics were grouped into this factor. Finally, 50% of the skeptical and trusting groups were representatives of the hotel industry.

The horizontal reading of Table 9 allows us to highlight some additional nuances. No one in the energy supply subsector belonged to the techie group. Representatives of technical enterprises and energy consultancy firms belonged to either the techie or the skeptical group. Members of the energy associations were represented only in the low-carbon mindset group. As for the hotel sector, hotel associations fell into the trusting group. Maintenance technicians differed somewhat from hotel managers: the former were divided between the low-carbon group and techies, whereas of the latter, two were skeptics and one was a techie. With regard to other interest groups, it should be noted that no public administration representative was in the skeptics group; 80% of public administration representatives were in the low-carbon and techie groups. Finally, academics and NGO representatives all belonged to the techies group.

These results indicate that each sector group was most concerned with matters related to its members' occupations. For instance, the energy sector is interested in reducing consumption and emissions, whereas the hotel industry focuses on its business and its relations with public administration. Likewise, the other stakeholders, who are less involved in the day-to-day operations of hotels, were concerned with the role of new technologies.

## 5. Proposals for an integrative energy strategy

After identifying and classifying the respondents' various visions, we identified some specific opinions that would allow us to design a possible integrative strategy. In order to accomplish this, we identified issues where a general opinion may be shared by the majority. In addition, we highlighted particular points of disagreement that in some cases define a specific mindset. We also took into account the answers gathered from the post-survey, where participants were invited to share their reasoning for their rankings. This analysis was performed in the order of the three blocks that constitute the issues that were evaluated.

*5.1 General measures, taxation and awareness.*

Table 10 presents the composite Q-rankings of each factor for Block 1: General measures, taxation and awareness aspects.

**Table 10.** Composite sort. General measures, taxation and awareness

| No. | Statements | Low-carbon | Techies | Skeptics | Trusting |
|---|---|---|---|---|---|
| 1 | In order to improve energy consumption management, the installation of self-consumption energy systems using renewable energies, together with demand management and storage systems is a priority. | 2 | 4 | 2 | 4 |
| 2 | The hotel sector is very proactive in adopting energy efficiency measures. | 1 | 2 | -2 | 3 |
| 3 | Regulatory requirements and bureaucratic difficulties hinder the installation of infrastructures for self-consumption of electricity produced from renewable energies. | 3 | 2 | 4 | 1 |
| 5 | High-tech R&D projects developing new applications or energy flow management systems applicable to the hotel industry should be prioritized. | 0 | 4 | 3 | 1 |
| 6 | Bonuses and subsidies for energy efficiency and renewable energy usage projects are sufficient and reach all stakeholders in the tourism sector. | -2 | -3 | 0 | 0 |
| 7 | "Green" taxes (eco-taxes) should be imposed on tourists in order to raise funds for the decarbonization of the islands. | -4 | 1 | -1 | -3 |
| 8 | "Green" certificates awarded to hotels for using clean electricity and for their efficient use of energy are a decisive factor in customers' choice when booking a hotel. | 0 | -3 | 1 | -2 |
| 10 | Informative energy-saving campaigns that aim to raise awareness among tourists, fail to change their behavior. | -1 | 0 | 0 | -2 |

1. Self-consumption using renewable energies together with demand management and storage systems (1) is a measure on which all factors agree. There was also total agreement in the case of the techie and trusting groups. Based on these observations, this strategic objective can be deemed a priority.
2. All factors except skeptics considered the hotel sector to be proactive in adopting EE measures (2). They held optimistic views of the sector's commitment to EE measures.
3. Regulatory requirements and bureaucratic difficulties with regard to installing self-consumption systems based on renewable energy (3) present a considerable obstacle to implementing renewable energies. All factors agreed to a greater or lesser extent upon the latter, suggesting the need to simplify existing administrative processes.
4. High-tech R&D projects (5) were supported by all groups except for the low-carbon factor. It is important to highlight that the techies expressed particularly strong support on this matter. It thus appears that these types of projects are well received and should be encouraged.

5. Measures like bonuses and subsidies (6) were considered insufficient by the low-carbon and techie groups, whereas the other two groups were neutral. The experts expressed strong opinions on this topic: “They are not sufficient and they are not well focused, since they are based only on the small script of the energy efficiency certificate, which employs very basic and easily manipulated software. What is more, in the Canary Islands there are many examples of not taking advantage of the funds that they make available to us, as is the case of the PREE program, still pending activation in the Canary Islands, we will lose €13 million. Unacceptable!” It therefore seems necessary to rethink the effectiveness of the current public aid system.
6. Green taxes (eco-taxes) (7) do not seem to be a good measure for financing the decarbonization of the islands, as nearly all respondents held negative opinions of such taxes (the exception was the techies, who moderately tolerated them). A representative from the trusting group stated: “Companies and workers in the sector already pay their taxes, and tourists already spend billions on the islands: at destination and in taxes. Therefore, I do not think it is necessary to charge more fees but to provide better services to our visitors.” Such taxes should thus not be considered without further consensus from the stakeholders involved in the sector.
7. Green certificates awarded to hotels (8) and informative energy-saving campaigns (10) were not considered an effective way to change consumer behavior by the trusting group. Interestingly, the skeptics moderately agreed that these campaigns changed consumer behavior.

The measures proposed for this block are resumed in Table 11.

**Table 11.** General measures, taxation, and awareness.

| Statements | Measures proposed |
|---|---|
| 1 | Self-consumption using renewable energies together with storage systems should be the priority strategic objective of the energy transitions of hotels in the Canary Islands. |
| 2 | Energy efficiency measures should also be a priority strategic objective, given the sector’s proactivity in adopting them. |
| 3 | Administrative procedures need to be simplified to accelerate the introduction of renewable energy and self-consumption. |
| 5 | High-tech R&D projects should be publicly promoted and co-financed, as they generate high value-adding activities and quality employment. |
| 6 | Bonuses and subsidies need to be reassessed by performing a case-specific analysis and prioritizing those that generate the most emissions savings. |
| 7 | Green taxes should not be imposed on tourists, as they are not supported by the vast majority of the sector. |

| | |
|---|---|
| 8, 10 | The conditions in which these types of campaigns are more successful should be analyzed from the point of view of both consumers' preferences and the services that the hotel can offer. |

*5.2 Saving measures in air conditioning and sanitary hot water.*

Table 12 presents the composite Q-rankings of each factor for Block 2: Saving measures in air conditioning and sanitary hot water.

**Table 12.** Composite sort. Saving measures in air conditioning and sanitary hot water.

| No. | Statements | Low-carbon | Techies | Skeptics | Trusting |
|---|---|---|---|---|---|
| 14 | In the short term, it is essential to replace the use of diesel with natural gas/LPG in the hotel sector. | -3 | -1 | 4 | 0 |
| 15 | Short-term reduction in air conditioning and sanitary hot water consumption will be achieved by replacing thermal equipments, using petroleum derivatives with heat pumps. | 3 | 0 | -2 | 2 |
| 16 | In the short term, it is a priority to boost the use of propane-air (LPG-air) to reduce energy consumption in hotels. | -2 | -2 | 0 | 1 |
| 17 | Aerothermal heating systems (with several heat pumps) are the best option for replacing diesel boilers in the medium term. | 4 | -2 | 2 | 2 |
| 19 | Residual biomass boilers (pellets, olive bone, etc.) are a reasonable medium-term solution to reduce energy consumption in hotels. | -4 | -4 | -4 | -1 |
| 21 | The installation of photovoltaic power panels is the best medium-term solution to reduce energy consumption in hotels. | 4 | 3 | 1 | -4 |

1. The introduction of natural gas or LPG to replace the use of diesel (14) is a measure supported only by the skeptics group. This view contrasts with the disagreement shown by the low-carbon and techie mindsets, who consider this measure to be too late. A respondent in the low-carbon group stated: "Solutions to replace polluting fuels with less polluting fuels can be ruled out in the face of mature and competitive alternatives such as heat pumps. It is too late for that solution because the investment has little time to monetize and it is better to make investments in more definitive solutions." Furthermore, the low-carbon and techie groups did not consider the use of propane-air an applicable measure (16). From our point of view, such energies could play an important role in the transition process (in the short to medium term), so a serious and transparent debate should take place on the islands to decide the role they will play in the immediate future.
2. The introduction of heat pumps as a substitute for thermal equipment (15) was supported by the low-carbon and trusting groups. This view contrasts the disagreement from the skeptics group. However, its combined use with aerothermal systems (17) may be a more applicable measure, since it was supported by all groups except for the techies.
3. The installation of residual biomass boilers (19) was not a solution for any group. In addition, low-carbon, techies and skeptics, were in total disagreement with their

installation. A participant in the low-carbon group stated: “As for biomass boilers, some of our hotel customers have installed them in the past but the results have not been entirely satisfactory. Biomass has to be brought from the peninsula and that’s already a problem and [has] transportation costs. There have also been problems with affected by falling ashes neighboring hotels.” The need to transport pellets to the islands, storage costs, and generated emissions make this energy solution unsustainable on the islands.

4. The use of photovoltaic solar panels (21) was supported by the low-carbon and techie groups. However, the trusting group was in total disagreement with their installation on the basis that they deemed the solution incompatible with the hotel business, since the installation occupies a considerable amount of space and affects aesthetics.

The measures proposed for this block are resumed in Table 13.

**Table 13.** Energy-saving measures in air conditioning and sanitary hot water.

| Statements | Measures proposed |
|---|---|
| 14, 16 | An information dissemination policy should be established in order to shed light on the feasible energy mix in the transition process. It is also necessary to guarantee what the system of distribution to hotels will be and over what timeframes. |
| 15, 17 | Although heat pumps are an accepted solution, it is necessary to further investigate why some industry representatives and technicians do not agree on their use. |
| 19 | Residual biomass boilers are not a solution for Canary Islands hotels. |
| 21 | Alternatives should be found to ensure that photovoltaic solutions are integrated appropriately into hotel establishments or locations outside hotels (solar farms). |

### *5.3 Energy efficiency measures.*

Table 14 presents the composite Q-rankings for each factor for Block 3: Energy efficiency measures.

**Table 14.** Composite sort. Energy efficiency statements.

| No. | Statements | Low-carbon | Techies | Skeptics | Trusting |
|---|---|---|---|---|---|
| 22 | Efficient climate construction does NOT generate significant energy savings. | -3 | -4 | -2 | -4 |
| 24 | The use of presence or occupancy detectors for lighting savings is widespread in all hotel establishments. | 1 | -1 | -3 | -2 |
| 25 | Outdoor lighting systems (facade, gardens, etc.) must use photovoltaic panels. | -1 | 0 | 0 | -3 |
| 28 | In order to optimize medium-term energy consumption, it is a priority to install energy management systems for the building (BMS-EMS) for better control and obtaining of information for decision-making. | 2 | 3 | 1 | 3 |
| 29 | It is a priority to reduce the thermal losses of the entire installation through adequate insulation and maintenance. | 1 | 0 | 0 | 4 |
| 30 | Hotels must install charging points for electric vehicles. | 2 | 2 | -4 | 1 |

1. Efficient climate construction (22) was deemed to generate significant savings by all groups. In addition, this agreement was the maximum possible for the techie and trusting groups.
2. Occupancy detectors for lighting savings (24) are not widely used. A campaign should be carried out to generally ensure the use of these detection systems in hotels.
3. The use of photovoltaic panels for outdoor lighting systems (25) was not considered an appropriate measure by the trusting group. Once again, the members of this group expressed some reluctance to using photovoltaic plates.
4. All groups considered the installation of energy management systems (28) a good measure for EE. An expert from the skeptics group added: "Information is basic to be able to make decisions. Where possible, measurements of key parameters and artificial intelligence management of facilities will improve the design of the energy efficiency measures to be applied." The implementation and correct usage of this type of tool is essential.
5. Adequate insulation and maintenance to reduce thermal losses (29) was only a priority for the trusting group, although no group was against it.
6. While the low-carbon, techie, and trusting groups showed some degree of agreement that hotels must install charging points for electric vehicles (30), the total disagreement of the skeptics group should also be highlighted. We believe that this measure is important for the electrification process proposed in the PNIEC; accordingly, these infrastructures must be promoted.

The measures proposed for this block are resumed in Table 15.

**Table 15.** Energy efficiency measures.

| Statements | Measures proposed |
|---|---|
| 22 | Keep the regulatory requirements for new constructions up to date in terms of energy efficiency requirements, taking into account the climatology of the islands. |
| 24 | Campaign to make the use of presence/occupancy detection systems more widespread. |
| 25 | Find solutions for outdoor lighting systems using photovoltaic panels that can be integrated appropriately into the facility environment. |
| 28 | Conduct training courses for hotel staff to familiarize them with the use of new technologies such as BMS and EMS tools. |
| 29 | Conduct staff training on maintenance oriented toward energy efficiency. |
| 30 | Funding lines should be established to accelerate the implementation of charging infrastructures for electric vehicles in hotel establishments. |

## 6. Conclusions

This paper studies the preferences of the stakeholders involved in EE and the use of renewable energies in the hotel industry in the Canary Islands. The objective is to identify the main aspects to consider in the design of an integrative strategy to achieve the decarbonization of the island sector. The possible effect of the COVID-19 crisis, which has significantly affected the tourism sector, is also analyzed. We apply the Q methodology by surveying experts from all areas related to energy consumption in the hotel sector (stakeholders).

The analysis of the results allowed us to identify four stakeholders' strategic mindsets, which can be used to propose an integrative and sustainable strategy for energy use in hotels in the Canary Islands. After a deeper analysis we have identified the following mindsets: “low-carbon,” “techies,” “skeptical,” and “trusting":

- The low-carbon group strongly supports applying the existing energy saving solutions in the short term and strongly dislikes all alternatives associated with $CO_2$ emissions.
- Techies demand management systems that use software technologies.
- Skepticals expressed clear mistrust toward public institutions and their financial helpfulness and supportiveness.
- The trusting group is characterized by their trust in the hotel industry and tourists.

After conducting an in-depth analysis of the responses of the experts from each mindset, we point out the main measures to take into account when designing an integrative strategy.

We reached the conclusion that a priority objective of the integrative strategy for energy transition of hotels in the Canary Islands includes self-consumption using renewable energies together with storage systems. Given the sector's proactivity in adopting energy efficiency measures, they should also be given priority as a strategic objective. Another important point towards an integrative strategy is the simplification of the administrative procedures in order to accelerate the introduction of renewable energy and self-consumption. Our analysis concludes that the strategy needs to promote the use of heat pumps for air conditioning and SHW and that biomass boilers is not a solution for the Canary Islands. Experts' opinions confirmed that it is important to keep the regulatory requirements for new hotel constructions up to date in terms of energy efficiency requirements, taking into account the climatology of the islands. Moreover, our study showed that the energy efficiency strategy should find a way to properly integrate photovoltaic panels into the hotel facility environment, thus measures to reduce the resistance from the trusting group are needed.

Another interesting result drawn from the consensus statements, is respondents' skepticism and uncertainty regarding the post–COVID-19 reality. Participants also expressed doubts that post–COVID-19 tourists would be more aware of their environmental impact during their stays. The post–COVID-19 reality is an unclear area for respondents across mindsets.

To our knowledge, this is the first time that Q methodology has been used to identify perspectives in the hotel industry. Our work thus makes a novel contribution to the existing literature in the field of energy transition in hotels. Moreover, the strategy of hotels' energy consumption is a basic pillar in the energy governance of the Canary Islands. The results of this work could be used by energy policy makers in the Canary Islands to propose an integrative and sustainable strategy for energy use in hotels in the Canary Islands.

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