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NS global economics ECONOMICS
Volume 10, No. 2, 2022

www.economicsrs.com

FACTORS OF INVESTMENT IN RENEWABLE ENERGY AND ENERGY EFFICIENCY IN ALGERIA

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Received 29. 07. 2022. | Sent to review 08. 08. 2022. | Accepted 27. 10. 2022.

Review Article

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JEL Classification:
O1, O14, Q2

Doi: 10.2478/eoik-2022-0020

UDK: 620.8:502.171(65)

ABSTRACT

Our paper aims to identify the most important factors determining companies' decision to invest in the energy transition in Algeria. Energy transition has been many governments' main topic of interest over the last decades, climate change has led many of them to establish long-term plans for a successful energy transition; these plans aim to reduce greenhouse gas emissions following the guidelines of the COP21. Through a quantitative approach, we have addressed a questionnaire to different companies operating in Algeria and have obtained a total of 117 responses. The results show that financial, technical and regulatory factors have minimal impact on companies' decision to invest in renewable energy and energy efficiency in Algeria. Further studies should explore other investment factors to help accurately determine those that significantly impact companies' decisions to invest in Algeria's renewable energy and energy efficiency. Furthermore, targetting one sector at a time and exploring the alternatives of foreign direct investment in renewable energy can result in higher efficiency.

Keywords: *Investment, renewable energy, energy efficiency, energy transition, Algeria.*

1. INTRODUCTION

By the beginning of the 21st century, the world had started to run out of usable energy from fossil fuels (oil, gas, coal, natural gas, and nuclear power) (Strielkowski, Civín, Tarkhanova, Tvaronavičienė, &Petrenko, 2021). Climate concerns were first expressed at the first world climate conference in 1979 (Mert, Bölük, &Çağlar, 2019).
Climate change refers to the progressive alteration of the Earth's climate and physical geography that is associated with the increase in the planet's global temperature. The human contribution to this can be measured by the carbon footprint (Azarkamand, Ferré, &Darbra, 2021). The energy transition is defined as the shift from the production and use of conventional sources of energy to renewable and sustainable energy sources (Thomas, DeCillia, Santos, &Thorlakson, 2022).
It is widely recognized that an " energy efficiency gap" has been identified between current energy use and optimal energy use (Jaffe, Newell, &Stavins, 2004). Increased energy efficiency and behavioral changes in consumer demand could significantly contribute to achieving climate goals (Löffler et al., 2022).
Even though the cost of renewable energy has dropped significantly over the past twenty years and

certain renewable energy projects are now cost-effective, nonetheless, it remains more expensive than other forms of energy (Wiser& Pickle, 1998). Wind and solar energy are not yet developed enough to be a complete and flexible backup (Strielkowski et al., 2021). Renewable energy also hinges on a social strategy that creates shared value from cost leadership strategy, differentiation strategy, and strategic interaction (Kherchi, Mohamed & Ahlem, 2019).

The interest in corporate climate strategy is linked to the apparent shift in the attitude of the company's stakeholders towards international action on climate change (Okereke, 2007). The investment decision of companies is the result of a process influenced by the perceptions and power of different actors, by the context, and also by the characteristics of the investment project, particularly whether it is more or less strategic (Cooremans, 2010).

Wiser and Pickle (1998) studied the factors that lead some companies to invest in renewable energy. Cooremans (2010) is concerned with companies' investment in energy efficiency. According to these studies, the main objective of our study is to determine the type of factors among financial, technological, and legal factors that are influencing the investment decision of companies in renewable energy and energy efficiency in the Algerian context.

To understand and address the reasons underlying the different behaviors of companies towards renewable energy and energy efficiency investments, based on several studies (Abban& Hasan, 2021; Cooremans, 2010; Kozlova& Collan, 2020; Li, Liu, Zhang, & Xu, 2021; Okereke, 2007; Wiser& Pickle, 1998; Zhou, Luo, Cheng, Yüksel, &Dinçer, 2021), we state our research question as follows: What are the main factors that determine renewable energy and energy efficiency investments in Algeria?

The present paper is based on a quantitative approach (Cooremans, 2010; Wiser & Pickle, 1998) that aims to analyze the factors influencing the decision of companies to invest in renewable energy and energy efficiency in Algeria, and this, through a survey by questionnaire.

2. BACKGROUND

In their paper, Benetatos et al (2019) highlights the issue of energy demand which, according to their study, will experience a continuous increase in the future, mainly due to the population's continuous growth, which is estimated to reach 9.7 trillion by 2050. Final energy demand is expected to increase by about 1.8% per year, driven by the need for energy to support higher living standards, and accompanied by massive energy efficiency gains. There are studies such as (Dupont et al., 2021) present scenarios that are based on the possibility of an absolute decoupling between the production of goods and services and energy consumption.

2.1. ENERGY TRANSITION IN ALGERIA

Algeria ranks among the top five natural gas-producing countries in the world, and among the top ten countries in the world for oil production. It plays a key role in global energy markets as a major producer and exporter of these products (Zaid et al., 2017). The Algerian economy is very heavily dependent on fossil fuels (Díaz-Cuevas et al., 2021) and in particular natural gas (Zaid et al., 2017), approximately 93% of its exports from Algeria are primarily oil and natural gas exports (Bouraiou et al., 2020; Mohamed & Hanane, 2021).

Due to the increase in the emissions of CO2 and energy consumption, environmental economists and policy analysts have focused their attention on the use of renewable energy rather than traditional energy consumption (Youcef & Bouabdellah, 2022). The transition to an energy system focused on the electricity sector is increasingly crucial to extend the longevity of fossil fuels, but also to meet current greenhouse gas emission commitments (Makhloufi, Khennas, Bouchaib, & Arab, 2022).

Algeria may be divided into two distinct major climatic areas. The northernmost consists principally of the Atlas Mountains and is subject to the influence of the Mediterranean Sea. While the southern region is largely desert (Bouraiou et al., 2020; Makhloufi et al., 2022). With different potentials in terms of renewable energy resources, these two regions' budding differs especially for wind and solar resources, which are considered the most promising energy alternatives (Makhloufi et al., 2022).

Algeria ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1993 and the Kyoto Protocol in 2005. Moreover, in 2010, it insisted through the Schéma National d'Aménagement du Territoire (SNAT) on integrating the sustainability dimension as a priority concern in urban and national planning (Chettah & Nait Amar, 2021).

2.2. POTENTIAL OF RENEWABLE ENERGY IN ALGERIA

Algeria is characterized by abundant renewable energy resources such as solar, wind, hydraulic, biomass, and geothermal energy (Bouraiou et al., 2020). However, Makhloufi et al, (2022) highlighted the issue of solar photovoltaic and wind energy which are both intermittent energy sources and are therefore not available all day, especially at night for solar. It is therefore particularly important to maintain the stability of the power system and adequate reserve margins. Fossil fuel plants will then still be needed by 2050 to overcome these constraints.

The selection of appropriate sites for the deployment of wind or solar energy requires taking into account other specific criteria besides the estimation of the resource potential, avoiding as much as possible negative impacts on the environment and the population (Díaz-Cuevas et al., 2021).

Díaz-Cuevas, Haddad, & Fernandez-Nunez (2021) have considered five feasibility criteria for wind and photovoltaic installations: distance to the electrical grid, proximity to population centers and the road network, inclination, and availability of wind and solar resources.

Table 1. Algeria's capacity for renewable energy.

CAP (MW)	Total renewable energies	Hydropower	Wind power	Solar energy
2012	253	228	-	25
2013	253	228	-	25
2014	264	228	10	26
2015	312	228	10	74
2016	482	228	10	244
2017	663	228	10	425
2018	686	228	10	448
2019	686	228	10	448
2020	686	228	10	448
2021	686	228	10	448

MW stands for Megawatt.

Source: Compiled by the authors, data extracted from IRENA (2022).

The global volume of rainfall per year in Algeria is significant and estimated at 65 billion m3. Nevertheless, due to the lack of exploitation of all existing sites, they are not very exploitable by the country for the production of hydroelectric energy (Bouraiou et al., 2020). However, from table 1, we can see that solar energy is the most deployed and present form of renewable energy in Algeria due to its relatively large capacity. Hydroelectricity comes in the second position followed by wind energy.

Algeria has a strong solar energy potential, especially in the Saharan region (Bouraiou et al., 2020), with an average annual solar exposure estimated at 2,000 hours, and an average of 6.57 kWh/m2/

day, Algeria's photovoltaic production capacity is estimated at 13.9 TWh/year in 2017 (Zaid et al., 2017). The country's solar energy capacity increased significantly from 2012 to 2018 only to stagnate thereafter.
78% of Algeria's area is characterized by winds exceeding 3m/s with about 40% of these winds exceeding 5 m/s. The southern region is characterized by higher speeds than the northern region, which makes it favorable for the use of wind energy such as wind farms or hybrid systems (Bouraiou et al., 2020). However, from the above table, it can be seen that the country's wind energy capacity is low, as it is poorly deployed in the country.
A renewable energy and energy efficiency development program was adopted by the Algerian government in 2011 and revised in 2015 (Bouraiou et al., 2020). Renewable energy in Algeria, particularly solar and wind power, has already achieved commercial acceptability, economic viability, and compatibility with existing energy production modes, making it an alternative to traditional energy (Zaid et al., 2017).
Algeria has a large geothermal capacity, estimated in terms of electricity generation, at 700MW. More than 200 heat sources have been identified in the north of the country, of which nearly 1/3 (33%) have a temperature above 45° C (Zaid et al., 2017).

3. LITERATURE REVIEW

The global renewable energy market is growing at an exponential pace due to favorable government policies and technological advancements; solar photovoltaic and wind power are the most promising sectors due to market size, decreasing costs, and profitability potential (Peng et al., 2019).
Further development prospects indicate that oil, gas, and coal will gradually withdraw from the power generation market. Hydro and nuclear power plants will continue to be developed, and a larger share of the market will be taken by generation from non-conventional sources: so-called green technologies, and renewable energy sources (Kosarev, Rebrov, Naumenko, &Barch, 2020).
Most of the investments in renewable energy stem from European countries. Indeed, the European Union is one of the main supporters of the Paris Agreement on climate change and is committed to reduce its greenhouse gas emissions and increase the use of renewable energy by 20% in 2020 (Abban & Hasan, 2021).
The term "driver" is used to refer to the factors that have the potential to "force" companies to take action on climate change, even if they would not normally do so. The main source of these external pressures is usually government regulation and public and non-governmental pressure, as well as investor pressure (Okereke, 2007).
Kozlova & Collan (2020) estimated the attractiveness of investments in different regions of Russia based on four investment factors: profitability; accessibility of the region; power grid conditions and finally demand. These factors are assumed to have equal weight. The results allow for a comparative analysis of different regions in terms of the attractiveness of renewable energy investments. In terms of profitability, a region with the highest renewable energy potential is not necessarily the best place for renewable energy investment.
Companies tend to understand that the climate change concern at the national and global levels will eventually lead to fundamental changes in the way they conduct business. By being proactive and pioneering in implementing certain climate-related actions, they would gain credibility and influence, allowing them to play an active role in determining the exact direction of change (Okereke, 2007). The companies of the primary sector in the context of their activities are more aware of the importance of the energy transition, and they are more likely to be the first ones to do some actions in this context (Cooremans, 2010).
Table 2 summarizes the determinants or factors of investment decisions in renewable energy. These factors have been classified into dimensions, which are: a technical dimension; those related to the market, and finally the financial dimension.

Table 2. Dimensions and criteria for energy investment decisions.

Dimensions	Criteria
Technical dimension	Technological infrastructure Availability of the materials Organizational performance
Market-related dimension	The fair competition Suppliers' equipment Customer expectations
Financial dimension	Profitability Sales growth Return on investment (ROI)

Source: Zhou et al., (2021)

The results of the study conducted by Zhou et al, (2021) show that organizational efficiency and profitability are defined as the most important criteria for investment in renewable energy. However, other studies (Löffler et al., 2022) found that the reglementary and market-related factors are those which impact most companies' decision to invest in renewables and energy efficiency which was the case in Germany.

Large-scale investments in renewable energy and storage systems are a compelling option for achieving climate goals and are proving to be minimum requirements for other technologies (Löffler et al., 2022). Investments in renewable energy, including solar and wind power equipment, which provide carbon-free electricity, are growing significantly (Li, Liu, Zhang, & Xu, 2021).

3.1. TECHNICAL DIMENSION DETERMINANTS

Okereke (2007) discusses the basic technological transformations in the energy transition, which can be subdivided into three categories based on their cost. The low ones, he cites the example of energy-saving light bulbs; motion sensors; compact fluorescent tubes; video-conferencing technology via telephone; and the installation of hand dryers. Medium transformations such as the refurbishment of company premises; change of operating system; change of windows; reorganization (of work/offices). As well as high-level conversions such as replacement of cooling towers, generators, boilers; insulation; installation of waste heat recovery equipment; heat traps; change of chimneys; vehicle exhaust pipes. There is a requirement for companies to exploit information and communication technologies as part of strategic planning processes to ensure transformational development (Mašić, Nešić & Vladušić, 2018).

3.2. MARKET-RELATED DETERMINANTS

Competitiveness and affordability are important drivers of market growth (Rechsteiner, 2021). It can be argued that treating corporate climate responses as part of corporate social responsibility could result in fewer losses than if carbon control programs were integrated into their business strategy (Okereke, 2007).

Abban & Hasan's (2021) study reveals that a government's policy orientation directly influences investment in renewable energy. Developed countries do not see renewable energy as an alternative to the conventional method of power generation. If these countries are committed to the growth of renewable energy, it is because they believe that these investments are essential for the environment. Indeed, government support policies encourage such investments; however, the nature and effectiveness of these support policies depend on the type of renewable energy technology.

It can be inferred that viewing corporate climate protection actions in terms of responsibility and ethical obligations rather than in terms of strategy is a better way to link corporate commitment to reducing greenhouse gas emissions to people's rights to a quality environment (Okereke, 2007). In addition, there is a need to develop effective economic and social policies, such as tax incentives, research and development, labor force training, etc., in order to improve and increase productivity, especially in the real market (Dada, Olomola & Ajide, 2020).

3.3. FINANCIAL DETERMINANTS

The costs of renewable energy technologies strongly influence the future costs of electricity generation (Löffler et al., 2022). Wind and solar energy, considered too expensive in the past, turned out to be cheaper than the use of oil, coal, gas, or nuclear energy for electricity production, even without taking external costs into account (Rechsteiner, 2021).
The initial investment cost of renewable energy is much higher than that of conventional energy and represents a very large part of its lifetime cost. On the other hand, their operating cost is lower than that of conventional energy and they generate fewer carbon emissions than the latter (Li et al., 2021).
The energy transition has become an unavoidable step, especially in emerging countries. Since 2019, investment in renewable energy has declined significantly due to the Covid-19 pandemic, geopolitical conflicts, and the global economic recession. Indeed, with insufficient investment in renewables and energy efficiency projects, it is difficult to achieve Sustainable Development Goals (Wang, C. et al., 2022).
In today's era, the main focus of emerging economies is environmental protection, where scientists, researchers, and policymakers insist on exploiting clean energy resources, such as renewable energy. However, it is noticed that in reality, the attention given to renewable energy investments and consumption remains timid at the global level (Wang, C. et al., 2022).
To answer our research question and based on the results of (Abban & Hasan, 2021; Bauwens, 2019; Cooremans, 2010; Li, Liu, Zhang, & Xu, 2021; Okereke, 2007; Wiser& Pickle, 1998), we highlight the following hypotheses:

- H1: Companies in the primary sector are more invested in energy efficiency and are more likely to invest in renewable energy.
- H2: Regulation is the main factor influencing the decision of companies to invest in renewable energy in Algeria.

4. METHODS

4.1. DATA

To determine our population, we have identified 190 companies through the database of the Algerian Chamber of Commerce and Industry and the address books of SAFEX. Among them, only 145 companies have a valid e-mail address and were therefore included in our sample.
The platform LinkedIn was also used as a database. Through this platform, we were able to collect the contact information of 190 professional people from different sectors of activity who were then contacted.
The selection of the respondents' profiles is based on their roles within their companies as well as their level of knowledge about the information on which we want evidence (Cooremans, 2010).
In order to have a representative sample, the number of respondents to our questionnaire must be relatively large. We obtained 117 usable responses. This gives us a response rate of 34.92%. Our confidence interval is 95% with a margin of error of about 9%. These percentages were calculated using the website: https://fr.checkmarket.com/calculateur-taille-echantillon/, a site recommended by many statisticians.

Our questionnaire addresses the three types of determinants previously outlined in our literature review, namely financial, technological and legal factors. In order to analyze them, we will consider different variables that explain them, such as financial constraints, the degree of mastering the technology related to renewable energies, the competitive advantage that this type of investment could bring, and the existing legislation. These variables are mentioned in Appendix 1.

4.2. METHODS

To test our hypotheses and to answer our research question, we are conducting a quantitative study that aims to validate or not our hypotheses through a bi-dimensional analysis and a multidimensional analysis through a discriminant factor analysis. According to the study of Cooremans (2010) These methods are considered sufficient to examine our hypotheses.

The survey questionnaire was constructed using Google Forms, and was distributed online; by email as well as on the professional platform LinkedIn on April 2022. The questionnaire consisted mainly of closed-ended questions, both dichotomous and multiple choice, and Likert scale questions.

The questions, scales, and different elements composing the questionnaire are founded based on an exhaustive review of the literature and the opinion of experts in the field. The questions are grouped into categories according to the topic to which they refer, in different sections, thus obtaining a total of eight (8) items. The average response time for this questionnaire is 10 to 15 minutes, according to feedback from some of the study participants.

Referring to the study by Cooremans (2010) the data collected are processed statistically with the Excel tool and the SPSS program (Statistical Package for the Social Sciences: version 25).

5. RESULTS

5.1. RESPONDENTS' CHARACTERISTICS

5.1.1. RESPONDENTS' PROFILES

The last section of our questionnaire contains questions related to the respondents' profiles. This part of the questionnaire aims to provide a brief description of the profiles of the people participating in the survey.

Table 3 summarizes the overall respondents' profile, i.e., their gender and age category. This may affect the quality of the responses to the questionnaire and their perceptions on the subject of energy transition and business investment in renewable energy and energy efficiency. Of the 117 participants in our survey, 103 men filled out the questionnaire, which represents about 85%. Nearly two-thirds of the respondents are between 30 and 50 years old.

Table 3. Respondents' profiles.

		Gender		
		Women	Men	Total
Age range	Under 30 y. o.	4	23	27
	Between 30 and 40 y. o.	4	48	52
	Between 40 and 50 y. o.	6	17	23
	Over 50 y. o.	0	15	15
	Total	14	103	117

Source: Author's calculation.

Table 4 presents the characteristics of all respondents to our survey questionnaire. The majority of them hold technical and supervisory positions, with more than 50% being engineers, managers, and heads of departments. It is important to note that the respondents hold positions of responsibility and have knowledge and experience related to finance and energy.

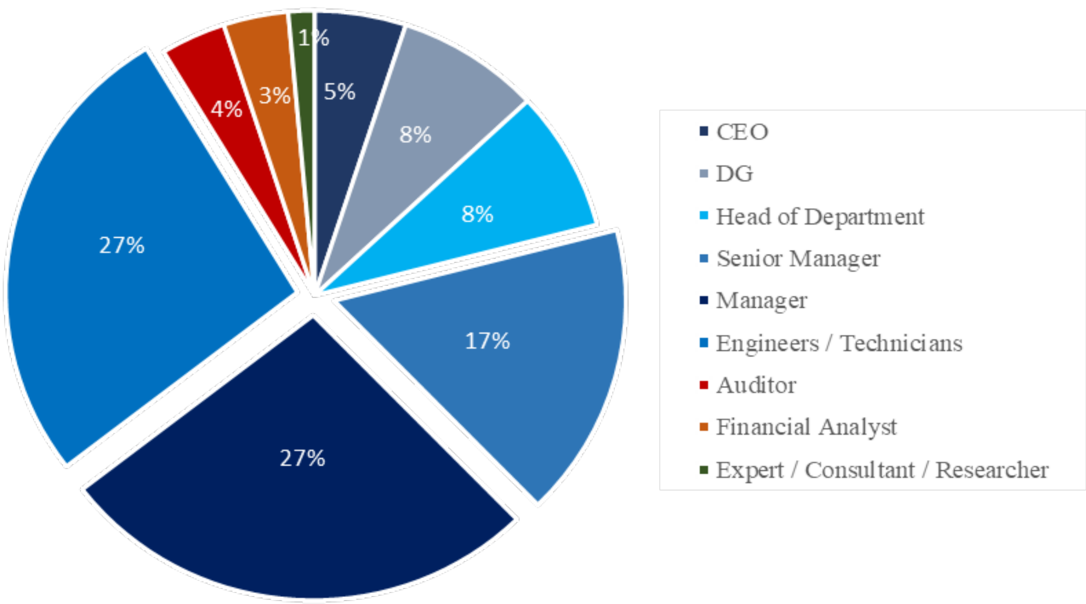
Table 4. Characteristics of the respondents.

		Headcount	Percentage
Company's status	Executives	45	38.46
	Technicians, supervisors	61	52.14
	Employees, staff members	11	9.40
	Total	117	100
Experience within the company	Less than a year	13	11.11
	1 to 5 years	36	30.77
	5 to 10 years	28	23.93
	Over 10 years	40	34.19
	Total	117	100

Source: Author's calculation.

From Table 4 we can see that the majority of the respondents are experienced and have been in their current positions for more than 10 years; about 24% of our respondents have 5 to 10 years of seniority and experience in their current positions; while almost 41% are moderately experienced and have been in their positions for less than 5 years. According to figure 1, more than 50% of the respondents are managers and engineers in their companies, followed by senior executives.

Figure 1. Occupational status of the respondents.



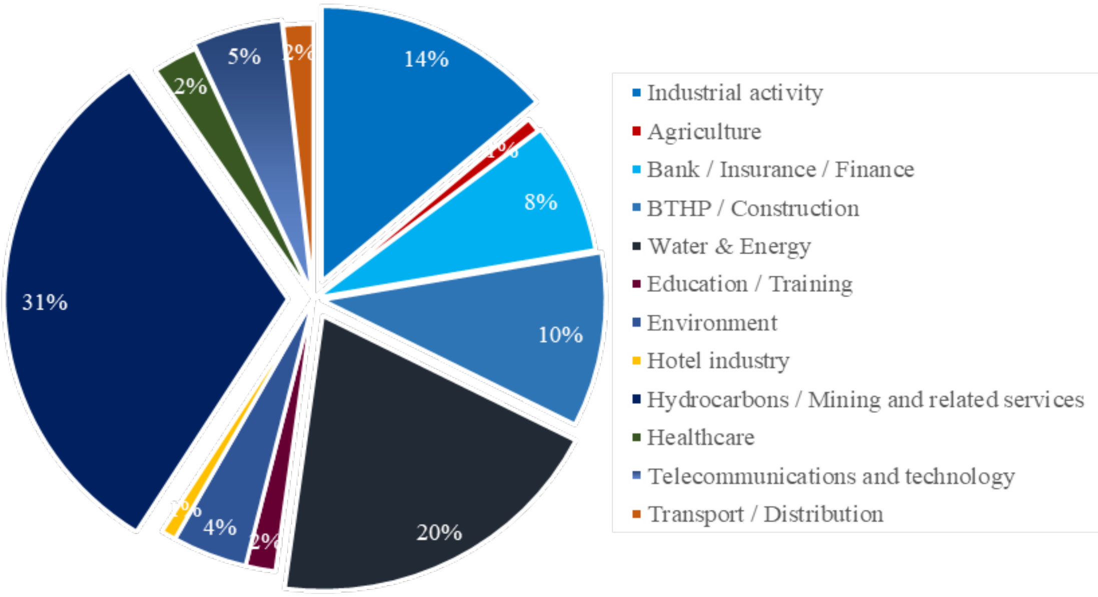
Source: Author's calculation.

5.1.2. COMPANIES' PROFILES

The first part of our questionnaire is composed of questions related to the companies, from these questions we can identify the general characteristics of the companies in our sample, namely: the age of the company, its workforce, its sector of activity, its legal nature, as well as the characteristics

of the sectors of activity of the companies in our sample.
Our questionnaire was administered to a population composed of companies from all sectors operating in Algeria. The figure below presents the different sectors of activity of the companies that constitute our sample.

Figure 2. Companies' sectors of activity.



Source: Author's calculation.

To simplify our study, we will group these various activities of the companies responding to our questionnaire into three major sectors. The primary sector consists of all the activities whose purpose is to explore natural resources, such as agriculture and mining. The secondary sector for its part, groups all the activities consisting of a more elaborate transformation of raw materials such as construction. While the tertiary sector is defined as the sector that groups together the complementary activities of the primary and secondary sectors.
Table 5 provides an overview of the age of the company, its size in terms of number of employees, as well as the sector of activity of the company. More than half of our sample consists of firms in the primary sector. The previous figure shows that the hydrocarbons, mining and related services sector represents 31% of our sample, followed by the water and energy sector with 20%.
The majority of the companies in our sample are quite old, 74 companies have been in business for more than 20 years, which is about 63%. There are only 19 companies that have been in business for less than 5 years. The table below shows that the majority of the companies in our sample are relatively large and have more than 200 employees.

Table 5. Characteristics of the companies.

		Company's sector of activity			
		Primary sector	Secondary sector	Service sector	Total
Company's period of activity	Less than 5 years	13	4	2	19
	Between 5 and 10 years	2	3	2	7
	Between 10 and 15 years	10	4	3	17
	Over 20 years	41	17	16	74
	Total	66	28	23	117
Company's workforce	Less than 10 employees	6	3	1	10
	10 to 50 employees	3	2	2	7
	50 to 100 employees	6	5	3	14
	100 to 200 employees	10	1	4	15
	Over 200 employees	41	17	13	71
	Total	66	28	23	117

Source: Author's calculation.

According to figures 3 and 4, the majority of the firms in our sample are privately owned with 41% followed by public firms with about 40%, we count a total of 48 private companies and 47 public. Only 39.3% of the companies in our sample are multinationals or their subsidiaries, amounting to a total of 46 companies.

Figure 3. Legal status of the company.

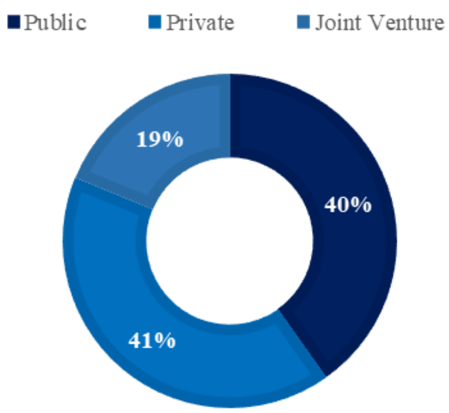
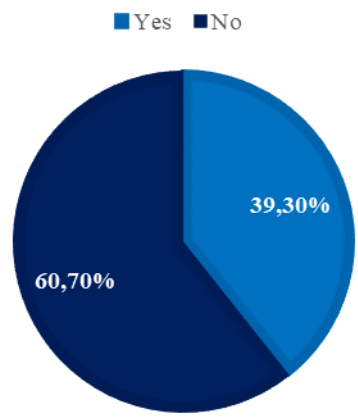


Figure 4. Foreign ownership of the company.



Source: Author's calculation.

5.1.3. CHARACTERISTICS OF THE SECTOR OF ACTIVITY OF THE COMPANIES

Tables 6 and 7 summarize the degree of competition of the companies of our sample as well as the level of stability according to their sectors of activity following a Likert scale of 1 to 5. The majority of the companies in the sample operate in a highly competitive environment, and the primary sector remains the most competitive of the three.

As for the level of stability of the sectors of activity, the companies are operating in a rather stable environment, with an average of 3.70 on a scale of 1 to 5. More than 60 firms report operating in a moderately stable to a stable environment, with firms operating in the primary sector has the highest stability.

Table 6. The level of competition according to the sector of activity.

	Company's sector of activity					
	Primary sector	Secondary sector	Service sector	Total	Mean	Standard deviation
Low	9	3	2	14	3,60	1,390
Light	10	1	2	13		
Neutral	10	7	5	22		
Strong	15	6	4	25		
High	22	11	10	43		
Total	66	28	23	117		

Source: Author's calculation.

Table 7. The level of stability according to the sector of activity.

	Company's sector of activity					
	Primary sector	Secondary sector	Service sector	Total	Mean	Standard deviation
Unstable	1	3	2	6	3,70	1,169
Low stability	6	4	1	11		
Neutral	17	9	7	33		
Moderately stable	14	8	7	29		
Stable	28	4	6	38		
Total	66	28	23	117		

Source: Author's calculation.

5.2. RESULTS OF THE BI-DIMENSIONAL ANALYSIS

To test our first hypothesis, we conduct a bidimensional analysis between the sectors of activity of the companies in our sample and their renewable energy uses. Companies' use of renewable energy reflects their interest in investing in energy efficiency (Cooremans, 2010).

5.2.1. CHI-SQUARE TEST

We first proceed to a Chi-square test; its results are presented in Table 8. The asymptotic significance of the test is less than 0.05, which makes our result highly significant. The null hypothesis is then rejected.

Table 8. Chi-square test.

	Value	ddl	Asymptotic significance (bilateral)
Pearson's chi-square	20,365[a]	2	,000
Likelihood ratio	20,978	2	,000
Linear association	18,038	1	,000
No. of valid observations	117		

a. 0 cells (0.0%) have a theoretical number less than 5. The minimum theoretical size is 10.81.

Source: Author's calculation.

However, it is interesting to cross-analyze the sectors of activity of the companies in our sample and their use of renewable energy to get a clearer picture of which sector uses renewable energy the most, and therefore which sector invests the most in renewable energy and energy efficiency projects.

5.2.2. CROSS ANALYSIS

From Table 9 and Figure 11 we note that of the three sectors of activity, the primary sector is the one that uses the most renewable energy, and thus represents more than 50% of our sample size.

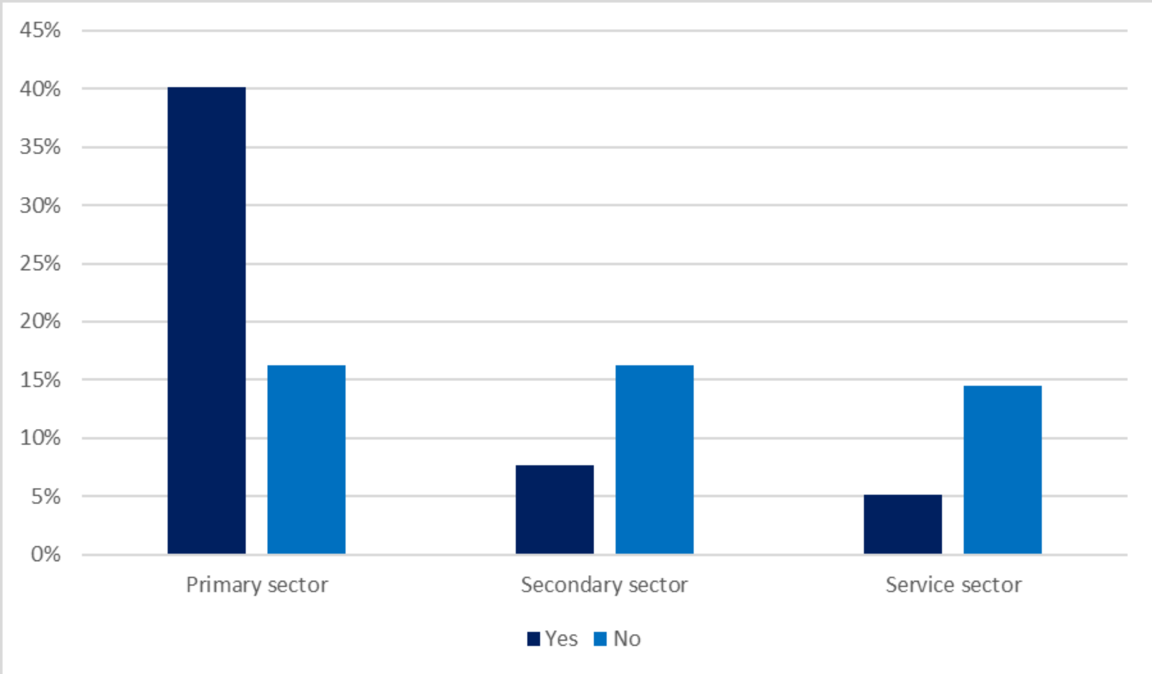
Table 9. Crosstabulation - sectors of activity and renewable energy use.

			Use of renewable energy		Total
			Yes	No	
Company's sector of activity	Primary sector	Headcount	47	19	66
		% of total	40,2%	16,2%	56,4%
	Secondary sector	Headcount	9	19	28
		% of total	7,7%	16,2%	23,9%
	Service sector	Headcount	6	17	23
		% of total	5,1%	14,5%	19,7%
Total		Headcount	62	55	117
		% of total	53,0%	47,0%	100,0%

Source: Author's calculation.

However, Figure 5 shows the percentages of renewable energy use by our sample for each sector of activity, where there is a significant difference between the sectors of activity in their use of renewable energy.

Figure 5. Companies' sectors of activity.



Source: Author's calculation.

To see the different symmetrical measures between our two variables, we performed a Gamma test whose results are shown in Table 10. The value of Gamma is 0.644 which is comprised between 0.5 and 0.8, this indicates that there is a strong relationship between the sectors of activity and the use of renewable energy.

Table 10. Symmetric measurements – Gamma.

		Value	Standard asymptotic error[a]	T approx[b]	Approximate significance
Ordinal by Ordinal	Gamma	,644	,105	4,884	,000
No. of valid observations		117			

a. The null hypothesis is not being considered.

b. Use of the standard asymptotic error when considering the null hypothesis.

Source: Author's calculation.

5.3. RESULTS OF THE MULTIDIMENSIONAL ANALYSIS

To test our second hypothesis on the determinants of investment in renewable energy and energy efficiency in Algeria, we conduct a discriminant analysis through the use of a software tool (SPSS). We opted for this method of analysis because it is the most suitable for studying our data, as it allows us to identify the most discriminating determinant with respect to the determinants that we have drawn from our literature review.

This analysis requires metric explanatory variables and a check of the collinearity of the items in our variables. In case of collinearity we must remove this multi-collinearity between the variables in order to apply this analysis method.

5.3.1. VERIFICATION OF THE MULTI-COLLINEARITY

To perform a discriminant factor analysis, we must first check that there is no collinearity between our variables. A collinearity test was performed for the variables concerned by our hypothesis.
The results of the test for multi-collinearity of the variables are presented in the table in Appendix 1. They show the existence of strong collinearity between the different variables selected.
To perform a discriminant factor analysis of our variables, we must first eliminate the existing collinearity between them. To do this, there are two methods available to us: a factorial analysis of the components, or a grouping by average.
Since we have a grouping of our variables based on our literature review, we then proceed to group these variables by average, thus obtaining three groups of variables: finance; technology; and regulation and market-related variables.

5.3.2. DISCRIMINANT ANALYSIS

Once we have grouped our variables into three large groups, we proceed to discriminant analysis. The purpose of this analysis is to verify the existence of differences between the groups, to check the discriminating power of the axes and to validate or not the hypothesis.

Table 11. Combined intra-group matrices.

		Finance	Technology	Regulation
Correlation	Finance	1,000	,246	,235
	Technology	,246	1,000	,604
	Regulation	,235	,604	1,000

Source: Author's calculation.

Table 11 shows the correlation between the groups of variables defined. It can be seen that the axes reflecting the technology and regulatory variables are highly correlated, while the financial axis is only slightly correlated with the regulatory and technology axes.

Table 12. Results of the Box test.

	Test of Box	8,632
F	Approx.	1,317
	ddl1	6
	ddl2	10356,779
	Sig.	,245

Tests the null hypothesis of covariance matrices with equal populations.

Source: Author's calculation.

The results of the Box test are not significant. From table 12 we can see that the Sig of the Box test is 0.245 higher than 0.05, so it is statistically not significant. The null hypothesis is therefore maintained. This indicates that the intra-class covariance matrix is not equal.

Table 13. Wilks's Lambda.

Test of function(s)	Wilks' Lambda	Chi-square	Ddl	Sig.
1	,941	2,265	3	,519

Source: Author's calculation.

From table 13 we note the value of the Wilkes Lambda test which is close to 1, which indicates that the means of the classes are equal. The sig is equal to 0.519, it is higher than 0.05, which makes it not significant. The null hypothesis is therefore maintained. This indicates that there is no relationship between the dependent variable and the independent variables.

6. DISCUSSION

The main objective of the quantitative study is to test the validity of the hypotheses mentioned in the literature review. To meet our objectives, three different types of analyses were conducted: a unidimensional descriptive analysis; a bi-dimensional analysis; and multidimensional analysis.

Through the descriptive analysis, we were able to identify general information on the profiles of the respondents as well as those of the companies. Our sample is mainly made up of companies from the primary sector, more precisely companies from the hydrocarbons, mining, and related services sector with a proportion of approximately 31%, followed by the water and energy sector which represents 20% of our sample.

The companies of our sample are mostly ancient, nearly 63% of them have more than twenty years of existence in their assets. They are mainly large companies with more than 200 employees. As for their legal nature, our sample is composed of 41% of private companies and 40% of public companies, and mixed companies. From this analysis, we can see that the size of the company is positively correlated with its age.

The main part of respondents to our questionnaire are men aged between 30 and 40 years old with more than 10 years of experience in their field of activity. Our sample is mostly composed of senior executives, engineers and, managers. These profiles are characterized by having positions of responsibility and can influence on the decision-making process for renewable energy and energy efficiency investments within their companies.

The position of the respondents could indeed have an impact on their responses to the survey and their perceptions of the topic. Cooremans (2010) has emphasized this point in his research, it is particularly important to target the population to obtain reliable and relevant results.

To test our first hypothesis, we conduct a bidimensional analysis by performing a chi-square test and a cross-tabulation between the sectors of activity of the companies in our sample and their use of renewable energy (Wiser & Pickle, 1998).

The results of our bivariate analysis indicate that the primary sector is the one that uses the most renewable energy and by equivalence the one that invests the most in renewable energy and energy efficiency. As per the results of Bauwens (2019), the results we obtained affirm our first hypothesis which states that firms in the primary sector are more invested in energy efficiency and are more suitable to invest in renewable energy.

Through a discriminant factorial analysis, and in the framework of the multidimensional analysis, we studied the various variables previously grouped according to the dimensions retained from our literature review. Three groups of variables were studied: financial variables; technical variables related to renewable energy technology; and regulatory and political variables.

The results of our study show that the above-mentioned factors only weakly determine companies' decision to invest in renewable energy and energy efficiency in Algeria. This suggests that other factors have more impact on firms' decision-making for this type of investment. These results are at odds with the findings of Abban & Hasan (2021); Kozlova & Collan (2020); Löffler et al, (2022); Okereke (2007); Rechsteiner (2021); and Zhou (2019).

7. CONCLUSION

The main objective of our research is to identify the factors that determine the decision of companies to invest in renewable energy and energy efficiency in Algeria. We have studied three main families of factors, namely: financial factors; factors related to renewable energy technology; and regulatory factors. These factors are drawn from an exhaustive literature review that we conducted at the beginning of our research.

Our study aims to answer our research question formulated as follows: "What are the main factors that determine renewable energy and energy efficiency investments in Algeria?". From our literature review, we have drawn two hypotheses, the first one assumes that companies in the primary sector are more invested in energy efficiency and are more able to invest in renewable energy. As for the second hypothesis, we assume that the regulation represents the main factor impacting the decision of companies operating in Algeria.

A quantitative study based on a questionnaire was conducted with a sample of 117 companies from all sectors operating in Algeria. This approach aims to validate our hypotheses.

First, we conducted a descriptive analysis. The objective of this analysis is to determine the composition of our sample. The results show that our sample is mainly composed of companies operating in the primary sector, more precisely in the sector of hydrocarbons, mining, and related services. The people who filled out our questionnaire are professionals with more than 10 years of experience, and most of them hold senior management positions within their companies, as well as managers and engineers.

To test our first hypothesis, we conducted a bidimensional analysis, using a chi-square test and a cross-tabulation between the sectors of activity of the companies in our sample and their use of renewable energy. We arrived at the following result: the primary sector is more receptive to the use of renewable energy and investments in energy efficiency.

Through a discriminant factorial analysis, we studied the various factors determining the investment decision of companies in renewable energy and energy efficiency retained from our literature review. This part of our study aims to verify the validity of our second hypothesis. The results of the analysis indicate that these factors are not significant and do not impact the decision of companies in Algeria to invest in the energy transition.

However, our study presents some limitations, among which are the following:

Targeting companies from different sectors of activity may be considered as a limit. However, this choice remains relevant and the most adequate to be able to make a comparison between them and determine the sector that is most involved in the energy transition;

Our survey was administered by e-mail and on the professional platform LinkedIn. It would be more relevant to adopt a more direct mode of administration by heading to the headquarters of different companies.

In addition to the above-mentioned limits of our research, the main objective was to determine which of the financial, technological, and regulatory factors impact the decision of companies operating in Algeria to invest in renewable energy and energy efficiency. In addition, the secondary objectives previously defined in the introduction of this research work have also been achieved.

Table 14. Achievement of the objectives of our study.

Aims of the research	
✓	To identify the factors that determine the decision of companies to invest in renewable energy and energy efficiency
✓	To broaden knowledge in the field of renewable energy and the economy of energy in general
✓	To have a better insight into the current state of energy transition in Algeria as well as into the country's energy potential
✓	To identify the factors that influence the decision to invest in the energy transition in Algeria

Source: Author's calculation.

Our analysis seems relevant, it allows us to explore the determinants of investment in renewable energy and energy efficiency selected from an exhaustive literature review, to identify the sector of activity most involved in energy transition and the most conducive to investment in renewable energy and energy efficiency, as well as to determine the most important factor retained that impacts the decision of companies to invest in the energy transition.

Future studies could explore other investment factors to determine with accuracy those that most impact the decision of companies to invest in renewable energy and energy efficiency in Algeria. It would also be interesting to target one sector at a time and explore the alternative of foreign direct investment in renewable energy.

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Appendix 1. multi-collinearity of the variables.

	Non-standardized coefficients		Standardized coefficients			Co-linearity statistics	
	B	Standard error	Beta	t	Sig.	Tolerance	VIF
(Constant)	,678	,463		1,465	,146		
Energy transition is a low priority for the company	-,074	,074	-,124	-1,007	,316	,549	1,823
Lack of a clear vision on available technologies	,135	,086	,223	1,561	,122	,403	2,479
Internal financing constraints for renewable energy technologies	,057	,093	,093	,610	,544	,354	2,822
External financing problem	-,006	,090	-,011	-,070	,945	,362	2,761
Implementation difficulties due to internal organization	-,081	,089	-,121	-,914	,363	,473	2,113
The available technology is not yet mature	,044	,090	,070	,491	,625	,400	2,501
The level of control of the technology	-,048	,093	-,077	-,518	,606	,371	2,699
Other important investments	,209	,081	,309	2,589	,011	,579	1,727
Better to wait for feedback from other companies	-,028	,083	-,044	-,338	,736	,486	2,056
Lack of coherence between energy and land use policies...	,063	,087	,089	,723	,471	,547	1,827
Absence of a replacement scenario for conventional energy	-,038	,086	-,054	-,437	,663	,548	1,826
Lack of legal security and absence of regulatory laws	-,080	,095	-,114	-,845	,400	,454	2,204
Environmental and administrative constraints	,142	,081	,216	1,742	,085	,534	1,871
Conventional energy costs do not internalize external costs	-,045	,080	-,067	-,560	,577	,572	1,750
Availability and access to renewable energies	,014	,070	,023	,208	,836	,662	1,512
Actions of the competition	-,286	,145	-16,353	-1,975	,051	,000	8312,940
Compliance with the legislation	,093	,132	5,288	,701	,485	,000	6891,487
Taxes related to the financing of investment	,167	,142	9,524	1,179	,241	,000	7910,604
Cost reduction resulting from reduced energy consumption	-,244	,130	-13,821	-1,872	,064	,000	6609,520
Improving the competitive position	-,183	,159	-10,455	-1,156	,251	,000	9919,804
Improving the company's image	,260	,149	14,765	1,747	,084	,000	8662,958
Carbone tax	,029	,138	1,657	,211	,834	,000	7495,068
Sustainable development objectives	,018	,149	1,007	,119	,906	,000	8687,455
Having a competitive advantage	,148	,158	8,411	,934	,353	,000	9833,572

a. Dependent variable: Company's sector of activity

Source: Author's calculation.