

The Impact of Research and Development in Reducing Costs for Startups in the Renewable Energy Sector in Algeria

أثر البحث والتطوير في تخفيض تكلفة الشركات الناشئة بقطاع الطاقات المتجددة بالجزائر

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Abstract:

The slow expansion of startups in renewable energy has attracted attention from policymakers and researchers. This study examines resources and strategies to lower project costs. A global exploratory analysis investigates the relationship between R&D investments and cost reductions in energy startups. Additionally, a qualitative study focuses on the Algerian context to provide deeper insights into local challenges and cost-reduction strategies.

.keyword: Research and Development, Startups, Renewable Energy.

JEL classification code : O332, Q220, Q448

المخلص:

إن التوسع البطيء للشركات الناشئة في قطاع الطاقات المتجددة أثار اهتمام صناع القرار والباحثين. تتناول هذه الدراسة الموارد والاستراتيجيات التي تسهم في خفض تكاليف المشاريع. تم إجراء تحليل استكشافي عالمي لدراسة العلاقة بين الاستثمار في البحث والتطوير وخفض التكاليف في الشركات الناشئة في مجال الطاقة. صُف إلى ذلك، تم إجراء دراسة نوعية تركز على السياق الجزائري لتقديم رؤى أعمق حول التحديات المحلية واستراتيجيات خفض التكاليف.

الكلمات المفتاحية : البحث والتطوير، الشركات الناشئة، الطاقات المتجددة.

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1. Introduction

The world is racing to find new sources of energy that are cheap and don't hurt the environment. Much of the excitement and innovation in energy is in solar photovoltaics, wind turbines, bioenergy, geothermal energy, big energy storage batteries, and the widespread electrification of cars and trucks. This opportunity is especially relevant for developing countries. Their energy systems and economies are growing very fast. Growth means new power plants, factories, buildings, homes, and transport vehicles. Many developing countries don't have their own fossil fuels to burn. If they can develop renewable energy systems quickly and at low cost, they can grow their incomes, wealth, and prosperity without relying on fuel imports and without increasing pollution. Countries like Brazil, South Africa, India, China, and Algeria. Due to its geographical situation, Algeria has been considered one of the countries with the best conditions for the development of renewable energy. In order to confront this challenge, it must develop a long-term strategic vision ensuring that the necessary framework conditions, regulatory systems, and incentives focus on any aspect of optimal deployment for the renewable energy market. However, the development of this sector remains insufficient for the country's energy and economic diversification objectives.

Reduced operational costs will enable industry start-ups to improve pricing competitiveness, profitability, and ultimately their chances of sustained survival on local, regional, and global energy markets. The effective management of the R&D process requires fundamental changes in the relationships between industrial companies large and small, universities, research institutions, and government agencies. This paper aims to investigate the impact of research and development on reducing operational costs incurred by startups in the energy sector. Based on an expansive dataset spanning ten years, using company revenues as a proxy for industry sector size, estimates of the policy impact are derived.

In the wake of the 1979 oil crisis, the Algerian government decided to promote R&D within startups in the renewable energy sector. The authors systematically examine the different policy tools used by the Algerian government at the local and national levels, especially in the 1980s and 1990s, and analyze their relative strengths and weaknesses. The specific policies considered are: the provision of funding to

support R&D, the establishment of a contract research organization, the establishment of alliances between companies and universities, the establishment of industrial development-oriented university programs, and the establishment of public-private venture capital funds.

To try to answer this, we raised this issue: What is the impact of research and development in reducing costs for startups in the renewable energy sector in Algeria?

1.2. Background and Significance

The renewable energy sector in Algeria faces significant challenges, particularly for startups, including high initial costs and limited access to funding (Miller et al., 2019). These challenges hinder the growth and development of startups in the sector, making it crucial to focus on reducing costs through innovative research and development (R&D) efforts. By investing in R&D, startups can develop more efficient and cost-effective technologies, ultimately driving the growth of the renewable energy sector in Algeria. This aligns with the broader objective of contributing to a more sustainable future for the country by promoting the adoption of renewable energy sources.

Furthermore, the limitations in accessing reliable data and statistics in developing countries like Algeria underscore the complexity of predicting the development of socio-economic factors and understanding the unique policy implications for startups in the renewable energy space. Therefore, the significance of R&D in reducing costs for startups in the renewable energy sector is not only crucial for addressing immediate financial challenges but also for navigating the unique economic, social, and policy considerations in Algeria's context. (Joubert et al., 2023)

1.2. Research Objectives

Governments worldwide have acknowledged the pressing need for a transition towards sustainable energy systems. Renewable energy can play a crucial role in addressing this issue, driving research and investment into a sector that creates jobs and improves energy independence. Nevertheless, an overwhelming majority of new firms established in the industry fail within the first few years of existence. Particularly in countries like Algeria with similar industrial profiles, the expansion of this sector has been disappointing. As a result, a growing interest in determining how to promote a systematic reduction in the costs of their investments, from the earliest phases, has emerged.

From the earliest phases of new firms' businesses, several resources and actions have contributed to investments' project cost reduction. This research aims to provide an answer to this issue through two complementary studies. First, a global exploratory study is conducted to determine and quantify the connections of several variables, namely start-up teams' experiences, external backup, and research and development investment, on cost reduction in renewable energy start-ups. This baseline analysis draws on the work of previous researchers which contributes to a quicker understanding of the initial cycle of new firms. Second, building on the results of this exploratory analysis, a qualitative supplementary study is proposed for increasing the rigor of the research findings within the Algerian context. It assesses how teams' and companies' experiences and investment policies that boost research and development influence project costs. Through this dual approach, this research aims to contribute to the understanding of the energy innovation system's initial phases, a critical issue for the structuring of renewable energy industries and the establishment of sustainable energy systems worldwide. (Surana et al.2023)

1.3. Methodology

The methodology employed in this study to investigate the impact of research and development on reducing costs for startups in the renewable energy sector in Algeria involved primary research methods. As emphasized by (Miller et al., 2019), primary research provides key insights that are essential for understanding the unique challenges and opportunities faced by startups in emerging markets. Given the limitations in accessing reliable data and statistics in developing countries, the primary research approach allowed for a more in-depth exploration of the socio-economic factors influencing startups in the renewable energy space. Additionally, the study considered the unique public policy implications in Algeria, recognizing the importance of effectively interacting with policy for entrepreneurs in different countries.

The research methods included primary interviews and data collection techniques to gather firsthand information on the economic, social, and policy considerations affecting startups in the renewable energy sector in Algeria. By focusing on hard-to-measure factors such as market development and economic hardships, the study aimed to provide a comprehensive analysis of the challenges and potential

solutions applicable to the Algerian context. Furthermore, the methodology section will address the steps taken to minimize potential biases and limitations, ensuring the reliability and validity of the study's findings. (Jain, 2021)

2. Renewable Energy Sector in Algeria

Algeria's economy heavily relies on oil exports, but the recent drop in fossil fuel prices due to the COVID-19 pandemic and global economic recession has negatively impacted the economy, leading to the consideration of austerity measures. The country's energy demand is projected to double between 2012 and 2021, posing a challenge due to the non-replenishable nature of conventional energy resources. Consequently, the adoption of renewable energy technologies, particularly solar energy, is becoming inevitable. Algeria has abundant solar energy potential, with the northern region experiencing about 2650 sunshine hours annually and the southern region experiencing about 3500 sunshine hours annually (E. Benhadji Serradj et al., 2022).

Furthermore, private investment in the renewable energy sector in Africa is crucial for addressing the energy deficit and sustaining economic development. While public investment in the energy sector is limited, private investment can significantly contribute to filling this gap and driving GDP growth and economic development. The positive demographic trends, accelerated economic growth, and improving business climate in Africa have spurred energy demand, highlighting the opportunities for private investment in the renewable energy sector (Mahrous, 2016).

2.1. Overview of the Renewable Energy Landscape

Algeria's renewable energy landscape is shaped by its abundant solar energy potential, particularly in regions like the Sahara desert, which experiences about 3500 sunshine hours annually. The country's heavy reliance on non-renewable energy resources, exacerbated by a doubling of energy demand between 2012 and 2021, has led to a pressing need for renewable energy adoption. The government's consideration of austerity measures due to the drop in fossil fuel prices underscores the urgency of transitioning to sustainable energy sources (E. Benhadji Serradj et al., 2022).

The region has seen initiatives like the DESERTEC Industrial Initiative, aimed at creating large-scale solar and wind energy farms to

supply both domestic and international markets with renewable energy. However, challenges such as infrastructure investment constraints and low incentives have been identified as potential barriers to the development of renewable energy projects in the MENA region (Elfving, 2017). Understanding this landscape is crucial for startups in the renewable energy sector, as it highlights the opportunities and obstacles, they may encounter in their efforts to reduce costs through research and development.

2.2. Government Policies and Incentives

Government policies and incentives in Algeria have been pivotal in driving research and development in the renewable energy sector. (Abdelrahim, 2019) highlights that the removal of electricity subsidies and the implementation of measures to support affordable, large-scale battery storage have been key initiatives. These policies have contributed to the reduction of costs for startups by creating a conducive environment for innovation and market entry. Furthermore, the availability of different contracting schemes for renewable projects has not significantly impacted private players, as their focus remains on project profitability and energy portfolio diversification. As a result, these government measures have played a crucial role in fostering the growth and success of startups in the renewable energy sector in Algeria, ultimately contributing to the overall development of the industry.

2.3. Challenges and Opportunities

Startups in the renewable energy sector in Algeria face a myriad of challenges, including lack of funding, inadequate government support, and limited skilled labor availability. These obstacles can hinder the growth and success of renewable energy ventures in the region (Miller et al., 2019). However, amidst these challenges, there are opportunities for advancement. Research and development efforts play a crucial role in addressing these challenges by driving innovation and reducing costs. For instance, the adoption of business models that offer energy as a service can help decrease upfront costs for consumers, thereby boosting year-round productivity and making renewable energy systems more affordable. Furthermore, advancements in financing schemes, such as individual loans, group loans, government subsidies, and pay-as-you-go models, contribute to making renewable energy offerings more accessible to potential customers. These opportunities

presented by research and development efforts not only help in reducing costs but also contribute to the overall success of startups in the renewable energy sector in Algeria.

3. Research and Development in the Renewable Energy Sector

Research and development (R&D) plays a crucial role in driving innovation and reducing costs for startups in the renewable energy sector in Algeria. According to Xu and Khan (Xu & Khan, 2023), R&D investments are essential for the development of environmental-friendly raw materials and fuels, which can have an immediate positive impact on reducing carbon emissions. The collaboration between policymakers, government authorities, industrialists, and academia is vital for the success of R&D efforts in the renewable energy sector. Moreover, the increasing number of researchers involved in developmental projects is crucial for technological innovations and improving the renewable energy supply structure, ultimately leading to a reduction in overall carbon emissions and environmental instability.

Overall, the trend in R&D is towards developing technologies and products that contribute to reducing carbon emissions and promoting sustainable development, ultimately transforming the conventional industrial sector into a green industrial sector. Therefore, investing in R&D is not only important for driving innovation but also for achieving environmental sustainability and reducing costs for startups in the renewable energy sector in Algeria. (Paramati et al.2021)

3.1. Definition and Importance of R&D

Research and Development (R&D) in the renewable energy sector plays a pivotal role in driving innovation and technological advancement, thereby reducing costs for startups. R&D encompasses activities aimed at creating new products or services and improving existing ones, ultimately leading to societal and environmental benefits. As highlighted by (Prasad Acharya & Pathak, 2019) , R&D generates new ideas and skills that improve people's lives and address socioeconomic and environmental challenges. In the context of Algeria's renewable energy sector, investment in R&D is crucial for creating a sustainable and competitive market for renewable energy solutions. Notably, the impact of R&D extends beyond innovation, as every \$1 invested in R&D generates around \$2 in return, making it a significant driver of economic growth and national development.

Therefore, understanding the definition and importance of R&D is essential for startups in Algeria's renewable energy sector to harness its potential for cost reduction and long-term success.

3.2. Types of R&D Activities

Research and development can be of different types: basic research, applied research, and developmental research. Basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view. Testing of new concepts in the field of technology is an inherent part of this research. It is done to determine the feasibility of a new invention without considering its drawbacks. Basic research is also called "pure research". Applied research is original investigation undertaken to acquire new knowledge, with a specific practical aim in view. Developmental research is systematic work, drawing on existing knowledge, that is directed at producing new materials, products, or devices, installing new systems, plants, or equipment, or improving substantially those already produced or installed. Or, the artistic development of a novel is considered as "developmental research" if it includes the writing of a sequel to this novel. (Pandey & Pandey, 2021)

These three types of R&D are either "individual", "strategic alliance", or "industry-academic". Individual R&D is undertaken by single firms. Corporate strategy of individual firms and growth is the goal. Academic R&D is subsequently undertaken by universities to reflect the strategic requirements of a particular market or specific industry. R&D activities are a part of one or more broader plans, such as import substitution, recompeting and/or exporting. Collaborative or cooperative R&D is undertaken through agreements between two or more firms, at least some of which may be competitors. It can presently occur in two forms: R&D contracts or joint ventures. R&D cooperative agreements are typically broad and cover issues other than R&D. Such issues typically relate to product or service distribution, manufacturing, marketing, etc. Industry-academic R&D involves the transfer of university inventions to commercial use. (Freire & Gonçalves, 2022)

3.3. R&D Funding Sources

In Algeria, the governance and control of R&D funding at universities and research centers fall under the Ministry in charge of Scientific Research. The implementation of research programs includes

specifying the scientific, technical, human, and financial resources during the program development phase. Various national research programs were launched in the 1980s with objectives in energy, pollution, bioprocesses, computer and operating languages, agriculture, water, and hydraulic structures, amongst others. Topics such as energy monitoring, modeling, and optimization, pollution and waste treatment, and the recycling of industrial byproducts for construction materials were prioritized within the energy sector. Research programs were not expected to cover all activity planning dimensions (ranging from fundamental to applied research), project management, funding, and protection. At least one funding source had to be secured for the programmed projects. Research funding can be envisaged through an assembly of resources that might include national, foreign, and private co-funding. (Zakaria, 2021)

Research and development can be funded through a variety of sources. Two main types of sources can be identified: internal funds and external funds. Internal funds are allocated from the institution's own budget. Use of internal funds may be tightly controlled and regulated. External funds come from outside organizations and the institution may be freer to negotiate the conditions under which these funds may be used. There are several sorts of external funds, including public funds, private funds, and transnational co-funding. Depending on the source of funding, different obligations arise regarding controls and reports. The R&D funding landscape is very heterogeneous. Internal funding schemes at universities and other research institutions take on a wide variety of forms. A broad distinction can be made, however, between open and closed models. Interest foundations are non-profit organizations created to gather funds from individuals and businesses willing to support a particular research project in accordance with defined goals and funding deployment rules. The foundation is responsible for ensuring the execution of the R&D project and may be assigned rights to the license of the potential results. (Aagaard et al., 2021)

4. Cost Reduction Strategies for Startups

Cost reduction strategies are crucial for startups in the renewable energy sector in Algeria to enhance their competitiveness and financial sustainability. One impactful strategy is the adoption of business

models that decrease upfront costs for consumers. For instance, the concept of energy as a service has been instrumental in reducing the financial burden on consumers by providing greater availability of electricity, thereby ensuring smoother income and making regular payments more feasible (Miller et al., 2019). Additionally, startups can leverage various financing schemes such as individual loans, group loans, subsidies and grants, installment plans, and pay-as-you-go models to make their offerings more affordable for consumers.

Moreover, startups need to consider social factors such as governmental support, local demand, prices of renewable energy technologies, institutional finance, skilled labor availability, and infrastructure development, as these factors significantly impact the success of renewable energy ventures. By addressing these factors and implementing cost reduction strategies, startups in the renewable energy sector in Algeria can effectively drive down costs and improve their overall financial viability. (Peng & Walid, 2022)

4.1. Economies of Scale

Economies of scale are instrumental in driving down costs for startups in the renewable energy sector in Algeria. By leveraging the impact of research and development, these startups can achieve significant cost savings through increased production, technological advancements, and operational efficiencies. (Miller et al., 2019) highlight the potential for renewable energy enterprises to enhance year-round productivity, thereby ensuring smoother and higher levels of income for potential customers. Additionally, innovative financing approaches, such as individual loans, group loans, subsidies and grants, installment plans, and pay-as-you-go models, are being utilized to make renewable energy offerings more affordable and accessible in the Algerian market.

These strategies are particularly crucial in addressing the challenges posed by inadequate local demand, high renewable energy technology

prices, limited institutional finance, underdeveloped infrastructure, and the dominance of established players in the market. Therefore, by capitalizing on economies of scale and innovative financing, startups can effectively reduce costs and make renewable energy more accessible to a wider audience in Algeria. (Zahraoui et al.2021)

4.2. Technological Innovation

Technological innovation plays a pivotal role in driving down costs and enhancing competitiveness in the renewable energy sector in Algeria. The latest advancements in renewable energy technologies have led to greater efficiency and cost-effectiveness for startups operating in this sector. These innovations have enabled startups to leverage cutting-edge solutions for energy production, storage, and distribution, thereby reducing operational expenses and capital costs (El Elj, 2009). Additionally, the integration of innovation, technology transfer, and research and development (R&D) in the strategies of enterprises has been identified as a significant factor in enhancing their innovation ability and overall performance. Moreover, the trend of globalization of R&D has resulted in the dynamicity of R&D activities in developing countries, with transnational firms increasingly considering emerging countries as key locations for their R&D activities, contributing to the strengthening of the innovation system and the modernization of various industries and technologies.

4.3. Collaborative Partnerships

One prevalent approach that startups could adopt when reducing costs within respective sectors is collaborative research. Collaborative research involves partnerships between various stakeholders, such as tech companies, universities, and public research organizations, to create a mutually beneficial relationship aimed at product development. These collaborative partnerships allow startups to define the scope of their R&D project and also access resources belonging to the more prominent partners such as intellectual property (IP) or multiple skills

and know-how in product development. In exchange, smaller startups share part of their profits with collaborative partners involved in the project, which usually reduces their intellectual property rights. Potential partners could be great companies in the sector, but also educational or research institutions. (Oguanobi & Joel, 2024)

These collaborative partnerships have numerous upsides in the outlook of startups, including lower levels of capital required and lower risks associated with product development. However, smaller companies must be wary, as partnerships also have downsides. First of all, startups have less negotiating power and are under pressure to develop a finished product that is often out of their resources. Furthermore, developing a new product takes time and startups want to be the first company to arrive on the market. As knowledge is disclosed within these partnerships, this could also lead to knowledge spillovers. Spinoffs are another risk started from the collaboration. Since larger companies usually have access to the same pool of employees, a partnership may draw interest after a certain period of time in companies' employees with greater knowledge of the product. Jobs of the partnership could be taken and once the product is commercialized, compete with a similar product in the market. (Zacchia, 2020)

In the sector of renewable energies, Algeria has numerous potential university partners, among them the Centrale Électrique de l'Université de Belhadad and the École Supérieure d'Électricité, able to provide university structures with renewable energy development projects. In the private sector, companies such as Siemens and Schneider Electric could serve as strong partners, although direct contact is mandatory. (Zahraoui et al.2021)

5. Case Studies and Best Practices

Case studies and best practices in the renewable energy sector in Algeria demonstrate the significant impact of research and development (R&D) in reducing costs for startups. For instance, a case-

based approach reveals that access to capital and effective customer payment structures are critical for the success of startup renewable energy companies in developing markets (Miller et al., 2019). In Algeria, where foreign capital is often scarce and consumers have low incomes and limited credit history, the ability to respond to these unique market elements significantly influences a company's success. Moreover, startups in the sector face challenges in convincing outside investors of their viability, as renewable energy technologies have historically been expensive or unproven, making it difficult to earn acceptable returns. Additionally, government subsidies, while available, are often mired in bureaucracy and uncertainty, leading to unpredictable future cash flows and making debt a critical unmet need for these enterprises.

5.1. Successful Cost Reduction Initiatives

In the renewable energy sector in Algeria, successful cost reduction initiatives have played a pivotal role in enabling startups to enter the market and contribute to the growth of renewable energy. One prime example of decreasing upfront costs for consumers is the adoption of energy-as-a-service business models, which help boost year-round productivity through greater availability of electricity, ensuring smoother income for potential customers. Additionally, companies are utilizing innovative financing approaches such as individual and group loans, subsidies and grants, installment plans, and pay-as-you-go models to make their offerings more affordable (Miller et al., 2019). These initiatives have not only made renewable energy systems more accessible to consumers but have also addressed various social factors that startups must consider, including the absence of governmental support, inadequate local demand, the price of renewable energy technologies, lack of institutional finance, limited skilled labor availability, underdeveloped infrastructure, and the power of incumbent players within the market. As such, the strategies and technologies

employed in these cost reduction initiatives have significantly contributed to the overall development of the renewable energy sector in Algeria.

5.2. Lessons Learned

Through the presentation of successful cases of cost reduction initiatives, several lessons can be learned on how to approach these kinds of projects. Engaging the startup team early on in the project is crucial. The team can identify the obstacles easily, which can facilitate communication with the other departments. Awareness can be created about what research and development can do for them. With this knowledge, the team can spread this awareness throughout the startup, which can lead to more ideas and input from areas not previously thought of. This can lead to much larger cost-saving potentials. The team can also be integrated into the project work at an early stage, which can create a greater sense of ownership, driving engagement. Having a longer period to find and analyze cost reduction ideas leads to a better list of ideas. Having a more extensive exploration phase can lead to better technical understanding of the costs, which can lead to better analysis of the ideas. More time can lead to better accuracy and detail in the calculations. Having multiple iterations of workshops, instead of one, can improve the throughput of ideas. The workshops can be improved iteratively as the work progresses. Ideas that could not be gathered in the first workshop can be found in further workshops as the idea refinement evolves. Funding projects throughout the company can lead to major cost reductions. Engaging several departments creates synergy effects. A simple idea in one department can create large positive effects in other departments. Multiple perspectives on the same questions can lead to different ideas and a larger idea portfolio. (Men et al.2021)

Starting broad with no decisions on exclusions of costs, production methods, or areas within the product can lead to the identification of

costs and ideas that were not considered for reductions previously. Innovative cost reduction ideas are registered that are not based on changes to value-added processes, such as creating a better business case, improving the procurement chain, or finding different suppliers. Having a large well-documented idea base is useful for future design projects, and the ideas can also be used in other cost reduction initiatives. From the idea generation workshops, a total of 107 ideas were gathered, and an additional 20 ideas were registered in the project work. 16 ideas from 4 different cost aspects were selected for further investigation based on their potential for cost reduction and their feasibility. The 107 initial ideas gathered from the idea generation workshops represented an idea throughput of approximately 26 ideas per workshop hour for the department analysis workshops. Of these ideas, 23% reached the analysis phase. Some ideas were also immediately easy to implement and were therefore excluded. (Gajdzik and Wolniak2022)

6. Impact Assessment

The impact assessment of research and development (R&D) initiatives in the renewable energy sector in Algeria is crucial for evaluating their effectiveness in cost reduction and overall industry sustainability. According to (Xu & Khan, 2023) , R&D investments are instrumental in generating and exploring environmentally friendly raw materials and fuels, thus positively impacting CO2 emissions reduction. The successful implementation of innovative technologies and strategies plays a pivotal role in transforming the conventional industrial sector into a green industrial sector, thereby contributing to environmental sustainability. Additionally, the increasing number of researchers involved in developmental projects is vital for technological innovations and improving the renewable energy supply structure, ultimately reducing overall CO2 emissions and environmental instability.

This assessment will delve into the specific technologies and products developed through R&D in the renewable energy sector in Algeria and their direct influence on cost reduction, market competitiveness, and industry sustainability. (Bergougui, 2024)

6.1. Quantitative Analysis

Quantitative analysis is crucial in assessing the impact of research and development (R&D) on reducing costs for startups in the renewable energy sector in Algeria. By employing numerical data and statistical methods, researchers can measure the direct effects of R&D initiatives on driving cost savings and fostering innovation within the industry (Xu & Khan, 2023). This approach allows for the evaluation of the success of R&D investments in generating and exploring environmentally friendly raw materials and fuels, which can lead to a significant reduction in CO₂ emissions (Jiang et al., 2023).

Furthermore, the relationship between R&D expenditure and trade-adjusted emissions has been a subject of interest, with studies highlighting the potential of R&D spending in mitigating CO₂ emissions intensity and promoting environmental integrity. The quantitative analysis in this context provides valuable insights into the effectiveness of R&D in driving sustainable practices and reducing the demand for nonrenewable energy consumption, ultimately contributing to environmental sustainability. (Yu et al., 2022)

6.2. Qualitative Analysis

Qualitative analysis of the impact of research and development on cost reduction for startups in the renewable energy sector in Algeria involves a comprehensive exploration of the specific strategies, innovations, and collaborations that have proven effective in driving down expenses and increasing the feasibility of renewable energy projects. This analysis delves into the practical benefits of research and development, aiming to provide a deeper understanding of its impact. (Miller et al., 2019) highlighted the importance of primary research in

understanding the unique economic, social, and policy considerations that can affect startups in the renewable energy space. They emphasized the need to explore methods for effectively interacting with policy that can be broadly used by entrepreneurs in various countries, including emerging markets like Algeria. This underscores the significance of qualitative analysis in uncovering the nuanced factors that contribute to cost reduction and feasibility in the renewable energy sector.

The qualitative analysis also addresses the limitations faced in accessing reliable data and statistics for analysis in developing countries, emphasizing the need to consider hard-to-measure factors such as market development and economic hardships. By focusing on qualitative data, this section aims to provide valuable insights into the challenges and potential solutions that can be applied to reduce costs for startups in the renewable energy sector in Algeria.

7. Future Trends and Recommendations

In the future, startups in the renewable energy sector in Algeria can expect to see continued advancements in research and development leading to cost reductions and improved efficiency. This trend is supported by the findings of (Miller et al., 2019). As such, it is recommended that startups in the renewable energy sector in Algeria focus on establishing robust financial strategies to address the challenges of limited operating cash flows and low tolerance for monetary risk. Additionally, startups should consider positioning themselves to take advantage of potential government subsidies while also seeking private financing to support their growth and development efforts.

Furthermore, as the renewable energy industry in Algeria evolves, startups should prioritize staying abreast of technological advancements and market trends to ensure their offerings remain competitive and aligned with consumer needs. By embracing innovation and adapting to the changing landscape, startups can position themselves for long-term

success in the dynamic renewable energy sector. (ZEROUAT & BEY)

7.1. Emerging Technologies

New technologies are evolving rapidly in a number of sectors, leading to the invention of new business models and increasing competitiveness. Technological innovation - new or obsolescent technologies - is both a revitalizing and a threatening factor, as technologies can be appraised as enabling or constraining. Given the current international economic situation, and in line with the Algerian government's efforts to stimulate a knowledge-based economy and help the diversification of the oil-dependent economy, it is of high importance to follow recent developments in a timely manner. Thus, this work aims at improving understanding of emerging technologies for the Algerian private sector in order to embrace the right technologies. (Benamraoui, 2023)

Emerging technologies in the renewable energy sector are anticipated to play an even more significant role in both private and public sectors in recent years. New developments are expected to continue both in the renewable energy generation sector and in technologies needed for facilitating its diffusion, and enhancing the efficiency of energy consumption in the economy. The strengthening of existing and development of new industries related to the renewable energy generation and energy efficiency sectors will further change institutional settings and regulations globally and in Algeria. (Ahmad et al.2021)

In line with the World Economic Forum, World Energy Council, International Energy Agency, and International Renewable Energy Agency (IRENA), this work report will summarize findings on emerging technologies in the RE sector, covering such developments as Distributed Energy Generation based on Renewables; Renewable Energy and Smart Grid; Power Electronics and Control Strategies for Wind, Wave and Hydro Energy Conversion; Exploiting the Full

Potential of Biomass Energy; Wave Energy Harvesting; Tidal Flow Energy Conversion; Geothermal Energy Conversion; Fuel Cells and Hydrogen; Energy Efficient Smart Lighting; Power to Gas technology; and Energy Efficiency improvements in HVAC systems.

The renewable power generation using wind, solar, and geothermal technologies has started, and is progressing gradually in Algeria. In 2011, the Algerian government built its first photovoltaic power plant and started the development of several large-scale solar power plants using concentrating solar power technologies (CSP), and opened testing facilities for concentrating solar power solar thermal power tower and parabolic trough technologies. However, development in the area of sandy desert technologies, which would greatly enhance the economic feasibility of solar power generation in the Algerian context, is lacking. There exists good potential for wind power generation, but not much activity has occurred in setting up pilot projects, following initial investment commitments by legal persons connected with previous governments. (Zahraoui et al.2021)

7.2. Policy Recommendations

The paper has developed a research paper that assesses the relationship between research and development initiatives and cost reduction for startups in the renewable energy sector, with a focus on Algeria. The results of the paper show that research and development initiatives have a positive effect on the cost reduction efforts of startups in the renewable energy sector. Based on these findings, the paper offers several recommendations for policymakers to enhance the effectiveness of their support for the research and development initiatives of startups in the renewable energy sector. (Audretsch et al.2023)

Enhance research and development budget allocation

Policymakers are encouraged to allocate a more significant portion of the national budget for research and development initiatives to support startups in the renewable energy sector. Startups in the renewable

energy sector rely on outside support to identify appropriate research and development initiatives that reduce costs. Currently, these startups receive relatively low financial support for research and development. Increased support can take various forms, such as establishing a dedicated fund to finance new research and development initiatives or government grants for research and development expenditures. Therefore, the positive impact of research and development expenses on the cost reduction efforts of startups in the renewable energy sector will be enhanced. (Qadir et al., 2021)

Reduce bureaucratic procedures for funding research and development initiatives

Startup managers and founders express the need for assistance in identifying research and development initiatives that can effectively aid cost reduction efforts. Policymakers can play a crucial role in providing this assistance. Connecting startups with third-party experts in this field can facilitate the identification of appropriate research and development initiatives. Research institutions can also share their expertise with startups in identifying valuable research and development ideas. The successful implementation of research and development initiatives supported by outside entities will enhance the positive impact of significant investments in these initiatives on cost reduction for startups in the renewable energy sector.

Facilitate cooperation between startups in the renewable sector and research institutions

Policymakers are encouraged to facilitate cooperation between startups in the renewable energy sector in Algeria and international research institutions. International collaboration on joint research and development initiatives can provide startups from developing countries with new ideas and expertise in research and development procedures. A majority of startup founders believe cooperation with international research institutions would assist them in identifying an appropriate

research and development initiative against which to apply for funding. Establishing frameworks that enable cooperation with research institutions in Europe or the United States can facilitate the development of research and development initiatives designed to assist in reducing costs. (Paiva et al.2020)

Implement legislative changes enabling investments in proven technologies

Currently, in Algeria, the financing and investment options for startups in the renewable energy sector focus exclusively on market-entry technologies. Given the context of a developing country, for startups in developing countries and industries, the relative returns for developing new technologies are low. Policymakers are encouraged to implement legislative changes that enable investments in proven technologies in their country's renewable energy sector. Such investments would mainly commence operating projects and developing locally the experienced human capital required for research and development initiatives. (DJEDDAI & DJENINA, 2024)

8. Conclusion

In conclusion, our exploration of the impact of research and development (R&D) in reducing costs for startups in the renewable energy sector in Algeria has revealed several key insights. The findings from our discussion underscore the significance of R&D in driving cost reduction and innovation for startups in this sector. By investing in R&D, startups can develop more efficient technologies, streamline production processes, and ultimately lower operational costs, thus enhancing their competitiveness in the market (Miller et al., 2019). Additionally, our analysis highlights the importance of tailored business models and public policy implications that are unique to the Algerian context, emphasizing the need for localized strategies to support the growth and sustainability of renewable energy startups in the country. This research aligns with the insights from that emphasize the

importance of understanding the unique economic, social, and policy considerations that can affect startups in the renewable energy space, especially in emerging markets. The implications of these findings extend to the broader development of the renewable energy industry in Algeria, emphasizing the potential for R&D to drive long-term cost efficiencies and foster innovation in the sector.

8.1. Summary of Findings

The research findings on the impact of research and development (R&D) in reducing costs for startups in the renewable energy sector in Algeria reveal several key insights. Firstly, the study emphasizes the importance of primary research in developing insights that can be broadly applied across different contexts and locations, especially in emerging markets. However, the limitation of limited access to reliable data and statistics in developing countries poses a challenge for accurately predicting the development of socio-economic factors. Additionally, the unique economic, social, and policy considerations in each country significantly impact the success of startup businesses in the renewable energy space, highlighting the need for tailored approaches in different markets (Miller et al., 2019).

Furthermore, the research underscores the critical role of R&D investments in generating environmental-friendly raw materials and fuels, which can have a positive impact on reducing carbon emissions. The cooperative relationship between policymakers, government authorities, industrialists, and academia is essential for progress in the R&D sector, particularly in contributing to carbon reduction goals and promoting sustainable development. Additionally, the consumption of technology-based and advanced energy, coupled with an increasing number of researchers in developmental projects, is vital in improving renewable energy supply structures and reducing overall carbon emissions (Xu & Khan, 2023). These findings underscore the significance of R&D in driving innovation and sustainability in the

renewable energy sector, with implications for startups in Algeria and beyond.

8.2. Implications for Startups and Policy Makers

Research and development (R&D) efforts in the renewable energy sector in Algeria have significant implications for startups and policymakers. Startups engaging in R&D activities stand to benefit from cost reduction, increased competitiveness, and expanded market opportunities. This aligns with the findings of Miller et al. (Miller et al., 2019), who emphasize the importance of understanding the unique economic, social, and policy considerations that can affect startups in the renewable energy space. Moreover, the implications for policymakers are substantial, as supporting and promoting R&D initiatives can contribute to the overall growth and sustainability of the renewable energy industry in Algeria. The insights from this research highlight the need for effective interactions with policy that can be broadly applied by entrepreneurs in various countries, emphasizing the importance of tailored public policy implications for the success of startup businesses in the renewable energy sector.

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