

Financing the Energy Transition in Algeria: A Comparative Analysis of Green Financing Mechanisms and the Role of Commercial Banks in Risk Management

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Abstract

This article aims to analyse the financing mechanisms for the energy transition in Algeria, with a particular focus on the role of commercial banks in mobilising financial resources and managing the risks associated with green investments. It addresses the financing challenges facing energy-transition projects, particularly high initial investment costs, long capital-recovery periods, and the difficulty of assessing technical and environmental risks. To achieve these objectives, the study adopts a descriptive-analytical approach and a comparative approach to examine the characteristics of the main green-financing mechanisms, including green loans, green bonds, green sukuk, and public-private partnerships, and to analyse their suitability for financing energy projects and sharing their associated risks. The study concludes that strengthening the contribution of commercial banks to financing the energy transition requires the development of sustainable-finance instruments, the improvement of risk-guarantee mechanisms, the integration of environmental considerations into credit decision-making, and the adaptation of regulatory and supervisory frameworks to support the allocation of financial resources to green investments.

Keywords: Energy transition; green finance; commercial banks; risk management; sustainable-financing mechanisms; Algeria.

I. General Framework of the Study

1. Introduction

The world is witnessing rapid changes in energy policies, driven by the growing consequences of climate change, increasing pressure to reduce carbon emissions, and the move towards building a low-emission economy. In this context, the energy transition is no longer merely an environmental trend; it has become a strategic choice linked to energy security, resource sustainability, and the diversification of energy sources. These changes have increased the need to mobilise substantial financial resources to finance renewable-energy projects and improve energy efficiency, thereby strengthening the importance of green and sustainable finance as a key means of directing investment towards low-emission activities. Financial institutions and banks play an important role in financing such projects through various mechanisms, including green loans, green bonds and sukuk, as well as public-private partnership arrangements, while taking account of the financial, technical and environmental risks involved.

In Algeria, financing the energy transition is particularly important given the need to diversify the economy, strengthen energy security and reduce excessive dependence on hydrocarbons, while making use of available national potential, especially in solar energy. Turning this potential into implementable projects, however, requires the mobilisation of financial resources suited to the nature of energy investments, which are often characterised by high initial costs, long capital-recovery periods, and multiple risks associated with construction and operation. Commercial banks and financial institutions are therefore central actors in financing these projects, not only by providing credit but also by developing risk-assessment and risk-management mechanisms, selecting appropriate financing arrangements, and strengthening coordination with the State and investors.

In light of these considerations, it is necessary to examine how suitable the different green-financing mechanisms are for financing energy-transition projects in Algeria by comparing their characteristics, requirements for use, and capacity to respond to project financing needs. The study must also analyse the role of commercial banks in deploying these mechanisms and managing the associated risks, in order to identify the main challenges that may limit their effectiveness and propose ways to strengthen their contribution to financing the energy transition.

On this basis, the study addresses the following main question:

To what extent are green-financing mechanisms suitable for financing the energy transition in Algeria, and what role do commercial banks play in deploying these mechanisms and managing the associated risks?

To examine the research problem from its different angles, it is divided into the following subsidiary questions:

1. What are the main green-financing mechanisms that can be used to finance energy-transition projects, and how do they differ in their characteristics, requirements for use, and capacity to manage risk?
2. What are the main financing and banking challenges and risks facing commercial banks and financial institutions when financing energy-transition projects in Algeria?
3. To what extent are the different green-financing mechanisms compatible with the specific features of Algeria's financial environment, and how can commercial banks deploy them and strengthen their role in managing the risks of energy-transition projects?

2. Research Hypotheses

Based on the research problem and its subsidiary questions, the study proceeds from the following hypotheses:

Hypothesis 1: Green-financing mechanisms differ in their financing characteristics, requirements for use, and ability to meet the financial needs of energy-transition projects; their suitability therefore depends on the nature and size of the project and its level of risk.

Hypothesis 2: Commercial banks face several challenges when financing energy-transition projects, particularly high investment costs, long capital-recovery periods, and the difficulty of assessing certain technical and environmental risks, in addition to collateral and financing requirements.

Hypothesis 3: Diversifying green-financing mechanisms, developing risk-guarantee instruments, and strengthening regulatory frameworks and banking capabilities can improve commercial banks' ability to finance energy-transition projects in Algeria.

3. Significance of the Study

The significance of this study stems from the growing need to provide appropriate sources of finance for energy-transition projects amid challenges arising from high investment costs and the range of financial, technical and environmental risks. Its academic significance lies in examining green-financing mechanisms from a comparative perspective by analysing their characteristics, requirements for use and suitability for financing energy projects, while highlighting the role of commercial banks in mobilising financial resources and managing the risks associated with these investments. In practical terms, the study highlights the challenges facing energy-transition financing in Algeria and identifies possible ways to develop the contribution of commercial banks and financial institutions by diversifying financing instruments, strengthening risk-guarantee mechanisms, and adapting banking practices to the requirements of sustainable finance, thereby supporting the allocation of financial resources to energy projects with positive environmental effects.

4. Objectives of the Study

This study seeks to achieve the following objectives:

- Clarify the conceptual framework of the energy transition and green finance, and highlight the role of commercial banks in financing sustainable energy projects.

- Analyse and compare the main green-financing mechanisms in terms of their financing characteristics, requirements for use, and suitability for energy-transition projects.
- Identify the main financing and banking challenges, as well as the financial, technical and environmental risks facing the financing of energy-transition projects in Algeria.
- Analyse the role of commercial banks in deploying green-financing mechanisms and assess their suitability for the specific features of Algeria's financial environment.
- Propose mechanisms and measures to strengthen the contribution of commercial banks to financing the energy transition by developing sustainable-finance instruments and improving the management of risks associated with energy projects.

5. Research Methodology

To achieve the study's objectives and answer its research question, the descriptive-analytical method is used to present the key concepts associated with the energy transition and green finance and to explain the role of commercial banks in financing energy projects and managing their associated risks. The comparative method is also used to analyse the principal green-financing mechanisms—green loans, green bonds, green sukuk, and public-private partnerships—by comparing their financing characteristics, requirements for use, and suitability for financing energy-transition projects. The study is supplemented by an analysis of financing and banking challenges in the Algerian context, with the aim of deriving practical proposals to strengthen the contribution of commercial banks to mobilising financial resources and developing risk-management mechanisms. The analytical framework is based on academic literature, previous studies, relevant documents and reports, drawing on available and reliable sources when considering the state of energy-transition financing in Algeria.

II. Theoretical Framework for Financing the Energy Transition

Financing the energy transition has become a central issue as the world moves towards renewable energy and greater environmental sustainability, given the substantial financial resources and financing mechanisms required by such projects. Commercial banks are among the principal actors in mobilising financial resources and directing them towards green investments while addressing the risks involved. Accordingly, examining this topic requires discussion of the concepts of the energy transition and green finance, the role of commercial banks in financing the transition, and the main mechanisms used in this field.

First: Basic Concepts of the Energy Transition and Green and Sustainable Finance

Amid the global acceleration of efforts to reduce carbon emissions and address climate change, the energy transition has emerged as an indispensable strategic choice. Its effectiveness depends largely on financial innovation and green-financing mechanisms capable of turning environmental ambitions into viable, sustainable projects.

1. Concept of the Energy Transition

In principle, there is no single, universally accepted definition of the energy transition, because several factors influence the formation and interpretation of the concept, including countries' levels of development, their energy systems, and their international commitments concerning climate change. Nevertheless, Algeria's Conservation of Renewable Energies and Energy Efficiency defines the energy transition as "one of the components of the ecological transition. It refers to a profound change in the means of producing and consuming energy, towards a sustainable energy mix with an acceptable environmental footprint. The term also refers to a shift towards an economic and social model based on sustainable development. It requires changes in our consumption and production habits in order to respond to recognised environmental challenges, such as climate change, resource depletion, declining biodiversity, and increasing health risks" (Achachi Mohamed, 2021).

2. Concept of Green Finance and Sustainable Finance

Sustainable finance has been defined as the integration of environmental, social and governance considerations into financial decision-making, with the aim of balancing economic, social and environmental dimensions. It goes beyond being a financial technique and reflects a transformation in economic and social values, with a focus on people, ideas and fair reward rather than speculation. It is also viewed as a social concept arising from historical interactions and institutional pressures.

Financial sustainability also focuses on three main dimensions: the environmental dimension (the institution's impact on nature), the social dimension (the management of relationships with employees and communities), and governance (leadership structures and transparency) (Mehni Dinizad, 2026).

3. Relationship between Green Finance and Financing the Energy Transition

Green finance is one of the principal mechanisms supporting the energy transition by directing financial resources towards renewable-energy projects, improving energy efficiency, and reducing carbon emissions. Because these projects require substantial investment and long periods to recover capital, diversifying financing sources is important. These sources include green loans, bonds and sukuk, as well as public-private partnerships.

In this context, commercial banks play an important role in mobilising financial resources and assessing risks associated with energy projects, thereby improving their prospects of obtaining finance. The effectiveness of these mechanisms depends on their suitability for the nature of the projects and on the availability of appropriate guarantees and regulatory frameworks. This makes it necessary to examine the characteristics of green-financing instruments and the possibility of deploying them in Algeria.

Financing mechanism	Role in financing the energy transition	Importance for energy projects
Green loans	Provide bank financing for environmentally eligible projects	Finance renewable-energy and energy-efficiency projects
Green bonds	Mobilise funds from investors for projects with specified environmental objectives	Provide additional sources of finance for large projects
Green sukuk	Mobilise resources through financing structures compliant with Islamic law	Broaden the potential investor and financier base
Sustainable investment funds	Pool financial resources and direct them towards sustainable projects	Diversify funding sources and investments
Public-private partnerships (PPP)	Involve public and private parties in financing, implementation and risk allocation	Support the delivery of energy infrastructure projects

Source: Prepared by the authors on the basis of theoretical literature on green-financing mechanisms and financing the energy transition.

Second: Green and Sustainable Financing Mechanisms

Activating the banking sector's role in financing the energy transition requires a package of modern green-financing instruments and mechanisms that can mobilise the necessary financial resources and share the risks associated with these distinctive projects. The principal mechanisms are outlined below.

1. Green Bonds

Green bonds are fixed-income securities that raise capital for projects with specified environmental benefits. Many green bonds issued by international and public financial institutions and various funds are “climate bonds”. They are issued at a fixed interest rate, with the principal repaid in full at maturity. Green bonds/sukuk are financial instruments issued by governments, the private sector, commercial banks or international financing institutions—for example, the World Bank issued the first green bond in 2008. The proceeds from green bonds are used exclusively to support specified projects that meet predetermined criteria for low-carbon development. These bonds have been welcomed by environmentally sustainable investors.

Green bonds have also been defined as “bonds whose proceeds are directed towards investment in environmentally friendly projects. Like other bonds, they nevertheless require specific, high standards and principles” (Lahcine Abdelkader, 2018).

2. Green Loans

Green loans are loans intended to finance projects that reduce the environmental impact of companies and institutions. They are used to support initiatives such as installing renewable-energy systems, improving energy efficiency in buildings, and adopting sustainable agricultural practices. Green loans are characterised by low interest rates and favourable terms designed to encourage companies to adopt sustainable practices. They also require periodic reports and third-party certification to ensure that funds are used for their designated purposes, thereby strengthening transparency and credibility.

3. Sustainable Sukuk

Sustainable sukuk are Islamic financing instruments designed to finance environmental projects in accordance with the principles of Islamic law. They rely on an asset-based financing model and risk-sharing, ensuring that funds are directed towards specified projects such as renewable energy and sustainable infrastructure. Sustainable sukuk are an attractive option for investors interested in ethical and sustainable investments because they combine financial returns with adherence to Islamic principles. The sustainable-sukuk market has grown noticeably in recent years, reflecting increased global demand for ethical and environmentally oriented finance. The aforementioned financial instruments were analysed in terms of their structures, advantages and challenges. Practical examples were also reviewed to illustrate how these instruments can be applied to successful green projects. This analysis provides a framework for understanding how the efficiency of green financial instruments can be improved and their positive effects on the environment and the global economy increased (Madouri Hada, 2024).

4. Green Investment Funds

These funds operate according to the same principles as conventional investment funds. They provide a system through which individual and corporate investors jointly participate in an investment programme managed by specialised investment advisers, with the aim of achieving the highest possible returns at the lowest possible level of risk. They also pool small investments for placement in different investment instruments, seeking to maximise returns, distribute risks, and provide liquidity to unit holders when requested. On this basis, funds have been established whose principal objective is to achieve environmental goals and launch environmentally friendly projects (Hammou and Mersli, 2022).

5. Public-Private Partnerships

A public-private partnership (PPP) is defined as a contractual agreement between a public authority and a private-sector partner under which the latter finances and provides public services using dedicated equipment or facilities. It is also defined as a contractual arrangement between a public body and a private-sector actor to deliver a project serving the public interest.

In this context, a partnership contract involves deferred payment by the public sector: the private company receives its dues in the form of periodic payments or rents from the date on which the completed facilities are made available. The financial consideration is linked to performance criteria contractually defined for each

project stage. Such partnerships also allow private consortia and companies to bear financing risks and participate in the different stages of a project's life cycle, from design and construction to the maintenance and operation of public facilities, under a carefully designed long-term contract intended to ensure that agreed objectives are achieved (Hanane Chikhi and Chikhi, 2025, p. 129).

Third: The Role of Commercial Banks in Financing the Energy Transition and Managing Its Risks

Commercial banks are key actors in supporting the financing of the energy transition, whether by providing the finance required for energy projects or by adopting effective mechanisms to assess and mitigate associated risks, thereby improving the likelihood that these projects will succeed and remain financially sustainable.

1. The Role of Commercial Banks in Financing Energy-Transition Projects

Commercial banks play an important role in financing energy-transition projects by providing loans for investment in renewable energy and improvements in energy efficiency, mobilising financial resources, and developing green-finance products suited to these projects' needs. They also contribute to financing large projects through co-financing and by strengthening partnerships with public and private institutions, allowing financing burdens to be shared and available funding sources to be expanded.

Their principal roles in this field include:

- Providing loans for renewable-energy and energy-efficiency projects.
- Mobilising financial resources and developing green-finance products.
- Participating in the co-financing of major projects.
- Contributing to project financing through partnerships with public and private institutions.

2. Managing Risks Associated with Financing the Energy Transition

Risk management is a fundamental element of commercial banks' decisions concerning the financing of energy-transition projects, given the financial, technical, regulatory, market and climate-related challenges these projects entail. Managing these risks requires assessing projects' economic viability, analysing expected cash flows, verifying the adequacy of collateral, and assessing borrowers' repayment capacity. It also requires examining technical and technological risks associated with project implementation and operation, and monitoring regulatory changes, energy-price fluctuations and climatic conditions that may affect project returns. In addition, incorporating environmental, social and governance criteria into credit decisions helps improve risk assessment and direct finance towards more sustainable projects.

The main aspects of risk management are as follows:

- Credit risk: assessing borrowers' ability to meet their obligations and reducing the risk of default.
- Technical and technological risks: examining the reliability of the technologies used and the risks associated with project implementation and operation.
- Regulatory, market and climate risks: monitoring regulatory changes, energy-price fluctuations and climatic conditions that affect project returns.
- Viability and collateral assessment: analysing economic feasibility and expected cash flows, and verifying the adequacy of collateral.
- Integration of sustainability criteria: taking environmental, social and governance criteria into account in credit decisions, thereby improving risk assessment and directing finance towards sustainable projects.

III. Comparative Analytical Study of Energy-Transition Financing Mechanisms in Algeria

The diversity of green and sustainable financing mechanisms is a key starting point for understanding the options available for financing energy-transition projects in Algeria, given the differences between these mechanisms in their characteristics, financing requirements, and ability to mobilise resources and distribute

risks. An analytical comparison is therefore required between green loans, green bonds, green sukuk, sustainable investment funds, and public-private partnerships, in terms of their advantages, limitations and suitability for the nature of energy projects and the specific features of Algeria's financial and banking environment.

1. Comparison Criteria and Analytical Method

The comparison of energy-transition financing mechanisms is based on a set of criteria that help identify each mechanism's characteristics and suitability for financing energy projects in Algeria. The main criteria include the volume of finance that can be mobilised, the suitability of the mechanism for long-term investment needs, its capacity to distribute risks, its implementation requirements, and its compatibility with Algeria's financial and banking environment.

Methodologically, the analysis draws on the descriptive-analytical and comparative approaches. It first presents the characteristics of green loans, green bonds, green sukuk, sustainable investment funds, and public-private partnerships, and then compares them according to the specified criteria to highlight each mechanism's advantages, limitations and activation requirements. The analysis also takes account of the nature of energy-transition projects and their differing financing needs, allowing areas in which each mechanism may be useful to be identified without assuming that one instrument is suitable for every project.

The comparative results are interpreted in light of the specific features of Algeria's financial and banking environment, distinguishing the theoretical characteristics of financing mechanisms from the practical possibilities for applying them. The latter depend on the availability of appropriate regulatory frameworks, the development of financial markets, and financial institutions' capacity to assess and manage risks.

2. Comparison of Green-Financing Mechanisms in Terms of Advantages, Constraints and Risks

Green-financing mechanisms differ in their ability to mobilise financial resources, their suitability for the scale and investment horizons of energy projects, and the nature of the risks associated with their use. Analysing these differences makes it possible to identify the advantages and limitations of each mechanism and clarify the conditions for using it to finance the energy transition in Algeria.

Financing mechanism	Advantages	Constraints	Main risks
Green loans	Relatively easy to use through existing banking channels; repayment periods can be adapted to the project.	Adequate collateral is required, along with a careful assessment of economic feasibility and repayment capacity.	Credit risk, project failure, and technical and operational risks.
Green bonds	Mobilise long-term financial resources, broaden the investor base, and direct funds towards specified environmental projects.	Require a suitable financial market and procedures for issuance, disclosure and monitoring the use of funds.	Market and interest-rate risks, liquidity risk, and failure to meet declared environmental objectives.
Green sukuk	Attract investors seeking Sharia-compliant instruments and finance energy projects through appropriate contractual structures.	Require clear Sharia and legal structuring, identification of eligible assets or projects, and an available investor base.	Project- and asset-related risks, as well as market and operational risks depending on the sukuk structure.
Sustainable investment funds	Pool funds from multiple investors, diversify investments, and	Require specialised management, transparency in project	Investment risk, return volatility, portfolio concentration, and

Financing mechanism	Advantages	Constraints	Main risks
	distribute risks across a portfolio of projects.	selection, and suitable investment opportunities.	exaggerated environmental claims.
Public-private partnerships (PPP)	Mobilise private-sector finance and expertise and share some construction and operating risks between parties.	Contracts are complex, negotiations can be lengthy, and an effective regulatory and institutional framework is needed.	Construction delays, operational risks, regulatory changes, and failure to achieve expected revenues.

Source: Prepared by the authors on the basis of the theoretical characteristics of green and sustainable financing mechanisms.

The comparison shows that green loans are a suitable option for projects whose repayment capacity can be assessed clearly. Green bonds and green sukuk can mobilise broader resources for projects requiring substantial long-term financing, provided that issuance and disclosure requirements are met and an investor base is available. Sustainable investment funds make it possible to pool resources and diversify investments, while public-private partnerships are more suitable for large projects requiring long-term coordination between public bodies, investors and financing entities.

In Algeria, the suitability of these mechanisms depends not only on their theoretical advantages but also on the availability of the conditions required for implementation, including financial-market development, clear regulatory frameworks, adequate guarantees, and banks' capacity to assess risks. Diversifying and combining financing mechanisms may therefore provide more flexible options for financing the energy transition than relying on a single instrument for all projects.

3. Assessing the Suitability of the Mechanisms for Algeria's Financial Environment

The suitability of green-financing mechanisms for financing the energy transition in Algeria depends on the nature of energy projects, the scale of their financial needs, the level of development of the banking system and financial markets, and the regulatory and institutional framework governing sustainable finance. Opportunities to benefit from these mechanisms therefore vary according to their requirements and their capacity to respond to the specific features of Algeria's financial environment.

Financing mechanism	Suitability for Algeria's financial environment	Main activation requirements	Role of commercial banks
Green loans	Can be deployed through existing banking channels to finance renewable-energy and energy-efficiency projects.	Adapt financing periods, develop risk assessment, and provide appropriate guarantees.	Finance projects, assess their economic and environmental feasibility, and monitor repayment capacity.
Green bonds	Can mobilise long-term resources, although their spread depends on capital-market development.	Establish a clear issuance and disclosure framework, attract investors, and monitor the use of funds.	Arrange issues, invest in them, or finance related projects according to banks' capabilities.
Green sukuk	Can diversify funding sources and attract investors seeking Sharia-	Provide an appropriate legal and Sharia framework, identify	Help structure financing or arrange issues, or finance projects under

Financing mechanism	Suitability for Algeria's financial environment	Main activation requirements	Role of commercial banks
	compliant instruments.	eligible projects, and develop the issuance market.	approved structures.
Sustainable investment funds	Can pool resources and distribute investments across several projects, depending on the development of the investment environment.	Strengthen specialised expertise, transparency, and disclosure of environmental impact.	Finance projects directly or help mobilise resources and assess investment risks.
Public-private partnerships (PPP)	Potentially suitable for major energy projects requiring diverse investment and expertise.	Ensure clear contracts, define parties' responsibilities, allocate risks, and maintain transparent contracting.	Provide finance, participate in co-financing, and assess projects' financial risks.

Source: Prepared by the authors on the basis of a comparative analysis of the theoretical characteristics of green-financing mechanisms and the requirements for deploying them in Algeria's financial environment.

The comparison reveals differences between green-financing mechanisms in their implementation requirements and suitability for Algeria's financial environment. Green loans can make use of existing banking channels, whereas green bonds, green sukuk and sustainable investment funds require the development of financial markets and disclosure and governance frameworks. Public-private partnerships can facilitate the financing of major projects and the sharing of their risks through clear contractual arrangements. Accordingly, strengthening the financing of the energy transition in Algeria requires diversifying and combining mechanisms according to project type, size and risk, while developing commercial banks' role in risk assessment and resource mobilisation.

4. Discussion of the Hypotheses in Light of the Analytical Results

In light of the comparative analysis of green and sustainable financing mechanisms and the assessment of their suitability for Algeria's financial and banking environment, the study's hypotheses can be discussed with reference to the theoretical characteristics of these mechanisms, their advantages and limitations, and the requirements for activating them in the financing of energy-transition projects.

Hypothesis 1: Green and sustainable financing mechanisms help diversify sources of energy-transition finance.

The analytical results support this hypothesis. Green loans, green bonds, green sukuk, sustainable investment funds, and public-private partnerships offer diverse financing options that differ in the resources they mobilise, financing periods, conditions of access, and capacity to distribute risks. However, the benefits of these mechanisms are not realised to the same degree in every context; they depend on financial-market development, the availability of appropriate regulatory frameworks, and institutions' ability to attract investors and direct resources towards eligible projects.

Hypothesis 2: Commercial banks play a central role in financing the energy transition by mobilising financial resources and managing risks associated with green projects.

The comparison supports this hypothesis in theoretical terms, given commercial banks' ability to provide finance through loans, assess projects' creditworthiness, analyse expected cash flows, and monitor implementation, operational and repayment risks. They can also contribute to co-financing arrangements with investors and other institutions. Nevertheless, the effectiveness of this role depends on banks' ability to assess

technical and environmental risks, align financing periods with the nature of energy projects, and secure appropriate guarantees and supportive regulatory frameworks. The central role of banks does not mean that they can independently cover all financing needs; rather, it highlights the importance of complementarity with other financing mechanisms.

Hypothesis 3: Activating green finance in Algeria is linked to the development of the regulatory and institutional framework and the strengthening of risk-management mechanisms.

The analytical results support this hypothesis. Expanding the use of green-financing mechanisms requires clear criteria for identifying eligible projects, stronger disclosure and transparency requirements, and the development of banking expertise in assessing environmental and technical risks, alongside improvements in guarantee and risk-sharing mechanisms. The development of financial markets and the provision of a suitable contractual and regulatory environment for issuing green bonds and sukuk and activating public-private partnerships are also important. Diversifying financing instruments alone is therefore insufficient to ensure their effectiveness unless accompanied by institutional and regulatory development that supports their use and limits associated risks.

The analysis indicates that financing the energy transition requires an integrated approach combining diversified financing mechanisms, a stronger role for commercial banks in mobilising resources and managing risks, and the development of the regulatory and institutional environment for sustainable finance. The comparison also indicates that the suitability of financing mechanisms varies with project size, nature, financial needs and risk level, making a combination of financing instruments more appropriate than exclusive reliance on a single mechanism. These conclusions remain within the limits of descriptive and comparative analysis; they do not constitute a statistical test or field measurement of the extent to which these mechanisms are used in Algeria.

IV. Financing Challenges and Proposed Activation Mechanisms

Understanding the nature of banking constraints and exploring available alternatives is an essential step towards bridging the gap between national ambitions for the energy transition and the realities of financing on the ground. Although the financial sector has a central role, the banking system faces a range of structural and financing challenges that impede the flow of credit to green projects. This makes it necessary to seek alternative and innovative mechanisms and solutions that can activate banks' role and enable them to support this strategic transition efficiently and securely.

1. Financing and Banking Challenges in Algeria

Efforts to finance the energy transition in Algeria encounter structural and banking obstacles that hinder the flow of bank credit to renewable-energy projects. The principal challenges are as follows:

- **High investment costs and long payback periods:** Renewable-energy and hydrogen projects involve substantial initial investment costs and require a relatively long period to recover the investment and generate returns. This creates a genuine financing gap that conflicts with the financial structure of commercial banks, which rely mainly on deploying short-term deposits and are reluctant to tie up resources for extended periods without adequate structural guarantees.
- **Difficulty assessing environmental and technical risks:** The banking system lacks clear standardised tools and has insufficient specialised human and technical expertise to assess the environmental and climate-related risks of these activities accurately. This knowledge gap creates credit uncertainty and encourages financial institutions to adopt cautious policies that limit lending to projects involving complex technologies.
- **Inadequate conventional collateral and a lack of specialised insurance:** Investors in clean energy are often unable to provide the tangible and conventional collateral required by commercial banks, such as real estate and traditional assets. At the same time, specialised banking-insurance mechanisms and risk-guarantee funds that protect financiers against technological shocks or fluctuations in energy markets are weak or absent.
- **Limited alternative and specialised financing markets:** The limited depth of financial markets, such as the Algiers Stock Exchange, and the absence of active green capital markets, together with the limited use of environmentally oriented Islamic-finance instruments such as green sukuk, leave the financing burden almost

entirely on commercial banks, without bonds or shared investment channels through which risks can be distributed.

- Weak green-banking awareness among market participants: Many project owners and small and medium-sized enterprises lack sufficient awareness of environmental-transition requirements and of how to prepare financial feasibility studies aligned with environmental, social and governance (ESG) criteria. This makes it more difficult for banks to assess applications and market green financial products effectively.
- Complex administrative and bureaucratic procedures: Renewable-energy projects and their financing face complicated administrative and bureaucratic obstacles when obtaining the required permits and licences. These obstacles extend project-delivery periods and increase total costs, heightening banks' concerns about whether project cash flows will materialise on schedule.

2. Mechanisms for Developing Green Finance and Risk Management

Addressing the financing barriers to the energy transition in Algeria requires an integrated package of solutions and alternative mechanisms to activate the financial sector's role. The main areas are set out below:

- Developing green-banking and sustainable-finance products: To strengthen and develop green-banking and sustainable-finance products in the banking sector, the following strategic and operational steps may be adopted on the basis of theoretical and analytical frameworks:
 - Integrating environmental, social and governance considerations: These criteria should be embedded in financial and banking decision-making to achieve a careful balance between economic, social and environmental dimensions.
 - Adopting the principle of double materiality: This principle should be applied as a core requirement obliging financial institutions to assess impact materiality (the effect of the bank and its activities on the environment and society) and financial materiality (the effect of climate risks on the institution's financial position).
 - Activating responsible-investment strategies: Key strategies, such as screening to determine investment eligibility, should be used, and environmental and governance factors integrated to improve risk-adjusted returns.
 - Adopting an impact-investing approach: Banking products should be directed towards creating a genuine and measurable positive impact on the environment and society while also seeking financial returns.
 - Introducing environmentally friendly credit lines and banking services on preferential terms, such as longer maturities, lower interest rates and longer grace periods, to encourage institutions and investors to adopt clean technologies and energy-efficiency projects.
- Activating green Islamic sukuk: Green Islamic sukuk are a promising strategic financial instrument for mobilising savings and directing them towards energy-transition projects and sustainable infrastructure. To activate this instrument effectively in the financial and banking sector, attention may be focused on the following:
 - Using suitable participatory-finance structures: Islamic structures appropriate to energy projects, such as lease-to-own (ijarah muntahia bittamleek), istisna' for energy projects, and joint mudarabah, can provide the required finance without placing excessive pressure on conventional bank balance sheets.
 - Mobilising substantial financial resources: Available liquidity in Islamic capital markets can be used and investors interested in responsible and environmentally friendly investment attracted by issuing sukuk dedicated exclusively to green projects.
 - Providing off-balance-sheet financing alternatives: Financing pressure on commercial banks can be reduced by distributing the substantial financing risks associated with energy infrastructure more widely across the financial market.

Participatory-finance structures—such as *istisna'* for energy projects, lease-to-own (*ijarah muntahia bittamleek*), and joint *mudharabah*—can be used as effective financial instruments for mobilising substantial savings in the market and directing them towards major energy-infrastructure projects without overburdening conventional bank balance sheets.

- Establishing national risk-guarantee mechanisms: Specialised funds or institutions should be established, in partnership with the State, to guarantee loans for renewable-energy projects. By assuming a significant share of technological and climate-related risks, they could encourage commercial banks to reduce their credit conservatism.
- Establishing public-private partnership (PPP) frameworks: Joint arrangements between government institutions and the banking sector should be activated to finance major renewable-energy and hydrogen infrastructure projects, allowing financial burdens to be shared and the cost of capital to be reduced.

3. Regulatory and Institutional Requirements for Activating Sustainable Finance

Activating sustainable finance in Algeria requires the development of a clear regulatory framework that defines criteria for classifying green projects and requirements for disclosing their environmental effects. This would help banks assess projects and make financing decisions on a clearer basis. It is also necessary to strengthen banking expertise in assessing environmental and climate-related risks, improve coordination among banks, government bodies and guarantee institutions, and simplify administrative procedures associated with energy projects. These measures would create a more favourable environment for mobilising financial resources and directing them towards energy-transition projects.

Conclusion

In light of this study's theoretical analysis and comparison of green-financing mechanisms and the role of commercial banks in managing risks associated with energy-transition projects, financing this transition in Algeria clearly requires an integrated financial approach that goes beyond reliance on conventional bank loans. This entails diversifying funding sources, developing instruments suited to the nature of energy projects, and strengthening financial institutions' capacity to assess and manage associated risks. Investments in renewable energy, particularly solar energy and green hydrogen, are characterised by high initial costs and long capital-recovery periods, making the suitability of financing mechanisms and risk allocation essential factors for success.

The comparative analysis has shown that green-financing mechanisms—including green loans, green bonds, green *sukuk*, sustainable investment funds, and public-private partnerships—differ in their requirements for use, their capacity to mobilise financial resources, and the nature of the risks borne by the parties involved. No single financing mechanism is suitable for every project. Rather, the suitability of each mechanism depends on the project's size and stage, expected cash flows, risk level, and the characteristics of the regulatory and financial environment in which it operates.

First: Findings

Within the limits of its descriptive-analytical and comparative methodology, the study reached the following theoretical and analytical findings:

- The multiple dimensions of green finance: Green finance goes beyond allocating financial resources to projects with positive environmental effects. It also involves incorporating environmental considerations and climate risks into financing and investment decisions and developing disclosure and monitoring mechanisms to direct resources towards energy-transition projects.
- Differences in the characteristics and suitability of green-financing mechanisms: The comparison shows that green loans use existing banking-intermediation channels, while green bonds and *sukuk* offer additional opportunities to mobilise resources from investors. Investment funds and public-private partnerships can also contribute to project financing according to the nature and scale of each project. However, the effectiveness of

these mechanisms remains linked to the availability of suitable regulatory frameworks, clear criteria for the use of funds, disclosure and oversight mechanisms, and investors' willingness to participate.

- The importance of commercial banks' role in risk management: Commercial banks do more than provide finance; they assess projects' economic and financial feasibility, analyse cash flows, estimate credit, technical and market risks, and monitor the use of funds allocated to green purposes. These tasks require the development of banking expertise and stronger coordination between financial institutions and specialised technical bodies.
- The range of challenges associated with financing energy projects: The analysis highlights that high investment costs, long capital-recovery periods, and the difficulty of estimating certain technical and market risks may reduce the attractiveness of these projects to financiers, particularly when suitable guarantees or effective risk-sharing mechanisms are unavailable. Addressing these challenges requires assessment, guarantee and insurance instruments adapted to project characteristics.
- The importance of the financial and regulatory environment in activating green finance: Expanding the use of green bonds, green sukuk and sustainable investment funds depends on the existence of a financial market capable of accommodating these instruments and clear rules for issuance, disclosure and monitoring, as well as conditions that enable domestic savings to be mobilised and investors attracted. Developing green finance is therefore not solely a banking-sector task; it requires complementary roles for regulatory authorities, financial institutions and the private sector.
- The potential of Islamic finance and public-private partnerships: Green sukuk, together with financing structures such as ijarah, istisna' and mudarabah, depending on the project and financing structure, can provide additional alternatives for mobilising resources. Public-private partnerships can also distribute obligations and risks among the parties, provided that contracts are clear, responsibilities are defined, feasibility studies are rigorous, and monitoring mechanisms are effective.

These findings indicate that activating green finance in Algeria depends not only on the availability of financial resources but also on improving the regulatory environment, developing risk-management instruments, diversifying financing sources, and strengthening technical and institutional capacities. These conclusions derive from theoretical and comparative analysis and do not constitute a field measurement of the volume of green finance or the level of involvement of Algerian commercial banks. Further applied studies are therefore needed to verify them using official banking and financial data.

Second: Recommendations

Based on the preceding findings, the study proposes the following recommendations to strengthen the role of commercial banks and develop mechanisms for financing the energy transition in Algeria:

- Developing the regulatory framework for green finance: Establish clear guidance and criteria for identifying projects eligible for green finance and strengthen disclosure of environmental objectives, the use of funds and results achieved. This would reduce the risk of unsupported environmental claims and help financial institutions standardise their practices in this area.
- Strengthening the integration of environmental risks into banking decisions: Encourage commercial banks to incorporate environmental, climate-related and technical risks into the assessment of financing applications, and develop tools to evaluate project feasibility and risks throughout the project life cycle, in coordination with experts and specialised energy institutions.
- Examining the establishment of a national green-risk guarantee mechanism: Assess the possibility of creating a fund or guarantee scheme shared by the State and financial institutions, offering carefully designed partial guarantees for eligible projects. This would reduce credit risk and improve banks' ability to finance projects with economic and environmental viability, while ensuring the financial sustainability of the mechanism.
- Diversifying financing sources and developing the financial market: Encourage the development of green-bond and green-sukuk issues under clear regulatory frameworks and strengthen the role of the securities market

in mobilising domestic savings and attracting investors, while providing disclosure requirements and verification of the environmental use of funds.

- **Developing Islamic finance for energy projects:** Examine the use of green sukuk and financing structures such as *ijarah*, *istisna'* and *mudarabah*, as well as other suitable forms, according to each project's nature and legal, Sharia and financial requirements. This would broaden the financing base and provide a wider range of financing alternatives.
- **Strengthening specialised banking expertise:** Organise training programmes in green finance and environmental and technical risk management, and encourage commercial banks to establish specialised units or teams to assess and monitor energy projects in cooperation with universities, research centres and specialised bodies.
- **Expanding the use of public-private partnerships:** Examine the use of this arrangement to finance energy infrastructure projects, including renewable-energy and green-hydrogen projects whose feasibility studies demonstrate suitability. The responsibilities of each party should be specified, risks allocated clearly, and contracting and monitoring procedures kept transparent.
- **Strengthening institutional coordination and simplifying procedures:** Support cooperation among regulatory authorities, the banking sector and institutions concerned with energy and investment; improve the exchange of technical and financial information; and facilitate administrative procedures for projects eligible for green finance.

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