European Journal of Business, Economics & Management

Vol. 1 No. 2 2025

Article Open Access

Research on the Innovative Application of Fintech and AI in Energy Investment

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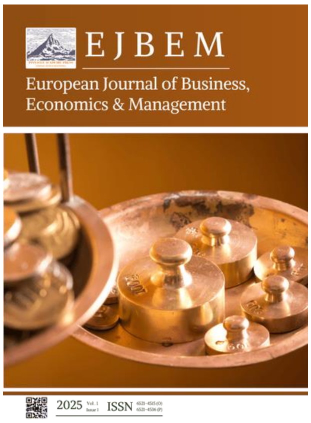

Abstract: With the transformation of energy structure and the rapid rise of digitalization, financial technology and artificial intelligence technology have enormous potential in the field of energy investment. This article mainly explores innovation in the field of energy investment based on the application of financial technology and AI technology. It summarizes relevant theories, constructs corresponding application architectures, analyzes challenges such as data silos, weak risk identification capabilities, and insufficient regulatory adaptability, and provides countermeasures, such as multi-source data analysis and processing technology, AI-based risk prediction systems, and regulatory sandbox mechanisms. The deep integration of financial technology, AI technology, and other technologies will fully enhance the efficiency of energy investment, risk control capabilities, and intelligent decision-making ability, and help build a more efficient energy finance system.

Keywords: financial technology; artificial intelligence; energy investment

Received: 26 April 2025
Revised: 08 May 2025
Accepted: 23 June 2025
Published: 26 June 2025

1. Introduction

In the context of the "dual carbon" goal, the energy industry is developing from high carbon to low-carbon, from intensive to distributed, and from industrialization to intelligent. Traditional energy investment methods can no longer meet the needs of market changes, investment risk management, and resource allocation. Correspondingly, financial technology applications are gradually integrating artificial intelligence technology with the investment field through emerging methods such as big data analysis, intelligent algorithms, and blockchain. These technologies are being applied to energy project investment evaluation, risk control, investment operation, and other aspects. At present, energy investment companies both domestically and internationally are utilizing AI technology for power generation forecasting, price modeling, and intelligent trading, achieving significant results in improving efficiency, reducing costs, and preventing risks. However, in practice, energy investment with fintech and AI faces problems such as weak technological integration and weak regulatory adaptability, which require further theoretical discussion and empirical testing for improvement. Therefore, in order to promote the digitalization of the energy industry, systematic research should be conducted on the methods for solving problems, and targeted solutions for problem improvement should be proposed.

2. Theoretical Overview of Fintech and AI in Energy Investment

FinTech is the application of new technologies such as big data, cloud computing, blockchain, and AI to financial services, optimizing financial services to enhance financial efficiency and innovation capabilities. The integration of financial technology into the energy sector not only solves information asymmetry and low operational efficiency, but also provides a new approach to address energy project risk management and real-time monitoring issues [1]. In particular, AI, as a core technology of financial technology, demonstrates superior capabilities through data analysis, prediction of future trends, and intelligent decision-making.

In the field of energy investment, the combination of financial technology and AI is mainly reflected in three aspects:

1) Analyzing energy market dynamics with big data, capturing price trends, trading methods, and investment opportunities through algorithm models.
2) Raising funds and providing investment project options for investors in an intelligent form, capable of identifying project feasibility, environmental risks, and economic benefits on their own.
3) Adopting smart contracts and blockchain to enhance the transparency and security of project fundraising and asset exchange processes.

In addition, artificial intelligence can be used to predict the efficiency of renewable energy generation, optimize storage management, and determine the value of carbon asset management. Currently, financial technology (FinTech) and artificial intelligence (AI) have gradually formed a full-process digital path covering "financing, investment, and transaction management", promoting the transformation of energy investment from experience-driven to data-driven, and becoming an important engine for the green transformation of the energy sector and sustainable financial development.

3. Framework Construction of Fintech and AI in Energy Investment

3.1. Framework for Energy Financial Technology Applications

The energy fintech application framework is a digital system structure composed of core capabilities in fintech innovation, covering various stages from energy investment, fund management, risk identification and control, transaction implementation, and the entire investment cycle. The framework is divided into four levels:

1) Data Collection and Integration Layer: Real-time data on energy production and trading, carbon emissions, etc. are collected and integrated through IoT technology, satellite imagery technology, blockchain technology, etc.
2) Intelligent Analysis and Modeling Layer: Using artificial intelligence (AI) technology, including machine learning, natural language processing, etc., to analyze and design market trend research, project evaluation, credit rating, and risk identification.
3) Financial Services and Transaction Layer: Adopting integrated financial service methods and products such as intelligent investment advisory, blockchain smart contracts, and online financing platforms to enhance investment value and facilitate services.
4) Regulatory and Compliance Support Layer: Establishes a verifiable and traceable security protection mechanism through the use of data tracking, intelligent review, compliance algorithms, etc.

This framework places greater emphasis on the interoperability and data-driven nature of each component, greatly enhancing the precision, feedback speed, and transparency of energy investment. At the same time, it provides technical and policy prerequisites for promoting the development of green finance and reducing carbon footprint (Figure 1) [2].

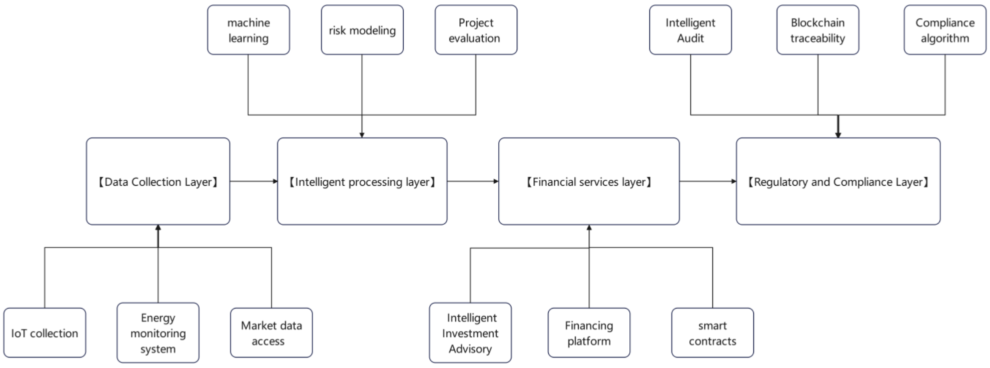

Figure 1. Application Framework of Energy Financial Technology.

3.2. Artificial Intelligence Decision Support Framework

The artificial intelligence decision support framework is a system structure that utilizes AI technology to achieve data-driven processes, dynamic feedback mechanisms, and intelligent judgment in the energy investment process, aiming to improve decision-making efficiency and risk control capabilities. This framework generally has four core modules:

1) Data Input Layer: responsible for integrating multi-source data, such as changes in the energy market, the impact of laws and regulations, financial situation, environmental impact, etc., to ensure the integrity of input information and real-time updates.
2) Model Analysis Layer: Using advanced technologies such as machine learning and deep learning to establish various prediction models, including factor elements such as power generation prediction, project profit prediction, carbon emission assessment, etc.
3) Strategy Output Layer: Based on model analysis, outputs countermeasures and suggestions, which may include project screening, fund allocation, risk warning, etc.
4) Feedback Optimization Layer: Provides feedback on the received information, continuously updates model parameters, and improves the system's adaptability and stability.

This framework realizes the transformation from "experience-based decision-making" to "intelligent decision-making", enhancing the scientific rigor, flexibility, and adaptability of energy investment to highly volatile and challenging energy markets, and achieving precision and long-term benefit maximization in various investment performance management (Figure 2).

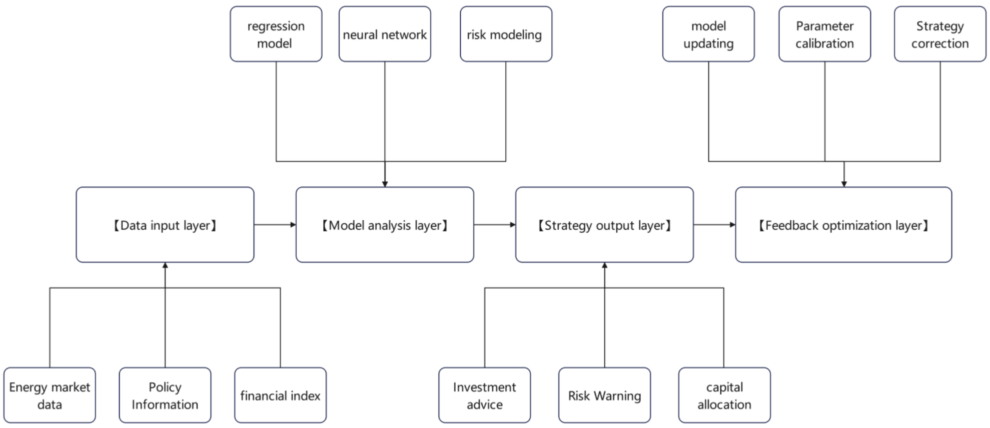

Figure 2. Artificial Intelligence Decision Support Framework Diagram.

3.3. Collaborative Innovation and System Integration Mechanism

Energy investment driven by financial technology innovation and artificial intelligence is moving towards intelligence, platformization, and ecosystem development. The collaborative innovation and system integration mechanism aims to break down industry barriers, enable efficient linkage between technology, platforms, and institutions, and create an energy investment industry ecosystem that combines financial technology and AI technology [3].

Firstly, various digital technologies such as big data analysis, blockchain, artificial intelligence, and the Internet of Things are applied to build a data management chain that covers the entire process from data collection, analysis, algorithm processing to decision output. For example, the application of blockchain ensures the credibility of transaction security, artificial intelligence assists in assessing and quantifying potential risks, big data analysis analyzes market trends, creating synergistic effects through multi-technology integration. Secondly, promote the establishment of a common platform system among energy companies, banks, and various technology suppliers, allowing data, algorithms, service modules, etc. to be interconnected, making data flow and the provision of various services more convenient, ultimately providing investors with more services. Thirdly, with the framework of "finance + technology + energy" tripartite cooperation, we will strengthen the sharing of policies, regulations, resources, and manpower. The government will create pilot areas or regulatory sandboxes, enterprises will implement technological applications and business model innovations, and research institutions will provide technical support and algorithm research and development to jointly build an investment environment that adapts to changes and updates.

4. The Problems of Financial Technology and AI in Energy Investment

4.1. Data Silos and Obstacles to Information Integration

In the field of energy investment, data is required throughout the entire lifecycle of project screening, risk management, fundraising, and decision-making. However, due to diverse data sources and relatively independent platforms, the phenomenon of "data silos" in the energy finance system is prominent. The lack of information interconnection and weak system interoperability affect the effectiveness of artificial intelligence model learning and the decision-making of fintech innovation products [4].

At present, organizations such as energy manufacturers, banks, and government departments with supervisory functions usually build independent data platforms, lacking unified data interfaces and communication rules. Even within the same company, there are issues of inconsistent formats and interface permissions between information systems of different departments, leading to drawbacks such as duplicate data capture and low data update rates, resulting in a decrease in the efficient analysis ability of artificial intelligence and a decline in the quality of artificial intelligence models. In addition, in order to ensure information security and confidentiality and take profitability into account, all institutions hold a conservative attitude towards data sharing, further increasing the difficulty of data exchange (Table 1).

Table 1. Typical Manifestations of Data Silos and Integration Barriers.

Serial Number	Expressions	Influence Outcome
1	Data platforms operate independently and lack interfaces	Unable to form a unified view, severe information fragmentation
2	Inconsistent data standards	The model training data has high noise, resulting in a decrease in prediction accuracy
3	The permissions between systems are not interoperable	Low efficiency of interdepartmental collaboration and delayed business processing

4	Lack of shared incentive mechanism	Data is unwilling to be shared, and resource allocation efficiency is limited

4.2. Insufficient Risk Identification and Intelligent Decision-Making Capabilities

Despite the initial introduction of fintech and artificial intelligence technologies in energy investment, many challenges remain. Firstly, current artificial intelligence models are insensitive to unexpected events and unknown data, making it difficult to capture global risks in real time caused by policy changes, extreme weather, or sudden shifts in the international energy market. Secondly, current intelligent decision-making relies on past data to build models but lacks the ability to integrate multiple factors and simulate scenarios. As a result, decision-making strategies are often simplistic and have limited execution effects. Thirdly, some artificial intelligence models operate as "black boxes", making it difficult to understand their decision processes, which reduces investor and regulator trust and limits their practical adoption. Under such conditions, if energy investment decision-making systems with low data quality, unclear model architecture, and incomplete response mechanisms still depend mainly on "human-assisted machines", truly intelligent management is difficult to achieve (Table 2).

Table 2. Typical Problems of Insufficient Risk Identification and Intelligent Decision-Making Capability.

Serial Number	Problem Expression	Resulting in Consequences
1	Slow response to sudden risk events	Expansion of investment losses and imbalance in asset allocation
2	The model relies on historical data and lacks foresight	Unable to adapt to dynamic markets, decision-making lags behind
3	The decision model structure is complex and difficult to explain	Low user trust, affecting the promotion and application of intelligent systems
4	Lack of simulation and feedback mechanism	The strategy adjustment is not timely, and the risk warning system is not sound

4.3. Inconsistent Technical Standards and Poor Regulatory Adaptability

Against the backdrop of accelerated empowerment of energy investment through fintech and artificial intelligence, issues such as differences in technical standards and lagging regulatory adaptation have become prominent. Firstly, different standards and rules for data interfaces, model structures, and risk levels set by various energy financial service platforms make it difficult to connect data interfaces. Model structures are not interoperable, and dynamic supervision of risk control is challenging. This results in difficulties in achieving cross-regional and cross-institutional technological system integration, and a common phenomenon of technological "islands" exists among various entities. For example, some platforms customize their design based on their own project evaluation methods, which may result in the inability to be "shared" by other financial institutions, thereby weakening the investment and financing effectiveness among various entities. Secondly, in algorithm systems that adopt AI technology, the "black box" algorithm decision-making makes it difficult for regulatory agencies to track and audit the activities and results of intelligent decision-making, further increasing blind spots in regulation. Thirdly, at present, financial regulation focuses more on traditional financial businesses, paying insufficient attention to emerging businesses involving AI decision-making. These businesses are data-driven and based on blockchain technology transactions, resulting in policy lag and regulatory gaps.

5. Innovative Application Optimization Strategies of Financial Technology and AI in Energy Investment

5.1. Building a Multi-Source Data Fusion and Intelligent Analysis Platform

In the field of new energy investment and construction, the integration and intelligent analysis of multi-source data have become critical components in improving decision-making accuracy. For example, in a wind power project of State Power Investment Corporation, data integration is achieved by combining wind speed monitoring data, meteorological data, historical power generation, electricity market prices, carbon emission indices, and other data, and importing them into a shared database to form a process model of economic output benefits caused by natural conditions. The platform introduces AI algorithms to clean and fuse multi-source data, and on this basis, constructs a power generation estimation model and a financial value profit and loss evaluation model, providing investors with dynamic adjustment strategies and risk avoidance methods. This system can reduce the prediction error rate by 22% and increase the total project revenue by about 15% compared to traditional methods.

In the process of model construction, intelligent analysis platforms often use weighted feature fusion methods to uniformly express multi-source data. The basic formula is:

$$X_f = \sum_{i=1}^{n} \omega_i \cdot x_i \quad (1)$$

Among them, X_f represents the fused feature vector, x_i is the standardized feature input from the i-th data source, ω_i is its corresponding weight coefficient, and satisfies $\sum_{i=1}^{n} \omega_i = 1$. Using machine learning algorithms such as RF or XGBoost to dynamically assign weights further improves the accuracy of comprehensive analysis results and the stability of the model. The application of platform models provides an intelligent investment foundation for energy decision-making, solving problems such as data fragmentation, analysis lag, and low decision-making efficiency.

5.2. Promote AI Driven Risk Modeling and Investment Prediction System

In the energy investment sector, risk factors are complex and constantly changing, making traditional static analysis methods no longer suitable for dynamic monitoring and real-time estimation. An energy investment fund introduced artificial intelligence risk models and investment prediction frameworks to comprehensively simulate policy reforms, energy price changes, equipment stability, market demand, and other aspects involved in investing in a photovoltaic and energy storage project. This framework utilizes Long Short-Term Memory (LSTM) networks for sequence prediction of historical data and employs Monte Carlo techniques to evaluate the distribution of investment returns. This framework is able to reduce the prediction error of project net present value (NPV) by 18% compared to traditional methods, while accurately identifying two core risk factors, helping investors make targeted optimization investment decisions.

The core risk modeling adopts the following LSTM time series prediction formula:

$$h_t = \sigma(W_h \cdot h_{t-1} + W_x \cdot x_t + b) \quad (2)$$

Among them, h_t represents the implicit state of the current time step, x_t is the current input feature (such as electricity price, radiation intensity, etc.), W_h and W_x are weight matrices, b is the bias term, and σ is the activation function (such as tanh). This structure is able to preserve the long-term impact of historical risk factors, maintain sensitivity to the latest market information, and enhance the forward-looking prediction and response capabilities of energy investment through AI-based risk modeling methods. It provides a scientific and quantitative tool for complex projects, promoting the healthy, efficient, and stable development of investment.

5.3. Establish a Sound Technical Standard System and Regulatory Sandbox Mechanism

The widespread application of financial technology and artificial intelligence in energy investment cannot be separated from a unified technical standard system and inclusive regulatory mechanisms. Due to the incompleteness of technical standards and regulatory frameworks, development has been hindered. Therefore, it is necessary to establish a complete standard system focusing on data interoperability, model design, and risk control compliance. This system should unify technical specifications and operational guidelines, facilitating communication between different platforms, model reuse, data interoperability, and sharing. At the same time, by constructing regulatory sandboxes through regulatory authorities, a policy environment with limited space and controllable risks can be provided for the market, which can promote experimental research on new technologies.

Taking the "Green Financial Technology Sandbox" pilot in Shanghai Free Trade Zone as an example, a new energy enterprise and financial institution have teamed up to create a blockchain-based carbon asset trading platform. In a sandbox environment, projects can undergo on-chain testing and operation in compliance with current regulations, and regulatory agencies are also involved in the assessment and evaluation of the legality and technical risks of such systems. At this stage, the platform has achieved full traceability of carbon asset certification, trading, and verification, improving its trading efficiency and credit transparency. This case illustrates that the sandbox mechanism not only lowers the threshold for technological legitimacy, but also contributes to actively guiding and promoting flexible regulation.

6. Conclusion

Fintech and AI technologies are increasingly changing the mechanisms and methods of energy investment. On this basis, this article constructs an overall framework for energy finance technology and AI applications. It analyzes the problems still faced in practice, such as data fragmentation, limited risk identification ability, and low regulatory efficiency, and proposes improvement strategies through diversified integration of data resources, construction of intelligent models for risk identification, and innovation of institutional methods. It is concluded that only by achieving the coordinated evolution of technology, data, and institutions can the potential of financial technology and AI in the field of energy investment be better released. In the future, it is necessary to establish an intelligent, efficient, and sustainable energy finance ecosystem for the construction of industry standards and policy guidance.

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