Research on the Intrinsic Correlation Relationship of Low-Voltage Platform Power Data Based Online Loss

Jing Yang, Wenbo Ye, Qiang Song and Zhongjing Zhang
Guizhou Power Grid Co., Ltd, Guiyang, Guizhou, China

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Abstract: In modern power grid management, accurately grasping and analyzing the power data of low-voltage stations is an important part of improving energy efficiency and optimizing resource allocation. One of the links that cannot be ignored is the in-depth study of the line loss rate. Line loss, that is, the energy loss in the process of power transmission, is directly related to the economic benefits and operational safety of the power system. Therefore, this paper aims to reveal the complex relationship between power and line loss in the low-voltage station area through rigorous data correlation analysis, and discuss how to effectively reduce the line loss and improve the overall performance of the system. The MATLAB simulation results show that under certain evaluation criteria, the line loss is superior to the traditional electric energy inspection mode in terms of the accuracy of the internal correlation relationship research and the time of the influencing factors of the data internal correlation research.

1 INTRODUCTION

In order to understand the internal logic of the power data (ZHANG, TAN, et al. 2022) in the low-voltage station area (Zhou, Tan et al. 2022), it is necessary to start from its constituent elements (Quan, Bao, et al. 2022). Electricity data includes electricity consumption, power supply (ZHOU, 2022), and the resulting line loss (SHA, ZHOU, et al. 2022). These three form a dynamic equilibrium system (WU, YU, et al. 2022) that influences and restricts each other (Wang, Wang, et al. 2022). Electricity consumption reflects the actual demand of the end user (Zhongyao, Zhang, et al. 2023), power supply is the amount of resources invested by the grid to meet this demand (Cai, Li, et al. 2023), and line loss represents the energy loss that has to be sustained in this supply and demand process (Zhang,, Li, et al. 2023).

2 RELATED CONCEPTS

2.1 Mathematical Description of Line Loss

Specifically, when the low-voltage power data collected by the monitoring equipment shows an abnormal increase or fluctuation, the first thing to do is to rule out accidental factors, such as short-term power spikes caused by weather changes. Then, it is necessary to deeply analyze the influence of potential factors such as line aging, uneven load, and equipment defects on line loss. This analysis is not a simple linear inference, but a multivariate comprehensive evaluation process.

$$\lim_{x\to\infty}(y_i \cdot t_{ij}) = y_{ij} \geq \max(t_{ij} \div 2) \tag{1}$$

Among them, the judgment of outliers is shown in Equation (2).

$$\max(t_{ij}) = \partial(t_{ij}{}^2 + 2\cdot t_{ij}) \succ mean(\sum t_{ij} + 4)\mathrm{M} \tag{2}$$

Line loss combines the advantages of computer technology and uses data intrinsic correlation research to quantify, which can improve the accuracy of data intrinsic correlation research.

If a line is operating at high load for a long time, even if there are no obvious signs of failure in the short term, it may lead to a gradual increase in the line loss rate. In addition, with the arrival of peak demand periods, energy losses can also be exacerbated if the distribution transformer capacity cannot meet the

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sudden increase in demand. These phenomena show the complexity and variability of the internal logic of the power data in the low-voltage station area.

$$F(d_i) = \square \prod \sum t_i \bigcap \xi \cdot \sqrt{2} \rightarrow \oiint y_i \cdot 7 \quad (3)$$

2.2 Selection of Research Protocols for Data Intrinsic Correlation Studies

In response to this problem, effective solutions should include measures such as updating old equipment, intelligent adjustment of load distribution, and energy-saving guidance for high-energy-consuming users. Taking equipment renewal as an example, the introduction of energy-efficient transformers and cables can not only reduce the loss rate of the base line, but also improve the system's ability to withstand peak power pressure.

$$g(t_i) = \ddot{x} \cdot z_i \prod F(d_i) \frac{dy}{dx} - w_i \quad (4)$$

The use of big data analysis and artificial intelligence technology to deeply mine the power data of the low-voltage station area can more accurately predict and adjust the load of the power grid. This not only helps to achieve the optimal control of line loss, but also can detect potential safety hazards in advance, providing strong data support for the stable operation of the power grid.

$$\lim_{x \to \infty} g(t_i) + F(d_i) \le \bigcap \max(t_{ij}) \quad (5)$$

In order to improve the effectiveness of data intrinsic association research, it is necessary to standardize all data, and the results is shown in Equation (6).

$$\overline{g(t_i)} + F(d_i) \leftrightarrow mean(\sum t_{ij} + 4) \quad (6)$$

2.3 Analysis of the Research Protocol of the Intrinsic Association Relationship of the Data

In addition, the implementation of time-of-use electricity price policy is also an effective means. By setting the electricity price reasonably in different time periods, users are encouraged to use electric energy at staggered peaks, which can not only smooth the electricity consumption curve, reduce the additional line loss caused by the peak power consumption, but also promote a more reasonable allocation of social resources.

$$No(t_i) = \frac{\overline{g(t_i)} + F(d_i)}{mean(\sum t_{ij} + 4)} \sqrt{b^2 - 4ac} \quad (7)$$

Among them, it is $\frac{\overline{g(t_i)} + F(d_i)}{mean(\sum t_{ij} + 4)} \le 1$ stated that the scheme needs to be proposed, otherwise the scheme integration is required, and the result is $Zh(t_i)$ shown in Equation (8).

$$Zh(t_i) = \bigcap [\sum \overline{g(t_i)} + F(d_i)] \quad (8)$$

As an important bridge connecting users and the power grid, the accuracy and real-time nature of the power data of the low-voltage station area play a vital role in the operation efficiency and reliability of the entire power grid. This article will discuss how to optimize the collection, monitoring and management of electricity data in low-voltage stations to improve the overall performance of the power grid, while ensuring the safety and satisfaction of end users.

$$accur(t_i) = \frac{\min[\sum \overline{g(t_i)} + F(d_i)]}{\sum \overline{g(t_i)} + F(d_i)} \times 100\% \quad (9)$$

The key to achieving effective power management in the low-voltage station area is to establish a comprehensive monitoring system. The system should include smart meters that enable real-time data acquisition and transmission of data to a central database via a communication network. This not only provides accurate information on electricity consumption, but also instantly detects any abnormal fluctuations, such as sudden increases or decreases in power, so that timely action can be taken to prevent power loss and potential system failures.

$$accur(t_i) = \frac{\min[\sum \overline{g(t_i)} + F(d_i)]}{\sum \overline{g(t_i)} + F(d_i)} + randon(t_i) \quad (10)$$

Through in-depth analysis and scientific management of the power data of the low-voltage station area, we can gradually uncover its internal correlation logic, so as to effectively reduce the line loss and improve the overall performance of the power grid. It's as much a science as it is an art. In today's increasingly tight energy situation, let us work together to pursue a more efficient, more economical and more sustainable power system, so that every wisp of current can exert its maximum value and light up every possibility in the future.

3 OPTIMIZATION STRATEGY FOR DATA INTRINSIC CORRELATION RESEARCH

Of course, the efficient use of power data in the low-voltage station area is also inseparable from a professional analysis team. This team should be made up of power engineers, data analysts, and information technology specialists who are responsible for conducting in-depth analysis of the collected data and proposing improvements based on the results. For example, by comparing and analyzing the power consumption data of different stations, it is possible to identify areas of low energy efficiency, and then improve energy efficiency by upgrading technology or adjusting operation strategies.

3.1 Introduction to the Research on the Intrinsic Relationship Between Data

In addition, by applying data analysis techniques, we can extract usage patterns and trends from historical data to make load forecasts on the grid. Such predictions can help power grid operation and maintenance personnel reasonably arrange the power grid operation plan, balance power supply and demand, avoid overload, and ensure the stability of the power grid.

Table 1: Data intrinsic correlation research requirements

Scope of application	Grade	Accuracy	Research on the intrinsic correlation relationship of data
Energy management	I	85.00	78.86
	II	81.97	78.45
Trend analysis	I	83.81	81.31
	II	83.34	78.19
Run monitoring	I	79.56	81.99
	II	79.10	80.11

The process of studying the intrinsic association relationship of the data in Table 1 is shown in Figure 1.

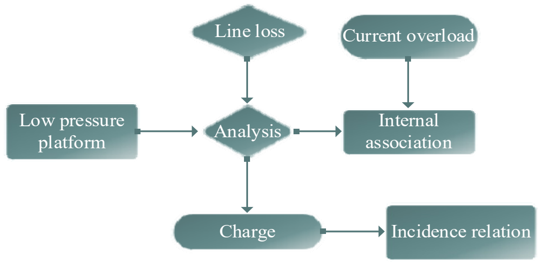

Figure 1: The analytical process of the study of the intrinsic association relationship of data

The optimization of power management in low-voltage stations also needs to be supported by policies and the cooperation of users. The government can encourage and guide users to participate in demand-side management by formulating relevant policies, such as implementing time-of-use electricity prices, to encourage users to reduce electricity consumption during peak demand periods and reduce the burden on the power grid. At the same time, popularizing energy-saving knowledge and improving public awareness of energy-saving are also important factors to promote the development of power management in low-voltage station areas.

3.2 Research on the Intrinsic Correlation Relationship of Data

Through accurate data collection, efficient data transmission, in-depth data analysis and scientific decision support, we can greatly improve the efficiency of power management in low-voltage station areas, which not only means cost savings and service quality improvement for power suppliers, but also contributes to social energy conservation and emission reduction, and more importantly, it ensures the stable operation of the power system, meets the growing demand for electricity, and benefits the majority of end users.

Table 2: The overall picture of the study program for the intrinsic correlation of data

Category	Random data	Reliability	Analysis rate
Energy management	85.32	85.90	83.95
Trend analysis	86.36	82.51	84.29
Run monitoring	84.16	84.92	83.68
Mean	86.84	84.85	84.40
X6	83.04	86.03	84.32
		P=1.249	

3.3 Research and Stability of Data Intrinsic Correlation

In order to further improve the application value of power data, the geographic information system (GIS) and customer information system (CIS) can be combined to realize the refined management of low-voltage station area. Using these tools, O&M personnel can intuitively see the power distribution of each station area on the map, understand the power consumption characteristics of different regions and users, and provide a scientific basis for power grid upgrading and resource allocation, and the data intrinsic correlation research scheme was shown in Figure 2.

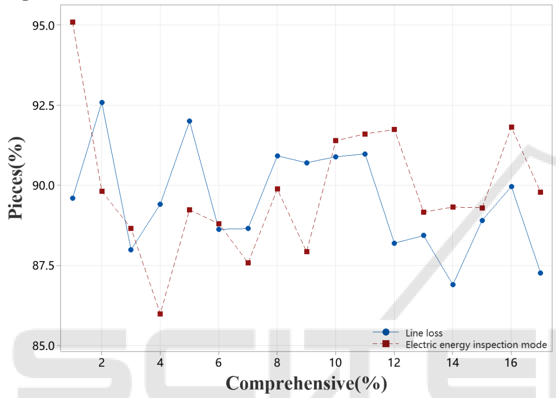

Figure 2: Research on the intrinsic correlation relationship between data of different algorithms

As the artery of modern society, the stable supply of electricity is related to the national economy and people's livelihood. Among the many links, the power management of the low-voltage station area is particularly important. It is directly related to the quality of electricity consumption by the end user and the stability of the entire power supply network. Therefore, improving the efficiency of power management in low-voltage stations is a key part of ensuring the stable operation of the power system.

It can be seen from Table 3, it is necessary to understand the importance of power management in low-voltage stations. The low-voltage station area usually refers to the end of the distribution grid, which is the part of the network that directly faces the end user. Here the voltage level is lower, the current is larger, and the line loss and transformation loss are also more significant. If the load is increased uncontrollably, it will lead to increased line loss, voltage drop, and may even cause unstable power

Table 3: The accuracy of the study of the intrinsic association relationship between the data of different methods was comprised

Algorithm	Survey data	Research on the intrinsic correlation relationship of data	Magnitude of change	Error
Line loss	85.33	85.15	82.88	84.95
Power inspection mode	85.20	83.41	86.01	85.75
P	87.17	87.62	84.48	86.97

supply, and in severe cases, equipment damage or power outages. Therefore, an effective management strategy is essential to maintain the efficient operation of the power grid, Figure 3 shown.

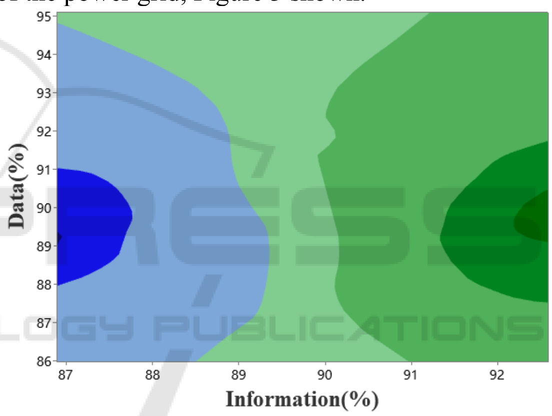

Figure 3: Research on the intrinsic correlation relationship of line loss data

There is a need to emphasize the involvement of the user side. Encouraging users to participate in the power management process is an important measure to improve performance. Through demand-side management, users are incentivized to reduce electricity consumption or shift electricity consumption time during peak periods, which can not only balance the load and reduce the peak-to-valley difference, but also improve the overall energy efficiency. This requires relevant departments to formulate reasonable policies and incentive mechanisms, such as the implementation of time-of-use electricity prices, the provision of energy-saving consulting services, etc.

3.4 The rationality of the Study of the Intrinsic Correlation Relationship of the Data

Strengthening maintenance and emergency response capabilities cannot be ignored. Regular inspection and maintenance of the low-voltage station area can identify potential safety hazards and repair them, so as to avoid accidents. At the same time, a sound emergency response mechanism should be established to ensure that problems can be dealt with quickly and effectively in the event of an emergency, and the safe operation of the power system can be guaranteed, and the data intrinsic correlation research scheme is shown in Figure 4.

Figure 4: Study on the intrinsic correlation relationship of data of different algorithms

It is necessary to explore how to improve management efficiency. In the modern power system, the application of smart grid technology has brought revolutionary changes to the power management of low-voltage stations. Through real-time monitoring and data analysis, abnormal fluctuations can be detected in time and responded quickly. For example, the application of smart meters allows users to read their electricity consumption in real time, making it easy to predict and schedule loads. In addition, the access of distributed energy resources also provides auxiliary means for station management, such as solar photovoltaic and energy storage facilities, which can effectively alleviate the pressure during peak hours.

3.5 The Effectiveness of the Study of the Intrinsic Association Relationship of the Data

Load factor: The study reveals that there is a strong correlation between peak loads and line losses. As demand increases beyond the designed capacity of the system, losses also rise due to increased resistance and overheating of conductors, and the data intrinsic correlation research scheme is shown in Figure 5 shown.

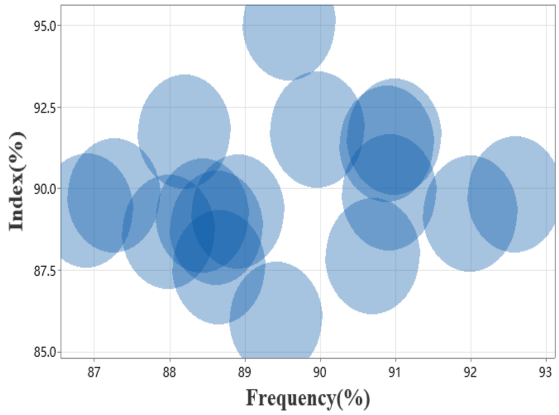

Figure 5: Study on the intrinsic correlation relationship of data of different algorithms

The improvement of the power management efficiency of the low-voltage station area is a systematic project, which not only requires advanced technical support, but also needs the guidance of policies and the participation of users. Only in this way can we ensure that each link can play its due role and jointly protect the stability and reliability of the power system. We, whether as managers, technicians or ordinary users, should shoulder our responsibilities and contribute to the optimization of power management in low-voltage stations and the stable operation of the power system.

Table 4: Comparison of the effectiveness of data intrinsic association studies of different methods

Algorithm	Survey data	Research on the intrinsic correlation relationship of data	Magnitude of change	Error
Line loss	82.21	85.92	84.59	82.85
Power inspection mode	83.73	84.23	84.41	83.55
P	84.20	87.39	84.76	83.90

The efficient distribution and usage of electricity in low-voltage (LV) districts are crucial to the stability and sustainability of power networks.

However, the complexity and variability inherent in these systems lead to significant challenges, particularly concerning line losses. This research aims to explore the intrinsic relationships within LV district power data that contribute to such line losses, thereby providing insights into effective management strategies and potential improvements in power distribution efficiency, the general analysis of line loss is performed by different methods, Figure 6 shown.

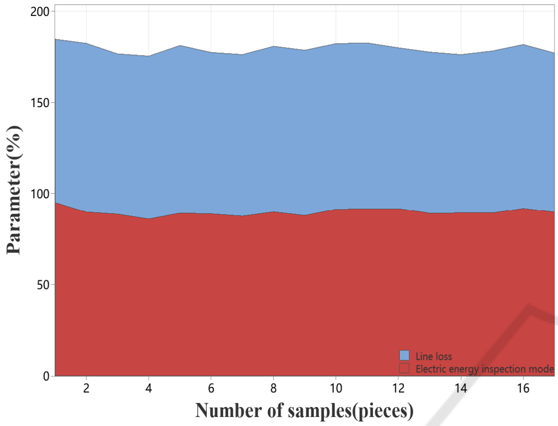

Figure 6: Research on the intrinsic correlation relationship of line loss data

This study employs a comprehensive analysis of LV district power data, focusing on the correlations between various factors such as current load, power consumption patterns, time of day, and environmental conditions. Statistical techniques and data visualization methods have been used to identify key trends and relationships, while machine learning algorithms have been employed to predict future scenarios based on existing patterns.

4 CONCLUSIONS

Time-dependent variations: Line losses exhibit distinct patterns during different times of the day, with higher losses observed during peak hours. These findings suggest that power distribution systems need to be optimized to handle varying loads throughout the day. Environmental factors: Temperature, humidity, and other climatic variables can significantly affect line losses. In hot weather, for instance, resistance in wires increases, leading to higher energy dissipation. Aging infrastructure: Older power lines are more susceptible to losses due to deteriorating insulation and increased corrosion rates. Regular maintenance is essential to minimize such losses. Implications and Recommendations: The identified relationships offer valuable insights for stakeholders seeking to improve the effic.

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