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Thoughts and Suggestions on the Quality Inspection Methods of Energy Consumption Statistical Data under the Background of "Dual Carbon"

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Abstract: Drawing on the national energy statistics reporting system, this article examines the critical stages of energy consumption statistics and systematically identifies the key challenges in ensuring data quality. Integrating recent practical experiences from a provincial-level energy statistics data quality inspection program, it proposes a "2+1" full-coverage inspection method designed to enhance the accuracy and reliability of enterprise energy consumption data. The findings offer a practical reference for improving data quality assurance mechanisms within energy consumption statistical work.

Keywords: "Dual carbon" background; Data quality; Inspection method

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1. Introduction

Carbon emission statistics and accounting are important foundational tasks for promoting carbon peaking and carbon neutrality. Doing a good job in the quality management of carbon emission data and ensuring the authenticity and accuracy of the source data at the enterprise end is an important prerequisite for accurately calculating regional carbon emissions and promoting the work of carbon peaking and carbon neutrality [1]. Under the background of "dual carbon", the original energy consumption statistics methods can no longer meet the current practical needs of energy and carbon emission statistics, and there is an urgent need for optimization and improvement, especially the inspection of energy consumption data by category, to further improve the quality of energy statistics data, continuously consolidate the foundation of carbon emission statistics and accounting, accurately calculate regional carbon emissions, and provide support for promoting the "dual carbon" work.

2. Basic information

The current energy statistics reporting system covers the statistical contents of energy production, sales, use

and inventory in various fields such as agriculture, forestry, animal husbandry, fishery, industry, services and residents' lives, forming a full-process energy statistics system from the grassroots reports of enterprises to quarterly accounting and the compilation of annual balance sheets [2]. In terms of the grassroots reports on energy consumption, they mainly include regulations.

Four reports of industrial enterprises above the model size, namely "Energy Purchase, Consumption and Inventory", "Energy Processing, Conversion and Recycling", "Energy Consumption per Unit Product of Major Energy-consuming Industrial Enterprises" and "Energy Consumption of Key Non-Industrial Energy-consuming Enterprises". Among them, the energy consumption of large-scale industrial enterprises in a certain province account for approximately 55% of the total energy consumption of the whole society. The quality of their data directly affects the accuracy of the energy consumption accounting data of the entire province and society, and serves as an important basis for monitoring the progress of energy conservation and consumption reduction and formulating energy conservation and consumption reduction policies [3]. In recent years, statistics departments in various regions have been actively exploring the implementation of energy consumption statistics data quality verification and law enforcement inspections, etc. They have been supervising and inspecting the implementation of statistical regulations and energy statistics reporting systems by enterprises, and have gradually formed a set of inspection indicators based on the comprehensive energy consumption of enterprises. The inspection method for verifying the energy consumption data of enterprises mainly based on the original materials such as enterprise statistical ledgers, the inbound and outbound orders of major energy varieties, and energy purchase invoices, as well as accounting vouchers, has played a significant role in standardizing the energy consumption statistics process at the grassroots level, improving data quality, and perfecting the energy statistics report system [4].

At present, against the backdrop of carbon peaking and carbon neutrality, carbon emission statistics and accounting work is about to be fully launched. The quality of energy consumption data by category, which serves as the basis for accounting, is particularly important as it directly affects the accuracy of carbon emission statistics and accounting data. The original method of checking ledgers and original vouchers, mainly based on the comprehensive indicator of comprehensive energy consumption, can no longer meet the current practical requirements of energy and carbon emission statistics. It is urgently necessary to establish a set of quality inspection methods for energy consumption data of different types that match it [5]. Meanwhile, as the work of preventing and punishing statistical fraud and falsification continues to advance, conducting quality inspections of energy statistics data has become a regular and important task for statistical departments at all levels to consolidate the foundation of energy statistics and improve data quality. Further improving and optimizing the inspection methods for energy consumption statistics data of sub-enterprises has practical guiding significance [6].

3. Existing problems and difficulties

3.1.There are certain limitations in the routine review, query and screening of the inspected enterprises

The energy consumption of industrial enterprises above a designated size is characterized by high concentration in industries and enterprises. In a certain province, about 75% of the energy consumption of industrial enterprises above a designated size is concentrated in eight high energy-consuming industries, namely textile, papermaking, petroleum processing, chemical raw materials, chemical fibers, non-metallic mineral products, ferrous metal smelting and power and heat [7]. Approximately 78% of energy consumption is mainly concentrated in energy-

consuming enterprises with a capacity of over 5,000 tons of standard coal. Therefore, when conducting quality checks on energy consumption statistics, it is often necessary to screen these enterprises.

Generally, logical reviews are carried out, such as the matching review between the output and energy consumption of high-energy-consuming products, the output value and energy consumption, and the fluctuation trend review of enterprise energy consumption [8]. However, in actual operation, there are certain limitations. For instance, enterprises may have long-term energy consumption misreports due to errors in measurement units or conversion, but their energy consumption growth rate matches the growth rate of product output and output value. Therefore, conventional trend and matching reviews cannot detect problem clues [9].

3.2. Inspections that take comprehensive energy consumption as the core indicator tend to overlook the issue of misreporting energy consumption varieties

As a direct indicator reflecting the energy consumption situation of enterprises, the comprehensive energy consumption volume has been the sole indicator for the quality inspection of energy consumption statistics in the past. Based on this, the error rate between the inspected figures and the reported figures of enterprises is calculated and determined. During actual inspections, it was found that some enterprises had misreported energy consumption types, such as misreporting anthracite as general bituminous coal and liquefied petroleum gas as other types of gas, etc. [10]. However, the calculated comprehensive energy consumption was not much different from the inspected figures, or even had no errors. Therefore, using comprehensive energy consumption to determine the error rate often masks the problem of misreporting energy consumption types by enterprises. To a certain extent, it affects enterprises' attention to and rectification of the problem of incorrect reporting of energy consumption varieties [11].

3.3. The statistical ledger and original voucher inspection method needs to be improved in accurately identifying the quality problems of enterprise statistical data

On the one hand, at present, data quality checks are carried out based on the original ledgers such as the entry and exit data of various energy types of enterprises. This involves a large amount of work and it is difficult to verify the authenticity of the ledgers themselves. Especially if enterprises intentionally underreport or omit information, the checks often cannot cover the energy consumption types that enterprises have underreported or omitted [12]. On the other hand, for various types of energy

The examination of the conversion coefficient and the input-output data of energy processing and conversion enterprises is not in-depth enough. In particular, the basic data such as the ledgers of processing and conversion input-output and actual measurement conversion of enterprises are relatively lacking.

The problem of fluctuations in total energy consumption caused by changes in the conversion coefficient or processing and conversion efficiency is also easily overlooked [13]. Energy statistics business is highly specialized and the logical relationships among statistical indicators are complex. It requires inspectors to be proficient in business knowledge, such as the data sources of various energy types of enterprises, data acquisition methods, and energy processing and conversion technology flows. However, at present, the quality inspection of energy statistics data, especially the quality inspection of energy consumption data by type, is still in its infancy, and the frequency and quantity of inspections are relatively small [14]. Relevant inspection business training is also relatively scarce, and the supporting knowledge is relatively lacking, with a relatively weak foundation.

3.4. The supporting knowledge for energy statistics inspection is relatively lacking and the foundation is weak

Based on the energy statistics reporting system, this paper comprehensively considers the rapidity and effectiveness of data acquisition, the simplicity of operation and the universality of methods. It explores and optimizes the quality inspection methods of energy consumption statistics data from aspects such as screening the inspected enterprises, inspection methods and processes, with the aim of further improving the effectiveness and pertinence of energy consumption data quality inspection [15].

4. Optimized design for quality inspection of energy consumption statistics data

4.1. Check the optimization of enterprise screening

On one hand, by refining the regular review and query of the output, output value and energy consumption growth rate of high energy-consuming products, more attention should be paid to the review and query of fluctuations in the standard conversion coefficient, processing conversion efficiency and the unit consumption of key energy-consuming products, and enterprises with abnormal data fluctuations should be collected regularly [16]. On the other hand, expand data sources. Through platform exchange, the energy monitoring center provides data on key energy-consuming enterprises, and use data fusion to calculate the coal consumption data for power generation and heating provided by the provincial power company. Conduct multi-cross collaborative data verification and validation for individual enterprises, and list enterprises with significant differences as key inspection targets.

4.2. Optimization of inspection methods and processes

Focusing on how to quickly obtain all energy consumption types of enterprises and effectively carry out inspections, a “2+1” full coverage inspection method is proposed, that is, to comprehensively inspect the energy production and consumption situation of enterprises from the “financial system + paper account set” and “production and consumption ledger” [17]. By reviewing the detailed list of raw material purchases and inventories as well as the detailed list of costs and expenses in the financial system of the inspected enterprise, the various energy consumption types of the enterprise are initially determined, and the financial accounts receivable and payable and the detailed list of inventories and inventories of each type are collected. If the enterprise is an energy producer, the production, sales and inventory accounts and detailed statements of the enterprise should be collected simultaneously to initially determine the types of energy produced by the enterprise. On this basis, through the financial system, search and query the financial transaction details of refined oil products such as gasoline, diesel, and lubricating oil, as well as consumption varieties such as heat and electricity [18]. Further verify and determine the energy consumption varieties that are not included in the raw material details and cost expenses, and collect the financial transaction data of each energy consumption variety.

On one hand, select the enterprise’s financial paper account sets for 2 to 3 months, re-verify each energy consumption variety by reviewing the paper account sets, and at the same time check whether the monthly paper account sets are consistent with the purchase data of each energy consumption variety in the financial system to determine the purchase volume of each energy consumption variety during the inspection period. On the other hand, screen out the energy consumption varieties that have not been registered in the financial system or have only been registered in the financial system in terms of amount but not physical quantity from the paper account set, and summarize the purchase volume data of these energy consumption varieties during the inspection period through the paper account set. Finally, based on the inspection results of the financial system and the paper account

set, the purchase volume and inbound and outbound data of each energy consumption type of the enterprise are determined in accordance with the principle of "who purchases, who counts" [19].

5. Future recommendations

5.1. Continue to strengthen the review of reports

We should promote the in-depth and detailed review of regular reports, further refine the energy consumption review and query of industries, especially high energy-consuming industries, and strengthen the matching review and trend review of product output, main business income, output value, etc. Meanwhile, the joint efforts of various departments will continue to expand the sources of data, further strengthen cooperation with departments and enterprises such as the provincial Department of Ecology and Environment, the Energy monitoring center, power companies, and natural gas companies, constantly optimize the data collection model, and carry out more targeted data verification. Based on the report review work, strengthen the collection and organization of problem leads and improve the screening work of inspected enterprises.

5.2. Continuously deepen research related to energy statistics inspection

Research should be strengthened in key areas such as enterprise energy statistics reporting workflows, the on-site measurement of raw coal, and processing conversion efficiencies in major industries, including petroleum refining. Methodologies for energy consumption statistics inspections require continuous improvement, alongside efforts to refine and streamline inspection procedures. Additionally, the development of clear operational guidelines for energy consumption statistics inspections should be accelerated. Parallel to these efforts, it is essential to explore the implementation of meter-based inspections for energy production, distribution, unit product energy consumption, and water usage to advance methodological refinement and promote procedural standardization. Furthermore, issues and recommendations identified during inspections should be systematically synthesized to support ongoing enhancements to the energy statistics reporting system and to strengthen the review and verification of submitted reports [20].

5.3. Strengthen business training on quality inspection of energy statistics data

Personnel with strong expertise in energy statistics and extensive experience in data quality verification should be selected from within the statistical system to form an expert database dedicated to energy statistics data inspections. This expert group would be responsible for key tasks such as conducting data quality assessments, advancing methodological research, and providing specialized training [21]. In addition, training on energy statistics inspection should be integrated into routine training programs for energy statistics reporting, with dedicated modules on identifying enterprises for inspection and the practical application of inspection methods. These initiatives collectively aim to develop a professional inspection team that is proficient in both reporting requirements and inspection practices.

6. Conclusion

It is an inevitable trend for the energy industry to adapt to China's economic transformation. Low-carbonization and clean energy are the future development directions of the world's energy industry. In 2018, China's oil and gas consumption accounted for 27% of its primary energy, still some distance from the world's 57.5% share.

Despite the continuous decline in the proportion of coal and the fact that the development of renewable energy still requires time, the oil and gas industry remains an important part of the energy sector. Improving the quality of energy consumption statistics requires a multi-pronged approach involving technology, systems and management. Through standardized, digitalized and transparent means, reliable decision-making support should be provided for the dual carbon goals.

Disclosure statement

The author declares no conflict of interest.

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