# Study on Differentiation Management of Grid Energy Metering Device under High Permeability by Distributed Energy and Smart Grid Technology

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**Abstract:** At present, the electric energy metering device is classified according to the amount of electric energy and the degree of importance of the measurement object. The measuring device is also selected according to the characteristics of the traditional metering object.With the continuous development of smart grid, the diversification of measurement objects increasingly appear, the traditional measurement object classification has been unable to meet the new measurement object of personalized, differentiated needs.Withal, this paper constructs the subdivision model based on the object feature-system evaluation, classifies according to the characteristics of the measurement object, and carries on the empirical analysis with some kind of measurement object as the research object.The results show that the model works well and can be used to subdivide the metrological objects into different customer groups, which can be reasonably configured and managed for the metering devices. The research of this paper has effectively improved the economy and rationality of the energy metering device management, and improved the working efficiency.

## 1. Introduction

With the continuous advancement and development of smart grid, there are more and more new elements in the power system. At the same time, the intelligent electricity technology is all-round and multi-level development, which makes the characteristics of power grid diversification become more and more prominent[1]. The contradiction between the depletion of traditional energy and the rapid development of human beings on the growing demand for electricity is becoming more and more prominent. In order to solve the power crisis, distributed energy power generation and smart grid become the focus of the study of governments, power departments and scientific research institutions.The increase in distributed power supply on the user side and the power generation side, especially the roof solar power generation and the large amount of wind power generation, have brought new challenges to the configuration and management of grid energy metering devices.With the vigorously construction of smart grid, the grid shows the coexistence of intelligent substation and traditional substation, and the coexistence of intelligent equipment and traditional equipment in intelligent substation, which put forward higher requirements to power metering device management, metering business process management. Power grid in a variety of new technologies, the integration of new elements, to the power metering professional management challenges, for which we urgently need to improve the level of energy metering device management for the development and management of power grid marketing strategy.

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The traditional electric energy metering system classifies the electric energy metering device according to how much the electric energy is measured and the important degree of the metering object[2]. With the development of distributed energy, smart grid and intelligent power technology, the demand for various types of metering objects is different. The traditional classification management approach for the diversification of the object of the homogenization of the ordinary service, lack of relevance, timeliness and accuracy.

How to develop targeted management strategies to meet the measurement needs of different measurement objects, to achieve differentiation and personalized service, has become an urgent task of power marketing management. The evaluation and classification of electric power customers can provide important basis for the development of targeted marketing management strategy. In this paper, clustering algorithm is used to evaluate and classify electric power customers.

## 2. Research Status

Currently, there has been a lot of research on energy metering management. Paper [3] introduces the energy metering management system platform, which set up energy metering systems management platform from four aspects equipment, standard equipment, personnel, quality control, and implement streamline, information and network business. Paper titled [4] which used serial asynchronous communication technology to build the supply-side pass energy management system and realized the meter information collection and information of load forecasting assessment. These documents are more grid-based business's point of view, in order to facilitate the effective management of energy metering device. However, specific measurement object applies to the types of energy metering device, research in this area are few.

Classification of the measurement point, to the public in a manner approved is the energy metering device technical management procedures which clearly stated: Energy metering device according to how much electricity they metering and the importance of measurement objects divided into five categories (I, II, III, IV, V) to manage. According to the size of the average monthly electricity consumption or transformer capacity, etc., all electrical energy metering devices are divided into five categories. According to the number and importance of electrical energy metering point, configure the appropriate energy metering device and operation and maintenance mechanism. This classification method to a greater extent classify from the perspective of a single grid operation metering points, without considering differentiated demand of power users.

Rapid development of information technology and networking, fast construction of various types of energy data management system platform based on big data analysis techniques [5], which provide a good platform to the new energy measurement management. Based on a common perspective of grid companies and electricity customers, this paper makes evaluation to different types of metering point, configure the appropriate energy metering device to the measurement object, to achieve double win of the businesses and customers.

## 3. Energy Metering System Classification Based on Bi-direction Perspective

### *3.1 Research approach*

Different electrical characteristics of electric power customers often have different energy metering needs. Therefore, by calculating the electricity customer behavior, characteristics, demand similarity, classification clusters, this paper taps the inherent characteristics of the customer groups. This article assign feature similar electric power customers to the same group, and assign the different characteristics of electric power customers to different groups. Meanwhile, considering the electricity customer metering rationality and grid operation management effectiveness, this article configures the appropriate energy metering device to the metering points of electricity customers.

### *3.2 Classification Algorithm*

Clustering method is a process divides the samples into the number of classes of similar objects. Object segmentation using clustering algorithm is a commonly used data mining techniques. K-means method

[6] is a typical clustering algorithm, which uses the distance as the similarity index, namely that the closer the two objects, the more similar they are, to achieve clustering. Its main advantage is that the algorithm is fast, simple and scalability. This article will use the K-means algorithm on the measurement point type cluster analysis, algorithm flow shown in Fig.1.

K-means algorithm is as follows:

Input: the number of clusters k, and a database comprising n data objects.

Output: k clusters meet minimum variance criteria.

Specific operational procedures:

(1) Select the k initial centers, such as c[0]=data[0],…c[k-1]=data[k-1].

(2)Comparing the data [0]….data[n] with c[0]…c[k-1] respectively, assuming the difference between that data [i] and c[i] is minimum, then it is marked as i.

(3) For all the points marked i, recalculates the c[i].

(4) Repeat (2) (3) until all changes in the value of c[i] are less than a given threshold.

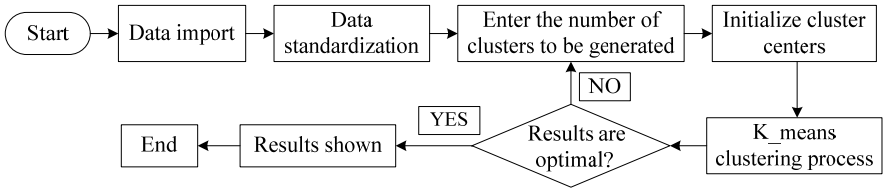


**Fig.1** K_means algorithm flowchart

*3.3 Metering point type subdivision index*

Energy parameters and power parameters could reflect the measurement object's metrological characteristics, therefore they are used as categorical variables, which includes power variable, voltage variable, current fluctuation percentage variable, while considering the construction costs and the cost of transport inspection. Based on actual case of the grid, measuring point type subdivision index system is shown in Table 1.

**Table 1** measuring point type subdivision index system

| Dimensionality | Derived variable | Subdivided quota | Segmentation variable name |
|---|---|---|---|
| Metering point | Aggregated variable | electric quantity index | Annual electricity consumption |
| | Average variable | Voltage index | Voltage level |
| | Trend variable | Range index | Current Percent Volatility |
| | State variable | transport inspection index | Online/blackout transport inspection |

Annual electricity consumption: year of electricity consumption, reflecting the size of the customer, as the basis for configuring power metering device.

Voltage grade: reflect electricity capacity size, to determine the corresponding power meter.

Current fluctuations domain: fluctuation range of primary current, to determine the corresponding current transformer and power meter.

Online/blackout transport inspection: operation state evaluation, according to this index and the measurement point object operational requirements, configure the power metering device.

## 4. Empirical Analysis

In this study, we obtained a city 2013, 2014 two years of all metering point object electricity data. According to the research needs, doing pretreatment to the data, finally we obtained 4320 variable data. After the data standardization, doing clustering analysis to normalized variable. First temporarily designated cluster number in the range of 4 to 7 classes. After repeated testing, found that subjects were divided into 5 categories metering point, the cluster effect is better, the results are shown in Table 2.

**Table 2** Clustering iterative process

| Iteration | Change in cluster centers | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| 1 | 7.658 | 4.356 | 8.978 | 9.673 | 5.271 |
| 2 | 0.341 | 5.271 | 0.497 | 0.834 | 3.748 |
| 3 | 0.265 | 2.659 | 0.354 | 0.361 | 1.957 |
| 4 | 0.107 | 1.472 | 0.187 | 0.176 | 1.325 |
| 5 | 0.063 | 0.387 | 0.473 | 0.264 | 0.195 |
| 6 | 0.012 | 0.116 | 0.836 | 0.203 | 0.003 |
| 7 | 0.035 | 0.065 | 0.472 | 0.076 | 0.000 |
| 8 | 0.044 | 0.008 | 0.410 | 0.036 | 0.000 |
| 9 | 0.032 | 0.000 | 0.098 | 0.053 | 0.000 |
| 10 | 0.018 | 0.000 | 0.045 | 0.0033 | 0.000 |
| 11 | 0.005 | 0.000 | 0.021 | 0.014 | 0.000 |
| 12 | 0.000 | 0.000 | 0.014 | 0.009 | 0.000 |
| 13 | 0.000 | 0.000 | 0.007 | 0.004 | 0.000 |
| 14 | 0.000 | 0.000 | 0.003 | 0.000 | 0.000 |
| 15 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |

As shown in Table 2, in the first 15 iterations, 5 class centers no longer changed, cluster analysis was finished. Each category contains the number of clients clusters are shown in Table 3 characteristics of various types metering point objects as shown in Table 4.

**Table 3** the number of each cluster customers

| Cluster | 1 | 2 | 3 | 4 | 5 | Valid | Missing |
|---|---|---|---|---|---|---|---|
| Quantity | 67 | 121 | 327 | 1325 | 2480 | 4320 | 0 |

## 5. Conclusion

On the basis of data mining, this paper do classification to metering point object from the perspective of business and customer-way, and configure the appropriate energy metering devices and management measures, carry out empirical analysis finally.

The empirical results show that taking business-customer perspective to analyze, on the one hand could dig the different characteristics of different metering points, on the other hand could evaluate the value of the measurement point object. This classification is not only able to effectively meet the needs of the measurement object, but also improve the efficiency of energy metering device management unit, reducing operation and maintenance process, human and material resources, significantly improve metering device lean management.

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