

基于多维特征分析与动态定权聚类的电力居民用户分类

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Residential electricity users classification based on multidimensional feature analysis and dynamic weighted clustering

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摘要:由于居民用户用电需求的高度随机性和不规则性,亟需详细的数据分析来定义用户的行为特征,以提供更加合理的用电建议和需求响应潜力。为了进一步挖掘非介入式辨识数据的价值,提出一种基于多维用电行为数据的电力居民用户分类方法。首先通过非介入式智能电表获取居民细粒度用电数据,分析用户的用电行为,寻找关键用电特征量;接着使用CRITIC权重法自适应配置各指标权重,通过6类聚类评价指标,对4种聚类算法和3个数据距离计算进行对比,实现最优聚类方法和聚类数目的选择。通过某小区实际数据验证了本文所提用电特征量以及定权聚类方法的有效性,将居民用户群体分成用电行为差异明显的两类。

关键词:电力居民用户分类;多维负荷数据;用电行为分析;动态聚类;需求响应

Abstract: Due to the high randomness and irregularity of residential users' electricity demand, detailed data analysis is urgently needed to define the behavior characteristics of users to provide more reasonable electricity suggestions and demand response potential. Based on the fine-grained electricity consumption data and user information of residents, a classification of electricity residential users based on multi-dimensional electricity consumption behavior data is proposed. First of all, the non-intrusive smart meter is used to obtain the fine-grained electricity consumption data of residents; Then the user's electricity consumption behavior is analyzed, and electricity consumption characteristics are found. Then, the CRITIC weight method is used to adaptively configure the weights of each index, and through the evaluation indicators of 6 types of clusters, 4 kinds of clustering algorithms and 3 data distance calculations are compared to achieve the optimal clustering method and the choice of the number of clusters. The actual data of a residential area are used to verify the power consumption characteristics and the effectiveness of the weight-fixing clustering method proposed in this paper, and the residential user groups are divided into two categories with obvious differences in electricity consumption behavior.

Key words: classification of electricity residential users; multidimensional load data; electricity consumption behavior analysis; dynamic clustering; demand response

0 引言

随着高比例可再生能源的并网与电力市场的改革,电力用户已从传统的被动用电变得更加地主动,其灵活性有待进一步挖掘。同时电力物联网的推进以及非介入式负荷辨识(non-intrusive load monitoring, NILM)技术的发展,产生并记录了海量的电力数据^[1]。利用数据挖掘技术中的聚类分析对居民用电

负荷进行分类^[2],可以有效开展需求响应、电价设置等用户用能服务,为用户互动提供市场基础^[3]。

随着售电市场的改革,分析电力用户的用电行为为变得越来越重要,基于各类数据的电力用户分类在需求侧响应方面的政策的制定具有重要的意义。文献[4]对加州地区4万户居民长达3年的研究中发现,20%居民用户占了该地区需求响应潜力的89%。

以往的需求响应建模仅关注负荷的电气特性,而未考虑到用户本身。大量的研究试图从负荷层面对用户进行分类,这是一种基于粗粒度的数据分析,从日负荷提取特征后划分居民的用电行为^[5-8]。NILM的研究始于20世纪70年代,目前已成

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