台電工程月刊 855 期（11 月號）目錄

AMI 應用與用戶服務　專輯

AMI 資訊應用規劃與大數據平台分析實例

Big Picture of AMI Data Applications and Big Data Platform Analytics

王玟菁[*] 朱漢農[*] 賈方霈[*] 王金墩[*]

Wang, Wen-Ching Chu, Han-Nun Jia, Fang-Pei Wang, Chin-Tun

摘　要

台電公司已於民國 102 年全面佈建高壓以上之先進讀表基礎建設(Advanced Metering Infrastructure, AMI)，低壓 AMI 之佈建亦依規劃進度陸續進行中。而隨著資通訊設備的發達，大數據等相關分析技術日漸受重視，各界皆針對 AMI 資料的應用有強烈的期待。事實上，台電公司內部各單位應自身業務需求，持續有進行相關分析作業，惟各單位間分工細緻，未進行整合。現經成立專案小組全面盤點，提出 AMI 資訊運用發展藍圖，彙整各領域之應用項目，並分組管控追蹤。同時，持續強化以 AMI 資料為核心所建立之用戶服務大數據分析平台，搜集多樣資料源，完善分析工具，以期達成更廣泛之應用。本文將針對 AMI 之佈建期程、系統架構、盤點資料應用，及協助分析之大數據平台進行說明與介紹。

Abstract

Taipower has finished the deployment of high-voltage AMI (Advanced Metering Infrastructure) since 2013 and is continuing the deployment of low-voltage AMI according to the planned schedule. With the advancement in the analytical capability of AMI data, people are increasingly interested in its applications. Although different sections within Taipower had done various analysis of their own for their unique purposes, the lack of integration was still an issue that has to be addressed. Recently, Taipower has started to organize all the on-going applications and the others which are still at the planning stage. This paper is intended to introduce the planned AMI deployment in Taiwan, the system structure, the big picture of AMI data applications, and the big data supportive platform in Taipower.

關鍵詞(Key Words)：先進讀表基礎建設(Advanced Metering Infrastructure, AMI)、大數據(Big Data)、平行處理(Massive Parallel Processing, MPP)、資料分析(Data Analytics)。

---

*台灣電力公司綜合研究所

智慧電表與用戶端整合之 1000 戶示範計畫

Smart Meter and Home Client Integration of the 1000 Household Demonstration Program

徐彬海[*]
Hsu, Ping-Hai

蔡家楷[*]
Tsai, Chia-Kai

卓明遠^{**}
Cho, Ming-Yuan

張文曜^{***}
Chang, Wen-Yao

林承毅^{**}
Lin, Cheng-Yi

摘　要

　　台電公司依照行政院指示於 106 年底前完成 1000 戶含電業端(Route A)及家庭端(Route B)連結之完整 AMI 布建測試。以使電表用電資訊能即時呈現於家庭內，提升 AMI 的加值效益，進而改變用戶的用電行為，以及提升節電效果。

　　本計畫研究內容涵蓋 Route B 技術趨勢調查、Route B 通訊模組開發的設計規格及測試規範、AMI Route B 1000 戶示範場域的場勘結果及 Route B 系統建置的成果、本研究在 1000 戶 Route B 建置與通訊調整的過程中所遭遇的問題以及解決的方法等。此外，為了提高未來 Route B 查修維運的效率，研究團隊也針對 Route B 通訊的改善辦法提出建議，最後亦針對智慧電表與用戶端整合之效益進行評估，提供實務改善具體方法與建議，做為未來台電公司推行時之參考。

Abstract

In accordance with the instruction of Executive Yuan, Taiwan Power Company (Taipower) was required to complete a total of 1000 field trials on AMI installations of household power users - including both "Route A" and "Route B" - before the end of 2017. The purpose of these trials is that the real-time energy consumption information from the meters can be presented to home users instantly. This is expected to increase the benefit of AMI utilization and change the user's energy usage behavior to enhance the energy-saving benefits.

The project includes the survey of the latest Route B communication technology development trends, the interface between Route B and homes, development of AMI Route B field trial system - including Route B communication module physical layer, utilization protocol, and meter information content which will be transferred to Meter Gateway at home. Finally, the study will evaluate the results of these field trials, and will provide a practical enhancement mechanism and suggestions for Taipower's future reference.

---

*工業技術研究院
**高雄科技大學
***台灣電力公司綜合研究所

基於 OAuth 2.0 之 AMI Route B 讀表金鑰授權機制設計

An Authorization Mechanism Based on OAuth 2.0 for AMI Route B Meter Key

陳宣同*
Chen, Hsuan-Tung

徐彬海*
Hsu, Ping-Hai

張仕穎*
Chang, Shih-Ying

洪裕翔*
Hung, Yu Hsiang

蔡雨憙*
Tsai, Yu-Shi

摘　要

　　隨著全球石化能源逐漸短缺，世界各國除了積極尋找新的能源替代方案外，亦努力推動各種節能措施，向社會大眾推廣節能意識，期望將節能減碳變成一項全民運動。而要讓民眾在生活中融入節約能源的習慣，最直觀的方法就是讓民眾能夠隨時掌握自己的用電資訊，因此現有的電力系統必須進行一系列的革新，包含了既有電網的資訊化、自動化與智慧化，這也就衍生出智慧電網的相關議題。智慧電網最大的特色即是民眾可藉由智慧電網中的智慧電表了解自己的即時用電資訊，但即時用電資訊的外洩也將侵犯用戶的隱私，甚至危害到用戶的生命財產，因此本文將設計出一套基於 OAuth 2.0 且相容於台電 AMI 系統的 HEMS 資訊安全機制，藉由讓用戶參與電表金鑰的授權，以降低個人用電資訊的外洩的風險。

Abstract

With the increasing shortages of fossil energy in the world, governments worldwide are seeking not only new alternative energy but also promoting various energy-saving measures among the public, expecting to turn energy-saving and carbon-reduction efforts into a national activities. The most intuitive way to enable people to incorporate energy-saving habits into their daily life is to enable people to instantly keep track of their electricity usage information. Therefore, the existing power system must undertake a series of innovations, including the informatization, automation and intellectualization of the power grids. These changes will create new issues related to the utilization of smart grid. The major feature of the smart grid is that people can obtain their real-time electricity consumption information through smart meters in the smart grid. But the leakage of real-time electricity information will likely involve infringement of the users' privacy and even be harmful, to some extent, to the normal lives and property of users. To reduce the risk of leakage of personal information, we design a security-ensuring mechanism based on OAuth 2.0 for AMI and HEMS and allow users to participate in the security mechanism through getting its authorization by using a meter private key.

---

*工業技術研究院

國外**AMI**資料於售電業務及用戶服務之應用研析

The Application of AMI Data in Electricity Retail Business and Customer Services

詹穎儒*　　　　　　　　　　鄭伊秀*　　　　　　　　　　施恩*

Chan, Ying-Ju　　　　　　　Cheng, I-Hsiu　　　　　　　Shih, En

摘要

　　由於我國電業環境正走向自由化，台電公司將面臨售電競爭與能源轉型等挑戰，在未來用戶擁有購電選擇權的情況下，除了提供有競爭力的電價方案外，用戶服務也愈趨重要。本研究蒐集國外電力零售業者與面臨到的挑戰，以及如何透過 AMI 資料精進售電業務與提供更好的用戶服務，來增加競爭優勢與維持用戶滿意度，作為台電公司的借鏡。

Abstract

With the market of power industry in Taiwan moving toward liberalization, Taipower is going to face a lot of challenges – such as power retailing market competition and energy utilization transformation. In the future, when users have the right to choose a retailer to purchase electricity, utilities need to provide competitive energy pricing programs, with the customer services becoming more and more important. In the light of the above, this study collected relevant experiences about the challenges that the electricity retailers of foreign countries have faced, and about how they optimized their business and provided better customer services. Besides, this study provides useful information to help Taipower enhance its competitiveness in the future.

關鍵詞 (Key Words)：零售市場(Retail Market)、售電業務(Retail Business)、用戶關係管理(Customer Relationship Management)、加值服務(Value-added Service)。

---

*財團法人台灣經濟研究院

公用售電業如何運用 AMI 資料掌握目標用戶

The Study on using AMI Data to Identify Utility's Target Customers

古文潔*　　　　　　　　　　　　　　　　徐孟儒*
Ku, Wen-Chieh　　　　　　　　　　　　　Hsu, Meng-Ru

摘要

　　電業自由化已成為目前全球發展趨勢，因應自由化之浪潮，未來預期將開放多家售電業競爭。電力用戶可自由選擇售電業的情況下，公用售電業恐面臨大用戶流失的情況。為了鎖定重要關鍵用戶，本文運用 AMI 用電資料，建立目標用戶分析流程，透過流程的判斷方式，採用分群分析並加入 RRMSE 及用電規模等資訊，區隔不同用戶之間的特性，進一步掌握每個用戶特定用電型態，篩選出對於公用售電業具有價值的目標用戶，提供最適方案以保留重要用戶，進而幫助售電業達到最佳購電策略。

Abstract

　　Electricity market liberalization has already become a global trend in the development of the power industry. With the progress of electricity liberalization, it is expected that there will be more and more competitors joining the power market. Under this situation, the electricity users will have a right to choose their electricity suppliers, making power utilities worry about the possibility of losing their customers. In order to secure the primary customers, the study applied the AMI data and to establish the analysis procedures for the targeted customer. By use of the cluster analysis, along with use of RRMSE and analysis of the scale of electricity utilization, this study aims to categorize the different users, collect their information, and keep track of each customer's characters and electricity usage type. Utilities can apply all this information obtained to screen out their customers and then to establish a list of most valuable customers who is expected to make a major contribution to the company. Therefore, utilities can establish the optimal operation strategy, secure the major customers and figure out the best way to purchase power from outside sources.

關鍵詞(Key Words)：電業自由化(Electricity Liberalization)、公用售電業(Utility)先進讀表基礎建設(Advanced Metering Infrastructure, AMI)、集群分析(Cluster Analysis)、相對均方根誤差(Related Root Mean Squire Error, RRMSE)。

---

*財團法人台灣經濟研究院

利用 AMI 資料於高壓用戶參與需量反應抑低潛力評估

The Estimation of Potential Demand Reduction for High-Voltage Users to Participate in Demand Response by Using AMI Data

張文奇*
Chang, Wen-Chi

張文贏**
Chang, Wen-Ying

蔡昊廷**
Tsai, Hao-Ting

蔡森洲*
Tsai, Sen-Chou

蘇嬛嬛*
Su, Hsuan-Hsuan

摘　要

用戶抑低潛力評估對於台電公司或用戶群代表在新開發或招募新參與用戶上是相當有幫助的，除可作為新用戶之初步評估，亦可作為用戶群聚合之初步可靠度評估。本文利用 SVR 演算法進行高壓用戶參與需量反應抑低潛力評估，首先利用 k-means 分群演算法將各產業別用戶依其日用電曲線進行分群，再由各別產業之已參加需量反應方案用戶，其 AMI 每 15 分鐘之歷史用電資料及參與需量反應之歷史抑低資料進行分析，以建立各別產業之高壓用戶抑低用電模型，進而預測未參與用戶之抑低潛力。最後，透過高壓用戶實場訪談，以驗證潛力評估模型。

Abstract

It is very helpful to estimate the potential of power user's demand reduction for recruiting new users to participate in demand response program and for Taiwan Power Company and user's aggregator. It can be used as not only in the preliminary estimation of new users who are likely to participate in demand response program but also in the preliminary reliability estimation of aggregated users. In this study, the SVR algorithm is used to estimate the potential demand reduction for high-voltage users to participate in demand response. At first, the users of each industry are clustered by daily load pattern using k-means algorithm. And then the users' AMI history data are used for demand reduction estimation model training. Finally, the SVR model is verified by conducting field interviews among users.

關鍵詞(**Key Words**)：需量反應(Demand Response)、用戶群代表(Aggregator)、抑低潛力評估(Estimation of Potential Demand Reduction)。

---

*台灣電力公司綜合研究所
**工業技術研究院綠能與環境研究所

AMI 應用於需量反應措施之潛力估計

Estimating Demand Response Potential with AMI Data

楊新全*
Yang, Shin-Chuan

謝智宸**
Hsieh, Chih-Chen

洪萌翡**
Hung, Meng-Fei

劉恒秀**
Liu, Heng-Hsiu

蔡家緯***
Tsai, Chia-Wei

彭佳玲****
Peng, Chia-Lin

摘　要

　　行政院「電力系統總體檢」建請台電公司進行「合理評估需量反應方案成效」及「重新展開需量反應潛力及可行性調查，深入瞭解不同行業之抑低用電潛力及配合抑低方式，以吸引更多用戶參與」，故本研究首先進行大用戶用電特性調查，了解用戶基本特性、抑低尖載方式及參與需量反應意願，以做為未來評估抑低潛力之參考依據。

　　以台電公司高壓與特高壓電力用戶為調查母體，抽樣 2,500 戶高壓以上用戶並區分為大型用電用戶(5,000 瓩以上，約 600 戶)、非大型現行需量反應措施參與用戶、高潛在用戶、其他潛在用戶共四個副母體進行分層調查，調查其用戶型態、負載特性、抑低用電潛力、抑低方式等項目，並結合台電公司用戶用電與需量反應資訊進行分析以透過市場調查回收的問卷，結合台電現有的智慧電表讀表系統、新電費開票系統、需量反應資料庫系統，及氣溫、營業額指數、生產量指數等外部資料，有別於以往傳統統計分析或工程模型建置方式，採用機器學習及深度學習的方法建置需量反應潛在用戶及抑低潛力估計模型，用以推估母體用戶參與需量反應的參與傾向及其潛在抑低量。

Abstract

In accordance with the instruction of the government's "General Inspection Group for Power System," the Executive Yuan required Taipower to carefully review the performance of Demand Response(DR) programs, and to proceed to conduct the investigation and feasibility of DR's potential, The purpose of this study is to fully understand the future potential, coordinate to the ways of executing load reduction in various industries and to encourage customers to participate in the DR programs. Therefore, our research conducted a survey on the characteristics of large users' electricity consumption to understand their basic characteristics, methods of peak load reduction, and their willingness to participate in the DR program.

The 2,500 high voltage and UHV power users are sampled from targeted customers, and are classified into four sub-groups: large users' of electricity (approximately 600 customers with contract capacity over 5MW), non-large users of electricity who participated in the current DR programs, highly potential users of DR programs, and other potential users of DR programs. The survey items are comprised of load patterns, potential reduction of energy consumption, and reduction methods. The analysis is conducted by using the result of survey and integrates with power consumption data from AMI and NBS. Our research collects market research questionnaires, coupled with the use of external data from Taipower's existing smart meter system, new billing system, DR database system, and temperatures, revenue index and production index. Apart from the

traditional statistical analysis or engineering model construction methods, the machine learning and in-depth learning methods are applied in building models for evaluation of potential of DR program customers and load reduction, and can thereby estimate the DR program participation rates as well as its load reduction potential for our customers.

關鍵詞**(Key Words)**：需量反應(Demand Response)、問卷調查(Questionnaire)、智慧電表讀表系統(Advanced Metering Infrastructure, AMI)、新電費開票系統(New Billing System, NBS)、機器學習(Machine Learning)、深度學習(Deeping Learning)。

---

*台灣電力公司綜合研究所
**財團法人台灣綜合研究院
***國立臺東大學資訊工程系
****典通股份有限公司

國際智慧電表發展趨勢與電業用戶專屬帳戶服務分析

The International Development of AMI System and Dedicated Power-User's Account Service of Electricity Retail Supplier

吳志剛*   劉世君*   王苑如*   盧姵君*

Wu, Chih-Kang   Liu, Shih-Chun   Wang, Yuan-Ju   Lu, Pei-Jyun

摘 要

為達節能目的，促進低碳能源轉型，台電公司依政府智慧型電表基礎建設政策，業已完成智慧電表於高壓所有用戶與低壓約 20 萬戶之布建。智慧電表與傳統電表相較，其優點眾多，除可節省抄表成本外，其累積之即時用電量資訊，亦有許多加值應用服務之空間。

另依據106年1月26日之頒布修正《電業法》，我國電力市場開放係採取「綠能先行」為原則，並於第一階段開放成立再生能源售電業。於預期將來售電市場，台電公司將面臨更多競爭者挑戰下，如何提高用戶服務之品質，建構符合用戶需求之服務方案為當務之急。本文擬以先進國家電業智慧電表之發展趨勢與用戶專屬帳戶之功能，比較分析目前台電公司用戶服務方案尚待精進處，提供可行之電業用戶專屬帳戶服務之發展建議。

Abstract

For the purpose of achieving the goal of energy conservation and promoting the the transformation towards utilization of low-carbon energy, Taiwan Power Company has completed the construction of smart meters for all users of high-voltage and about 200,000 low-voltage users in compliance with the government's Advanced Metering Infrastructure(AMI) policies. Compared with traditional electric meters, smart meters have many benefits. Aside from the cost-saving from reducing the need for onsite meter readings, the accumulated real-time electricity consumption records also have great potential for value-added application services.

In addition, according to the amendment of the "Electricity Act" which promulated on January 26, 2017, the national approach to the deregulation of electricity market includes the adoption of a principle of "Green Energy First" by first opening up the markets for renewable energy electricity. Faced with the deregulation progress of the retail electricity market, Taiwan Power Company will inevitably be challenged by more and more market participants and competitors. Therefore, making efforts to improve the quality of customer services and to develop services which can fully meet customers' needs are the company's top management priorities. Our study is intended to analyze the limitations of current the customer services of Taipower Company and to provide suggestions for the development of viable approaches to the use of "Dedicated Power-User's Account," which will be evaluated with making reference to the development trends and related experiences in the developed countries regarding the smart meter and the function of the "Dedicated Power- User's Account".

關鍵詞(Key Words)：數位化(Digitalization)、智慧電表(AMI)、用戶服務策略(Customer Service Strategy)、用戶專屬帳戶(Dedicated Power-User's Account)。

---

*財團法人台灣綜合研究院

運用 AMI 資料研析需量競價得標用戶負載特性

Analyze on the Load Reducing Prosperities of the Participants of Demand Bidding Program through AMI Data

唐文祥*
Tang, Wen-Shiang

楊凱智*
Yang, Kai-Jhin

楊新全**
Yang, Shin-Chuan

摘　要

需量反應為在電力系統供電吃緊時，透過提供用戶優惠或誘因，鼓勵其將尖峰用電移轉至離峰時段使用。然而需量反應的負載移轉會增加預測負載的難度，當用戶在進行負載移轉時，有可能移轉至當天的離峰時段、或在事件日前一天接收通知時，即進行移轉、抑或移轉至事件日後一天的時段。因此負載預測須考量外溢效果，實施需量反應不止對當天負載有所影響，也可能對前一天或後一天的負載有所影響。為了掌握不同用戶配合需量競標得標後的用電移轉型態，本研究整理過去兩年需量競價歷史執行資料，篩選合適的資料數據，並建構出抑低日負載變化曲線，再利用自我組織特徵映射網路(Self-Organizing Maps, SOM)針對負載變化曲線進行分群，並嘗試針對分群結果解釋各群組的負載變化特性。本篇研究的對象主要為參與需量競價措施四小時的鋼鐵業、水泥業、石油業和紙漿業等四個行業的參與用戶。

Abstract

Demand Response (DR) is a program to provide an opportunity for consumers to reduce or shift their electricity usage during peak periods by giving rewards or incentives. DR is a scheme where consumers can directly participant in demand management. When participants shift the load from one time to another, the load may take place in the off-peak period of the event day, or take place on the day before or after the event day – which would increase the difficulty in forecasting the loads. This study aims to cluster the load profiles of the demand bidding event days and analyze the property of each clustering group. We design the load curve of each event day for a user who participants in the demand bidding program. This curve is the result of the difference per 15 minutes between the event day and customer baseline load (CBL). We use the Self-Organizing Maps (SOM) method to cluster the load curves of those participants. In this thesis, we only focus on four industry groups: steel, oil, cement and pulp industries.

關鍵詞(Key Words)：需量反應(Demand Response)、需量競價(Demand Bidding)、資料分析(Data Analysis)、自我組織特徵映射網路(Self-Organizing Maps)。

---

*財團法人工業技術研究院資訊與通訊研究所
**台灣電力公司綜合研究所

低壓用戶申請住商型簡易時間電價之用電分析

Analysis of Low Tension Customer Demand for Time-of-use Tariffs

蔡宗霖*
Tsai, Tsung-Lin

陳束弘*
Chen, Su-Hong

摘　要

　　台灣夏季尖峰用電逐年成長，需求面管理(Demand Side Management, DSM)為有效節電措施，可提高用戶端用電效率與改善用戶高用電行為。台電公司推出許多不同類型的需求面管理措施與節約能源推廣宣傳，包括智慧電表基礎設施佈建、住商型簡易時間電價推廣等。我國低壓用戶智慧電表AMI佈建預計113年累計設置完成300萬戶，運用數據分析，找出目標用戶，推廣住商型簡易時間電價；對於住宅用電戶而言，可以了解尖離峰用電區間、用電比例與用電行為，以利評估是否適合時間電價，對於整體尖峰用電節能管理將有助益。

Abstract

In Taiwan, the power consumption of the country continues to grow year after year, with peak load appearing in summer. An effective technique - known as Demand Side Management (DSM) – has been used by Taipower to encourage end consumers to use electricity in a more efficient way. Taipower company has implemented some Demand Response Initiatives such as "Time-Of-Use Programs" and "Summer-Season Electricity Pricing Scheme". In addition, Taipower is planning that the deployment of the low voltage AMI will reach a goal of 3 million units by 2024. The data gathered from the smart meters can be used to provide better understanding of end customer behavior and facilitate segmentation of residential customers precisely. This study aims to use relevant data gathered from the smart meters , like residential load curve profile, to deliver the useful message at the right time to the target customers effectively - which is expected to be beneficial to the management of peak load power consumption.

關鍵詞(**Key Words**)：智慧電表基礎建設(Automated Metering Infrastructure, AMI)、需求面管理(Demand Side Management, DSM)、顧客價值分群(Customer Segmentation)、用戶互動參與(Customer Engagement)。

---

*工業技術研究院