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# 大用戶諧波潮流判定法與系統分界點變更對於電壓閃爍值之影響

Large User Harmonic Power Flow Determination Method and the Influence of Changes in System Responsibility Demarcation Points on Voltage Flicker Values

周昱緯\*  
Chou, Yu-Wei

劉尚銘\*  
Liu, Shang-Ming

呂明忠\*  
Lyu, Ming-Jhong

## 摘要

隨著國家再生能源快速發展的同時，對於維持電網良好之電力品質亦應高度重視並與用戶共同努力，供電區營運處每年針對轄下大用戶(再生能源廠、鋼鐵廠)進行電力品質量測時，偶有諧波電流超標之問題，過去往往難以釐清諧波污染源來自何處，本文利用電力品質分析儀搭配三相三線接線法，並以諧波功率之電壓、電流相位夾角(Phase Angle)進行分析，對於單一線路上具有多家用戶之情形能更明確地釐清諧波電流污染之主要來源。同時，電壓閃爍值過高，一直是遽變負載用戶(煉鋼廠、電焊工廠等)常見之問題，本文亦透過實例分析，探討系統責任分界點變更時，不同電力系統短路容量對於電壓閃爍代表值之影響。

## Abstract

With the rapid development of renewable energy in Taiwan, we should attach great importance to maintaining good power quality of the power grid and work together with users. When the Power Supply Branch of Taipower conducts power quality tests for large users (such as renewable energy plants and steel plants) every year, the problems of harmonic current exceeding the standard is often seen. However, in the past, it was difficult to clarify where the source of harmonic pollution came from. In this article, we use a power quality analyzer with a three-phase three-wire (3P3W) connection method to analyze the voltage, current and phase angle. For situations with multiple users on a single line, the main sources of harmonic current pollution can be more clearly clarified. In addition, excessive voltage flicker has always been a common problem for users with rapidly changing loads (such as steel plants, welding plants). Through case analysis, this article explores the influence of short-circuit capacity (SCC) of different power systems on voltage flicker values when the system responsibility demarcation point changes.

**關鍵詞(Key Words):** 電力品質(Power Quality)、電壓閃爍(Voltage Flicker)、諧波電流(Harmonic Currents)、鋼鐵廠(Steel Factory)、再生能源(Renewable Energy)、短路容量(Short Circuit Capacity)。

# 固態技術於電力轉換系統之應用與案例研析

Application and Case Study of Solid-state Technology in Power Conversion Systems

江文莊\*  
Jiang, Wen-Zhuang

林士傑\*  
Lin, Shih-Chieh

謝振中\*\*  
Shieh, Jenn-Jong

黃琮恩\*\*  
Huang, Tsung-En

葉丞竣\*\*  
Yeh, Cheng-Jun

## 摘要

由於有越來越多的再生能源與電動車充電設備併入配電網，導致了配電網的饋線電壓容易受到影響。隨著電力電子技術不斷地提升，因此藉由利用電力電子技術，可以讓電力轉換裝置更具有彈性。其技術可分為固態變壓器(Solid-state Transformer, SST)與混合式變壓器(Hybrid Transformer, HT)。其中固態變壓器為全部由電力電子元件所構成，可以達成四象限控制、電壓調整、虛功補償以及不斷電系統功能。國際上針對固態變壓器最早是應用在船艦，目的是為了減輕船艦的重量與體積。固態變壓器會根據不同應用而有所差異，例如分散式能源、交直流微電網、電動車充電系統、資料中心電源系統、以及配電系統等。因此，本研究蒐集與整理國際上針對固態變壓器以及混合式變壓器之應用案例，作為電力公司未來應用固態變壓器以及混合式變壓器之參考依據。

## Abstract

As more and more renewable energy and electric vehicle charging equipment are integrated into the distribution network, the feeder voltage of distribution network is easily affected. As power electronics technology continues to improve, related technologies such as solid-state transformer (SST) and hybrid transformer (HT) can make power conversion devices more flexible. Among them, solid-state transformers are composed entirely of power electronic components and can achieve four-quadrant control, voltage adjustment, reactive power compensation, and uninterruptible power system (UPS) functions. The earliest application of solid-state transformers was to reduce the weight and volume of ships. At present, they have nevertheless more diverse applications, such as AC and DC microgrids, electric vehicle charging systems, data center power systems, energy storage systems, and power distribution systems. This study is dedicated to collecting and organizing international application cases of solid-state transformers and hybrid transformers as a reference for the company's future applications.

**關鍵詞(Key Words)**：再生能源 (Renewable Energy)、固態變壓器 (Solid-state Transformer, SST)、混合式變壓器 (Hybrid Transformer, HT)。

\*台灣電力公司綜合研究所

\*\*逢甲大學電機工程學系

# 探討非破壞式探勘技術應用於配電管路管挖工程之 可行性

Feasibility of Applying Non-destructive Prospecting Technologies to Distribution Pipeline  
Construction Projects

黃銘宏\*  
Huang, Ming-Hung

柴建業\*  
Chai, Chien-Yeh

董群驥\*  
Tung, Chun-Chi

廖苡均\*  
Liao, Yi-Chun

謝治均\*  
Hsieh, Chih-Chun

## 摘 要

台灣地區地下管線之配置非常複雜，地下配電管線因孔蓋掩埋、地理圖資錯誤等問題，導致難以監測與維護。本文研析及比較現有非破壞式探勘技術，尋求適用於配電地下管線工程之技術，以獲得正確地下電纜埋設位置資訊，並提高地下物質與結構物的空間判釋與評估潛在災害能力。本案團隊歷經多次現場實務挫折但仍努力不懈，獲得多項進展，將可強韌配電系統並提升供電品質。

## Abstract

The configuration of underground pipelines in Taiwan is very complex. Underground distribution pipelines are difficult to monitor and maintain due to problems such as buried hole covers and incorrect geospatial distribution mappings. This article analyzes and compares the existing non-destructive prospecting and seeks technologies suitable for distribution underground pipeline projects to obtain correct underground cable burial location information and improve the spatial interpretation and potential disaster assessment capabilities of subterranean materials and structures. Although the team has gone through many on-site practical setbacks but still worked tirelessly and made many progresses that will strengthen the power distribution system and improve the quality of the power supply.

**關鍵詞(Key Words)**：探勘(Prospecting)、超低頻電磁波探勘(Super-Low Frequency Electromagnetic Prospecting)、透地雷達(Ground Penetrating Radar)、慣性定位儀(Inertial Locator)、無線電波探測儀(Radiodetector)。

# 台電雙城會館之耐震評估及補強案例分享

A Case Sharing of Seismic Performance Evaluation and Retrofit of Taipower's Shuangcheng Guild Hall

戚光平\*  
Chi, Kuan-Ping

黃偉光\*  
Huang, Wei-Kuang

楊德錦\*  
Yang, Der-Jin

## 摘要

本研究係以本公司台北雙城會館作為研究案例，由於此舊有建築物是依據當時法規進行耐震設計並施工完成，已不符合現今規範之要求，且本會館屬臺北市政府都市發展局所列管之耐震能力評估檢查申報不合格場所，須依「原有合法建築物公共安全改善辦法」第 25-1 條規定改善完成。研究方向原則採行國家地震工程研究中心「校舍結構耐震評估與補強技術手冊」及「臺灣結構耐震評估側推分析法」，並輔以我國「建築物耐震設計規範及解說」之條文規定。本會館曾委託「社團法人臺灣省土木技師公會」於民國 109 年完成耐震詳細評估，並於民國 112 年完成耐震補強，由於本案涉及諸多法令，完工申報亦屬冗長，事前規劃設計宜應謹慎。

## Abstract

In this project we use Taipower's Shuangcheng Guild Hall in Taipei as a case study. The building was seismically designed and constructed in accordance with the regulations at the time, and no longer meets the requirements of today's regulations. Besides, the building was previously inspected by Taipei City Government's Urban Development Bureau for seismic performance evaluation and declared as an unqualified site. Therefore, improvements must be completed in accordance with article 25-1 of the "Measures for Public Safety Improvement of Existing Legal Buildings". The direction of this research basically follows the "Technical Manual for Seismic Evaluation and Retrofit of School Building Structures" and "Taiwan Structural Seismic Assessment by Pushover Analysis Method" formulated by the National Center for Research on Earthquake Engineering, supplemented by the relevant regulations of "Seismic Design Code and Explanation for Buildings". Shuangcheng Guild Hall had entrusted the "Taiwan Provincial Civil Engineers Association" to complete a detailed seismic evaluation in 2020, and completed seismic retrofit in 2023. Considering this case involves many laws and regulations, and the procedures for declaration of completion are cumbersome and lengthy, every effort should be made to be thorough and cautious during the planning and design stage.

**關鍵詞(Key Words)**：耐震評估(Seismic Performance Evaluation)、耐震詳細評估(Detailed Seismic Evaluation)、耐震補強(Seismic Retrofit)。

# 基於多代理人強化學習結合長短期記憶網絡的社區能源管理系統

Community Energy Management System Based on Multi-Agent Reinforcement Learning (MARL) and Long Short-Term Memory (LSTM) Network

魏峻為\*  
Wei, Chun-Wei

邱偉育\*  
Chiu, Wei-Yu

## 摘要

基於價格的需量反應家庭能源管理系統為實現能源效率提供了新的機會，透過有效的能源調度，旨在不影響用戶滿意度的前提下最大程度地降低能源成本。然而，缺乏協調的響應可能導致低價時期的能源消耗峰值反彈。本文提出了一個基於多代理人強化學習(Multiagent Reinforcement Learning, MARL)結合長短期記憶網絡(Long Short-Term Memory, LSTM)的社區能源管理系統，此框架使用循環神經網路處理時間序列資訊並且最大限度地減少用戶的成本。此方法包括一個需量反應聚合器，可優化多個住宅用戶的社區總電力成本。在住宅端，系統會對家用電器、電動車、儲能系統和再生能源發電進行能源管理。系統會預測再生能源發電量，以減少能源供應的不確定性，而使用長短期記憶網絡可以處理更大的時間序列數據，並且獲得更加完整的特徵，使學習效果更佳。實驗結果所示，所提出的方法在降低用戶成本方面，優於單代理人強化學習和使用多代理人強化學習的方法。

## Abstract

The combination of price-based demand response (DR) measures and home energy management systems provide new opportunities to achieve energy efficiency through efficient energy dispatch and minimize energy consumption cost without affecting user satisfaction. However, a lack of a coordinated response may lead to a peak rebound during periods of low prices. In this article, we propose a community energy management system based on Multi-Agent Reinforcement Learning (MARL) combined with Long Short-Term Memory (LSTM), which uses recurrent neural networks to process time series information and minimize the cost to users. The approach includes a DR aggregator that optimizes total community electricity costs for multiple residential users. On the residential side, the system will perform energy management on household appliances, electric vehicles, energy storage systems, and renewable energy generation. The system will predict renewable energy generation to reduce the uncertainty of energy supply. In addition, the LSTM network can process larger time series data and help obtain more comprehensive features, so as to enhance the learning effect. Experimental results show that the proposed method is superior to single-agent reinforcement learning and traditional multi-agent reinforcement learning methods in terms of reducing the cost to users.

**關鍵詞(Key Words):** 家電調度(Home Appliance Scheduling)、能源管理系統(Energy Management System)、博弈論(Game Theory)、多代理人強化學習(Multiagent Reinforcement Learning)、神經網路(Neural Network)、峰值反彈(Peak Rebound)。

# 氣候變遷下時間電價調整對負載曲線之影響

The Impact of Time-of-Use Pricing Adjustment on Load Curve under Climate Change

蕭宇喬\*  
Hsiao, Yu-Chiao

許家勝\*\*  
Hsu, Chia-Sheng

李桂君\*  
Lee, Kuei-Chun

## 摘要

氣候變遷下全年溫度提升，且提升幅度依季節有所不同。台電公司採取多項價格措施以因應此變化，包括提前實施夏季電價、調整尖峰時段、擴大尖離峰價比等。本文結合時間序列與主成份分析，建立各小時別負載預測模型，後透過模擬負載曲線在不同氣溫及新/舊時間電價帶下之情境組合變化。結果顯示，新時間電價方案可以有效抑制夜尖峰負載，且隨著氣溫持續上升，新時間電價政策仍可達到目前的負載移轉效果。然而，溫度上升對各時段負載影響的幅度不一，可能與各壓別用電對溫度反應不同，以及近年逐漸將計畫性需量反應方案抑低時段從白天調整至夜晚有關。本研究建議，若能取得各需量反應方案在調整前後的完整歷史資料，以及各電壓別逐時負載資料，將有助於分析溫度、時間電價及需量反應方案對民生和工業用電的影響，並為未來需求面管理政策的制定提供參考依據。

## Abstract

Under climate change, temperatures are increasing throughout the year, and the extent of the increase varies depending on the season. In response to the aforementioned changes, Taipower has implemented a number of pricing measures, including early implementation of summer electricity rates, adjustments to peak hours, and expansion of on-peak to off-peak price ratio. This study combines time series (ARIMA) and principal component analysis to establish an hourly load forecast model to simulate the changes in the load curve under different temperature scenarios and new/old time-of-use (TOU) pricing schemes. The results show that the new TOU pricing scheme can effectively suppress night peak load, and as the temperature continues to rise, the new pricing policy can still achieve the current effect of load shifting. However, the impact of temperature rise on loads in different periods is different, which may be related to the different responses of electricity consumption at different voltage levels to temperature and the gradual adjustment of the planned demand response (DR) scheme's reduction period from daytime to nighttime in recent years. This study suggests that if the complete historical data of each DR scheme before and after adjustment and the hourly load data of each voltage can be obtained, it will be helpful to analyze the impact of temperature, TOU pricing, and DR scheme on residential and industrial electricity consumption and provide a reference for the formulation of future demand-side management (DSM) policies.

**關鍵詞(Key Words)**：時間電價(Time-of-Use)、氣候變遷(Climate Change)、負載預測(Load Forecasting)。

\*台灣綜合研究院

\*\*中華經濟研究院

# 售電服務之用戶特徵蒐集及應用研究

Taipower Electricity Sales User Digital Persona Analysis

朱鏡如\*  
Chu, Ching-Ju

黃柏崴\*  
Huang, Po-Wei

陳亮丞\*  
Chen, Liang-Chen

姜佑昇\*  
Chiang, Yu-Sheng

## 摘要

為提升台電品牌價值並加強顧客服務，支持企業決策和維運，維繫用戶良好關係，本研究蒐集精準行銷之業界與產業相關最新趨勢，參考多個國內外案例，盤點現有台電現有行銷模式、架構，與資安相關規範等，配合本案的研究範疇，提出對應的具體建議。並使用一專為台電建置的「台電售電用戶數位輪廓分析系統」，以符合各相關規範為前提，蒐集本案研究範圍內的台電數位服務系統之用戶站內行為及站外數位足跡，進而為相關售電用戶標註興趣與關鍵字標籤，藉此分析各群體用戶之間的差異性、數位足跡、站內行為、用戶輪廓等。可作為台電未來精準數位行銷之參考要素及基礎，期能達到自動化且個人化之訊息溝通並提升用戶滿意度。

## Abstract

In order to enhance Taipower's brand value and strengthen customer service, support corporate decision-making and operations, and maintain good relationships with users, this study collects the latest industry and industry-related trends in precision marketing, and takes stock of the company's existing marketing models with reference to multiple domestic and foreign cases, architecture and information security related specifications, etc., to provide corresponding suggestions based on the research scope of this project.

In addition, under the premise of complying with relevant specifications, this study uses the "Taipower Electricity Sales User Digital Persona Analysis System" specially built for Taipower to collect on-site behaviors and off-site digital footprints of its users, and mark their interests and keyword tags to further analyze the differences between each group of users, digital footprints, on-site behavior, personas, etc.

The results of this study may serve as a reference for Taipower's future precision digital marketing to achieve automated and personalized message communication and improve user satisfaction.

**關鍵詞(Key Words)**：人工智慧 (Artificial Intelligence)、大數據 (Big Data)、數據管理平台 (Data Management Platform)、數位轉型 (Digital Transformation)、用戶輪廓 (Persona)。