台電工程月刊 916 期 (12 月) 目錄

同步調相機改善塔山系統弱點

Applying Synchronous Condenser to Improve the Weakness of Tashan System

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摘 要

同步調相機(Synchronous Condenser, SC)為同步旋轉電機的一種，本身不對系統發出實功，但可為電網提供慣量、故障電流和調節虛功。金門系統隨者風力發電、太陽能等再生能源發電設備增加，再生能源滲透率增加後供電系統慣量減小，導致系統頻率在嚴重擾動下更加的脆弱，且可能出現頻率不穩定等現象。而 SC 可以減緩再生能源滲透率增加產生的問題，提供電網包括高慣量、高短路能力、高過載能力與調節虛功。本論文將模擬同步調相機應用於金門系統，並討論用 SC 後改善金門系統之結果。然，SC 的價格不菲，因此本論文也討論利用變頻器的網構(Grid-forming)控制替代 SC，而得到相同的結果。

Abstract

Synchronous condenser (SC) is a type of synchronous rotating motor that does not generate real power but can provide inertia, fault current, and reactive power regulation to the power grid. As the penetration of renewable energy sources such as wind and solar power increases in the Kinmen system, the inertia of power system decreases, making system frequency control more fragile under severe disturbances, and frequency instability may occur. SC can mitigate the problems caused by the increasing penetration of renewable energy sources, providing the power grid with advantages such as high inertia, high short-circuit capacity, high overload capacity, and reactive power regulation. This article introduces the application of SC in the Kinmen system and the results of improvement. Since SC is expensive, this article therefore also discusses using inverter grid-forming control to replace SC and nevertheless achieve the same results.

關鍵詞(Key Words)：同步調相機(Synchronous Condenser)、再生能源(Renewable Energy)、虛功調節 (Regulating Virtual Power)、短路電流(Short-circuit)、慣量(Inertia)。

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輸電級併網型儲能系統併聯審查

Review of Energy Storage System Connected to Transmission System

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摘　要

政府推動能源轉型，訂定 2025 年再生能源發電占比 20%的政策目標。隨著再生能源併網滲透率提高，其易受天候與季節所產生的間歇性發電問題更加嚴重，電力系統頻率亦隨之快速變動。電池儲能設備具有快速充放電能力，可參與本公司輔助服務市場交易平台推出的調頻備轉容量，協助電網快速調整頻率。目前儲能主要參與調頻備轉服務包含動態調頻備轉(Dynamic Regulation Reserve, dReg)、靜態調頻備轉(Static Regulation Reserve, sReg)以及電能移轉複合動態調節備轉(Energy-shifting with Dynamic Regulating Function Reserve, E-dReg)；dReg 和 sReg 可依據電網的狀況於一秒內完成充電或放電的雙向調頻反應，E-dReg 除調頻外且可協助尖離峰電能轉移，達到削峰填谷的功能。

本文針對現行之儲能併聯審查作業流程及檢討項目進行說明，藉由各審查階段預先掌握儲能系統併聯後對系統帶來之衝擊。文中亦針對設置區域及設置安全規範、併網審查檢討指標、併聯審查意見書有效期限及展延規定、容量保留費規定進行介紹。

Abstract

In order to promote energy transformation, the government has set a policy goal of reaching 20% of renewable energy (RE) power generation by 2025. As the penetration of RE resources into the grid increases, the problem of intermittent power generation caused by weather and seasons becomes more serious, and the frequency of the power system also changes rapidly. Battery energy storage equipment has fast charging and discharging capabilities. Therefore, it may serve as frequency regulation resource and participate in Taipower's ancillary service (AS) market, helping the power grid to quickly adjust the frequency. Currently, energy storage mainly serves as frequency regulation reserve and may participate in the transactions of three AS sub-markets, including dynamic regulation reserve (dReg), static regulation reserve (sReg), and energy-shifting with dynamic regulation function reserve (E-dReg). dReg and sReg can complete two-way frequency regulation response by charging or discharging within one second according to the conditions of the power grid. In addition to frequency regulation, E-dReg can also assist in shifting peak-hour load to off-peak period (peak shaving and valley filling).

This article explains the current grid connection review process and review items of battery energy storage system to understand in advance the impact of battery energy storage systems on the power grid. In addition, this article also introduces the installation area and installation safety regulations, grid connection review items, the validity period and extension regulations of the grid connection review opinion, the capacity retention fee regulations, etc.

關鍵詞(Key Words)：電池儲能系統(Battery Energy Storage System)、併聯審查(Grid Connection Review)、審查流程(Review Procedure)。

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國際葉片再生技術最新趨勢之探討

Discussion on the Latest Trends in International Blade Regeneration Technology

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摘 要

葉片再生是維護專業和服務並重的研產合一技術，位居電業渦輪機「維護、修理和大修 (MRO)」技術價值鏈中的關鍵地位。產業的未來成長和競爭力必須根據市場前景和用戶需求而定，將取決於對潔淨能源基礎設施、設備及技術進行有效投資與創新。數位化變革性方法，提供數據驅動的決策效率、準確性和整體管理，並優化維護工作流程、提高零件的使用壽命和完整性、延長維修間隔、增強可靠度和操作靈活性，以獲取最具成本效益的創新服務和產品升級。MRO 維修趨勢受到國際供應鏈壓力和勞動力短缺影響，已經轉向組件維修、更換及銷售，以確保零件隨時可用。未來預測性維護、數位化、自動化、人工智慧、機器人應用、積層製造以及精密測量技術是最重要且最具前景的創新維護方向。

Abstract

Blade regeneration is atechnology that integrates research and production with equal emphasis on maintenance expertise and services. It occupies a key position in turbines' value chain of maintenance, repair and overhaul (MRO). The future growth and competitiveness of the industry must be based on market prospects and user needs, and will depend on effective investment and innovation in clean energy infrastructure, equipment and technology. A digitally transformative approach provides data-driven decision-making efficiency, accuracy and overall management, and optimizes maintenance workflow, improves the service life and integrity of parts, extends maintenance intervals, enhances reliability and operational flexibility for the most cost-effective innovative services and product upgrades. MRO repair trends, affected by international supply chain pressures and labor shortages, have shifted toward component repair, replacement and sales to ensure parts are readily available. Predictive maintenance, digitization, automation, artificial intelligence, robotic applications, additive manufacturing and precision measurement technology are the most important and promising innovative maintenance direction in the future.

關鍵詞(Key Words)：葉片再生(Blade Regeneration)、台電綜合研究所(Taiwan Power Research Institute)、氣渦輪機(Gas Turbine)、維修服務(MRO Service)。

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燈力併供變壓器對配電系統及用戶影響研究

The Impact of Open Wye-Open Delta Transformers on the Distribution System and Users

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摘 要

台灣電力公司為配合臺灣地區各使用者不同用電需求，並減少對景觀之衝擊，採用燈力併供組，以提供單相 110/220V 及三相 220V 用電，可同時利用三相及單相負載之參差率，降低變壓器之裝置容量，發揮設備最大效率，然而此供電方式因接線結構上存在先天之不平衡因素，可能加深三相不平衡供電的影響，並衍生相關供電問題，隨著用戶用電量逐漸增大，燈力併供組設置數量隨之增多，大量燈力併供組對配電系統之供電穩定度及效率影響程度，以及對使用者端感應電動機、電子設備的影響，應進行深入探討。本文分析其主要影響因素。首先探討燈力併供組之供電方式，比較其他接線方式之差異；再依實際使用者之負載參數建立設備模型，模擬供電變化對使用者設備的影響；並建立系統模型進行潮流模擬，瞭解燈力併供組之供電損失情況，最後以實際現場量測記錄進行資料分析，驗證模擬結果，並歸納研究結果推論損耗變化。研究結果可供做為往後低壓供電改善及規劃之參考基礎。

Abstract

In order to meet the different needs of users in Taiwan and reduce the impact on the landscape, Taiwpower use sthe method of open wye-open delta connectionto provide single phase 110/220V and three phase 220V power needs. The aforementioned power supply method can utilize the high diversity factorof three-phase and single-phase loadsto reduce the installed capacity of transformers and maximize the equipment efficiency. However, due to the inherent unbalanced factors in the wiring structure of this power supply method, it may deepen the impact of the three-phase unbalanced power supply and cause related power supply problems. As users' electricity consumption increases, the number of installations using the power supply methods also increases.The manner and extent of the impact of the situation on the power supply stability and efficiency of the power distribution system, and even on the induction motors and electronic equipment at the user end, should be discussed in depth.This study first explores the differences between the power supply method and other wiring methods; then establishes an equipment model based on actual user load parametersto simulate the impact of changes in power supply

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methods on user equipment.In addition, this study also establishes a system model for power flow simulation to understand the line losses of the power supply method, and conducts data analysis with actual on-site measurement records to verify the simulation results. Finally, the study results were summarized to deduce the loss changes and may serve as reference for future low-voltage power supply improvement and planning.

關鍵詞(Key Words)：燈力併供組(Open Wye-Open Delta Connection)、三相不平衡(Three-Phase Unbalance)、電力品質(Power Quality)、線路損失(Line Loss)。

電費帳務管理系統重建及數位功能擴充規劃研究

Research on Billing and Accounting System Reconstruction and Digital Function Expansion Planning

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摘　要

為確保電費帳務管理之正確性並保障公司資金完整回收，同時能使系統可因應國際相關趨勢與科技變革，因而提出此研究案，希望透過系統診斷、系統重建、科技工具導入、數據應用等行動，提升整體電費帳務管理系統之數位能力，進而應對整體環境變化之影響。

研究團隊首先協助收集國內外相關標竿案例對於帳務管理與相關數位功能之實務作為，同時針對現行系統基本功能、各作業流程進行資料收集、訪談與分析，再進一步綜整當前系統需求、改進建議與未來新功能服務規劃。接著，彙整當前系統核心管理議題，再根據上述內容蒐研當前實務界之最佳化解決方案，並比較套裝軟體與系統客製化方案之優劣與可行性。

Abstract

To ensure the accuracy of electricity bill management, complete recovery of company funds, and in response to relevant international trends and technological changes, this research project hopes to enhance the digital capabilities of the company's electricity billing and accounting system through actions such as system diagnosis, system reconstruction, introduction of technology tools, and application of data.

In this research, we first collect benchmark cases both domestically and internationally regarding billing accounting management and related digital functions. Concurrently, data collection, interviews and analysis are conducted on the basic functions and operational processes of the current system. After completing the above work, the current system requirements and improvement suggestions are integrated to develop and plan new functional services in the future. Finally, the core management issues of the current system are summarized, and based on the above content, the optimal solutions are searched and the advantages, disadvantages, and feasibility of packaged software and system customized solutions are compared.

關鍵詞(Key Words)：電費帳務管理系統(Billing Accounting System, BAS)、帳務管理(Accounting Management)、系統重建(System Reconstruction)、自動化(Automation)、數位化(Digitalization)。

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經濟弱勢戶能源使用特性與未來挑戰

Energy Consumption Characteristics and Future Challenges of Energy Poverty Households

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摘　要

本研究以某縣市經濟弱勢戶為對象(包括獨居老人、低收入戶、中低收入戶及脆弱家庭)，結合村里長/幹事、在地水電師傅及節能診斷服務中心(Energy Diagnostic Center, EDC)，透過實際入戶執行能源健檢服務、用電設備盤查及面對面深度訪談，期透過了解弱勢經濟戶能源使用現況及困境，提供即時簡易設備修繕及節能補助挹注，改善經濟弱勢家戶設備能源效率及提升住家環境品質。惟弱勢能源補助政策立意良好，若能「以人為本」，納入節能、安全、健康、舒適度等多元考量，如對原先室內照明或室外照度不足的家戶來說，建議未來在整體精進或配套上可增設新的照明光源，藉以提升環境照明舒適度，或建議提高補助額度及彈性，降低家戶補助申請門檻。

Abstract

This study takes the energy poverty (economically disadvantaged) households, including the elderly living alone, low- and middle-income households, and vulnerable families in a county/city in Taiwan as the subjects, and combines the efforts of the village head/officer, local plumbers, and energy diagnostic centers (EDC), through actual home visits to perform energy health inspection services, electrical equipment inventory and face-to-face in-depth interviews. It is hoped that by understanding the energy poverty households, we can provide immediate simple equipment repairs and energy-saving subsidies, improve the energy efficiency of equipment of energy poverty households and enhance the quality of the home environment. The aforementioned energy subsidy policy for energy poverty households although has good intentions, but if it can be “people-oriented” and take into account multiple considerations such as energy conservation, safety, health, and comfort, it can produce greater results.For example, for households with insufficient indoor lighting or outdoor illumination, this study recommends that new lighting sources be added in the future in terms of overall improvement or supporting facilities to improve environmental lighting comfort, or it is recommended to increase the amount and flexibility of subsidies to reduce the application threshold.

關鍵詞(Key Words)：能源貧窮(Energy Poverty)、能源使用(Energy Consumption)、用電效率(Energy Efficiency)、能源可負擔(Affordable Energy)。

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高能耗家電健檢與汰換服務之建立與驗證

Establishment and Verification of Health Inspection and Replacement Service for High Energy Consumption Home Appliances

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摘　要

台電公司為因應售電自由化，參酌國際 2 家能源數據分析公司之服務案例，探討高能耗家電健檢與汰換服務模式於我國電業環境之可行性。評估後，擇定以智慧電表用電資料結合 AI 模型，提供住宅用電分析相關服務，定期分析用電數據，並結合家電販售通路商共同驗證高能耗家電健檢與汰換之服務模式。本研究之服務 111 年 9 月於台灣電力 App 上線，提供低壓智慧電表住宅用戶使用「家電月用電分析」、「家電汰舊換新優惠」等服務。使用者體驗調查結果顯示，服務滿意度達 88%以上。

Abstract

In response to the liberalization of domestic electricity market,Taipower studied the cases of two international energy data analysis companies to explore the models of health inspection and replacement service feasible for high energy consumption home appliances in Taiwan. After evaluation, it was decided to use smart meter data combined with AI models to provide electricity consumption analysis services related to the residential users, regularly analyze their power consumption data, and work with home appliance sales channels to jointly verify the feasible health inspection and replacement service models for their high-energy-consuming home appliances. The service of this study was launched on Taipower's Electric Power App in September 2011, providing low-voltage smart meter residential users with services such as "Home Appliance Monthly Power Consumption Analysis" and "Home Appliance Replacement Discounts." The results of user experience survey show that service satisfaction with the aforementioned two measures reached over 88%.

關鍵詞(Key Words)：售電大數據(Electricity Consumption Data)、設備用電分離辨識(Appliance Energy Disaggregation)、高能耗家電健檢與汰換服務(Health Inspection and Replacement Service for High Energy Consumption Home Appliances)、服務滿意度(Service Satisfaction)。

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運用 IPA 探討住宅家電節能補助網路申辦服務

Using IPA to Explore Online Application Service for Residential Appliance Energy-saving Subsidy

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摘　要

能源效率提升是淨零排放必要政策，我國 2022 年 3 月正式公布「臺灣 2050 淨零排放路徑及策略總說明」，其中住宅家電「能源效率極大化」為重要工作之一，經濟部能源署為鼓勵全民參與，共同實踐減碳淨零的目標，定期檢討產品能源效率進行源頭管理，並適時補助高能效產品。2023 年「住宅家電汰舊換新節能補助」以光學字元辨識(Optical Character Recognition, OCR)及人工智慧(Artificial Intelligence, AI)審件技術提升公共服務韌性，不但減輕大量審案所造成的行政負擔，更加速了全民的永續行動。然而，在賦能平台提升服務效能的作用下，為能持續優化住宅家電節能補助網路申辦服務水準、確保節能政策目標並使後續政策資源得以有效分配，本文採用重要性-績效分析法(Importance-Performance Analysis, IPA)探討此一站式智慧審案服務的未來改善策略，期透過研究分析建議，精進智慧政府服務的發展，進而帶動節能治理生態系的永續循環。

Abstract

Enhancing energy efficiency is a crucial policy to achieve net-zero emissions. In March 2022, the government officially announced the “Taiwan’s Pathway to Net-Zero Emissions in 2050” and “maximizing energy efficiency” of residential appliances was identified as a key initiative. To encourage the participation of all people to jointly achieve the goal of net-zero carbon reduction, the Energy Administration of the Ministry of Economic Affairs regularly reviews the energy efficiency of products for source management and subsidizes high-efficiency products in a timely manner. In 2023, the “Green Appliance Subsidy” program utilized optical character recognition (OCR) and artificial intelligence (AI) review technology to improve the resilience of public services. The measure not only alleviates the administrative burdens caused by a large number of cases, but also accelerates the sustainable actions of the whole people. However, under the influence of the empowerment platform to improve service efficiency, in order to continuously optimize the application service level of the residential appliance energy-saving policy goals, and effectively allocate subsequent policy resources, in this study we adopt the importance-performance analysis (IPA) to explore future improvement strategies of this one-stop smart review service, hoping to improve the development of smart government services through research, analysis and recommendations, thereby driving a sustainable cycle of the energy-saving governance ecosystem.

關鍵詞(Key Words)：重要性-績效分析(Importance-Performance Analysis)、住宅家電節能補助(Green Appliance Subsidy)、網路申辦(Online Application)、光學字元辨識(Optical Character Recognition)、人工智慧(Artificial Intelligence)。

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核三廠填換爐心暫態安全分析獨立驗證與技術精進

Technology Advancement and Independent Verification of the Reload Transient Safety Analysis for Maanshan Nuclear Power Plant

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摘　要

本計畫由台電公司核安處委託國家原子能科技研究院原子能系統工程研究所執行，計畫期程自 110 年 3 月 1 日至 113 年 2 月 29 日共計三年，並在契約原訂工作範圍內，採口頭說明或討論方式，提供諮詢服務至 114 年 5 月 17 日。本計畫延續使用「核一、二、三廠填換爐心暫態安全分析獨立驗證與技術提昇」計畫所建立的核三廠爐心熱水流分析模式與方法，進行每個燃料週期的爐心熱水流最終可接受準則(FAC)分析，也因應燃料廠家在偏離核沸騰(Departure from Nucleate Boiling, DNB)的經驗公式改良而更新模式。在系統暫態分析方面，本計畫將持續更新小幅度功率提昇(Measurement Uncertainty Recapture Power Uprate，簡稱 MUR 功率提昇或 MUR PU)後的分析模式、精進核三廠暫態安全分析方法，以掌握核三廠接近 40 年設計年限所可能之相關分析支援。

Abstract

This project was funded by the Department of Nuclear Safety of Taipower and implemented by the Department of Nuclear Systems Engineering of National Atomic Research Institute (NARI). The period of the project was from March 1, 2021 to February 29, 2024, a total of three years. According to the original work content of the contract, consulting services will be provided through oral explanation or discussion until May 17, 2025. This project will continue to use the reactor core thermal hydraulic analysis models and methods developed by the project of “The improvement of core safety and transient analyses for Chinshan, Kuosheng, and Maanshan nuclear power plant” to conduct the Final Acceptance Criteria (FAC) analysis, and the FAC model will be updated in response to the improvement of the fuel vendor's empirical formula for Departure from Nucleate Boiling (DNB). In terms of system transient analysis, this project will continue to update the Measurement Uncertainty Recapture Power Uprate(MUR PU) analysis model and improve the transient safety analysis method to provide the operation support for the Maanshan Nuclear Power Plant.

關鍵詞(Key Words)：核三廠(Maanshan)、最終可接受準則分析(Final Acceptance Criteria Analysis)、暫態安全分析(Transient Safety Analysis)。

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