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電池儲能系統於電網自動調頻控制之應用與驗證

Application and Verification of Battery Energy Storage System for Power Grid Automatic Frequency Control

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摘要

本研究以國產之 1MW/1.5MWh 貨櫃式鋰離子電池儲能系統，搭配具自動電網頻率調節功能之電能調節系統以及高速率即時電力數據量測設備。依循台電公司研擬推出之「儲能自動頻率控制(Automatic Frequency Control, AFC)調頻服務資源」輔助服務採購方案中所訂定之服務能力測試要求，逐項進行測試。試驗結果顯示目前建置於台電綜合研究所樹林所區之併網型 MW 配電級儲能系統符合標準，具備參與該項輔助服務之能力。

Abstract

In this study, a domestically manufactured 1MW / 1.5MWh container-type lithium-ion battery energy storage system had been constructed in conjunction with a power condition system capable to provide automatic frequency regulation (AFC) function and a high-speed real-time power data measurement equipment. According to the requirement of service performance tests stipulated in the Ancillary Services Procurement Program for AFC Services issued by Taiwan Power Company, we accordingly carried out the testing of the aforesaid system item by item. As the testing results indicated, the grid-connected MW distribution-level energy storage system in Shu-lin area of Taiwan Power Research Institute is qualified and capable to provide AFC service.

關鍵詞(Key Words)：電池儲能系統 (Battery Energy Storage System)、自動頻率控制(Automatic Frequency Control)、輔助服務(Ancillary Service)、高速率即時電力數據量測設備(High-speed Real-time Power Data Measurement Equipment)。

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Vestas V47 風機葉片加裝渦流產生器之數值研究

A Numerical Study on Vestas V47 Wind Turbine Blade Retrofitted with Vortex Generators

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摘要

本研究使用 COMSOL Multiphysics® 軟體進行 Vestas V47 風機葉片之二維流場數值模擬。分析在最大風速下不同位置之葉片性能，探討在不同位置加裝渦流產生器及渦流產生器尺寸對於葉片升阻力係數及升阻比的影響。討論二維流動的假設與實際物理現象的差異，了解加裝渦流產生器可能會帶來的優缺點。由最大風速下之葉片性能分析可得，葉片中段的空氣動力學性能最好，而且即使是在最大風速的運轉條件下，攻角為 0° 時，邊界層分離現象也不會發生。當攻角為 18° 時，加裝 VG3 的葉片截面性能提升效果最佳。升力係數提高 4.35%，阻力係數降低 4.33%，升阻比提高 9.07%。本研究探討二維流動，假設渦流產生器在翼展方向造成的影響可以忽略，此假設會讓數值結果與實際物理現象有偏差。流體流經大尺寸的渦流產生器時，會直接產生邊界層分離，造成反效果，因此縮小尺寸可能會是不錯的解決辦法。

Abstract

This study applies COMSOL Multiphysics® software to carry out numerical simulations of the two-dimensional flow field around Vestas V47 wind turbine blades. The major contents of this study include: (1) analyzing the aerodynamic performances of a blade's different sections at cut-out wind speed, (2) analyzing the effects of the positions where vortex generators are installed, (3) the sizes of vortex generators on lift coefficient, drag coefficient, and lift-to-drag ratio of the blades, (4) the difference comparison between the two-dimensional flow and the actual physical phenomena and, (5) the pros and cons of installing vortex generators on a wind turbine blade. The results of our analysis indicate: (1) the middle section of the blade has the best aerodynamic performance, (2) even under the operating conditions of cut-out wind speed, no flow separation phenomena are observed at an angle of attack of 0° , (3) at an angle of attack of 18° , the blade retrofitted with VG3 has the best cross-sectional performance (the lift coefficient goes up 4.35%, the drag coefficient goes down 4.33%, and the lift-to-drag ratio goes up 9.07%). We assume in this study that the effect of vortex generators in the spanwise direction is negligible and this causes the numerical results to deviate from the actual physical phenomena. As for flow separation caused by fluid flowing through large-sized vortex generators, reducing the sizes of vortex generators may serve as a sound solution.

關鍵詞(Key Words)：風機葉片 (Wind Turbine Blade)、數值模擬 (Numerical Simulation)、渦流產生器 (Vortex Generators)、邊界層分離 (Flow Separation)。

各級變電所所內交直流電源低壓突波吸收器之設置需求 及條件研究

Installation Requirements and Conditions of Low-Voltage Surge Protection Devices on the AC
and DC Sources in Various Voltage Level Substations

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摘要

本文針對台電公司各級變電所所內交、直流電源低壓突波吸收器之設置需求及條件進行研究，主要探討各級變電所所內交、直流電源低壓系統可能承受之突波電壓，其中考慮雷擊、開關突波及接地故障之狀況，以及檢討突波吸收器之抑制效果。文中將建置變電所之電磁暫態模型，藉此模擬變電所低壓電源回路之突波電壓；其中考慮不同位置發生雷擊、開關操作及接地故障時之狀況，以及低壓突波吸收器安裝與否。此外，本研究亦赴超高壓變電所進行低壓電源回路之開關突波電壓量測，並比較量測數據與模擬結果，藉此檢討既設低壓突波吸收器之效果，並提出突波吸收器設置時機、最佳安裝(保護)位置、接線方式及設備規格，以供變電所低壓電源系統突波保護規劃設計之參考。

Abstract

This research aims to study the installation requirements and conditions of low voltage surge absorbers, focusing on surge protection devices (SPDs) on low voltage AC and DC source systems in substations of different voltage levels. The main tasks of this study include surveying the surge voltage on AC and DC low voltage source systems under the situations of lightning, switching surge and ground faults, and reviewing the surge voltage suppression performance of SPDs. Electromagnetic model of substation is constructed to simulate the surge voltage on low voltage source circuits, putting lightning, switching, and ground fault at different points with and without SPDs into consideration. Furthermore, switching surge voltages on low voltage source circuits, measured from one of our extra high voltage substations, were used to compare with the simulation results. On the basis of the aforesaid reviewing of the performances of the existing SPDs, we herewith put forward the timing, best location, wiring manners, and specifications of SPD installations as a reference for planning and designing substation low voltage source system SPDs.

關鍵詞 (Key Words)：低壓突波吸收器(Low Voltage SPD)、開關突波(Switching Surges)、雷擊突波(Lightning Surges)。

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1070206 花蓮震災花蓮~美崙線地下管路增設工程 案例分享

A Case Share of the Underground Piping of Meilun-Hualien Port Line Due
to 1070206 Earthquake

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摘 要

臺灣位於地震活躍環太平洋火山帶中，菲律賓海板塊和歐亞板塊交界上。菲律賓海板塊以每年平均 82 公釐的速度朝西北碰撞歐亞板塊，因此地震頻繁。臺灣地震帶主要有三，分別為西部地震帶、東部地震帶以及東北部地震帶。花蓮位在東部地震帶以及東北部地震帶上，而東北部地震帶系多屬淺層地震，對地上及地下設備造成顯著的影響。107 年 2 月 6 日於花蓮地區發生芮氏規模 6.26 的地震，本次地震對於花蓮地區造成房屋傾倒、道路龜裂及 17 人死亡、285 人受傷、停電約 2,008 戶(1 條饋線全停)、停水約 4 萬戶，地上及地下設備均造成顯著的影響。

花東供電區營運處 69kV 花港~美崙線地下管路受本次地震影響甚大，於災後配合機電規劃電纜加大跨距設計，辦理該線路增設地下管路工程，地下管路工程涉及許多單位權責，現場管路埋設情形錯綜複雜、施工空間狹隘，本篇記錄工程推展過程及遭遇問題，並對本次地震對地下管路造成影響進行調查整理，供各單位未來辦理相關工程規畫參考。

Abstract

Taiwan locates in the seismically active zone of the Pacific Ring of Fire and the junction between the Eurasian Plate and the Philippine Sea Plate. The Philippine Sea Plate subducts the Eurasian Plate at a speed of averagely 82mm per year, causing frequent earthquakes in the area. There are three major seismic belts in Taiwan, i.e. the West Seismic Belt, the East Seismic Belt and the Northeast Seismic Belt. Hualien is located on the East Seismic Belt and the Northeast Seismic Belt. Since the Northeast Seismic Belt belongs to shallow Seismic zone, earthquakes on the belt are apt to cause significant effects to the ground and underground equipment. An earthquake of Richter scale 6.26 hit Hualien on February 6, 2018, and caused significant damages, such as house dumping, cracked roads, 17 deaths, 285 injuries, est. 2,008 household blackouts (one TPC feeder out of service), est. 40,000 household water outages, and severe damages to ground and underground equipment.

The underground piping of Meilun-Hualien 69kV port line of 花東供電區營運處 (the Branch of Taiwan Power Company in Hualien) was strongly hit by the earthquake too. After the earthquake, a decision was made to increase the cable span to accommodate the electrical planning of adding underground pipeline, but the execution of the decision encountered a series of

problems, to name a few (1)the engineering of underground pipelines involved jurisdictions of a numerous of government sectors, (2)the field conditions of underground pipelines were so complicated and (3)the construction space was extremely narrow, etc. This study aims to put down in writing the impacts of the earthquake, the process and problems encountered during the construction of the underground pipelines as a reference for other units and similar engineering of the company.

關鍵詞 (Key Words)：0206 花蓮震災 (0206 Hualien Earthquake)、米崙斷層 (Myron Fault)、地下管路受損 (Damage to Underground Lines)、地下管路防震 (Underground Pipe Shock-proof)。

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IED 故障文件自動回傳 DDCC 之接收系統雛型開發

Development of Prototype System for IED Event Data File Retrieving from DDCC

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摘要

現代智慧型電子裝置(Intelligent Electronic Device, IED)被廣泛應用於變電所，以數位化方式進行數據量測、儲存及監控應用，再將蒐集來的資料結合人工智慧學習加以分析診斷。傳統 IED 數據收集須經另外派遣人力至現場進行存取。本研究計畫目的在單一平台上建立一套將不同廠牌/型號 IED 之故障錄波資料檔案自動回傳至配電調度中心(Distribution Dispatch Control Center, DDCC，以下簡稱調度中心)之雛型蒐集系統，以利調度中心即時掌握配電饋線故障情況，藉此提升變電所饋線 IED 保護設備之附加價值與功能。本文針對新竹區處 DDCC 監控範圍之二次變電所裝設的不同廠家 IED 通訊協定及軟體進行測試，以發展故障錄波資料可自動回傳至 DDCC 之功能。

Abstract

Modern intelligent electronic devices (IEDs) have been widely applied in substations of power system to measure, store and monitor digital electric signals. The event data collected by IEDs, when combined with artificial intelligence techniques, can be used to diagnose system anomalies. Traditionally, IED data must be manually accessed at field sites. The purpose of this study is to build a single data concentration system to automatically retrieve power event data files collected by multiple brands/models of IEDs and upload them to the Distribution Dispatch Control Centers (DDCCs), so as the DDCCs may in real time detect the fault locations of the distribution feeders. The aforesaid system provides additional functions and added values to the IEDs. This study aims to test the IEDs communication protocols and software by different manufacturers to develop an integrated system in Hsinchu secondary substation.

關鍵詞(Key Words)：智慧型電子裝置 (Intelligent Electronic Device)、自動回傳故障數據系統 (Automatic Return System of Fault Information)、配電調度中心(Distribution Dispatch Control Center)、通訊協定(Communication Protocol)。

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AMI 電表金鑰管理系統建置研究

A Study on the Design and Implementation of AMI-based Key Management System

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摘要

為了降低 AMI 系統的資安風險，最顯著的方法是對 AMI 系統的存取權限進行控管，並將所有傳輸的資料進行加密。而為了達到這個目的，勢必需要在每顆電表內皆安裝存取與加密用的金鑰，並由一金鑰管理系統來對所有電表的金鑰進行產生、派發、更新及廢止等作業，以確保後續資料傳輸的私密性、完整性及認證性。本研究之目的即是建立此金鑰管理系統並規劃完整的金鑰管理機制，制定金鑰管理系統與其他 AMI 系統成員的通訊介面，如通訊廠商的 HES、台電控制中心的 MAM 及台電各區處所使用的近端操作軟體等。除此之外，為了增強金鑰管理伺服器的安全性，本研究亦研析導入 HSM(Hardware Security Module)的可行性，將伺服器端的金鑰產生與加解密都交由 HSM 裝置來運算，並保護資料庫所存放的金鑰，以符合 NIST IR 7628 的相關建議。

Abstract

To reduce security risks of AMI system, the most effective way is to control the access right of AMI system and apply encryption to restricted data transmission. To achieve the goal, we need to install access and encryption keys in each meter, and use a key management system to generate, distribute, update, and revoke the keys to maintain data transmission confidentiality, integrity and authenticity. This study aims to establish a key management system by devising a complete key management mechanism and develop communication interfaces between the key management system and other AMI system members, such as the HES on the communication company side, the MAM on the Taipower control center side, and the near-end operating software at each Taipower district office. In addition, to enhance the security of the key management server, this study also analyzes the feasibility of importing HSM (Hardware Security Module) to generate keys, encrypt/decrypt data on the servers, and protect the keys stored in the database, to comply with the recommendations of NIST IR 7628.

關鍵詞(Key Words)：智慧型電表基礎建設 (Advanced Metering Infrastructure, AMI)、金鑰管理系統(Key Management System, KMS)、加密(Encryption)。

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電業法修正下需量反應推動策略與效益驗證模型研析

A Study on DR Cost-benefit Analysis Model and Strategies for Promoting DR Programs

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摘要

為了維持供電可靠度與穩定電價，台電公司長期以來推動各類型需量反應負載管理措施。然而，缺乏一套較全面的需量反應的成本效益評估機制。因應現今需量反應措施的發展問題，本研究聚焦需量反應推動的先進國家(如美國、日本等)，掌握該國電業推動需量反應的準則或設計方式，作為我國推動不同類型措施之效益衡量方法以及作業流程的參考。同時蒐集國外需量反應效益評估機制，參考國外作法並因應我國國情與環境，提出我國需量反應方案之設計評估之相關建議，供台電公司檢討不同方案之推動成效。最終根據台電公司在電業改革過程之角色，進一步提出台電公司在電業改革下之不同時期需量反應策略，以及未來台電公司在不同階段之需量反應推動藍圖。

Abstract

To maintain reliable power supply and stable electricity prices, Taipower has promoted a numerous of demand response (DR) programs. However, a comprehensive mechanism to assess the cost/benefit of DR programs is yet available. To tackle the ongoing development of domestic DR programs, this study selected leading countries such as USA and Japan as a reference to understand the guidelines, design methods, and evaluation mechanism of DR programs in foreign countries.

Besides, by referring to the practices of DR evaluation mechanisms in foreign countries and the unique situations in Taiwan, this study puts forward recommendations aiming at the design and evaluation of DR programs for Taipower to review the effectiveness of its DR programs.

Finally, according to its role along the procedure of electricity market reform in Taiwan, we conclude some strategies and blueprints for Taipower to carry out DR programs at various stages in the future.

關鍵詞(Key Words)：需量反應(Demand Response)、成本效益分析(Cost-Effective)、事後驗證(Ex-Post Effect)。

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集合住宅公共區域電力消費現況與節電推動策略

Taiwan Multifamily Building Common Area Electricity Consumption and Strategies to Energy

Efficiency

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摘要

本研究針對台灣地區集合住宅公共區域用電進行市場研究，透過 10 場次深度訪談、602 份問卷調查及 3 場次焦點座談，以利釐清集合住宅公共區域用電消費現況，探討影響公共區域用電消費的關鍵因素、節能推動的障礙及潛在的因應策略，作為政府研擬住宅能源效率政策與相關計畫推動的參考。

Abstract

This study aims to proceed a market research on the current status and determining factors of the electricity consumption of common areas of multifamily buildings in Taiwan, and the barriers and coping strategies for energy conservation of the said buildings, by conducting 10 sessions of in-depth interviews, survey of a total of 602 questionnaires, and 3 sessions of focus group discussions (FGDs). The results of this study may serve as a reference for the government while planning and designing residential energy efficiency policies and programs.

關鍵詞(Key Words)：能源效率(Energy Efficiency)，集合住宅(Multifamily)，公共區域(Common Area)。

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