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風波能發電系統共置示範計畫可行性研究

Feasibility Study on Co-located Demonstration Project of Wind Wave Energy Generation System

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摘　要

台電公司為配合政府於彰雲海域以離岸風能與波能共置發電作為近程海洋能發展策略與規劃，以求降低大量開發之佈置成本及減低環境影響。本團隊參考歐盟 2010 年所啟動的 Marina Platform 計畫，進行風波能共置系統之可行性分析，以兩年時間完成四項重要任務：(1)風波能發電共置先期研究(2)台電公司在海洋能發電的推展構想與策略(3)風波能發電共置可行性評析(4)推動小型示範電廠及其運轉計畫。

數值分析結果顯示，適當的點吸收式浮體陣列組合約可提升 1.125 倍的發電量。由於點吸收式波浪發電機組小、佔地窄，國內工程與海上佈放掌握度較高，未來擬可推動成立一不超過 500kW 波浪發電小型試驗計畫。推動初期可採用國內外較具成熟機組在彰雲海域進行短期海測以了解機組相關特性。另外，本研究後續也規劃數值模擬與水工實驗以尋找更佳的佈放位置方案。

Abstract

Following the governmental policy of the Offshore Wind Farm (OWF) and combined Ocean Wave Converter (OWC) developed at Changhua coastal regions, this project conducts applicability of co-existing system of OWF and OWC of supported Taipower Company.

The combination of OWF and OWC system is a global trend for the sustainable development of renewable energy. The establishment of the platform requires optimizing the exploitation of the resources and challenge for both industries to enhance the power production efficiency and reduce their cost. The advantages of this combination could add the energy extraction during the lower offshore wind energy during the summer period. The absorbing and shelting of OWC could provide a good protection of the foundation scouring for wind turbines and thus increase the foundation stability.

Following the European marina platform project, the research team of National Taiwan Ocean University (NTOU) organized a cross field joint research team of Sinotech Engineering

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液流電池於微型電網之性能測試與應用評估

Performance Test and Application Evaluation of Flow Batteries in a Microgrid

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摘 要

為研究並驗證液流電池應用於電網之功效，本研究利用台電綜合研究所樹林所區建置的 125kW/750kWh 全釩氧化還原液流電池儲能系統，經導入能源管理系統，配合所區既設的太陽能電池、風力發電、柴油發電機、氫能燃料電池與負載等，形成具孤島運轉能力之微型電網架構。本研究說明液流電池儲能系統性能測試結果與實際應用經驗，並針對液流電池未來的可能應用模式進行技術驗證與評估。此外，由於系統建置至今已屆 3 年，亦進行長期效能追蹤，評估項目包括電池容量、效率遷移與輔助電源功耗等電池性能評估項目，結果顯示建置至今該系統性能相當穩定，作為能量型儲能系統應用之成效良好。

Abstract

In order to study and verify the functions and effects of flow batteries in a power grid, a 125kW/750kWh vanadium redox flow battery energy storage system has been installed in the Shu-Lin area of Taiwan Power Research Institute (TPRI), and an energy management system introduced to cooperate with the existing solar and wind power systems, diesel generators, and loads to form a microgrid architecture. The major contents of this study include performance tests, technical verification and evaluation of the flow battery system's possible applications. The system has been established and operated for 3 years with good results. In this paper, we put forward our long-term performance tracking of the system, including battery capacity, efficiency migration, and auxiliary power consumption.

關鍵詞 (Key Words)：全釩氧化還原液流電池(Vanadium Redox Flow Battery)、電池儲能系統(Battery Energy Storage System)、微型電網(Microgrid)、能源管理系統(Energy Management System)。

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流量平衡分析及對策-以塔山電廠海水冷卻系統為例

Analysis and Solution of Flow Rate Distribution – Taking the Seawater Cooling System of Tashan Power Plant as an Example

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摘　要

本案位於金門本島，三面環海，有豐富之海水水源可用來冷卻機組中央冷卻器排放之廢熱。因此，既有 1~8 號及新設 9、10 號引擎機組之冷卻系統均採用二次側開放式海水循環系統。新設海水泵之流量及揚程，皆大於既有海水泵之設計值，可滿足既有水系統需求；惟當全廠引擎海水冷卻系統並聯運轉時，發生流量未達最佳平衡狀態。本文將依承商提送資料，以分析軟體提供海水泵並聯運轉及流量平衡分析及對策。

Abstract

Tashan Power Plant locates in the main island of Kinmen. Surrounded by Ocean waters, the plant is abundant with seawater, which is used to cool down the waste heat emitted by the central cooling system. Therefore, Tashan's 10 engine units (#9 and # 10 are lately installed) without exception all applied the design of secondary open seawater circulation system. To be compatible with the existing systems, the flow rate and water head of the newly installed seawater hydro pumps are set deliberately greater than the design values of the original ones. Regretfully, when conducting whole plant parallel operation, the flow rate of the cooling system failed to reach the optimal state. In this paper, we use analysis software together with the technical information provided by the contractor to analyze and seek countermeasures of the said problem.

關鍵詞 (Key Words)：流量平衡(Flow Rate Distribution)、水泵並聯運轉(Hydro Pump Operation in Parallel)、管路系統分析(Pipe System Analysis) 、限流板(Orifice)。

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林口電廠粒狀汙染物去除設備維護實例

Case Study of Particulate Removal System Maintenance at Linkou Power Plant

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摘　要

林口電廠新機組鍋爐出口煙氣之粒狀汙染物去除設備(Particulate Removal System, PRS)採用大型袋式集塵器，為全國首例。在運轉兩年後壓差升高跳警報，經過審慎評估後，於歲修期間進行分階段濾袋更換。本專案透過長期監測及分析濾袋收塵機各倉室的壓差及利用林口發電廠一、二號機於 107 年、108 年的歲修，更換壓差過高倉室的濾袋，維持林口電廠之粒狀物去除系統之效率，出口濃度達到「固定污染源空氣污染物排放標準」所規範的粒狀物排放濃度(≤10 mg/Nm^3)，濾袋更新後達到相對較低的壓差且粒狀物持續維持低排放水準(目前自主管理≤5 mg/Nm^3)。本文將分享此大型袋式集塵器之歲修經驗以及降低壓差之技術。

Abstract

Linkou Power Plant (LPP) is the first power plant in Taiwan to utilize a baghouse for Particulate Removal System (PRS) on its three new ultra-supercritical coal-fired units. After the PRS has operated for two years, the alarm was triggered due to a significant increase in Differential Pressure (DP). As a result of thorough assessment, LPP initiated a plan to replace the Fabric Filter (FF) in stages during the overhual period. Based on long-term monitoring and analysis of the DPs in each PRS chamber, LPP replaced all FF in chambers with high DPs respectively in year 2018 and 2019 to maintain its PRS efficiency. After the replacement, DPs have returned to normal operating standards and particulate emissions from the stack were in compliance with government's regulations on air pollution emissions of stationary sources (≤ 10mg/Nm^3) and requirements of the internal emission control policy (≤5mg/Nm^3). The paper aims to share the experiences in baghouse maintenance and skills in lowering the DPs in PRS at LPP of unit 1 and 2.

關鍵詞 (Key Words)：粒狀物去除系統(Particulate Removal System, PRS)、粒狀物排放(Particulate Emissions)、濾袋(Fabric Filter, FF)。

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火力燃煤電廠鍋爐局限空間行動監控管理系統研發

The Development of Monitoring and Management System for Confined Space Operation of Thermal Power Plant Overhaul Boiler Area

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摘　要

火力燃煤電廠機組大修鍋爐區是屬於局限空間管制作業區受法規管制，單靠傳統進出管制登錄表很難有效即時掌控爐內之工作人員之人數及無法得知目前爐內工作人員的狀況，於是實有必要研發一套鍋爐局限空間作業行動監控管理系統。本系統直接以工作人員手機作為標的物進行鍋爐內部的即時定位偵測，可即時追蹤爐內工作人員位置、各區工作人員總人數，並與 LINE 整合，後台管理系統與鍋爐廠房作業人員，彼此可透過 LINE App 互傳影音、照片與即時訊息，輔助掌握鍋爐內工作人員的安全，如發生墜落或靜止不動過久均會出示警報告知，工作人員如有不適亦可發出求救信號求援。本系統附加價值為透過工作人員位置定位資料庫，經過大數據分析可精確統計出大修工期之總出工人日及各區之出工人日，對於往後工作發包更能精確掌握人工成本，並可結合 ERP(Enterprise Resource Planning)精準成本管理，並加速財務結算，提升企業效率。

Abstract

The boiler area of a thermal power plant under overhaul is a confined space and subject to regulations. To effectively control the numbers of workers and their status within the confined apace in real time, it is necessary to develop a set of monitoring and management system to replace the traditional access control registration form. In this project, we use the workers' mobile phones to track the numbers and positions of the workers in the boiler area. Besides, the backstage management and boiler plant operators may use LINE app to transfer videos, photos, and instant messages to each other to ensure the safety of the workers in the area. In case of a worker falling or standing still, an alert will be shown; when feeling unwell, they can signal for help. After big data analysis on the locating system's database, the total working days and working days in each area can be precisely calculated. When integrated with the Enterprise Resource Planning (ERP) system, the overhaul outsourcing costs can be more accurately controlled and minimized- so is the corporate efficiency.

關鍵詞 (Key Words)：鍋爐(Boiler)、局限空間(Confined Space)、定位型服務(Location-based Service)、室內定位系統(Indoor Positioning System)、 封包擷取(Sniffer)。

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輸電電纜洞道附屬機電設備維護管理平台之研究

Research on Maintenance Management Platform of Ancillary Electrical Devices for Transmission Cable Tunnel

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摘　要

台電公司除花東供電區處外，其餘 5 個供電區處均有輸電電纜洞道附屬機電設備定期維護的工作，現行作業仍以入口簽到及攜帶紙本表單紀錄巡檢結果，回到辦公室後再填寫至 WORD 表單，列印後進行人工簽核作業，但輸電電纜洞道最長近 20 公里及最多近 2 千個附屬機電設備，對於現場巡檢人員每次巡檢準備及攜帶各設備不同週期巡檢項目紙本表單，造成現場巡檢人員負擔及無法提高巡檢效率[1]。

本計畫之「洞道附屬機電設備維護管理平台」及「行動巡檢 APP 軟體」研究，主動排程提供每月應檢測設備及檢測項目及記載後續自營或委外維修作業，建立設備驗收接收及維運至今的運轉履歷，並以行動裝置 APP 取代原輸電電纜洞道現場紙本作業，紀錄拍照設備正常及異常狀態，將檢測資料於網路環境上傳伺服器，自動進行資料管理及應用，並提供台電供電處及各供電區處主管有效掌握洞道設備運作之現況，提高洞道輸電電纜的使用率與降低故障率。

Abstract

The island wide power supply has been divided into six areas. Five of the six areas (the Huadong Power Supply Area excluded) have regular maintenance work on their mechanical and electrical equipment affiliated to the transmission cable tunnels (TCT). The operating procedures of the said maintenance are as follows: 1) sign in at the entrance, 2) use paper forms to write down the inspection results, 3) fill the results into a WORD form, and 4) print-out and manual sign-off. However, the longest TCT is nearly 20 kilometers and has up to nearly 2,000 auxiliary electromechanical equipment. The maintenance procedures cast great burdens on field inspections and are inefficient- imagining the in-need-of paper forms and equipment for different cycles and purposes of inspections.

The Auxiliary Electromechanical Equipment Maintenance and Management Platform (AEEMMP) and Mobile Inspection APP (MI APP) software developed along with this project carry the functions: 1) actively schedule the equipment and items to be inspected in the month, 2) record the results of subsequent maintenances (self or outsourcing), 3) establish equipment operation history (acceptance, maintenance and operation…), 4) replace the original paper operation with mobile device APP, 5) record normal and abnormal status of the photographing equipment, 6) upload inspection data to the server, 7) automatically perform data management and applications, 8) provide status quo information of the operation of the tunnel equipment to the business related units and officers, including the Power Supply Department and the aforesaid six power supply areas for the purposes of improving TCT utilization rate and reducing TCT failure rate.

關鍵詞 (Key Words)：快速反應矩陣碼(QR Code)、電纜洞道(Cable Tunnel)、附屬機電設備(Auxiliary Electromechanical Equipment)、設備巡檢(Equipment Inspection)。

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動態熱容量系統精進及整合研究

The Research on Dynamic Thermal Rating Advancement and Integration

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摘　要

為因應實現智慧輸電計畫，本研究致力於探討在現有輸電線路增加送電容量的方法。目前，世界各電力單位：電機電子工程師學會 IEEE、歐洲國際大電力會議 CIGRE 等，依據導線熱平衡方程式制定估算標準，提出動態熱容量計算方法，運用真實輸電線路監測數據可更直接且實際地提升輸電容量。

本研究實現動態熱容量技術，與廠商合作開發工業級動態熱容量監測設備，並進行多項商業認證，並設計地圖式管理平台，可監看設備即時資訊，運用地圖資訊可監控廣域電網狀態。本研究有兩大重要成果：(1)透過所蒐集的數據分析與探究動態熱容量應用於臺灣輸電系統的助益與影響，經計算後，年平均熱容量可提升原有的 30~50%；(2)運用動態熱容量技術的同時，亦考量輸電線路的安全議題。例如，經數次實地弛度量測與本研究監測設備之弛度資訊進行數據分析，平均誤差在 4.35%以內。本研究成果證實：在提升線路輸電容量的同時，亦可精確地監控輸電線路的弛度，雙管齊下，增加操作人員信心，保障臺灣電網安全。

Abstract

In this study, we propose a method of increasing the transmission capacity of existing power lines to fulfill the goal of smart transmission. IEEE, CIGRE and some renowned institutions of the others have been recommending enacting transmission standards based on conductor heat balance equation and to use the dynamic thermal rating (DTR) method and real time monitoring data to increase transmission capacity in a much more effective way.

In this study, by collaborating with some manufacturers we successfully developed an industrial-grade DTR monitoring device- a variety of tests been conducted to verify the effectiveness of the device. Moreover, a map management platform had been designed to remotely monitor the power grid status and provide real-time information. There are two important research outcomes. The first, the power system in Taiwan will benefit greatly by adopting the DTR monitoring method- according to calculations, the annual average transmission capacity may see 30-50% increase. The second, the safety and capacity of transmission lines will be improved significantly. By comparing the actual sag values and that measured by DTR devices, we found that the average errors of sag measurements are less than 4.35%, proving that the proposed DTR monitoring method is capable of monitoring the safety of transmission lines and their capacity. The confidence of power dispatchers and the safety of power grids can be furtherly ensured.

關鍵詞 (Key Words)：動態熱容量(Dynamic Thermal Rating)、智慧電網(Smart Grid)、超高壓(Extra High Voltage)、安全監測(Safety Monitoring)、物聯網(Internet of Things)、大數據分析(Big Data Analysis)。

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借鏡英國論我國溫室氣體減量的挑戰：以部署無六氟化硫電力設備為核心

The Challenges of Establishing an SF_6 Free Environment for the Energy Sector in Taiwan-Taking the UK as Example

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摘　要

我國電力設備所使用的氣體絕緣開關，主要是以六氟化硫(Sulfur Hexafluoride, SF_6)作為氣體絕緣開關的介質，原因是其優異的絕緣效果，乃是確保用電安全的可靠選項。然而，六氟化硫的全球暖化效果比二氧化碳高出約 23,500 倍，多項研究早指出它雖然安全便利、卻對能源減碳甚為不利。近年科技雖已發展出其他絕緣流體，可做為兼顧用電需求與能源減碳的替代方案。然而，由於電力設備使用年限均為數十年以上，若要立即全面汰換運作中的電力設備，實有一定困難。事實上，其他國家在節能減碳的國際壓力下，亦遭遇同樣問題，必須設法有效達成減碳目標、同時兼顧用電需求。因此，本文以透過立法及政策鼓勵電業進行部署 SF_6 free 電力設備的英國為例，說明在減碳共識的國際背景下，國家如何在立法面規定減碳目標，並以部署 SF_6 free 電力設備為核心，探討其從科技發展至市場應用的不同階段、相關政策的規劃與執行成果。其次則由臺灣的減碳立法與政策目標出發，探討若要進一步落實無六氟化硫電力設備的部署、落實溫室氣體減量，從科技發展至市場應用的不同階段，可能面對的挑戰與對策。

Abstract

In front of ever-growing electricity demand and climate challenges, worldwide electric utilities have been struggling to find a balance between energy consumption and environmental protection. Take the gas-insulated switch (GIS) for example - an equipment commonly used by electric utilities utilizing Sulfur-hexafluoride (SF_6) as an insulting medium is closely related to the issues of global warming. Even if it is beneficial to energy efficiency, the warming effects of SF_6 is about 23,500 times higher than carbon dioxide. Although alternatives to SF_6 have been developed, it is still difficult for electric utilities to replace this widespread equipment so as SF_6 immediately. This article takes UK as an example to illustrate how a government develops its carbon emission goals and strategies to comply with the regulations and how Taiwan may in this regard learn from the UK experience.

關鍵詞 (Key Words)：六氟化硫(Sulfur-hexafluoride, SF6)、電力設備(Electrical Equipment)、減碳(Carbon Reduction)、英國(the UK)、台灣(Taiwan)。

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核一、二、三廠填換爐心暫態安全分析獨立驗證與技術提昇

The Improvement of Core Safety and Transient Analyses for Chin-shan, Kuo-sheng, and Ma-an-shan Nuclear Power Plants

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摘　要

本計畫由台電公司核安處委託核能研究所核子工程組執行，計畫期程自 105 年 3 月 1 日至 109 年 2 月 29 日共計四年，並在契約原訂工作範圍內，採口頭說明或討論方式，提供諮詢服務一年至 110 年 2 月 28 日。本研究計畫可持續提升台電公司自有的安全分析技術，並能獨立審查廠家在燃料填換週期之分析結果；同時計畫所建立之分析模式與分析工具又可隨時支援核一、二、三廠即時運轉之所需，不僅節省分析成本和爭取時效，而且可摒除國外廠家在商業技術上的壟斷。因此，本研究計畫的成果可對核電運轉的安全提供多一層的保障外，亦可增進民眾對核能安全的信心。

Abstract

This project was funded by the Department of Nuclear Safety, Taiwan Power Company (TPC) and conducted by the Division of Nuclear Engineering, Institute of Nuclear Energy Research (INER) starting from 2016 to 2021 (including one year consulting services in 2021). The results of this project may improve the ability of reload safety analysis of Chin-shan, Kou-sheng, and Ma-an-shan power plants, help examine the vendor's analysis results, and support operation analysis of the NPPs. In conclusion, this project provides extra protection to the safety of NPP operation and enhances public confidence regarding the safety of nuclear energy.

關鍵詞 (Key Words)：核一廠(Chin-shan)、核二廠(Kuo-sheng)、核三廠(Ma-an-shan)、燃料填換(Reload)、安全分析(Safety Analysis)。

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電漿焚化熔融爐之耐火材中鋂及鈽分析

Determination of Americium and Plutonium in Refractory from Experimental Plasma Melting Furnace

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摘　要

核能研究所低放射性廢棄物實驗型電漿焚化熔融爐規劃於近幾年除役，因此其零組件及材料必須要進行核種分析以利後續活度盤存及廢料分類等作業，核能研究所放化實驗室首先接收到的樣品是其中的耐火材料。本篇文章嘗試了多種常見的前處理溶解方法，如硝酸、鹽酸、過氯酸、王水、混酸、微波消化及熔融法等，然而僅有硼酸鹽熔融法可完全分解耐火材。經過熔融及液化程序後，鋂及鈽同位素可藉由串聯的 UTEVA-TRU 樹脂從其他干擾核種中萃取層析出來，鋂及鈽的阿伐核種可經電沉積後由阿伐能譜儀計測出活度，鈽-241 可由液體閃爍計數儀分析及計算得出活度。

Abstract

The existing experimental low-level radioactive waste plasma melting furnace of the Institute of Nuclear Research (INER) is to be decommissioned in the coming years. Some parts of the plasma melting furnace need to be analyzed for subsequent radionuclide inventory and classification. The first sample we received was refractory materials. Several dissolution methods had been applied in our study, such as nitric acid, hydrochloric acid, perchloric acid, aqua regia, mixed acid, microwave digestion, fusion, etc. However, only borate fusion dissolved the refractory completely. After fusing and liquefying, americium and plutonium isotopes were separated from interferences by using tandem and highly selective UTEVA-TRU resins. Americium-241 and the alpha emitters of plutonium were electrodeposited on a stainless disk for alpha spectrometer, and the activity concentration of plutonium-241 was calculated by the results of liquid scintillation counter and alpha spectrometer.

關鍵詞 (Key Words)：耐火材料(Refractory)、鋂(Americium)、鈽(Plutonium)、UTEVA樹脂(UTEVA Resin)、TRU樹脂(TRU Resin)。

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