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超超臨界燃煤電廠海水脫硫程序對懸浮固體、硼濃度貢獻之調查

Investigation on the Contribution of Seawater Desulfurization Process to Suspended Solids and Boron Concentrations in Ultra-supercritical Coal-fired Power Plants

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摘　要

台電林口、大林超超臨界燃煤電廠，採用海水排煙脫硫法處理煙道氣之硫氧化物。本研究目的為了解海水懸浮固體及硼背景值之變化，及電廠排煙脫硫過程對懸浮固體、硼濃度之貢獻。實驗分為海域及脫硫製程進出水口檢測兩部分，另亦對底泥之硼濃度進行調查。研究結果顯示，林口海域之中層海水懸浮固體濃度大於表層海水懸浮固體，表示較深之海水懸浮固體易受到海床懸浮物再揚起，硼濃度則無明顯變化趨勢；大林海域懸浮固體濃度沒有明顯趨勢。海域各點位之底泥硼濃度大多落在 20~40 mg/L，無顯著關係。在電廠進出水口檢測部分，林口電廠進水口、放流口懸浮固體、硼濃度均無明顯相關性；而大林電廠進水口、放流口懸浮固體、硼濃度均呈現明顯相關性。在貢獻量部分，懸浮固體濃度貢獻約 3±4.27 mg/L，硼濃度貢獻約-0.05±0.297 mg/L，說明兩電廠放流水之懸浮固體及硼之貢獻多來自海水本身。

Abstract

Taipower's Linkou and Dalin ultra-supercritical coal-fired power plants use seawater flue gas desulfurization (SWFGD) to treat sulfur dioxide (SO_2) in flue gas. The main purpose of this study is to understand the changes in the background value of suspended solids (SS) and boron in seawater, and the contribution of SWFGD system to the concentration of SS and boron. The experiment is divided into two parts: the sea area and the detection of the inlet and outlet of the desulfurization process. In addition, the boron concentration of the sediment is also investigated. As the results of this study show, the SS concentration in the middle seawater of the Linkou sea area is greater than that of the surface seawater, indicating that the SS in the deeper seawater are susceptible to re-lifting of the seabed SS, while the concentration of boron has no obvious trend of change; the concentration of SS in the Dalin sea area has no obvious trend. Boron concentrations in sediments at various points in the sea area mostly fell between 20 and 40 mg/L, and there was no significant correlation. In the

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detection part of the water inlet and outlet of the power plant, there is no obvious correlation between the concentration of SS and boron in the water inlet and discharge outlet of Linkou Power Plant; while the concentration of SS and boron in the water inlet and discharge outlet of Dalin Power Plant show a significant correlation. In terms of contribution, the SS concentration contributed about 3±4.27 mg/L, while the boron concentration -0.05±0.297 mg/L, indicating that most of the SS and boron in the discharge water of the two power plants came from the seawater itself.

關鍵詞(Key Words)：懸浮固體(Suspended Solid)、硼 (Boron)、超超臨界燃煤電廠 (Ultra Supercritical Power Plants)、海水脫硫(Seawater Flue Gas Desulfurization)。

建置「高壓大容量短路試驗室」之可行性評估

Feasibility Evaluation of Building a “High-Voltage and High-Power Short-Circuit Laboratory”

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摘 要

我國高壓大容量短路試驗能量不足，長久以來國內電力業者需送國外試驗，除曠日廢時並要花費數百萬新台幣方能完成型式試驗。為配合國家能源政策與電業法修法，台電公司綜合研究所已展開高壓試驗設備與試驗能量的更新與擴建計畫。

本計畫為「36 kV 40 kA 高壓大容量短路試驗室」建置工程的可行性評估研究，藉此針對台電公司綜合研究所之兩個所區(包含：樹林所區與深澳所區)用於建置國際級高壓大容量短路試驗室的可行性作廣泛地探討與比較。可行性評估主要項目包含：最適使用面積/位置、搬運道路限制、環境風險影響、試驗室營運模式、以及系衝分析等。

最終，計畫將針對台電公司綜合研究所之樹林所區與深澳所區完成各項可行性評估的完整比較與防制建議。

Abstract

The capacity of high voltage and high power short circuit tests in Taiwan is insufficient. For a long time, domestic electric power companies have to send their equipment abroad for testing, which was time consuming and cost millions of NT dollars to complete the type testing. To cooperate with the national energy policy and the amendment of the Electricity Act, Taiwan Power Research Institute (TPRI) has launched a plan to update and expand high-voltage test equipment. This project is a feasibility study for the construction project of the “36 kV 40 kA high-voltage and high-power short-circuit laboratory”, aiming to extensively discuss the feasibility of building an international level short-circuit laboratory in TPRI’s Shulin and Shen’ao branches. The contents of the feasibility study include: the most suitable use area/location, restriction of equipment transportation, environmental impacts, operation mode of the laboratory, power system impact analysis, etc. In the end, to accomplish a comprehensive comparison of various feasibility assessments and preventive recommendations for TPRI’s Shulin and Shen’ao branches.

關鍵詞(Key Words)：高壓大容量試驗(High-Voltage and High-Power Test)、短路試驗室(Short Circuit Laboratory)、可行性評估(Feasibility Evaluation)。

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基於深度強化學習的微電網能源管理

Microgrid Energy Management Based on Deep Reinforcement Learning

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摘 要

相較於傳統電網的集中式發電，多個分散式發電源與再生能源、負載的隨機不穩定性為微電網能源管理上帶來了挑戰。為此，許多方法相繼被應用於微電網能源管理以達到運作最佳化。強化學習演算法被視為相當具有前景的方法之一，因其能在不假定系統模型的情況下，透過與環境互動學習出底層系統動態，進而訓練出最佳控制策略。然而應用強化學習演算法於微電網能源管理不是一項直接且容易的事，為此，本研究因應微電網特性，在時間序列資料與電池管理上進行相關設計議題探討，促進前沿強化學習演算法於微電網能源管理的真實應用。本研究使用循環神經網路處理時間序列資訊，以及透過將神經網路輸出映射至電池有效充放電範圍來促進學習表現。實驗結果顯示，本研究提出之設計考量與方法，對強化學習應用於微電網能源管理上有不可忽視的影響。

Abstract

Compared with centralized power grids, the random instability of multiple distributed power generation sources, such as renewable energy and demand-side resources, introduces challenges to the energy management of microgrids. For this reason, many methods have been applied to the design of microgrid energy management systems to achieve operation optimization. Reinforcement learning algorithms are regarded as one of the most promising methods because they can learn the underlying dynamics through interaction with the environment without assuming a system model, and then train an optimal control strategy. However, applying reinforcement learning algorithms to microgrid energy management is not a straightforward and easy task. To this end, this paper discusses two design issues related to time series data and battery management in response to the characteristics of microgrids, and promotes the application of cutting-edge reinforcement learning algorithms in microgrid energy management. This study uses a recurrent neural network to process time series information and to facilitate learning performance by mapping the neural network output to the battery's effective charge and discharge range. The experimental results show that the design considerations and methods proposed in this study have a non-negligible impact on the application of reinforcement learning to microgrid energy management.

關鍵詞 (Key Words)：微電網(Microgrid)、微電網能源管理(Microgrid Energy Management)、強化學習(Reinforcement Learning)、深度強化學習(Deep Reinforcement Learning)、近端策略優化(Proximal Policy Optimization)、時間序列觀測(Time Series Observation)。

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台電綠網公益投資社會報酬(SROI)分析

Social Return on Investment (SROI) Analysis of Taipower Green Network

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摘　要

台電於 2019 年發布環境白皮書，並擬定環境保護六大策略面向，展現對環境保護的決心。其中，內外議合為台電在推動環境政策相當重要的一環。本計畫團隊針對「擴大內外議合」下「傳遞電力環境資訊」的「台電綠網之優化與行銷」研究案(簡稱「台電綠網」或「專案」)使用 SROI 方法學分析，評估台電投資於此研究案可創造的社會投資報酬率。

此案之 SROI 值為 1.42，意即投入 1 元的成本，可透過台電綠網創造 1.42 元的社會效益。此專案產生之效益中最顯著者為「提升對於台電的認同感」，透過台電綠網，專案發起者與執行者可更加了解各單位的環境友善作為，專案受益者亦可透過線上與實體媒介獲取台電環保資訊，進而對台電產生認同感。整體而言，台電綠網作為環境知識與活動之資訊傳遞交流載體，可帶給各類利害關係人不同程度的效益，並產生大於投入金額之社會影響力。

Abstract

Taipower released an environmental white paper in 2019, and formulated six strategic aspects of environmental protection, demonstrating its determination in the field. Among them, internal and external negotiation & cooperation is a very important part of the company's environmental policies. The project team uses SROI methodological analysis to evaluate the potential social return of Taipower's "Green Network Optimization and Marketing" research project, which aims to transmit environmental information related to electric power. The SROI value of the project is 1.42, which means that an investment of one NTD can create social benefits of 1.42 NTD. The most notable benefit of this project is "enhancing the sense of identity with Taipower". Through the Taipower Green Network, the initiators and executors of this project can better understand the environment friendly actions of each unit, and the beneficiaries can also obtain Taipower's environmental protection information through online and physical media, and then develop a sense of recognition for Taipower. On the whole, Taipower Green Network, as an information transmission and exchange carrier for environmental knowledge and activities, can bring benefits to various stakeholders to varying degrees, and generate social influence greater than the amount of investment.

關鍵詞(Key Words)：環境教育(Environmental Education)、社會投資報酬率(Social Return on Investment)、台電環境白皮書(Taiwan Power Company's Environmental Policy Guidelines)、利害關係人議合(Stakeholder Engagement)。

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雲端資料中心智慧營運與冷能利用最佳化之研究

Research on Smart Operation of Cloud Data Center and Optimized Cold Energy Application

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摘　要

因應 2050 年淨零排放，台電依循政府政策，規劃雲端資料中心採用綠電為主，碳權抵換為輔，以提升永續企業形象。藉由厚植高可用度、高能源使用效率及智慧營運管理之技術能量，打造具世界競爭力之雲端資料中心。

本案結合台電中部綠電及液化天然氣(LNG)冷能優勢，規劃以乾淨能源供應雲端資料中心之構想。除利用 LNG 冷能替代冰水主機外，並導入 AI 模型預測控制、物聯網、先進節能手法及智慧營運等技術，達到機房能源使用效率小於 1.25，並採用綠電為電力來源，以達全台首座淨零排碳雲端資料中心。

為持續精進服務能量，本案規劃雲端資料中心人才發展核心職能，供台電人才發展、升遷績效管理及人員招募應用，透過完善的永續治理架構，持續精進高可用度、高能源使用效率及智慧營運管理三大面向，提供優質關鍵基礎設施，以利推動電網資通訊整合，邁向 2050 淨零排放之目標。

Abstract

In order to achieve the goal of 2050 net-zero emissions (NZE), Taipower follows government policies and plans to use green energy as the main power source of its cloud data center, and supplemented by carbon offset, to enhance the company's sustainable image; in addition, by embedding high-availability, high energy efficiency and smart operation management technology, to create a world class cloud data center (CDC). This project is combined the advantages of Taipower's green energy and liquefied natural gas (LNG) cold energy in central Taiwan, to plan the concept of using clean energy as the power source of the CDC. In addition to using LNG cold energy to replace chiller, technologies such as artificial intelligence (AI) model predictive control, Internet of Things (IoT), advanced energy conservation methods, and smart operations have also been introduced to achieve a power usage effectiveness (PUE) value less than 1.25 in the computer room; Furthermore,

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the CDC is the first NZE cloud data center using green energy as the power source in Taiwan. To continuously improve service capability, this project plans the core functions of talent development in the CDC for the needs of Taipower's employee talent development, promotion/performance management, and recruitment. Through a sound sustainable governance structure, Taipower may continue to improve the three major management aspects, namely high availability, high energy efficiency and smart operation management; provide high-quality key infrastructure to facilitate the integration of grid information and communication; and move towards the goal of NZE by 2050.

關鍵詞 (Key Words)：液化天然氣(Liquefied Natural Gas, LNG)、冷能回收(Cold Energy Recovery)、綠電(Green Power)、能源使用效率(Power Usage Effectiveness, PUE)、模型預測控制(Model Predictive Control, MPC)。

台電轉型控股母子公司管控體制研究

Examining the Transition of Taiwan Power Company: Investigating the Governance Structure of Parent-Holding Subsidiary Model

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摘 要

電業法業於 106 年 1 月 26 日經總統公布施行，其中第 6 條明訂為達穩定供電目標，台灣電力股份有限公司(以下簡稱台電公司)之發電業及輸配電業專業分工後，轉型為控股母公司，其下成立發電及輸配售電公司，而台電公司組織型態將在 112 年(最晚得展延至 115 年)轉型控股母子公司型態。未來控股母公司須以妥適的架構持續帶領台電集團有效運作，事業子公司則以健全的體制持續達成我國電力穩定供應。本文透過對國內外控股集團案例調查研究，及日本東京電力轉型經驗，探討適合我國框架下之未來台電控股母子公司之「法人治理架構」、「母子管控體制」及「試運行機制」，並提出為達成順暢組織轉型及業務接軌之方案建議，作為台電公司後續轉型推動設計之參考。

Abstract

Article 6 of the Electricity Act, promulgated on January 26, 2017 stipulates that in order to ensure stable power supply, Taiwan Power Company (TPC) shall achieve the division of TPC's operations and transform into a parent holding company. Under this structure, separate power generation and power transmission/distribution companies will be formed as subsidiaries. This change in structure is planned to take place by 2023 (or no later than 2026). In the future, the parent holding company must continue to lead the effective operation of the TPC group with an appropriate framework, while the subsidiaries will ensure stable power supply in Taiwan with a sound system. Through the investigation of the domestic and international case studies of holding groups, and with the experience of transformation of Tokyo Electric Power company in Japan, this paper discusses an optimal "corporate governance structure", "parent-subsidiary control system", and "trial operation mechanism" suitable for Taiwan's framework. It also proposes suggestions for smooth organizational transformation and business alignment, serving as a reference for the subsequent transformation and design of TPC.

關鍵詞(Key Words)：控股集團(Holding Group)、組織轉型(Organizational Transformation)、國營事業(State-owned Company)、公司治理(Corporate Governance)、管控體制(Control System)、試運行(Trial Run Practice)。

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核一廠廠界輻射劑量評估精進計畫

Advanced Radiation Dose Assessment Plan at the Boundary of Chinshan NPP

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賴柏倫*
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摘　要

本計畫由台電公司核能發電處委託國立清華大學核子工程與科學研究所與財團法人中華民國輻射防護協會執行，計畫期程自109年08月21日至111年08月20日共計二年。本計畫目的為提升國內低階放射性廢棄物與用過核子燃料乾式貯存等設施之輻射屏蔽與劑量分析技術。針對低階放射性廢棄物貯存設施，過去評估主要採保守之點核仁法相關程式；針對用過核子燃料乾貯設施，雖有搭配利用蒙地卡羅程式，但往往受限於計算資源，無法更廣泛應用。有鑑於此，本計畫擬採用蒙地卡羅程式重新評估核一廠低放射性廢棄物貯存設施，避免不必要過度保守的計算假設，並能獲得更準確可靠的設施周遭與廠界劑量分布。另外，本計畫擬引進先進之變異數降低技術，利用高效率混合式蒙地卡羅程式分析核一廠未來可能採用之用過核子燃料乾貯設施，精進計算效率以擴大應用範圍。

Abstract

This project is entrusted by the Nuclear Generation Department of Taipower and implemented by the Institute of Nuclear Engineering and Science of National Tsinghua University (NTHU) and the Radiation Protection Association of the Republic of China (RPA). The project period is two years from August 21, 2020 to August 22, 2022. The purpose of this project is to improve the radiation shielding and dose analysis technology of domestic low-level radioactive waste and spent nuclear fuel dry storage facilities. For low-level radioactive waste storage facilities, the conservative point-kernel method was mainly used in the past. For spent nuclear fuel dry storage facilities, the Monte Carlo method was used, but limited by computing resources could not be widely applied. In view of this, this project intends to use the Monte Carlo method to re-evaluate the low-level radioactive waste storage facilities of the Chinshan Nuclear Power Plant (NPP) to avoid unnecessary and overly conservative calculation assumptions, and obtain more accurate and reliable dose distribution around the facility and the plant boundary. In addition, this project intends to introduce advanced variation reduction technology, use high-efficiency mixed Monte Carlo programming to analyze the dry storage facilities for spent nuclear fuel that may be used in the future of the Chinshan NPP, and improve the calculation efficiency to expand the scope of application.

關鍵詞 (Key Words)：低放射性廢棄物與用過核子燃料乾式貯存設施(Low-level Radioactive Waste and Spent Nuclear Fuel Dry Storage Facilities)、輻射屏蔽與劑量分析(Radiation Shielding and Dose Assessment)、蒙地卡羅法與點核仁法(Monte Carlo and Point-kernel Methods)。

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基於 WOG2000模型並考慮 RCP 被動式停機軸封的喪失廠外電源/喪失核機冷卻水安全風險評估分析

Risk Assessment for Loss of Off-site Power or Component Cooling Water Scenarios- Based on WOG2000 Model and Considering RCP Passive Shutdown Seal

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摘　要

對於壓水式反應器(PWR)，在喪失廠外電源或喪失核機冷卻水的情況下，反應器冷卻水泵(RCP)由於失去軸封注水以及熱屏蔽熱交換器冷卻，將使 RCP 軸封因暴露於高溫的一次側冷卻水中而發生劣化，從而導致反應器冷卻水流失事故(LOCA)發生。被動式停機軸封(PSDS)為一被動安全之保護裝置，可在 RCP 喪失所有冷卻的情況下，顯著減少 RCP 軸封洩漏量。目前國內核三廠已完成 RCP 被動式停機軸封的安裝，本研究係在 WOG2000模型的架構下，評估 RCP 被動式停機軸封在喪失廠外電源或喪失核機冷卻水肇始事件情節下的效益。評估結果顯示，在喪失廠外電源肇始事件下，被動式停機軸封可降低爐心熔損頻率(CDF)超過40倍；而在喪失核機冷卻水肇始事件下，則可降低爐心熔損頻率約1~2個數量級。

Abstract

For pressurized water reactors (PWR), in the event of loss of off-site power or component cooling water, the reactor coolant pump (RCP) will cause loss of coolant accident (LOCA) from seal due to loss of seal injection water and thermal barrier cooling, which is a potential and important core damage scenario. Passive shutdown seal (PSDS) is a passive safety protection device that can significantly reduce RCP seal leakage when the RCP loses all cooling. At present, the Maanshan Nuclear Power Plant (MNPP) has completed the installation of RCP passive shutdown seal. The purpose of this study is to evaluate the benefits of RCP passive shutdown seal in the event scenario of loss of off-site power or loss of component cooling water, under the framework of WOG2000 model. The assessment results show that in the event of loss of off-site power supply, the passive shutdown seal can reduce the core damage frequency (CDF) by more than 40 times, while in the event of loss of component cooling water, 1 to 2 orders of magnitude.

關鍵詞(Key Words)：喪失廠外電源(LOOP)、核機冷卻水(CCW)、被動式停機軸封(PSDS)、軸封冷卻水流失事件(Seal LOCA)、安全風險評估(PRA)。

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