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採用新型隧挖斷面工法突破工程瓶頸案例分享-以161kV 華十二～矽品三一進一出中積封線為例

Breaking Through Engineering Constraints Using a Novel Tunneling Cross-Section Method：A Case Study of the 161 kV Hua-12 to SPIL-3 In-and-Out Zhongjifeng Pipeline Engineering Project

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摘　要

隨著城市管線日益密集，為配合環境美化，管線地下化已成為趨勢。然而，在交通繁忙且地下管線密布的都會區，傳統的明挖工法風險極高。因此，免開挖工法已逐漸成為主流的施工考量。本文旨在分享「161kV 華十二～矽品三一進一出中積封電纜管路工程」的實務經驗。本工程位於車水馬龍的台中科學園區，不僅交通繁忙，地下更遍布著攸關園區運作的關鍵管線，使得施工的難度與風險遽增。

為滿足台積電公司急迫的用電需求，及後續的廠房興建規劃，經綜合評估後，決定採用隧挖工法。考量到此次佈設的管線量體龐大，且地面施工空間有限，傳統的圓形隧挖斷面難以滿足需求。為此，我們引進了創新的「拱門型」隧挖斷面。與傳統的圓形斷面相比，拱門型設計提供了更優良的施工空間，不僅有效降低了管線在彎道段的施工難度，更顯著地提升了整體工程的安全性與效率。

Abstract

As underground utility networks become increasingly congested in urban areas, pipeline undergrounding has emerged as an essential trend to support environmental beautification. However, in densely populated metropolitan settings, where traffic is heavy and underground utilities are closely packed, traditional open-cut construction poses significant risks. As a result, trenchless methods have gradually become the preferred engineering approach.

This article presents the practical experience gained from the 161 kV Hua-12 to SPIL-3 In-and-Out Zhongjifeng Pipeline Engineering Project, located in the highly trafficked Taichung Science Park. The area contains numerous critical utility systems that sustain the park's operation, greatly increasing the complexity and risks of construction.

To meet TSMC's urgent electricity demand and its subsequent facility expansion plans, tunneling was selected after comprehensive evaluation. However, due to the large volume of conduits to be installed and the limited workspace on the surface, the conventional circular tunnel cross-section was insufficient. To overcome this constraint, an innovative arch-shaped tunnel cross-section was adopted. Compared with the traditional circular design, the arch profile provides a more efficient workspace, reduces construction challenges, particularly at curved segments, and significantly enhances overall safety and engineering efficiency.

關鍵詞(Key Words)：免開挖工法(Trenchless Technology)、管路工程(Pipeline Engineering)、隧挖工法(Tunneling Method)、拱門型隧挖斷面(Arch-Shaped Tunneling Cross-Section)。

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丹娜絲颱風輸電鐵塔倒塌緊急搶修復電案例

Case Study of Emergency Repair and Power Restoration Following the Collapse of Transmission Towers During Typhoon Danas

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摘 要

丹娜絲颱風於 114 年 7 月 6 日深夜登陸，在雲林、嘉義地區掀起 17 級強陣風，測得最大陣風速高達每秒 60 公尺，造成嘉義縣義竹鄉新塭 S/S 出口 3 座鐵塔倒塌，致 69kV 新塭~永華線及大寮~新塭線兩回線無法供電，導致新塭 S/S 全停，有 10,188 戶無電可用，為自 1977 年賽洛瑪颱風後，台灣西部鐵塔再次發生多座鐵塔連鎖倒塌之事故，評估輸電線路搶修時間約需 7 日曆天，公司秉持兼顧民生及養殖業用電迫切需求，力拼 72 小時內復電，期間動員各供電區營運處及積點承攬商所有人力及機具投入搶修，最終提前 4 小時復電，完成上級所交付之重任。

Abstract

Typhoon Danas made landfall late on July 6, 2025, generating level-17 gusts across Yunlin and Chiayi, with maximum wind speeds reaching 60 m/s. The extreme winds caused the collapse of three transmission towers at the Xinwen substation (S/S) outlet in Yizhu Township, Chiayi County, resulting in the outage of both the 69 kV Xinwen–Yonghua and Daliao–Xinwen transmission lines. Consequently, the Xinwen S/S experienced a full shutdown, leaving 10,188 households without power. This incident marked the first cascading collapse of multiple transmission towers in western Taiwan since Typhoon Thelma in 1977.

Although the estimated repair time for the damaged transmission lines was approximately seven days, the company prioritized the urgent electricity needs of local communities and the aquaculture industry, setting a target to restore power within 72 hours. All available manpower and equipment from regional power supply operation offices and contracted service teams were mobilized for the emergency repair effort. Ultimately, power restoration was completed four hours ahead of schedule, successfully fulfilling the emergency mission assigned by the company.

關鍵詞(Key Words)：陣風(Gust)、輸電鐵塔(Transmission Tower)、搶修(Emergency Repair)。

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低壓直流微電網之應用與建置及其國際規範研析

Application and Implementation of Low-Voltage DC Microgrids and Analysis of International Standards

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摘 要

隨著再生能源占比的提升，微電網的應用也逐漸地受到重視。一般而言，微電網可以分為交流微電網與直流微電網。交流微電網為目前較普遍的架構，然而，大部分的再生能源與儲能系統的輸出為直流電，大部分負載可以利用直流供電，例如 LED、直流充電樁、電腦等。因此，如果要將再生能源與交流微電網整合，則需要先將再生能源的輸出直流電轉為交流電再跟交流微電網的交流母線(AC Bus)接在一起，負載也需要透過 AC/DC 和 DC/DC 轉換器與交流母線整合，導致傳輸效率降低。近幾年，專家學者們提出直流微電網，將再生能源與負載在直流母線(DC Bus)做整合。根據研究顯示，直流微電網的優點包含：低傳輸損耗、不需要相位與頻率同步、以及容易與再生能源整合等。本研究針對直流微電網的應用作一說明，同時研析目前國際上的直流微電網相關標準與規範。

Abstract

With the increasing share of renewable energy, the application of microgrids has received growing attention. Generally, microgrids can be categorized into AC microgrids and DC microgrids. AC microgrids are currently the more common configuration. However, most renewable energy sources and energy storage systems output DC power, and many loads, such as LEDs, DC charging stations, and computers, can operate directly on DC. Integrating renewable energy into an AC microgrid requires converting the DC output into AC and connecting it to the AC bus, while loads must be interfaced via AC/DC and DC/DC converters, which reduces overall transmission efficiency. In recent years, DC microgrids have been proposed to integrate renewable energy and loads directly on a DC bus. Research indicates that DC microgrids offer several advantages, including lower transmission losses, no requirement for phase or frequency synchronization, and easier integration with renewable energy sources. This study presents the applications of DC microgrids and examines the current international standards and regulations relevant to their implementation.

關鍵詞(Key Words)：再生能源(Renewable Energy)、低壓直流微電網 (Low Voltage DC Microgrid)、直流供電(DC Power Supply)。

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台電資料治理推動之研究

A Study on Advancing Data Governance at Taipower

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摘 要

面對快速演進的智能化與數位化浪潮中，「資料」已成為組織轉型與創新不可或缺的關鍵資產。無論是推動業務流程優化、提升決策效率，或是導入人工智慧與自動化技術，皆需仰賴高品質且可信的資料作為基礎。唯有建立良好的資料基礎與完善的管理機制，才能確保分析判斷的準確性、提升作業效率，並符合法規要求。

奠基於前期研究案「台電資料治理規劃與推動」的成果，本研究在既有基礎上持續深化與拓展，以解決業務問題為目標，並以「明確、築基、生態、素養」為主軸推動，盼能持續為台電公司未來長期的資料治理願景帶來以下貢獻，包含：明確且清楚的資料標準定義、築建牢固的資料基礎、規劃長期性資料治理生態及持續資料素養之養成。

本案希冀台電公司建立完善的資料治理架構，支援台電公司數位化轉型戰略，提升數位化營運能力，並通過標準化和規範化的資料管理，推動台電公司智能化和數位化發展。

Abstract

Amid the rapid evolution of intelligent and digital technologies, data has become an indispensable asset for organizational transformation and innovation. Whether improving business processes, enhancing decision-making efficiency, or implementing artificial intelligence and automation, all such initiatives rely on high-quality and trustworthy data. Establishing a solid data foundation and robust governance mechanisms is essential for ensuring analytical accuracy, improving operational efficiency, and meeting regulatory requirements.

Building upon the earlier project, “Taipower Data Governance Planning and Promotion,” this study aims to address practical business challenges while further advancing Taipower’s data governance capabilities. Guided by the four pillars, clarity, foundation building, ecosystem development, and literacy enhancement, the study seeks to strengthen and expand existing achievements. The expected contributions include: clearly defined data standards, a reinforced data foundation, a long-term data governance ecosystem, and continuous cultivation of data literacy across the organization.

Ultimately, this project aspires to support Taipower in establishing a comprehensive data governance framework aligned with its digital transformation strategy, enhancing digital operational capabilities, and accelerating the company’s progress toward intelligent and fully digitalized operations through standardized and systematic data management.

關鍵詞(Key Words)：資料治理(Data Governance)、資料治理框架(Governance@Scale、G@S)、詮釋資料(Metadata)、資料標準(Data Standard)、資料血緣(Data Lineage)。

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AI 驅動家庭節能診斷自動化：系統設計與功能驗證

AI-Driven Automated Home Energy-saving Diagnosis：System Design and Functional Validation

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摘 要

本研究提出一套人工智慧驅動家庭節能診斷自動化系統，以改善傳統診斷流程冗長、仰賴人力經驗及報告品質不一致等問題。首先，透過線上問卷蒐集住戶能源使用資料，利用 C# 自動化程式進行資料解析與報告生成，結合 SkiaSharp 製作圖表，呈現用電特性與診斷結果，最後，整合大型語言模型(如 Google Gemini API)，強化報告敘事完整性與建議之精確度。驗證結果顯示，本系統大幅提升報告生成效率及正確性，由三個工作日縮短至十分鐘內。診斷模組亦能針對家電耗能分布、老舊設備汰換與用電安全提出具體建議。整體而言，本系統兼具高效率、擴展性與跨領域應用潛力，可作為智慧節能決策支援的重要工具。

Abstract

This study proposes an AI-driven automated system for home energy-savings diagnosis, designed to address the limitations of traditional audit workflows, including lengthy processing time, dependence on human expertise, and inconsistent report quality. Household energy-use information is collected through an online questionnaire, parsed and structured using a C#-based automation module, and subsequently converted into standardized diagnostic reports. SkiaSharp is employed to generate visual representations of electricity-use characteristics and diagnostic outcomes. Furthermore, large language models (e.g., the Google Gemini API) are integrated to enhance narrative clarity, strengthen analytical explanations, and improve the precision of recommended energy-saving actions.

Validation results indicate that the system dramatically improves reporting efficiency and accuracy, reducing the report-generation time from approximately three working days to under ten minutes. The diagnostic module also provides actionable recommendations regarding appliance-level energy consumption, replacement of aging equipment, and household electrical safety. Overall, the system demonstrates high efficiency, scalability, and strong potential for cross-domain applications, making it a valuable tool for intelligent decision support in residential energy management.

關鍵詞(Key Words)：人工智慧(Artificial Intelligence)、節能診斷(Energy-saving Diagnosis)、自動化生成式報告 (Automated Report Generation)、功能驗證(Functional Verification)。

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表面增強拉曼光譜的發展與應用

Development and Application of Surface-Enhanced Raman Spectroscopy

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摘　要

本計畫由台電公司核安處委託工業技術研究院材料與化工研究所執行，計畫期程自 112 年 5 月 1 日至 114 年 4 月 30 日共計二年。主要開發表面增強拉曼光譜感測器並結合可攜式拉曼光譜儀，建立電廠事業廢棄物環境賀爾蒙檢測技術，本計畫完成汙染物光譜分析資料庫，可提供電廠追蹤與即時了解汙染現況。

本文回顧並闡述表面增強拉曼光譜(Surface-Enhanced Raman Spectroscopy, SERS)的基本原理、優勢與挑戰，並簡介其在不同領域的應用。SERS 是一種利用奈米結構增強拉曼訊號的分析技術，具有高靈敏度及特異性分子的檢測能力。應用拉曼光譜儀結合 SERS 分析電廠廢棄物中的環境荷爾蒙，研究人員應用模擬軟體預測雙酚 A 和戴奧辛的拉曼頻譜，並與實驗結果相比對，建立特徵頻譜資料庫，未來將持續改良 SERS 感測器的穩定性並評估其可重複使用性，以進行高精度定量分析並有效識別低濃度有害汙染物。

Abstract

This project, commissioned by the Nuclear Safety Department of Taipower and executed by the Materials and Chemical Engineering Division of the Industrial Technology Research Institute (ITRI), spans two years from May 1, 2023, to April 30, 2025. The main objective is to develop a Surface-Enhanced Raman Spectroscopy (SERS) sensor integrated with a portable Raman spectrometer to establish a detection technology for environmental hormones in industrial waste from power plants. A spectral database of pollutants has been completed, enabling power plants to track and assess pollution conditions in real time.

This paper reviews the fundamental principles, advantages, and challenges of SERS, and provides an overview of its applications across various fields. SERS is a nanostructure-enhanced analytical technique that offers high sensitivity and strong molecular specificity. In this project, Raman spectrometer combined with SERS is applied to analyze environmental hormones in power plant waste. Researchers utilized simulation software to predict the Raman spectra of bisphenol A and dioxins and compared the simulated spectra with experimental results to establish a characteristic spectral database. Future efforts will focus on improving the stability and reusability of the SERS sensor to enable high-precision quantitative analysis and effective identification of low-concentration hazardous pollutants.

關鍵詞(Key Words)：可攜式拉曼光譜儀(Portable Raman Spectrometer)、表面增強拉曼光譜(Surface-Enhanced Raman Spectroscopy, SERS)、環境賀爾蒙(Environmental Hormone)。

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核一廠 3 號低放射性廢棄物貯存庫考量山腳斷層之耐震能力評估

Seismic Capacity Evaluation of the No. 3 Low-Level Radioactive Waste Storage Facility at Nuclear Power Plant No. 1 Considering the Shanchiao Fault

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摘　要

依我國核能管制機關：「低貯庫相關耐震設計基準，應符合內政部『建築物耐震設計規範及解說』規定外，亦應以斷層新事證進行耐震檢核及意外事故評估，並列入設施之意外事件應變計畫。」。核一廠位於新北市石門區，由於山腳斷層為經濟部地質調查及礦業管理中心公告之活動斷層，且未納入「建築物耐震設計規範及解說」之近斷層效應考量，故新增山腳斷層為新事證進行低貯庫之耐震評估。本評估案利用定值法地震危害度分析(Deterministic Method, DSHA)求得廠址考慮山腳斷層之地震反應譜，作為耐震評估之需求反應譜，並採用非線性靜力分析(側推分析)及非線性動力歷時分析進行結構耐震評估，結果顯示，考慮山腳斷層之地震作用下，核一 3 貯庫結構仍維持完整性，安全無疑慮。

Abstract

According to Taiwan's nuclear regulatory authority, the seismic design of low-level radioactive waste storage facilities must comply with the Seismic Design Specifications and Commentary for Buildings issued by the Ministry of the Interior. In addition, new fault evidence must be incorporated into seismic verification, accident analyses, and the emergency response plans of the relevant facilities. Nuclear Power Plant No. 1, located in Shimen District, New Taipei City, lies near the Shanchiao Fault, which is classified as an active fault by the Geological Survey and Mining Management Agency. Because the near-fault effects of the Shanchiao Fault are not included in the current building seismic design code, it is treated as newly identified fault evidence for the seismic evaluation of the No. 3 low-level waste storage facility.

In this study, a deterministic seismic hazard analysis (DSHA) was performed to derive the site-specific earthquake response spectrum considering the Shanchiao Fault. This spectrum was used as the demand response spectrum for seismic assessment. Both nonlinear static (pushover) analysis and nonlinear time-history analysis were conducted to evaluate the structural seismic capacity. The results indicate that the No. 3 storage facility maintains its structural integrity under the seismic demands associated with the Shanchiao Fault, confirming that its safety is not of concern.

關鍵詞(Key Words)：山腳斷層(Shanchiao Fault)、定值法地震危害度分析(Deterministic Seismic Hazard Analysis, DSHA)、非線性靜力分析(Nonlinear Static Analysis)、耐震能力評估(Seismic Capacity Evaluation)。

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