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火力發電：
FOSSIL POWER GENERATION :

輸變電：
TRANSMISSION AND TRANSFORMATION :

環境與永續：
ENVIRONMENT AND SUSTAINABILITY :

減碳：
CARBON REDUCTION :

外部負載變化對大潭電廠 GT 轉軸轉速影響之研究

A Study on the Influence of External Load Variations on the Rotational Speed of GT Rotors at the Tatan Power Plant

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摘 要

本研究旨在探討大潭電廠 GT 機組轉子在面臨外部線路負載變化時的動態響應及其對疲勞壽命的影響。由於大潭電廠緊鄰用電量大的工業區，外部負載的劇烈變動可能導致機組負載、扭力及轉速的振盪，進而影響機組壽命。本研究透過實地量測與數值模擬分析相結合，利用無線扭振量測系統、轉速與電流感測器收集機組運轉數據，並應用有限元素力學分析及高週疲勞分析，探討不同負載情境下的應力變化與疲勞損壞可能性。研究結果顯示，即使在外部線路負載劇烈變化、機組計畫性升降載，甚至是極端輸電線路故障情況下，大潭電廠 GT 機組轉子的壽命消耗仍影響甚微。

Abstract

This study examines the dynamic response of gas turbine (GT) rotors at the Tatan Power Plant when subjected to external transmission line load variations, as well as the resulting impact on rotor fatigue life. Because the plant is located adjacent to industrial zones with high and fluctuating electricity demand, rapid external load changes may induce oscillations in unit load, torque, and rotational speed, thereby influencing the long-term durability of the units.

To evaluate these effects, the research integrates field measurements with numerical simulations. Operational data were collected using a wireless torsional-vibration measurement system, along with rotational-speed and current sensors. Finite element mechanical analysis and high-cycle fatigue assessments were then performed to investigate stress variations and the likelihood of fatigue damage under different loading conditions.

The results indicate that even under severe external load fluctuations, scheduled load-ramping operations, or extreme transmission-line fault scenarios, the fatigue life consumption of the GT rotors at the Tatan Power Plant remains minimal.

關鍵詞(Key Words)：外部負載(External Load)、氣渦輪機轉子(Gas Turbine Rotor)、有限元素法(FEM)、應力分析(Stress Analysis)、高週疲勞分析(High-cycle Fatigue)。

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台中發電廠空氣污染議題之研究整合與前瞻分析：學術成果回顧與未來挑戰

A Comprehensive Review and Prospective Analysis of Air Pollution Studies on the Taichung Power Plant

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摘　要

隨著環保意識提升，台中發電廠的空污排放議題受到社會各界關注。本研究旨在整合相關文獻，探討台中發電廠對區域空氣品質之影響程度及未來可能面臨之挑戰，以作為本公司電力調度及對外說明之參考。煙氣排放特性研究成果顯示台中發電廠歷經 AQCS 改善工程，空氣污染排放量大幅下降，防制設備亦能有效去除有害物質；文獻利用空氣品質模式分析電廠對區域空品之影響程度，整體而言多數研究皆指出台中發電廠對中部地區 $PM_{2.5}$ 年平均濃度的貢獻比例大多低於 10%，顯示其並非區域空氣污染之主要來源；人工智慧分析成果則說明電廠對周遭空氣品質雖可能存在潛在影響，但重要性相對低。未來隨著能源轉型及環保法規趨嚴，台中發電廠將持續為能源穩定與環境永續貢獻心力。

Abstract

With increasing environmental awareness, air pollution emissions from the Taichung Power Plant (TPP) have drawn considerable public attention. This study integrates existing literature to evaluate the plant's impact on regional air quality and to identify future challenges, providing scientific support for Taipower's power dispatching decisions and external communication.

Research on flue-gas emission characteristics indicates that, following the implementation of Air Quality Control System (AQCS) upgrades, pollutant emissions from TPP have been substantially reduced, and the control equipment effectively removes hazardous air pollutants. Air-quality modeling studies further show that TPP's contribution to annual average $PM_{2.5}$ concentrations in central Taiwan is generally below 10%, suggesting that the plant is not a major source of regional air pollution. Additionally, studies employing artificial intelligence methods reveal that although TPP may exert some localized influence on air quality, its relative importance remains low.

Looking ahead, as Taiwan advances energy transition policies and environmental regulations become increasingly stringent, TPP will continue to play an essential role in balancing energy reliability with environmental sustainability.

關鍵詞(Key Words)：燃煤電廠(Coal-Fired Power Plant)、空氣污染減量策略(Mitigation Strategies of Air Pollution)、$PM_{2.5}$ 貢獻分析($PM_{2.5}$ Contribution Analysis)、空氣品質模式(Air Quality Modelling)、人工智慧分析(Artificial Intelligence Analysis)、臭氧生成潛勢(Ozone Formation Potential)。

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回首頁

彰一 S/Y 離岸風電 50+2 實務分析

Practical Analysis of the Changyi Switching Yard 50+2 Scheme for Offshore Wind Integration

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摘 要

台灣海峽是全球最佳風場之一，彰化外海更匯集本島最大風能，擁有廣闊的淺海大陸棚與穩定的風場條件，自政府啟動能源轉型政策以來，成為發展離岸風電重要場域。經濟部核定並公告「彰化離岸風電海纜上岸共同廊道範圍」，北側在彰濱崙尾工業區，南側在芳苑，本公司配合規劃新設北側廊道的彰一開閉所、彰工升壓站，南側廊道的永興開閉所。本文將說明彰一開閉所電力系統狀態演進及離岸風電業者併網後造成之輸電線路過載瓶頸，並透過實例分享 50+2 動作情況，說明大量再生能源案場加入後對電力系統影響及其因應對策，當設備超載時，限制各再生能源案場之最大出力，以達到供電系統穩定之目的。

Abstract

The Taiwan Strait is recognized as one of the world's premier wind sites, with the offshore area of Changhua possessing the island's highest wind energy potential due to its broad shallow continental shelf and stable wind conditions. Since the government's launch of the energy transition policy, this region has become a key development zone for offshore wind power. The Ministry of Economic Affairs has approved and announced the "Common Corridor for Submarine Cable Landfall of the Changhua Offshore Wind Power Projects," with designated landing corridors in the Changbin–Lunwei Industrial Zone to the north and in Fangyuan to the south. In coordination with this plan,Taipower is developing the Changyi Switching Yard and the Changgong Booster Station in the northern corridor, as well as the Yongxing Switching Yard in the southern corridor.

This article outlines the evolution of the electrical system configuration at the Changyi Switching Yard and examines the transmission line overload constraints that emerged following the grid connection of offshore wind farms. Using real operational cases, the study presents the implementation of the "50+2" operational scheme and analyzes how the rapid influx of large-scale renewable energy projects affects system loading. Corresponding mitigation strategies are discussed, including output curtailment measures applied to individual renewable energy facilities when equipment loading exceeds permissible limits, ensuring overall power system stability.

關鍵詞(Key Words)：升壓站(Booster Station)、開閉所(Switching Yard)、併網熱區(Grid-connected Hot Zone)、再生能源(Renewable Energy)。

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正、複導體電纜遮蔽層之接地系統採對稱或不對稱交錯接地之影響

Effects of Symmetric and Asymmetric Staggered Ground on the Shielding Layers of Positive and Negative Conductor Cables

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摘 要

由於我國的工商業與高科技產業蓬勃發展，送電容量增加，既設線路無法完全負擔，因此自民國 54 年起開始實施電纜地下化，以提高供電品質、降低天然災害影響、改善架空線路佔地過大與改善市容景觀。然設置於地下的同時也會受到環境、道路、線路架構及接地結構之限制，因此在規劃線路路徑或更改接線方式前，需先考量施工後對電網可能造成之影響與評估後續維運成本。本計畫針對新竹公園與彰林大城之地下電纜與架空線兩者所結合的線路進行研究，探討遮蔽層迴路損失、感應電壓等特性，評估接地模式對線路維運、暫態突波、接地故障、短路故障等短中長期之影響，最後比較計算值與模擬結果之間的差異。

Abstract

With the rapid development of Taiwan's industrial and high-tech sectors, transmission demand has continued to grow, and existing overhead lines are no longer sufficient to accommodate the required capacity. Since 1965, Taipower has therefore implemented cable undergrounding to enhance power supply quality, reduce the impact of natural disasters, mitigate the excessive space occupation associated with overhead lines, and improve urban aesthetics. However, underground cable installation is subject to various constraints, including environmental conditions, road layouts, line configurations, and grounding structures. Consequently, before planning routing schemes or modifying wiring methods, it is essential to assess the potential impacts on the power grid after installation and evaluate the associated operation and maintenance costs.

This study examines the hybrid transmission corridor consisting of underground cables and overhead lines between Hsinchu Park and Zhanglin Dacheng. The analysis focuses on shielding-layer loop losses and induced voltages, and further evaluates the short-, medium-, and long-term effects of different grounding schemes on line operation and maintenance, transient surges, grounding faults, and short-circuit conditions. Finally, the calculated results are compared with simulation outcomes to identify and discuss their discrepancies.

關鍵詞(Key Words)：地下電纜(Underground Cable)、對稱及不對稱交錯接地(Symmetric and Asymmetric Staggered Ground)、遮蔽層迴路損失(Losses for the Shielding Layer Circuit)、循環電流損失(Circle Current Loss)。

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回顧新店溪粗坑壩魚道的百年歲月與展望

A Century of the Cukeng Dam Fishway on the Xindian River：Retrospect and Prospects

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摘　要

本計畫自 2023 年 5 月至 2025 年 4 月間於新店溪粗坑壩上下游進行魚類資源調查，以了解及建立洄游生態基本資料，檢討既有魚道適用性並研擬改善方案。本計畫共紀錄 25 種魚類，其中 20 種為原生種，共有 14 種原生魚類在魚道內被觀察到。粗坑壩魚道初建於 1909 年，中間經多次改建，最近一次至今已逾 33 年。魚道內部分混凝土結構受水流沖蝕損壞；目前粗坑壩魚道為水池階段式，隔壁高 0.8 m，間距 2.3 m，加上過往於粗坑壩堰頂增設 1.0 m 的閘墩等緣故，使魚道水力消能不足，難以發揮效用。

在檢討既有的魚道現況後，建議改建為垂直豎槽式魚道，並縮短隔壁間距至 1.7 m，以適應上游水位變化並改善功能。若未來進行大規模整建，建議於右岸排砂道導牆旁增設新垂直豎槽魚道，根據經濟部水利署粗坑壩水庫運用要點規範之生態排放流量 1.96 cms，作為魚道通流量(0.65 cms)和基流量排放道的設計參數。

Abstract

From May 2023 to April 2025, this project conducted a comprehensive survey of fish resources upstream and downstream of the Cukeng Dam on the Xindian River to establish baseline information on migratory ecology, evaluate the performance and suitability of the existing fishway, and develop improvement strategies. A total of 25 fish species were recorded, including 20 native species, 14 of which were observed within the fishway.

The original fishway at Cukeng Dam was constructed in 1909 and has undergone multiple reconstructions, with the most recent completed over 33 years ago. Several concrete components within the fishway have since deteriorated due to hydraulic erosion. The current structure is a pool-and-weir type fishway, featuring 0.8-m baffles spaced 2.3 m apart. In addition, the subsequent installation of a 1.0-m sluice block atop the weir crest has further reduced hydraulic energy dissipation, significantly limiting the fishway's effectiveness.

Following an assessment of current conditions, the project recommends converting the fishway to a vertical-slot design and reducing baffle spacing to 1.7 m to accommodate fluctuations in upstream water levels and improve functional performance. For future large-scale reconstruction, it is further recommended to install an additional vertical-slot fishway alongside the sediment-sluicing guide wall on the right bank. Design parameters should follow the ecological flow requirement of 1.96 cms specified by the Water Resources Agency, allocating 0.65 cms for fishway discharge and for base-flow release.

關鍵詞(Key Words)：粗坑壩(Cukeng Dam)、生態廊道(Ecological Corridor)、魚道改修方案(Fishway Renovation Plan)。

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從淨零政策下探討石灰石水泥於輸變電基礎設施之潛力與挑戰

Exploring the Potential and Challenges of Portland Limestone Cement for Transmission and Substation Infrastructure under Net-Zero Policy Initiatives

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摘　要

在全球推動淨零排放的趨勢下，建築產業面臨低碳轉型的挑戰。卜特蘭石灰石水泥(Portland Limestone Cement, PLC)因具較低碳製程、優異的材料性能，以及與現有施工技術的高度相容性，逐漸成為替代傳統卜特蘭水泥(Ordinary Portland Cement, OPC)的綠色材料。本文首先介紹國內外之淨零政策，其次介紹 PLC 的製程及其物理、化學與力學性能的表現，最後為應用於輸變電基礎設施的可行性探討。綜合研究文獻與產業資料顯示，PLC 能在保持結構強度與耐久性的重要前提下，具備低於 OPC 的碳排放量，特別適用於需長期服役的混凝土構造物。

Abstract

As the global movement toward net-zero emissions accelerates, the construction industry is undergoing an urgent transition toward low-carbon materials and practices. Portland Limestone Cement (PLC), characterized by its lower-carbon manufacturing process, favorable material performance, and strong compatibility with existing construction methods, has emerged as a promising alternative to Ordinary Portland Cement (OPC).

This article first reviews domestic and international net-zero policies, followed by an overview of PLC production processes and its physical, chemical, and mechanical characteristics. The final section evaluates the feasibility of adopting PLC in transmission and substation infrastructure. Evidence from research literature and industry data indicates that PLC can achieve lower carbon emissions than OPC while maintaining essential structural strength and durability, making it particularly suitable for concrete components requiring long-term service life.

關鍵詞(Key Words)：卜特蘭石灰石水泥(Portland Limestone Cement)、淨零政策(Net-Zero Policy)，輸變電基礎設施(Transmission and Substation Infrastructure)。

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回首頁

能源屬性憑證制度之國際發展與無碳電力憑證建構之初探

International Developments in Energy Attribute Certificate Systems and a Preliminary Exploration of Carbon-Free Electricity Certificates

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摘 要

為因應全球淨零轉型趨勢，能源屬性憑證制度已成為各國推動電力減碳與環境資訊揭露之核心機制。目前多數制度僅涵蓋再生能源電力，對於導入碳捕存技術之火力電廠所產生之去碳電力，尚缺乏明確之核算與認證架構。本文首先研析歐盟、美國、澳洲、日本及臺灣現行能源屬性憑證制度設計，解析其對電力來源分類、環境屬性標示及交易機制之運作方式，進一步以碳捕存去碳電力之國際標準為基礎，本文分析去碳電力之計量邊界、碳捕捉量與外加性排放量之核算邏輯，並說明其如何作為建置無碳電力憑證制度之技術依據。透過導入標準化計量與第三方查驗機制，該制度可強化無碳電力之可驗證性與交易透明度。若能進一步結合企業長期購電合約與綠色金融工具，將有助於降低碳捕存電廠之初期資本投資風險，提升專案可行性，並補足再生能源供電間歇性限制，健全我國未來多元去碳電力供應架構。

Abstract

With the accelerating global shift toward net-zero emissions, Energy Attribute Certificate (EAC) systems have become a central mechanism for facilitating electricity-sector decarbonization and enhancing transparency in environmental disclosures. Most existing EAC schemes focus exclusively on renewable electricity and lack a clear accounting and certification framework for carbon-abated electricity produced by fossil-fuel power plants equipped with carbon capture and storage (CCS) technologies.

This study first analyzes the design and operational features of EAC systems in the European Union, the United States, Australia, Japan, and Taiwan, including electricity-source classification, environmental attribute labeling, and market transaction mechanisms. Building on emerging international standards for CCS-based carbon-abated electricity, the paper further examines the accounting logic for defining measurement boundaries, quantifying captured CO_2, and determining additional emissions. It then explains how these technical elements can serve as the foundation for constructing a Carbon-Free Electricity Certificate (CFEC) system.

By introducing standardized measurement methodologies and third-party verification processes, a CFEC framework can strengthen the verifiability and market transparency of carbon-abated electricity. When integrated with corporate power purchase agreements (CPPAs) and green financial instruments, such a system may help reduce the upfront capital risks of CCS deployment, enhance project feasibility, and mitigate the intermittency limitations of renewable energy, ultimately supporting a more diversified and resilient carbon-abated electricity supply structure for Taiwan.

關鍵詞(Key Words)：淨零排放(Net Zero Emissions)、碳捕捉與封存(Carbon Capture and Storage, CCS)、能源屬性憑證制度(Energy Attribute Certificate, EAC)、無碳電力憑證(Carbon-Free Electricity Certificates, CFEC)。

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