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淺談水平導向鑽掘(HDD)工法規劃設計與應用
以「台西~北港、雲林暨台西~四湖線電纜管工程為例」

The Planning, Design and Application of Horizontal Directional Drilling Method Take Taixi~Beigang, Yunlin and Taixi~Sihu Line Cable Pipe Projects as an Example

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摘　要

水平導向鑽掘工法(Horizontal Directional Drilling, HDD)也有人翻譯成潛鑽工法或導鑽工法，係用來埋設地下管線的一種方法，當管線埋設時遭逢到一座橋梁、溪流、河流、高速公路或者人孔密集區及交通路口等，均可搭配水平導向鑽掘工法。水平導向鑽掘工法利用鑽機配合皂土液，先行導鑽鑽孔後進行多次擴孔，再修孔，當達到足以容納設計需要，比埋設管線數量大些空間之孔徑後，再利用鑽機順利又安全地將管線從到達坑之管端拖曳拉回(Drag Pulling Back)到推進坑，此一過程即稱水平導向鑽掘工法[1]。藉由此一工法不僅可突破施工困難地區、提升工作效率，亦可降低施工人員於施工過程之危害風險，以利達成電力管線如期輸送之目的。

Abstract

Horizontal Directional Drilling (HDD), also known as submersible drilling or guide drilling methods, is a method used to bury underground pipelines. When the pipeline is buried and encounters a bridge, stream, river, highway, dense manhole area, traffic intersection, etc., the HDD method can be used. The HDD method uses a drilling rig with bentonite liquid to drill holes with a pilot drill, then expand the holes multiple times, and then repair the holes. When the hole diameter is sufficient to accommodate the design needs and is larger than the number of buried pipelines, the drilling rig is used to smoothly and safely drag pulling back the pipeline from the pipe end of the arrival pit to the push pit. This process is called HDD method[1]. This construction method can not only break through difficult construction areas and improve work efficiency, but also reduce the hazard risks of construction workers during the construction process, so as to achieve the purpose of delivering power pipelines as scheduled.

關鍵詞(KeyWords)：水平導向鑽掘工法(Horizontal Directional Drilling)、拖曳拉回(Drag Pulling Back)、導孔(Guided Hole)。

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輸電級圖資資料自動化處理機制探討

Automated Processing Mechanism of Transmission Level Geospatial Data Processing

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摘 要

台灣電力公司已建立配電級饋線可併網容量查詢系統(Geospatial Information System to View Hosting Capacity on Feeders, FGIS)，依據饋線(Feeder)上負載與再生能源分布情形，計算每一條饋線之可併網容量(Hosting Capacity)並進行視覺化，利用圖資系統(Geospatial Information System, GIS)提供民眾與再生能源業者查詢可併網容量的工具，提升再生能源併網申請的速度。因應部分饋線已出現可併網容量不足的情形，在一些情況下再生能源發電設備可改至輸電級系統進行併聯，此時就應該參考輸電線路(Transmission Line)可併網容量，與輸電線路之圖資資料進行整合，然而，輸電線路之點位資料並非標準圖資格式，由於資料抄寫的方式，在輸電線路資料中可能會有人為錯誤的發生。為了將輸電級輸電線路可併網容量資訊與輸電線路圖資資料結合後產製圖磚，必須將輸電線路點位資料進行自動化處理。本研究針對地下電纜資料進行錯誤樣態的整理及修復方法的建立，對於地下電纜的人為錯誤模式進行研究，並對此提出一個自動化處理過程中可以依循的原理。

Abstract

In order to speed up renewable energy grid connection applications, Taipower has established the Geospatial Information System to View Hosting Capacity on Feeders(FGIS) at the distribution level. The aforementioned system can calculate and visualize the hosting capacity of each feeder based on the load and renewable energy distribution, and use the Geospatial Information System(GIS) to provide the public and renewable energy operators to check the available grid-connected capacity. In response to the situation that some feeders have insufficient grid-connected capacity, in some cases, renewable energy power generation equipment can be changed to a transmission-level system for parallel connection. In this situation, we can refer to the grid-connected capacity of transmission lines and integrate it with the geospatial information of transmission lines. However, the current geospatial data of transmission lines are not in a standard format, and manual transcription may cause data errors. In order to combine the available grid-connected capacity information of transmission lines with the transmission line geospatial data to produce map tiles, the geospatial data of transmission lines must be processed automatically. This study aims at sorting out error patterns of underground cable data and establishing restoration methods, and a so-called misstep principle is proposed to serve as the

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foundation for an automated processing mechanism containing errors on transcript without unique solution.

關鍵詞(Key Words)：輸電線路(Transmission Lines)、地理圖資(Geospatial Information)、自動化處理機制(Automatic Data Processing)、無唯一解的抄本錯誤(Errors on Transcript without Unique Solution)、短步原理(Misstep Principle)。

儲能系統規劃及改善

Energy Storage System Planning and Improvement

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摘 要

隨著再生能源發展趨於成熟，由集中式發電逐漸朝向分散式電網配置，為因應大量再生能源併入電網所造成的間歇性、波動性等不穩定因素，而無法直接併入電力系統使用，因此儲能便作為重要的「緩衝」功能。台電規劃自 2021 至 2025 年逐年自行建置路園 D/S、龍潭 E/S、冬山 E/S 及南鹽光共 160MW 儲能系統，以穩定系統頻率為目標。龍潭 E/S 建置儲能系統其標稱功率與標稱電量為 60MW 與 80MWh，是北部重要的儲能設備之一，具有自動頻率控制功能，主要在運用儲能快速充放電之優勢，使儲能設備追隨電力系統之頻率波動，主動調整充放電動作，以維持系統頻率穩定。龍潭儲能系統，依原設計規劃，儲能系統控制電源與輔助電源由變電所供給，本身無備用電源，除了影響儲能系統監視、控制、消防之安全，也不符合 ESS-1 7.2.1 之規範。本文提出增設柴油發電機及備用電源以改善上述之問題，以利後續併網及運轉之需求，確保儲能系統運轉之安全性。

Abstract

As the development of renewable energy becomes mature, the power system in Taiwan is gradually moving from centralized power generation to a decentralized power grid configuration. To cope with the intermittency, volatility and other unstable factors caused by the integration of large amounts of renewable energy into the power grid, which cannot be directly integrated into the power system for use, energy storage serves as an important "buffer" function. Taipower plans to build a total of 160MW of energy storage systems in Luyuan D/S, Longtan E/S, Dongshan E/S and Nanyan Solar each year from 2021 to 2025, with the goal of stabilizing the system frequency. The energy storage system built by Longtan E/S has a rated power and capacity of 60MW and 80MWh, one of the most important energy storage systems in north Taiwan. It has an automatic frequency control function; and taking advantage of the rapid charging and discharging of energy storage, it can follow the frequency fluctuations of the power system and actively switch from charging and discharging modes to maintain system frequency stability. According to the original design, the control power and auxiliary power of Longtan E/S are supplied from the substation and there is no backup power supply. The aforementioned design is not only detrimental to the monitoring, control and fire safety of the energy storage system, nor

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does it comply with the specifications of ESS-1 7.2.1. Therefore, this article recommends adding diesel generators and backup power supplies to improve the above problems to facilitate subsequent grid connection and operation needs and ensure the safety of the energy storage system operation.

關鍵詞(Key Words)：再生能源(Renewable Energy)、儲能系統(Energy Storage System)、緩衝(Buffer)、儲能系統自動頻率控制(Automatic Frequency Control)、備用電源(Backup Power)。

二次變電所巡檢機器人之 AI 影像辨識研究

Research on AI Image Recognition of Secondary Substation Inspection Robot

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摘 要

本計畫將擴增巡檢機器人功能以符合未來實際應用時的需求，提升巡檢品質與成效。運用可見光影像，進行 AI 影像辨識達到即時檢查設備運作狀態之目的。目前巡檢機器人已能夠執行特定路徑巡檢、紅外熱像儀溫度檢測、溫濕度檢測及故障通報，方可提升日常巡視點檢及維護試驗的效率及機動性以確保供電穩定，當異常通報發生時，立即通知中控中心，利用辨識前後上傳的資訊數據做整合分析，提供管理者預先研判設備、線路或環境影響預估時的依據。

Abstract

This project aims to expand the functions of inspection robots to meet the needs of future practical applications and improve the quality and effectiveness of inspections. Visible light images are used to perform AI image recognition to achieve the purpose of real-time inspection of the operating status of equipment. At present, inspection robots are able to perform specific path inspections, infrared thermal imaging camera temperature detection, temperature and humidity detection and fault notification to improve the efficiency and mobility of daily inspections and maintenance tests to ensure stable power supply. When an abnormal notification occurs, the central control center will be notified immediately, and the information data uploaded before and after the identification may be used for integrated analysis to provide managers with a basis for pre-judgement of equipment, lines or environmental impact estimates.

關鍵詞 (Key Words)：變電所巡檢機器人(Substation Inspection Robot)、自主移動與定位導航(Autonomous Moving and Positioning Navigation)、智慧巡檢(Intelligent Inspection)、人工智慧(Artificial Intelligence)。

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備轉容量率及備轉容量運用於夏季電力供需燈號分析之研究

A Study on the Application of Percent Operating Reserve and Operating Reserve in Summer Power Supply and Demand Signal Analysis

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摘　要

台電公司現行電力供應燈號，係採用備轉容量率以及備轉容量混合使用。本研究蒐集台電公司網站每 10 分鐘用電量、供電能力資料，探討備轉容量與備轉容量率變化情形，並將現行燈號套用至每 10 分鐘之電力供需變化歷程，且規劃以備轉容量取代備轉容量率之方式，假設以兩大(110 萬瓩)一中(60 萬瓩)作為備轉容量的分級計算原則。研究中設計兩個燈號方案進行分析，檢視各方案的燈號變化情形，同時運用水文分析常用於供水情勢分析之超越機率，進行供電情勢分析。

本研究以用電高峰且較為吃緊之夏季工作日作為研究探討，成果顯示若於用電量較高之情況，使用備轉容量率有可能誤判尚有供電餘裕時即顯示預警燈號之情形，建議可依調度人員實際操作情況研議大型機組及中型機組較為妥適之裝置容量進行燈號設計，並可改用備轉容量訂定門檻，務實揭露電力供需情勢。

Abstract

Taipower currently uses a mixture of Percent Operating Reserve and Operating Reserve to evaluate and reveal whether the reserve capacity is sufficient. This study uses the electricity consumption every 10 minutes and power supply capability information disclosed on the company's website to explore the changes of Operating Reserve and Percent Operating Reserve. In addition, this study aims to apply the current reserve capacity signals to the changes in power supply and demand every 10 minutes (to replace the Percent Operating Reserve with Operating Reserve), and uses two large-sized units (1,100 MW) and one medium-sized unit (600 MW) as the grading principle for reserve capacity. In this study, two signal schemes were designed for analysis. At the same time, the exceedance probability, commonly used in water supply scenario analysis, was used to analyze the power supply situation.

The study focuses on summer weekdays, when power consumption is high and power supply is relatively tight. The results show that when the power consumption is high, using Percent Operating Reserve may misjudge the situation and display an early warning signal when there is still reserve capacity. It is suggested that appropriate installed capacities of large-scale units and medium-sized units shall be studied based on the actual operation conditions of dispatchers, and Operating Reserve can be used as the basis for setting signals, so as to pragmatically reveal the power supply and demand situation.

關鍵詞(Key Words)：備轉容量(Operating Reserve)、備轉容量率(Percent Operating Reserve)、電力供需燈號(Electricity Supply and Demand Signal)、超越機率(Exceedance Probability)。

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電力交易平台資訊系統架構與運作機制檢討研究

Research on Reviewing the Information System Architecture and Operation Mechanism of Energy Trading Platform

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摘　要

本案旨在針對未來台電公司採購 MMS 模組後的電力交易平台之資訊安全、硬體架構，以及軟體功能等資訊架構面向提出規劃與建置建議，透過文獻蒐集與研析、現行系統解析及需求訪談討論，完成了國內外重大交易系統之資訊架構及其與台電公司差異比較，並對電力交易平台系統架構優化與資料流規劃提出了整體服務層級協議(Service Level Agreement, SLA)、資安機制和事故管理、硬體環境架構和備援機制、機房營運和持續營運、資料庫設計和優化建議、與外部系統資料介接整合、電力交易平台與 MMS 整合等幾大主題提出建議規劃說明。

本案進行過程中完成了協助現有電力交易平台效能優化的任務，提出的規劃建議內容也可做為電力交易平台未來持續精進，以及 MMS 產品模組採購的參考目標。

Abstract

The purpose of this project is to provide planning and implementation recommendations for the information security, hardware architecture, software functions and other information architecture aspects of Taipower's future energy trading platform (ETP) after the procurement of marketing management system (MMS) modules. Through literature review, current system analysis, demand interviews and discussions, we completed the information architecture of major domestic and foreign trading systems and their differences with Taipower, and put forward planning and implementation recommendations for the following matters: an overall service level agreement (SLA) regarding ETP's system architecture optimization and data flow planning; information security mechanism and incident management; hardware environment architecture management and backup mechanism; computer room operation and continuous operation; database design and optimization ; data interface and integration with external systems; the integration of ETP and MMS. This project has completed the task of assisting in optimizing the performance of the existing ETP. The aforementioned planning recommendations can also be used as reference targets for the future continuous improvement of the ETP and the procurement of MMS product modules.

關鍵詞(Key Words)：電力交易平台(Energy Trading Platform)、電力市場管理系統(Marketing Management System)、資訊系統架構 (Information System Architecture)。

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大甲溪發電廠環境教育之推動策略、歷程及成效

Promotion Strategies, History and Effectiveness of Environmental Education at Tachiachi Hydropower Plant

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摘　要

大甲溪發電廠(下稱本廠)為台灣中部重要的水力發電廠，水力發電是乾淨而零污染的能源，機組有快速起停之特性，能在尖峰時刻或緊急時迅速供電；上游的德基水庫可供給中部地區兩百萬居民民生用水，其涵蓋灌溉、工業用水及防汛等多元化功能。

本廠自轉型生態電廠以來，除發電本業外，持續推動環境保護及環境教育，設立馬鞍壩生態園區和白冷電力文物館等，進行環境資源盤點及發展環境教育教案，舉辦環境教育培訓等活動，持續精進環境教育軟硬體實力，於 109 年第七屆國家環境教育獎榮獲機關(構)組優等獎，111 年 10 月 20 日取得環境教育設施場所認證，未來將持續精進本廠環境教育實力，優化場域設施、發展環境教育課程及與合作夥伴共同推廣環境教育，使蒞臨本場域參訪的民眾，能了解水資源、水庫、水壩等水利設施的重要性及水力發電是重要的綠能，能了解本場域在環境教育方面的用心。

Abstract

Tachiachi Hydropower Plant is an important hydropower plant located in central Taiwan. Hydropower is a kind of clean and zero-pollution energy, and its generator has the characteristics of quick start and stop, which can in no time provide power during peak hours or emergencies. The upstream Techi Reservoir provides water for two million residents in central Taiwan and has diversified functions such as irrigation, industrial water and flood control.

Since its transformation into an ecological power plant, in addition to its original power generation business, the power plant has continued to promote environmental protection and education, including establishing the Maan Dam Ecological Park and the Bethlehem Electric Power Museum, conducting environmental resource inventories, developing environmental education courses, organizing environmental education training activities, continuous improvement of environmental education software and hardware capabilities. Thanks to the above efforts, the power plant won the Excellent Award in the Agency (Institution) Group at the 7th National Environmental Education Award in 2020, and the Environmental Education Facility Site Certification on October 20, 2022. In the future, the power plant will continue to improve its

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environmental education capabilities, optimize site facilities, develop environmental education courses, and jointly promote environmental education with its partners, so that people visiting the site can learn more about: the importance of water resources and water conservancy facilities, e.g. reservoirs and dams; hydropower is an important green energy; and the power plant’s intention in environmental education.

關鍵詞(Key Words)：環境教育(Environmental Education)、大甲溪發電廠(Tachiachi Hydropower Plant)、環境教育設施場所(Environmental Education Certification)、水力發電(Hydropower)。

二期監控系統中介 RTU 建置報告

The 2nd HDCS's Intermediary RTU Implementation Report

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摘 要

新竹 ADCC 二期階層調度系統(2nd Hierarchical Dispatch Control System)，自商轉以來服役時間已長達 20 年以上，隨著六輸計劃新增變電所、大用戶監視系統、再生能源監控及 IEC61850 變電所建置等需求，其系統點數容量早已超過設計上限，商轉至今共有五次 ECS 系統動態資料庫(ECS/m)點數擴充與程式修改工作。本次報告乃針對為減少二期系統資料點數增刪異動而設計之中介 RTU 建置方式，以防止因 AI、DI、CO 點數增刪後記錄點數(EDB_PidToIdx)突破其原有設計的最大點數量，確保二期系統能持續穩定運轉。

二期系統相關設備已無法採購新品及技術支援，加上新一代 ADCC 監控系統履約進度嚴重落後，導致系統上線時程未果，且資控人員更迭造成技術流失，使系統運維面臨嚴峻的挑戰，本文詳列二期系統中介 RTU 的設計方式，並建立資料異動等相關 SOP 供資控人員作為運轉維護上之參考，用以提升人員技術及延續既有二期系統之運轉可靠度。

Abstract

The Hsinchu ADCC 2nd Hierarchical Dispatch Control System has been in service for more than 20 years since its commercial operation. With the addition of new substations in the Sixth Transmission Plan, large customer monitoring systems, renewable energy monitoring and IEC61850 substation construction, its system point capacity has already exceeded the initial design upper limit. There have been five ECS system dynamic databases since the commercialization (ECS/m) point expansion and program modification work. Consequently, there have been five ECS dynamic database (ECS/m) point expansions and program modifications since the establishment of the system. This report is aimed at the intermediary RTU construction method designed to reduce the addition and deletion of data points in the 2nd phase system to prevent the number of recorded points (EDB_PidToIdx) from exceeding the originally designed maximum number due to the addition and deletion of AI, DI, and CO points to ensure the continuous and stable operation of the second phase system. It is no longer possible to purchase new products and technical support for the equipment related to the second phase system. In addition, the performance of the new generation ADCC monitoring system is seriously behind schedule, resulting in the failure of the system to go online. In addition, the change of information control personnel has caused the loss of technology, making system operation and maintenance face severe challenges. This article details the design method of the intermediate RTU of the second phase system, and establishes data changes and other related SOPs for

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information control personnel to serve as a reference for operation and maintenance, so as to improve personnel skills and maintain the operational reliability of the existing second phase system.

關鍵詞(Key Words)：二期階層調度系統(2nd Hierarchical Dispatch Control System)、能源監控系統(Energy Control System)、系統動態資料庫(ECS/m)、末端資訊設備(Remote Terminal Unit)。