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智慧變電所 IEC 61850 與傳統 RTU 架構之監控回路及取樣點設計之研討

The Design of Supervisory Circuits and Sampling Points for Intelligent Substations IEC 61850 and Conventional RTU Architecture

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摘　要

由於智慧變電所採用 IEC 61850 通訊協定架構，傳統變電所採用 RTU 架構，目前輸變電工程分為新建及擴建工程，新建工程皆採用 IEC 61850 架構，擴建工程可分為既設 RTU 及 IEC 61850 兩種監控系統，考量這兩種監控回路及取樣點位設計規畫皆有所不同，容易造成設計人員規劃時發生錯誤或遺漏相關設計，因此本文分析這兩種架構的差異性，並彙總出監控回路及取樣點設計之流程，進而提升新進人員設計能力，強化變電所監控核心技術。

Abstract

Intelligent substations adopt IEC 61850 communication protocols, while traditional substations adopt RTU. At present, power transmission and transformation projects are divided into new construction and expansion projects. New construction projects all adopt IEC 61850 architecture. Nevertheless, the expansion projects have two monitoring systems, RTU and IEC 61850. this article analyzes the similarities and differences between the two architectures, and summarize the process of supervisory circuits and sampling points design to enhance the design abilities of junior colleagues of the company and strengthen the core technology of substation monitoring.

關鍵詞 (Key Words)：監控系統(Supervisory Control and Data Acquisition, SCADA)、IEC 61850 通訊協定(IEC 61850 Communication Protocols)、資訊末端設備(Remote Terminal Unit)。

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台電電纜管路採用推進工法施工案例探討

Discussion on Construction Case of Taipower Cable Pipelines Using Pipe Jacking Tunneling Methods

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摘　要

推進工法具有減少在地表開挖施工，降低工區沿線交通和環境的衝擊，並可有效克服道路下既有複雜管線以及穿越重要結構物的優點。推進工法目前已被大量應用於地下管路工程，但卵礫石地質仍有許多困難需要解決，本文藉由中興工程顧問所承攬之台電公司監造技術服務案提出推管案例探討。

本案例為台灣電力公司輸變電工程處北區施工處為配合發展離岸風力發電的政策目標，發包之「161kV 大潭(甲)～梅湖線」統包管路工程，其中二工區全線位於新竹縣湖口鄉，為主要道路及住宅密集區。為降低交通及環境的干擾，在穿越管線複雜路口、河川渠道和國道 1 號等重要構造物時採用推進工法。本文以本案例採用推進工法之相關設計考量及施工特點，提供相關實務經驗予後續相關推管工程施工參考。

Abstract

Pipe Jacking Tunneling Methods have the advantages of reducing surface excavation construction, reducing the impact of traffic and environment along the work area, and can effectively overcome the challenges posed by complex underground utility pipelines and crossing important structures. The methods have been widely used in underground pipeline projects, but there are still many difficulties in gravel layers that need to be solved. This article aims to discuss the supervision technical service project entrusted by Taipower to Sinotech Engineering Consultants, Ltd.

The project case is the "161kV Datan (A)-Meihu Line" turnkey pipeline project contracted by the Northern Region Construction Office of the Transmission and Transformation Engineering Department, Taipower, aiming to comply with the government's policy goal of developing offshore wind power generation. The project’s entire second construction area is located in Hukou Township, Hsinchu County, which is a main road and residential dense area. In order to reduce traffic and environment interference, pipe jacking tunneling methods are used when crossing important structures such as complex pipeline intersections, river channels, and National Highway No. 1.This article explains the design considerations and construction characteristics of the methods to serve as reference for relevant units of the company to subsequently promote the construction of related projects.

關鍵詞 (Key Words)：推進工法(Pipe Jacking Tunneling Methods)、卵礫石層(Gravel Layers)、穿越段(Crossing Section)。

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饋線調度輔助線路開關節點負載計算平台研究

Research on Feeder Dispatching Auxiliary Line Switch Node Load Calculation Platform

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摘 要

隨著民生及工商用電需求增加，多數饋線供電接近滿載，當發生饋線事故停電時，故障偵測隔離復電功能可迅速將故障區間隔離並完成上游復電，但下游健全區間的轉供，將因轉供裕度不足，很難單純地由另一饋線轉供，需藉由主幹線部分區段負載移撥，甚至配合小環路負載轉供，將事故饋線負載分由多條饋線承擔轉供義務。囿於自動化開關及饋線末端設備未全面裝設，無法即時瞭解各開關節點負載狀況，需仰賴人工調閱圖資及蒐集相關轉供饋線、主變即時電流資料，導致研擬前述較複雜之負載轉供方案須耗費許多時間。

本研究計畫旨在建立最適負載模型與演算法，提供變電所一台主變全停轉供最適化建議並評估轉供前後電壓變動率。本計算平台在新竹區處、配電處以及綜研所的大力協助下，探討各種新式人工智慧演算法於轉供策略擬定與計算時之應用，期望未來於調度轉供時發揮更大的效用。

Abstract

With the increase of residential, industrial, and commercial electricity demand, the power supply of most feeders is close to full load. For power outages caused by feeder accidents, the fault detection, isolation and power restoration function can quickly isolate the fault interval and complete the upstream power restoration. However, due to insufficient dispatch margin, it is difficult to simply transfer the supply to another feeder. In this case, it is necessary to shift the load of some sections of the main line, or even cooperate with the load transfer of the small loop, to distribute the load of the accident feeder to multiple feeders. Due to the incomplete installation of automatic switches and feeder terminal equipment, it is impossible to understand the load status of each switch node in real time. Therefore, it is necessary to rely on manual retrieval of map information and collection of relevant real-time current data of the transfer feeder lines and main transformers, which results in a lot of time spent on developing the aforementioned more complex load transfer plan.

This research project aims to establish an optimal load model and algorithms, provide optimal supply transfer suggestion when a main transformer in a substation is shut down, and evaluate the voltage change rate before and after the transfer. With the full assistance of the Hsinchu District Office, the Power Distribution Office, and the Taiwan Power Research Institute

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(TPRI), this computing platform explores the application of various new artificial intelligence algorithms in the formulation and calculation of power supply transfer strategies, expecting to play a greater role in dispatching power supply transfers in the future.

關鍵詞(Key Words)：配電饋線自動化系統(Feeder Dispatch and Control System, FDCS)、監控自動化系統(Supervisory Control and Data Acquisition, SCADA)、系統整合(System Integration)。

從電力事故論增進電力系統韌性作為

Enhancing Power System Resilience from the Perspective of Large-scale Power Outages

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摘　要

電力系統強韌性包括強化電網系統面對或快速從巨大衝擊、低頻事件恢復能力。近年來美西停電事故、英國大停電事故及日本北海道大規模停電等電網衝擊事件對社會影響有更深、更遠及更廣泛的變化趨勢，也塑造出需增強電網強韌性需求。美國電力研究院報告指出，增強的電力系統強韌性奠基於損害預防、系統復原、存活能力等三個要素。電力系統強韌性的利害關係者可運用創新改進發電、輸電、配電及用戶等四個主要系統，採取增強電力系統強韌性作法。分析多數事故可知，所有電力事故多起因於單一事件，但單一突發事件後引發連串的跳電，多由於系統強韌性不足存在其他潛在弱點所導致。強化現有電力部門規劃流程，納入強韌性規劃，將可有效改善、保護電力系統，讓系統在面對干擾時可保持系統運行。本研究參考國外歷年大規模電力事故處置經驗，增進電力系統韌性作為，介紹如何從大停電事件的當時情境、事故肇因，連結改善整體電網強韌性、強化風險控制等作法，提出看法與建議。

Abstract

Power system resilience includes strengthening the ability of the power grid to face or quickly recover from high-impact, low-frequency (HILF) events. In recent years, large-scale power outages, such as those occurred in Arizona-Southern California, USA, the United Kingdom (August 9, 2019), and Hokkaido, Japan (2018), have had an increasingly profound and wide-spread impact on society, and have also given rise to the need to enhance the resilence of the power grid. A report from the American Electric Power Research Institute (EPRI) pointed out that enhanced power system resilience is based on three elements: damage prevention, system recovery, and survivability. Stakeholders of power generation, transmission, distribution sectors and users can improve resilience through innovation. The analysis results show that all power accidents are mostly caused by a single event, but a series of power outages triggered by a single emerency are mostly caused by insufficient system resilience and other potential weaknesses. Strengthening the existing planning process of the power sector and incorporating resilence planning will effectively improve and protect the power system, allowing the system to maintain normal operation in the face of disturbances. This study refers to the foreign experience in dealing with large-scale power accidents over the years, including efforts to improve power system

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resilience and the circumstances and causes of large-scale blackouts, and then provides opinions and suggestions on how Taiwan can improve the overall power grid resilience and strengthen risk control.

關鍵詞(Key Words)：大停電(Power Outages)、電力電網韌性(Resiliency of Electric Grid System)、改善對策(Improvement Measurements)、風險控制(Risk Control)。

國外高占比再生能源電網規劃探討

The Exploration of Foreign High-proportion Renewable Energy Power Grid Planning

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摘要

以往電網規劃已建立完善的程序，但隨著再生能源占比的提高，電網規劃程序應有所調整。本文蒐集國外輸配電高占比再生能源系統之中長期規劃方式，所蒐集資料可做為未來擬定高占比再生能源電網規劃評估流程之參考。

Abstract

In the past, complete procedures have been established for power grid planning, but as the proportion of renewable energy increases, the planning procedures should be adjusted accordingly. This study collects medium and long-term planning methods for foreign high-proportion renewable energy power transmission and distribution systems. The collected information may serve as a reference for formulating the planning and evaluation process of high-proportion renewable energy power grids in the future.

關鍵詞(KeyWords)：電網規劃(Power Grid Planning)、再生能源(Renewable Energy)、輸電系統(Transmission System)。

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因應大量再生能源併網國內電網技術規範盤點與整合

Investigation and Integration of Domestic Grid Connection Technologies and Regulations in Response to Large Amounts of Renewable Energy Connected to the Grid

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摘　要

本文旨在收集分析日本、美國、加拿大、澳洲、紐西蘭、英國等國家之電力公司以及台灣電力公司有關發電設備四種併聯技術要點(再生能源、發電廠、儲能系統及汽電共生)之相關資料，從國內外實務運作經驗及相互間之差異，綜合評估國內發電設備四種併聯技術要點之作業規範，進而針對各種可能方案，制定可行的推動策略與配套措施，提供作為台灣電力公司修訂相關併聯技術要點之參考依據。

Abstract

This study aims to collect and analyze the technical specifications of grid connection technologies for distributed generation systems (renewable energy, power plant, energy storage system, and cogeneration) in Japan, the United States, Canada, Australia, New Zealand, the United Kingdom and other countries, as well as Taipower. Based on the practical operating experience and differences between domestic and foreign countries, we then comprehensively evaluate the operating specifications of domestic distributed power generation systems, formulate feasible promotion strategies and supporting measures for various possible solutions, to serve as reference for Taipower.

關鍵詞(Key Words)：併網(Grid Connection)、高再生能源發電占比(High Penetration Renewable Energy)、分散式電源(Distributed Generation)、諧波管制(Harmonic Regulation)、法規整合可行性(Feasibility of Regulation Integration)。

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台電公司火力電廠排放對空氣品質之預測影響

Predicted Impact of Taipower's Thermal Power Plant Emissions on Air Quality

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摘　要

本研究利用三維網格空氣品質模式(Models-3/CMAQ)預測模擬台電電廠對未來三日全台之細懸浮微粒及臭氧八小時之影響；推估之排放量以最新版國內全國性排放清冊(TEDS)、連續自動監測設施系統(CEMS)與高速公路電子收費交通蒐集支援系統(TDCS)的即時資料庫，預測未來三日點、線源之排放量。本研究針對 2022/10/1 至 2023/9/30 期間，以 2023/3/31 為界，劃分成空污季、非空污季。針對細懸浮微粒與臭氧八小時第一天預測準確率，細懸浮微粒在空污季和非空污季分別為 72.3%和 58.3%；而臭氧八小時在空污季和非空污季分別為 78.0%和 51.2%，顯示空污季細懸浮微粒與臭氧八小時之模擬準確率優於非空污季。由於 5、8、9 月之模擬誤差較高，為模擬值出現峰值所導致之高估，而峰值又以境外傳輸增量濃度占比最高。由上風處測站之觀測值，評估境外傳輸高影響的合理性，結果顯示峰值日境外傳輸有明顯高估，模式對於此時期境外傳輸的掌握度較差。

Abstract

This study uses the Community Multiscale Air Quality Modeling System (Models-3/CMAQ) to predict and simulate the impact of Taipower's thermal power plants on fine particulate matter ($PM_{2.5}$) and Eight-hour Average Ozone Concentrations(O_3 8HR) throughout Taiwan in the next three days. The estimated emissions for point and line sources for the said time period are based on the data of the latest version of Taiwan Emission Data System (TEDS), the real-time database of the Continuous Emission Monitoring Systems (CEMS) and the Traffic Data Collection System (TDCS).

This study focuses on the period from October 1, 2022 to September 30, 2023, using March 31, 2023 as the boundary, divided into air pollution season and non-air pollution season. Regarding the prediction accuracy of $PM_{2.5}$ and O_3 8HR on the first day, the accuracy of $PM_{2.5}$ in the air pollution season and the non-air pollution season was 72.3% and 58.3% respectively; while the O_3 8HR prediction accuracy in the air pollution season and non-air pollution season was 78.0% and 51.2% respectively, showing that the simulation accuracy of $PM_{2.5}$ and O_3 8HR in the air pollution season is better than that in the non-air pollution season.

Since the simulation errors in May, August, and September are relatively high, it is believed

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to be an overestimation caused by the peak value of the simulation incremental concentration value, and the transboundary influence is the highest proportion of those peak values.When we evaluate the rationality of the high impact of transboundary influence based on the observation values at the upwind air quality monitoring station, the results show that the influence on the peak day is significantly overestimated, and the model has a poor grasp of such influence during this period.

關鍵詞 (Key Words)：三維網格空氣品質模式(Models-3/CMAQ)、火力電廠(Thermal Power Plant)、細懸浮微粒($PM_{2.5}$)、臭氧八小時(8-Hour Ozone)。

應用人工智慧(AI)模型實現台中火力發電廠氮氧化物數據預測

Application of Artificial Intelligence (AI) Model to Achieve Nitrogen Oxide Data Prediction at Taichung Thermal Power Plant

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摘　要

台中發電廠主要以燃煤作為發電用所需燃料，為了穩定提供充足的電力而產生相對量體的排放物，對於減量排放汙染物的因應策略成為重要議題。本研究主要目的是以人工智慧技術建立台中火力發電廠的氮氧化物排放量的預測模型。採用 ANN 回歸模型用以預測氮氧化物。比較了預測模型的訓練與驗證結果，其中比例分割數據集分別為訓練用數據集筆數為 515 筆與驗證用的新數據集筆數為 184 筆，其訓練與驗證用結果值分別為 R^2=0.97 與 R^2=0.91，綜合在預測模型的結果顯示模型性能表現良好，並且使用此預測模型延伸應用使用者介面實現氮氧化物數據預測數值。

Abstract

Taichung Power Plant (TPP) uses coal as its primary fuel for power generation. However, while stably providing sufficient power supply, a relatively large amount of emissions are also produced. Therefore, response strategy for reducing pollutant emissions has become a crucial issue. This study aims to establish an artificial neural network (ANN) regression predictive model for nitrogen oxide emissions from TPP using artificial intelligence technology. To compare the training and verification results of the predictive model, the dataset is proportionally split, among which, 515 records for training and 184 records from the new dataset for verification. The result values for training and verification are R2=0.97 and R2=0.91 respectively. Empirical results show that in addition to good performance, the model can also be extended applying a user interface to achieve nitrogen oxide data prediction values.

關鍵詞(Key Words)：氮氧化物(NOx)、人工神經網路(Artificial Neural Network, ANN)、火力發電廠(Thermal Power Plant)、燃煤(Coal)。

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發電系統建置調適自主管理之研究

Building Autonomous and Adaptive Management Capabilities for Taipower's Power Generation System

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摘　要

由於台電公司發電廠單位多且遍布全台，氣候變遷及其衝擊發生的時間、規模具不確定性，本研究針對發電廠進行自主管理能力建構，開發氣候風險管理平台作為輔助工具，將評估程序與準則、危害與災害潛勢 GIS 圖資建置於平台。建置防災監測管理平台，進行風險評估與調適策略比對。以防災設計、修復動員為評估參數，進行發電廠氣候風險評估。極高、高度風險的衝擊為腐蝕、海水溫度上升、雷擊、乾旱、淹水、沖毀、強風、坡地災害、取水口堵塞。

建立標準作業程序，於 ISO14001 環管系統下增加氣候變遷調適作業程序書，將氣候變遷調適落實於日常營運管理。建立調適策略規劃程序，以設施風險類型、影響發電裝置容量、調適成本為門檻，規劃調適策略項目。針對面臨雷擊、淹水、坡地災害、強風衝擊而可能嚴重影響供電的設施納入優先調適，提出調適項目並進行成本效益分析。

Abstract

Taipower has a large number of power plants spread across Taiwan. The timing and scale of the impact of climate change on the power plants are uncertain. The main contents of this study are as follows: building autonomous management capabilities for power plants; developing a climate risk management platform as an auxiliary tool, assessment procedures and criteria, hazards and disaster potential GIS maps on the platform; establishing a disaster prevention monitoring management platform to conduct risk assessment and adaptation strategies; using disaster prevention design and repair mobilization as evaluation parameters to conduct climate risk assessment of power plants (extremely high and high-risk impacts include corrosion, rising sea temperature , lightning strikes, drought, flooding, washouts, strong wind, landslide, and water intake blockage); establishing standard operating procedures, adding climate change adaptation operating procedures to the ISO14001 environmental management system, and implementing climate change adaptation in daily operations and management; establishing an adjustment strategy planning process, and planning adjustment strategy projects based on facility risk types, impact on power generation device capacity, and adjustment costs as thresholds; prioritizing adaptation of facilities that may be seriously affected by lightning strikes, flooding, slope disasters, and strong wind impacts, proposing adaptation projects, and conducting cost-benefit analysis.

關鍵詞 (Key Words)：氣候變遷(Climate Change)、發電系統(Power Generation System)、危害(Hazard)、脆弱度(Vulnerability)、風險評估(Risk Assessment)、調適策略(Adaptation Strategy)。

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