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電力交易平台增強型動態調頻備轉容量方案簡介

An Introduction to the Enhanced Dynamic Regulation Reserve Service of Energy Trading Platform

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摘 要

我國經濟部於2021年6月29日訂定發布電力交易平台設置規則，該法規命令規定台電公司應設立及營運電力交易平台，除用以驗證平台機制設計及運作之可行性及穩定性外，亦因應再生能源發展，促進輔助服來源之多樣化，以維持電力系統之穩定。台電公司於2021年8月26日發布電力交易平台管理規範及作業程序(即市場規則)，於日前輔助服市場進行調頻備轉、即時備轉及補充備轉等輔助服務項目之競價交易。惟伴隨低碳能源發展趨勢、再生能源滲透率漸增及氣候劇烈變遷等影響，電力系統面臨負載陡升及尖峰用電時段由日間轉移至夜間之挑戰，台電公司依據經濟部能源局指示檢討，擬訂增強型動態調頻備轉容量(Enhanced Dynamic Regulation Reserve，簡稱E-dReg)方案，善用併網型儲能設備快速反應與可大量儲存電能之特性，增進電力調度彈性。本文說明E-dReg之商品設計與技術規格要求、適用對象及條件、服務報酬計算及服務運作機制等。

Abstract

Under the influences of low-carbon energy, increasing penetration rate of renewable energy, and dramatic climate changes, the power system in Taiwan is facing challenges such as short/steep load rise and peak load shifting from the daytime to the nighttime. In accordance with the instruction of the Energy Bureau of the Ministry of Economy, Taipower proposed a plan regarding enhanced dynamic frequency regulation reserve (E-dReg) service to fully utilize the advantages of grid-scale battery energy storage systems (BESS-quickly and flexibly respond to changes of system frequency. This article aims to describe the features of E-dReg, e.g., market mechanism, technical specifications, applications and conditions, pricing and settlement.

關鍵詞(Key Words)：電力交易平台(Energy Trading Platform)、輔助服務(Ancillary Services)、增強型動態調頻備轉容量 (Enhanced Dynamic Regulation Reserve, E-dReg)、電池儲能系統(Battery Energy Storage System, BESS)。

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地下電纜洞道熱容量與氣體監測平台開發

Developing Heat and Air Condition Surveillance System for Underground Cable Tunnel Ventilation and Cooling

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摘　要

本計畫建置一套「地下電纜洞道熱容量與氣體監測平台」，以長時間監測洞道內溫度與氣體濃度，透過監測數據分析，提供台電公司可靠的洞道溫場分佈與換氣降溫建議，並評估平時運轉是否會達附屬機電設備換氣與降溫額定值，以確認設備建置的必要性或須採用的冷卻設備類型。此外台灣都市化發展快速，地下電纜建置也隨之增加，某些線路在用電尖峰時出現供電瓶頸，本計畫亦針對地下電纜電纜表面溫度進行量測，並加以分析導體動態熱容量，藉此可評估洞道內地下電纜導體的送電裕度，以利供電穩定。

本計畫包含前端硬體感測設備至後端軟體資訊平台，利用物聯網架構，使得電力設備相關量測資訊可透過雲端監測，在地下電纜之動態熱容量的計算上，透過介接現場運轉電流，估計線路利用率及送電裕度。本計畫成果期可供現場維護人員更有效掌握輸電安全與提升維護效率，運轉調度人員則擁有更充足的調度作業參考依據，以提升調度水平與供電可靠度。

Abstract

This project aims to establish an "underground cable real-time sensing system" to monitor the temperatures and gas concentrations in the tunnels. By analyzing on the sensing data, information regarding field distribution of temperature and recommendations regarding ventilation and timing of cooling have been brought up to serve as reference for Taipower. Besides, to evaluate the necessity of equipment procurement and types of cooling systems, it is necessary to evaluate whether the normal operation may reach the ventilation and cooling ratings of the auxiliary electromechanical equipment. Affected by the fast pace of urbanization and resulting need for underground cable construction, there are some lines experiencing

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transmission constraints during peak load hours. Moreover, this project measures the surface temperatures of underground cables to analyze their dynamic thermal rating. By so doing, the instant capacity margin of underground cables can be evaluated to facilitate stability of power supply.

The scope and contents of this project are as follows: front-end hardware sensing equipment to back-end software information platform; applying IoT architecture to enable the measured information related to power devices to be monitored through the cloud; realize dynamic thermal rating of underground cables; through connecting the operating current to estimate the utilization rate and margin reserve of power lines. The results of this project may serve as reference for personnel responsible for on-site maintenance and system dispatching to ensure power transmission safety, maintenance efficiency, and reliability of power supply.

關鍵詞(Key Words)：地下電纜(Underground Cable)、即時洞道監測(Real-time Tunnel Monitoring)、動態熱容量(Dynamic Thermal Rating)、物聯網(Internet of Things)、數據分析(Data Analysis)。

電力系統中熱機備轉容量需求量評估

Assessing the Requirement of Responsive Reserve Service for the Power System in Taiwan

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摘 要

隨著風力和太陽光電發電等再生能源在電力系統中取代同步發電，系統同步慣量下降，潛在的頻率變化率(Rate of Change of Frequency, RoCoF)也隨之上升。當再生能源占比超過一定程度，將對系統頻率保持在安全範圍的能力造成挑戰。高頻率變化率可能造成發電機組跳機，且若頻率變化率過於急遽，如低頻卸載(Under Frequency Load Shedding, UFLS)此等緊急控制方案也可能因無法正常運作而導致系統崩潰。本文收集美國德州電力可靠性委員會(Electric Reliability Council of Texas, ERCOT)因應大量再生能源併網的輔助服務架構與應用對策，並參考其實施的輔助服務中，評估熱機備轉容量(Responsive Reserve Service, RRS)最小需求量的計算方式，並利用一電網模擬不同再生能源占比對熱機備轉容量的最小需求，所得結果可提供再生能源占比提高後電力系統運轉調度之參考依據。

Abstract

Along with the increase of renewable energy sources (RES), such as wind and solar power, the synchronous inertia of the power system has been decreasing, while potential rate of change of frequency (RoCoF) increasing. When penetration rate of RE approaching/ exceeding a certain level, it is difficult to keep system frequency within safe ranges. High RoCoF may cause generator tripping and system collapse- under the worst cases of sharp frequency changes and load shedding unable to function. We apply the information regarding the design and application strategies of the ancillary services coping with high RES penetration by the Electric Reliability Council of Texas (ERCOT) to calculate the minimum requirement of responsive reserve service (RRS) for the power system in Taiwan- scenarios of different RE levels have been simulated. The results of this study may serve as reference for the departments responsible for power system operation and dispatch confronting with increasing RE penetration rates.

關鍵詞(Key Words)：再生能源 (Renewable Energy)、頻率變化率(Rate of Change of Frequency)、輔助服務(Ancillary Services)、熱機備轉容量(Responsive Reserve Service)。

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空調應用及節電效率之區域性電力研究

A Study on the Efficiency of Energy Saving for Regional Air Conditioners

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摘 要

本研究參考國外區域節電之作法，以統計分析技術，利用公開資料集找出國內具節電潛力之熱區里，並針對此里進行一定樣本戶數之問卷調查，以了解該區用戶冷氣設備及使用行為資訊，並配合冷氣設定溫度之實驗室的節電測試資訊，藉以評估該區之節電潛力。結果顯示4.1-7.2kW之冷氣能力於設定溫度25˚C開始，每調高設定溫度1˚C平均約可節省冷氣耗電6.59%。最後評估於該里導入汰換成一級能效空調及調高設定溫度1˚C等節電策略，可有效節省該里之年用電度數分別約達72,732度及464,500度。

Abstract

By referring to the measures commonly adopted by foreign countries to evaluate the efficiency of regional energy savings and statistical analysis methodology, this study aims to utilize open datasets to identify the community (in the unit of village, 里) with energy saving potential, conduct questionnaire survey to understand the characteristics of air conditioners (AC) and AC usage behaviors of the community, and evaluate the energy saving potential of the community based on laboratory AC operation test results. Taking AC with capacities in the range of 4.1 to 7.2 kWs as examples, the result shows that starting at a set temperature of 25°C, each increase of 1°C may reduce averagely 6.59% of the total cooling energy consumption. Last but most important, when replacing with first-class energy-efficient AC and raising the set temperature by 1°C, the energy consumption can be saved by 72,732 and 464,500 kWhs respectively.

關鍵詞(Key Words)：區域能效(Regional Energy Efficiency)、空調(Air Conditioner)、智慧電表(Smart Meter)。

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火力電廠 $PM_{2.5}$ 排放特性研究

$PM_{2.5}$ Emission Characteristic of Thermal Power Plants

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摘 要

本研究執行10根次火力電廠(燃煤、燃油、燃氣)煙囪排放$PM_{2.5}$調查，分析可過濾性微粒($FPM_{2.5}$)及可凝結性微粒(CPM)之質量濃度、並分析其上之陰陽離子、化學物質及碳成分。

研究結果顯示，不同燃料機組排放之CPM質量濃度均大於$FPM_{2.5}$，濃度高低依序為燃油、燃煤及燃氣。大部分機組$FPM_{2.5}$以化學物質及陰陽離子為主要成分；CPM則為陰陽離子。陰陽離子組成特性在$FPM_{2.5}$及CPM有一致之現象，皆反映防制設備之操作對排放之影響。此外，燃煤機組CPM組成占比最高者為硫酸根離子，與煤特性有關。化學物質分析中，可發現$FPM_{2.5}$化學物質濃度大於CPM，主因為化學物質沸點較高，易附著於粒狀物上。

由研究結果發現，各電廠排放特性受空污防制設備影響甚鉅，燃料成分亦為重要影響因子，若能針對兩項因子妥善加以控制，對後續之排放濃度降低應有相當大之助益。

Abstract

This study aims to conduct $PM_{2.5}$ (i.e. filterable particulate matter ($FPM_{2.5}$) and condensable particulate matter (CPM) emission sampling of thermal power plants (TPPs) with a total of 10 stacks to understand their $PM_{2.5}$ emission characteristics. The $FPM_{2.5}$ analysis includes mass concentration, ions, chemical composition and carbon components. The CPM analysis includes mass concentration, ions and chemical composition.

As the result shows, mass concentrations of CPM of TPPs are higher than those of $FPM_{2.5}$. The mass concentrations of $PM_{2.5}$ are in the (descending) order of oil-fired, coal-fired, and natural gas-fired power plants. For most $FPM_{2.5}$ samples, chemical substances and ions account for the majority of mass concentration, while CPM samples are mainly composed of ions. As for composition analysis, the ions emission in $FPM_{2.5}$ and CPM were both impacted by the operation parameters of air pollution control devices. The highest ion composition of CPM sample is sulfate. This is related to the chemical characteristic of the fuel. On the other hand, the concentration of heavy metal in $FPM_{2.5}$ is

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much higher than that in CPM. It can be concluded that the heavy metals having high boiling points so mostly exist in solid phase and can be adhered to $FPM_{2.5}$.

In conclusion, chemical characteristics of the fuels and the operation parameters of air pollution control devices are the most crucial factors affecting $PM_{2.5}$ emissions of TPPs.

關鍵詞(Key Words)：排放特性(Emission Characteristic)、可過濾性微粒(Filterable Particulate Matter, $FPM_{2.5}$)、可凝結性微粒(Condensable Particulate Matter, CPM)。

輸電塔基採用機械式鋼筋續接器及擴頭鋼筋之可行性研究-以簡支梁之實驗與分析為例

Feasibility Study of Mechanical Splices and Headed Deformed Bars of Electric Tower Foundation – A Case Study of Simply Supported Beam

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摘　要

本研究以實驗及分析方式，探討SA級摩擦壓接式鋼筋續接器及擴頭鋼筋，兩者在鐵塔基礎結構之適用性。根據土木401-110規範並參考四樁口字聯梁，設計6座縮尺簡支梁試體。研究變數包括：梁中央處鋼筋為搭接或錯位續接；梁兩端處鋼筋為標準彎鉤或擴頭鋼筋。實驗配置為四點抗彎，單向加載過程中紀錄破壞模式、梁中央之垂直力與垂直變位。實驗結果顯示，符合規範之續接器及擴頭鋼筋的試體，其表現與既有鋼筋搭接和標準彎鉤者相當，皆提供1.3倍標稱彎矩且變形能力佳。分析結果顯示，自定義塑鉸之分析準確度隨剪力跨度增加而提升。整體而言，本研究完成大型實驗與分析驗證，希冀在符合設計規範標準下，針對鐵塔基礎結構之使用提供更多元之選項，提昇現地施工性。

Abstract

This research aims to investigate the experimental performances and compares the applicability of SA grade mechanical splices and headed deformed bars of electric towers. We designed a total of six scaled-down simply supported beam specimens according to the actual four-pile foundation structure and the latest Concrete Structural Design Specification 401-110, and the test variables include: the rebar at the center of the beam, either lap spliced or using a mechanical coupler, and the rebar at both ends of the beam, either a standard hook or T-headed reinforcements. From the processes of four-point flexural tests, data regarding the failure mode of the beam, vertical force and displacement at the center of the beam subjected to unidirectional loading were recorded. As the experimental results show, the performances of test specimens with SA grade mechanical splices and headed deformed bars are similar to the existing practices using lap-splice and

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standard hook-both of the arrangements may provide 1.3 times nominal bending moment strength and have excellent deformation capability. Besides, analytical results demonstrate that the analysis accuracy of user-defined hinge increases along with the increase of the shear span. The experimental and analytical results of this study may serve as reference to improve on-site construction performances of large-scale simply supported beams, while in compliance with relevant standards of design specification.

關鍵詞(Key Words)：機械式鋼筋續接器(Mechanical Splices)、擴頭鋼筋(Headed Deformed Bars)、簡支梁(Simply-supported Beam)、四點抗彎試驗(Four-point Flexural Test)、側推分析(Pushover Analysis)。

適切我國電力市場之入門教材設計

Introductory Training Materials for Acquainting with the Electricity Market of Taiwan

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摘　要

台電公司目前為一垂直整合的綜合電業，負責臺灣的發電、輸電、配電和售電，我國於106年1月修正新版《電業法》，其中第11條規定，輸配電業應於廠網分工後，設立公開透明之電力交易平台，台電公司已於110年11月15日正式啟動電力交易平台。

本研究旨在培養未來電力交易專業人才，而有鑑於我國尚未有介紹各國電力市場發展歷程及電力交易相關機制一書，因此，本研究參考國外電力市場之教育訓練教材課程內容，並依我國電力交易平台的架構規劃需求進行適當之修訂，提供給電力市場相關參與者進行自我進修。其教材章節會先對於電力系統和電力市場之整體基本概念進行介紹，使讀者在閱讀後續章節時更為順暢，接著針對各市場及不同市場參與者之角色、責任及具備之程序，進一步予以闡述。

Abstract

Taiwan Power Company (TPC) is a vertically integrated electric utility- engaging in the businesses of electricity generation, transmission/distribution and retailing. As article 11 of the Electricity Act amended in January, 2017 specifies, the licensee of electricity transmission and distribution shall establish an open and transparent electricity trading platform (ETP), after functional unbundling of TPC's generation and grid assets. Since July 15th, 2021, the trading platform has officially commenced.

This study aims to cultivate wholesale electricity trading professionals by compiling introductory training materials regarding the budding ETP in Taiwan. To achieve this objective, we refer to the education textbooks and training materials of foreign electricity markets and make appropriate revisions in accordance with the structural planning needs of Taiwan ETP. The contents of the said training materials comprise introduction of power system and electricity market as the foundation course, and the roles, responsibilities and procedures for each individual market and its participants as the advanced course.

關鍵詞(Key Words)：教育訓練(Training)、電力市場(Electricity Market)、電力交易平台(Electricity Trading Platform)。

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回頁首

設計基準事故替代輻射源項分析技術發展

The Development of Alternative Source Terms Methodology for Design Basis Accidents

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摘 要

本計畫由台電公司核技處委託核能研究所核子工程組執行，計畫期程自106年10月1日至110年6月30日共計三年九個月。本計畫主要進行AST相關的技術發展，並分別完成核二廠及核三廠的可持續運轉判定評估、控制室包封內人員AST輻射劑量分析方法論及控制室適居性個案應用分析。本計畫完成可改善設計基準事故劑量分析結果，並藉以提升未經過濾內漏率允許值，增加安全餘裕，確保核電廠繼續運轉。

Abstract

This project was funded by Department of Nuclear Engineering of Taiwan Power Company and conducted by the Division of Nuclear Engineering of INER. The project started from 2017 and ended in 2021, a total of 3 years and 9 months. It had two primary purposes. One is to develop alternative source terms (AST) related technologies. The other, to complete the justification of continuous operation application of Kuosheng and Maanshan nuclear power plants (NPPs), AST dose analysis methodology of the personnel in the control room envelope, and application case study of control room habitability. This project may help improve the results of design basis accident dose analysis, increase the allowable value of the unfiltered in-leakage rate and safety margin, and ensure the continuous operation of the said NPPs.

關鍵詞(Key Words)：設計基準事故(Design Basis Accident)、替代輻射源項(Alternative Source Terms)、控制室(Control Room)、適居性(Habitability)、未經過濾內漏率(Unfiltered Inleakage Rate)。

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