台電工程月刊876期(8月)目錄

煤場設置抑塵系統之探討

A Study on Setting up a Dust Suppression System in Coal Yard

許逸誠* Shu, Yi-Cheng
張家維* Zhung, Jia-Wei
朱記民* Chu, Chi-Min
譚振邦* Tan, Jhen-Bang
曾順盈* Tseng, Shun-Ying
游吉璋* Yu, Chi-Chang

摘　要

在堆取、輸卸煤的作業過程中，時常伴隨煤塵的產生，尤其當煤種尺徑小且乾燥時，揚塵的情況便會加劇，需透過設備來加以抑制。灑水是簡單且直覺的抑制方式，但過度的噴灑在一些具粉狀特性的煤種上，容易造成煤堆黏結、輸卸煤作業異常。本研究之目的在於定義煤塵的產生因素、了解噴灑裝置之原理與特性，並以台中發電廠已有系統為例，探討煤場系統內抑塵系統之設置，最後提出建議作為後續改善之參考。

Abstract

The operation of stacking, transporting and unloading coals often comes with coal dust. The situation aggravates especially when the coal is small in diameter and dry. Intuitively, spraying is a simple way to suppress the coal dust, but for some coals with powdery characteristics excessive spraying nevertheless causes coal piles to stick and abnormal operation of coal transportation and unloading. This research aims to define the factors of the generation of coal dust and the principles and characteristics of spraying devices. We take Taichung Power Plant's coal yard system as an example to discuss the setting of dust suppression system and eventually put forward our recommendations as a reference for follow-up improvement.

關鍵詞 (Key Words)：煤塵(Coal Dust)、灑水設備(Spraying Device)、抑塵系統(Dust Suppression System)、煤場(Coal Yard)。

*台灣電力公司水火力發電事業部台中發電廠

從保護協調原則探討發電機容量曲線的構成

The Constitution of Generator Capacity Curve from the Viewpoint of Protection Coordination Principles

朱記民* Chu, Chi-Min
石士欣* Shih, Shih-Hsin
羅孝成* Lo, Hsiao-Cheng
谷震遠* Guu, Jenn-Yeuan
吳文智* Wu, Wen-Chih

摘　要

簡而言之，同步發電機由定子、轉子及其它零組件所組成。無論定子、轉子或絕緣材料均有其熱或應力極限。而發電機容量曲線的定義為機組可以安全運轉的邊界。由於人為不當操作或其它因素，使得機組運轉範圍可能超出容量曲線限制之外，藉由保護電驛、自動電壓調整器之限制器或偵測器可避免機組或設備受損。本篇將從保護協調觀點，介紹如何繪製發電機容量曲線，以及其它影響發電機容量曲線之因素。

Abstract

In short, a synchronous generator is composed of stator, rotor and other components. However, the stator, rotor and the insulation materials have their thermal or strength limits. Generator capacity curve defines the boundaries that generators may operate safely. Improper operation and some other reasons may lead a generator to operate out of the range of its capacity curve. By the aid of protection relays, limiters of automatic voltage regulator, or detectors, the damage of generators may be avoided. In this paper, we introduce how a generator capacity curve is considered from the viewpoint of protection coordination.

關鍵詞 (Key Words)：同步發電機(Synchronous Generator)、發電機容量曲線(Generator Capacity Curve)、保護電驛(Protection Relay)、自動電壓調整器(Automatic Voltage Regulator)。

*台灣電力公司水火力發電事業部台中發電廠

輸電設備維護管理系統導入大數據分析之加值應用

The Application of Big Data on Transmission Equipment Maintenance System

吳永仁* Wu, Yung-Ren
許炎豐* Hsu, Yen-Feng
毛敬豪** Mao, Ching-Hao
張孝賢** Chang, Hsiao-Hsien
王耀華** Wang, Yao-Hua
巫嘉勳** Wu, Jai-Shin

摘　要

「輸電設備維護管理系統導入大數據分析之加值應用」計畫的研發目標為納入及規劃供電與線路管理等部門之需求，強化與精進平台功能，包括：台帳管理、排程管理、異狀管理、事故管理，並建立新的 GIS 圖台模組。此外，也將導入大數據分析方法，對於輸電設備數據應用進行分析，多元呈現輸電設備台帳資料統計分析結果。

Abstract

This project aims to enhance the functions of TFMMS by incorporating the requirements of transmission operation and transmission line management department. TFMMS are made up of the subsystems of Equipment Account Management, Scheduling Management, Malfunction Management, Incident management, Public Facility Pipeline Data Exchange Management, and a new GIS map platform. In addition, this project adopts the method of big data to analyze transmission equipment data, and the statistical analysis results will be presented in multiple ways.

關鍵詞 (Key Words)：輸電設備維護管理系統(TFMMS)、排程管理(Scheduling Management Subsystem)、異狀管理(Malfunction Management Subsystem)、GIS 圖台(GIS Map)。

*台灣電力公司綜合研究所
**財團法人資訊工業策進會資安所

南亞製 23kV CGIS 真空推桿斷裂處理及分析

The Repairing and Analysis of a Broken VCB Insulated Connecting Rod

洪崇智* Hung, Chung-Chih
張峰榮* Zhang, Feng-Rong
卓冠志* Zhuo, Guan-Zhi
何權恩* He, Quan-En
陳銘宗* Chen, Ming-Tzung

摘　要

斷路器平常導通有負載電流，當出現異常狀況時，保護電驛動作跳脫斷路器隔離故障點以便保護人或主要機器設備。CGIS 是因設置地點不需太大空間因應的產物，可分為 GCB 及 VCB 兩種形式來啟斷電流，GCB 的優點為高電壓、大容量，VCB 的優點為小型、開關壽命長等。VCB 接點於高度真空中開啟，促使電弧之荷電粒子擴散，以達到消弧效果，電氣性、機械性能絕佳，開關壽命長，小型輕量、設備維護量少，並以低噪音等為重要特徵。

雖然 VCB 有如此多的優點，但操作機構中 VCB 的真空推桿亦得以設計良好，才能確保動作穩定。本文主要就發現南亞製 23kV CGIS 真空推桿斷裂、處理過程及原因分析。

Abstract

Under normal circumstances, circuit breakers carry load current. When abnormal situations occur, protective relays trip to isolate the fault point and protect the personnel and equipment. There are two kinds of CGIS, GCB and VCB, to cut off the current and the setting of CGIS does not require big space. The advantages of GCB are high voltage and large capacity. The advantages of VCB include small in size and long switch life. The VCB contact is opened in a high vacuum state to promote the diffusion of the charged particles to achieve arc suppression effect. Besides, it is featured with excellent electrical and mechanical performance, long switch life, small and light weight, low equipment maintenance, and little noise.

Even though owning many advantages, the vacuum push rod of VCB in the operating mechanism has to be well designed to ensure stable movement. This article focuses on analyzing cause and treatment of the failure of a Nan-Ya made 23kV CGIS vacuum push rod.

關鍵詞 (Key Words)：氣體絕緣斷路器(GCB)、真空斷路器(VCB)、六氟化硫(SF_6)。

*台灣電力公司輸供電事業部台中供電區營運處

饋線自動化系統資料平台擴增應用研究

Application of Data Exchange Platform for Feeder Distribution Control System

林建成* Lin, Chien-Cheng
李明峯* Lee, Ming-Feng
韓豫* Han, Yu
李兆惠** Lee, Chao-Hui
周昱緯** Chou, Yu-Wei
陳忠源*** Chen, Chung-Yuan

摘　要

基於資訊及網路安全架構下，台電已建構完成配電饋線自動化系統(Feeder Distribution Control System, FDCS)資料交換平台(以下簡稱 FDCS 平台)。其為一數據資料庫，收集並儲存全公司 21 個區處 FDCS 之即時資料與歷史資料，包含靜態(旗標、掛牌及非自動線路開關狀態)、動態(DI、AI)值及歷史(平均、最大、最小值)等資料。

隨著大數據與巨量分析技術的蓬勃發展，如何擴增應用 FDCS 平台，分析系統所蒐集到的資料，在大量數據中找出有價值的資訊，並建立標準的 API 介面，作為電力系統間資料交換的管道，則是本研究計畫的主要目標。本研究透過伺服器虛擬化及 Docker 技術的導入，強化資訊系統備援機制。並整合西門子 Spectrum、北南區處 SNC 配電系統、GeoOMS 拓樸圖資及智慧電表負載資訊，建立變電所、自動化開關及 AMI 電表之監測告警、饋線歷史資料回放等加值應用服務。同時，建立 API 金鑰管理制度，透過授權與認證的機制，確保機敏資料不外流或遭人任意使用。

本研究案以 FDCS 平台為基礎，持續整合電力相關異質資訊系統，並開發符合各單位需求的加值應用服務，建構一套完整的配電資訊整合平台(Distrubtion Information Integration Platform, DIIP)。期望未來可協助配電系統相關人員，於例行性維護與配電線路規劃皆能發揮助益。

Abstract

Taipower has completed the construction of the Feeder Distribution Control System (FDCS) data exchange platform (hereinafter referred to as the FDCS platform) to collect and store real-time and historical FDCS data at the company's 21 district offices.

For FDCS, the following two affairs need to be considered: 1) how to augment the application of the FDCS platform, 2) to analyze and use the collected data and to establish a standard API interface to facilitate other information systems to obtain the information in the platform. To strengthen the system hardware architecture, virtualization and Docker technologies have been introduced onto the platform. In terms of implementing feasible and value-added application services, through demand interviews with the power distribution office, we determined to establish some monitoring and alarming mechanisms aiming at substations and automatic switches, GIS interface integration of power distribution related information, AMI meters and automatic switch monitoring information, and feeder alarms value-added application services like visual painting. In addition to the measurement and event data collected, the platform also integrates feeder topology and smart meter load information. In addition to clearly presenting relevant information through the GIS interface, the historical data playback mechanism also enables the personnel to be well informed of the operating status of the power distribution system, so as they can fully utilize the big data function of the platform. At the same time, an API key management system has been established to ensure no leaking or arbitrary use of sensitive data through its authorization and authentication mechanisms.

This research aims to integrate more distribution information systems on the basis of Distribution Information Integration Platform (DIIP), and to develop more value-added application services. It is hoped that the platform will provide assistance to the personnel of power distribution system regarding their daily operation, maintenance and planning in the future.

關鍵詞 (Key Words)：配電饋線自動化系統(FDCS)、監控自動化系統(SCADA)、系統整合(System Integration)。

---

*工業技術研究院
**台灣電力公司綜合研究所
***台灣電力公司配售電事業部配電處

智慧變電所運轉策略模擬中心之建置及運用介紹

An Introduction of the Establishment and Applications of the Operation Strategy Simulation Center for Smart Substations

黃仰賢* 張文昌* 周瑞年**
Huang, Yang-Hsien Chang, Wen-Chang Chou, Jui-Nien

摘　要

本公司為配合政府政策，積極發展智慧電網以因應各式再生能源併入系統運轉，變電所智慧化扮演著溝通協調的重要角色。變電所智慧化技術係整合資訊科技、網路通訊及智慧化設備管理系統，使變電所設備運轉更具穩定及可靠。在智慧化變電所中智慧型電子裝置(IED)的主要功能為保護、控制、量測及通信，IED 之間可以透過通用物件導向變電所事件(GOOSE)相互溝通，並結合通訊功能將資訊傳送至數據採集與監控系統(SCADA)。然而，在變電所自動化過程中最大的困難在於不同廠牌 IED 之通訊協定如果不一致，將使得系統難以整合。因此可提升 IED 間互操作性之 IEC 61850 標準成為變電所自動化之趨勢。

為因應智慧型變電所發展，本研究建置一以 IEC 61850 通訊協定為基礎之 SCADA，整合輸電級數位保護電驛及配電級數位保護電驛，用以驗證輸電級保護電驛互操作性及以 GOOSE 機制為基礎之運轉保護策略的可行性。

Abstract

To cooperate with government policies, Taiwan Power Company actively develops smart grid to respond to the interconnection of renewable energy resources. Smart substations play an important role in communication and coordination. Information technology, network communication and intelligent equipment management system are integrated into smart substation technology to realize more stable and reliable operation of substations. The main functions of intelligent electronic device (IED) of smart substations include protection, measurement, control and communication. IEDs may communicate with each other through Generic Object Oriented Substation Event (GOOSE), and transmit information to Supervisory Control And Data Acquisition (SCADA). When inconsistent, communication protocols of various brands of IEDs will not be able to integrate. The major objective of the IEC 61850 standard is therefore to unify the communication protocols of IEDs at substations and to substantiate interoperable.

To cope with the development of smart substations, this study has built an SCADA on the foundation of IEC 61850 communication protocol to verify the interoperability of the protection relays of transmission and distribution levels and the feasibility of operation protection strategies based on GOOSE scheme.

關鍵詞 (Key Words)：智慧電子裝置(Intelligent Electronic Device)、數據採集與監控系統(SCADA)、智慧化變電所(Smart Substation)、通用物件導向變電所事件(GOOSE)。

---

*台灣電力公司輸供電事業部新桃供電區營運處
**台灣電力公司輸供電事業部供電處

以資料包絡法分析工業節能財稅獎勵制度之執行效益

Analyzing the Performance of Industrial Energy Saving Fiscal and Tax Incentive Policies by Applying the Method of Data Envelopment Analysis

羅仕京* Lo, Shih-Ching
黃睫晞** Huang, Chieh-Hsi
林靜芬*** Lin, Ching-Fen

摘　要

全球各國為協助節能減碳工作之推動，紛紛提出改善能源效率的因應對策或法規。國內近年亦以財稅獎勵制度推動工業節能工作。本研究目的在於衡量研析工業部門節能財稅優惠制度實施效益。首先回顧國際間相關節能財稅優惠制度之推動經驗與案例。其次，以資料包絡法分析節能獎勵制度的績效，根據分析結果提出國內工業節能獎勵制度的建議。據資料包絡法分析結果，採行節能投資租稅減免 1%的方案為最有效率方案，但其能達到的節能與減排總量有限。如加上節能與減排總量目標的要求，則以節能投資租稅減免 15%的方案為同時具有效率且能達成設定門檻的選擇。

Abstract

To promote energy saving and carbon reduction, worldwide countries have proposed strategies and regulations to improve the efficiency of energy consumption. In Taiwan, fiscal and tax incentive policies have been adopted to enhance the energy saving of industrial sectors. The purpose of this paper is to evaluate/analyze the performance of the said incentive policies in Taiwan. We reviewed the international fiscal and tax incentive policies, and analyzed the performance of industrial fiscal and tax incentive policies in Taiwan by applying the method of data envelopment analysis. According to the results, 1% tax discount for energy-saving investment policy is the most efficient alternative among others. However, it has limited effect on energy-saving and carbon reduction. To achieve the goal of energy-saving and carbon reduction, 15% tax discount for energy-saving investment may be considered.

關鍵詞 (Key Words)：節能減碳(Energy Saving and Carbon Reduction)、資料包絡法(Data Envelopment Analysis)、租稅減免(Tax Reduction)、獎勵制度(Incentive Policy)。

---

*中華大學企業管理學系智慧運輸與物流組
**中華大學運輸科技與物流管理學系
***中華大學區域運輸發展研究中心

建構城市級虛擬電廠層級式能源管理系統芻議

An Opinion about Constructing Hierarchical Energy Management System of City-level Virtual Power Plant

盧思穎* Lu, Su-Ying
陳彥豪* Chen, Yen-Haw
郭昱賢* Kuo, Yu-Hsien

摘要

虛擬電廠是將相同類型電價制度、需量反應或分散式發電設備方案下的用戶群，如住宅型、商業型或工業型等用戶集合，並將客戶群依特定地區或配電關聯細分成不同群體。更細膩的區分群體不僅可改善用電預測精確度，也可顯著優化營運決策制定，使電力公司對特定客戶做更好的預測與資訊分析。建構虛擬電廠使得電力公司得以將不同用電方案依據其配電網型態、地理實體位置分布等進行整合。而智慧能源管理系統具備即時監控與記錄城市內各場域的用電需量及電能使用量，除可實現平日主動節電並配合市府內部政策進行發用電管理，亦可透過參與台電公司需求面管理方案，整合城市內分散式電源與需量反應等微小容量成為虛擬電廠，並投入電力市場。本文將以台北市為案例，探討如何透過公部門領頭示範與成果展示，提升市民的創能與節能意識，進而帶動私部門共同響應，共同邁向低碳永續城市新里程碑之建議。

Abstract

Virtual Power Plants (VPPs) may be categorized into residential, commercial and industrial customers (by tariffs), Demand Response (DR) and distributed generation facilities (DGs). When necessary, they can be further categorized by area or distribution system. Dedicate categorization not only improves the accuracy of load forecasts, but also optimizes the operation decisions, through better prediction and information analysis. The construction of VPPs enables electric companies to integrate electricity schemes by the characteristics of distribution networks and their geographical locations. Smart Energy Management System is capable of monitoring and recording electricity demands (kWs and kWhs) around the city in real time, therefore it can help realize active power saving, cooperate with the electricity policies of city halls, and integrate DG and DR resources into VPPs by participating the demand side management programs proposed by Taipower, to join the electricity market in the future. This article takes Taipei City as a case study of public sectors to demonstrate the creation of energy by raising citizen's awareness of energy conservation. Expectedly, the private sectors will respond positively and move together with the public sectors toward a low-carbon and sustainable city.

關鍵詞 (Key Words)：虛擬電廠(Virtual Power Plant)、層級式(Hierarchical)、能源管理系統(Energy Management System)、需量反應(Demand Response)、輔助服務(Ancillary Service)。

---

*財團法人台灣經濟研究院

探討日本電業自由化最新發展與電業因應

The Latest Progress on Electricity Deregulation in Japan and the Coping Strategies of the Industry

左重慶*
Tso, Chung-Ching

葉虹*
Yeh, Hung

摘要

本文旨在探討日本電業自由化之最新發展以及綜合電業面臨市場變革之因應方式。內容包含零售市場全面競爭與輸配電業中立性兩大面向。其一，日本於 2016 年 4 月全面開放用戶購電選擇權，顛覆電力市場之既有思維與運作，各大電力公司在跨業新競爭者湧現，導致用戶流失與營收下滑的挑戰下，無不亟思突破既有經營模式的框架。再者，各大電力公司已於 2020 年 4 月完成第五次電力市場改革最後一哩路，也就是輸配電業法人分離，以落實中立性之目標。本文探討日本綜合電業因應市場變革之策略規劃與因應準備，可作為政府規劃相關政策及後續電業發展之參考。

Abstract

This paper aims to examine the latest progress of Japan's electricity market and the strategies of vertically integrated electric utilities responding to the reform. There are two major parts of this paper, the full openness of retail electricity market and the neutrality of the transmission and distribution sector.

Since April 2016, all household and small business customers are free to shop around. Vertically integrated electric utilities have to look for breakthrough innovations due to fierce market competition, loss of customers and revenues. In addition, the task of legal unbundling of transmission and distribution has been accomplished since April 2020, the last mile of Japan's Electricity Market Reform. The strategic planning and preparation of the vertically integrated electric utilities may serve as a good reference for Taiwan.

關鍵詞 (Key words)：電業自由化(Electricity Deregulation)、競爭(Competition)、法人分離(Legal Unbundling)、公平性與中立性(Fairness and Neutrality)。

*台灣電力公司企劃處

國外指標電業風險管理研究對於台電企業風險管理優化方向之評估參考

A Study on Enterprise Risk Management: Worldwide Cases and the Optimization of Taipower

陳維揚*
Chen, Wei-Yang

邱立成**
Chiu, Li-Chen

何鴻婕**
Ho, Hung-Chieh

摘　要

內外在經營環境變動快速，導致各種風險日益增加，如：綠能產業新營運模式衍生之第三方風險，科技化帶來之系統控管失當或舞弊風險，乃至電業法修法(開放再生能源發電業及售電業)對台電公司之策略、市場及營運所加諸之挑戰等。台電公司導入風險管理制度已逾十年，相關之制度設計應順應風險型態之變化，進行動態之更新以涵蓋新興之風險。由於相關之評估及調整過程，涉及財務、營運及法律等多面向，爰對國際指標能源產業之企業風險管理服務經驗進行研析，希冀能對台電公司企業風險管理機制未來精進方向及藍圖規劃提供參考。

Abstract

Rapid environment changes have imposed various risks to Taipower, from corporate strategy planning to daily market operation, to name a few, the third party risk derived from the new business model of renewable energy industry, improper control and fraud risks from emerging technologies, and the challenges from the amendment of the Electricity Act. Risk management system had been introduced within the company for more than ten years. It is time for Taipower to make dynamic updates to cope with the emerging risks derived from environment changes. The evaluation and adjustment of risk management involves the aspects of corporate finance, business operation, legal affairs, etc. Therefore, related practices of worldwide electric utilities may serve as good reference for Taipower.

關鍵詞 (Key Words)：法國電力集團(EDF)、東京電力集團(TEPCO)、南非電力公司(ESKOM)、企業風險管理(Enterprise Risk Management)、管理委員會(Management Committee)。

---

*台灣電力公司企劃處
**安侯企業管理顧問股份有限公司

運用 AMI 資料評估時間電價移轉負載效果~ 以高壓以上用戶為例

The Load Shifting Effect of TOU Rate: Taking High Tension & Extra High Tension Customers as an Example

黃培原* Huang, Pei-Yuan
吳鎮安* Wu, Chen-An
張正彥* Chang, Cheng-Yen

摘 要

為因應電力系統尖峰負載逐年攀升，台電公司自 68 年 8 月起實施時間電價，引導用戶調整作業時間，移轉尖峰時間用電於離峰時間使用，以促進電力有效運用。有關時間電價抑低負載之評估方式，歷年來已有相關文獻探討，囿於資料顆粒度限制，大多聚焦於抑低尖峰負載效果評估。基於高壓以上用戶已全面布建智慧型電表(Advanced Metering Infrastructure，簡稱 AMI)，本文嘗試運用資料顆粒度較細之 AMI 等資料，透過數據分析及統計模型實證以高壓以上尖峰、半尖峰時段電價，引導用戶移轉 108 年夏月平日尖峰、半尖峰用電至離峰時間使用之負載規模。

另本文亦實證以高壓以上三段式尖峰時段電價，引導用戶移轉 108 年夏月尖峰 10~12 時用電，至半尖峰 18~20 時使用之負載規模。考量太陽光電持續併網造成傍晚負載急速拉升之問題，假如未來系統尖峰時段為平日下午至傍晚時分，前述移轉負載規模可視為屆時透過時間帶調整引導之傍晚抑低潛力。

Abstract

To deal with increasing peak loads, TPC has implemented TOU Rate since August 1979 to guide customers to shift their power consumption from peak period to off-peak period. The related studies regarding evaluating the load shifting effect of TOU Rate in the past, restricted by time granularity, mostly focused on the effect of clipping peak load. Since high-tension and extra-high-tension customers have been comprehensively deployed with AMI meters, we therefore decided to utilize the AMI data to construct statistical models. The daily load shapes of the said customers are roughly divided into two types, those consume more electricity at off-peak period and those at peak & semi-peak period. We then applied the data of the summer months of 2019 to analyze how TOU rates may affect the behaviors of customers. In view of the fact that the system peak loads due to high percentage PV interconnection have been moving from the afternoons to the evenings, the said load shifting may be regarded as the potential evening load clipping caused by TOU rate.

關鍵詞 (Key Words)：時間電價(Time-of-use Rate)、智慧型電表(AMI)、複迴歸模型(Multiple Regression Model)、羅吉斯迴歸(Logistic Regression)。

---

*台灣電力公司配售電事業部業務處