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水力發電廠導入 IEC 61850 之研究

The Research on Implementing IEC 61850 Standards for Hydroelectric Power Plant

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摘　要

為因應未來智慧電網之應用，相關資通訊之基礎建設須先落實，尤其在考慮電力自動化架構下，公司也追隨國外先進國家的腳步，採用 IEC 61850 等國際資通訊標準，期望打造 OT/IT 資訊互通的情境，以利未來智慧電網之自動化操作及各領域之資料整合應用。本研究主要參考 IEC 61850-7-410 之標準資料模型，及 IEC 61850-7-510 水力發電廠整廠架構、各系統之 IEC 61850 介面等，並以明潭發電廠濁水機組作為規劃案場，建立水力發電廠標準資料模型 Profile，作為本公司未來建置先導型 IEC 61850 水力發電廠之參考依據，期許加速標準之落實。

Abstract

To fully support Smart Grid (SG) applications in the future, corresponding information & communication infrastructure must be implemented in advance, especially taking the power system automation architecture into account. To follow the footsteps of advanced countries, Taiwan Power Company adopts the international information and communication standards (e.g. IEC 61850) to develop an accessible context for OT/IT information to facilitate the automation operations, information integration and applications for all respects SG domains and zones. The references for this research majorly include the standard information model of IEC 61850-7-410, the hydropower plant architecture of IEC 61850-7-510, and the IEC 61850 interfaces for each of the systems. We take the Zhuoshui generator of Ming-tan Hydropower Plant as our test field to heap up standard information model profiles. We expect that the results of this research may serve as reference for the company's pilot IEC 61850 hydropower plant in the future, and help accelerate the implementation of the aforesaid standards.

關鍵詞 (Key Words)：IEC 61850、水力發電廠(Hydroelectric Power Plant)、激磁系統(Excitation System)、自動電壓調整(AVR)、調速機(Governor)、濁水機組(Zhuoshui Generation Unit)。

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供電線路智慧故障定位系統開發

Development of an Intelligent Fault Location System for Transmission Lines

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摘　要

本研究計畫針對台電161 kV混合線徑型輸電線路故障定位系統之故障定位演算法程式進行優化改善。並進一步結合網際網路的科技，發展成為具備網頁化、雲端化及行動化的智慧型故障定位系統，可提供台電公司員工如：檢測電驛波形數據、轉換電驛資料格式，以及線路導線參數之增刪、修改與下載等資訊管理功能。而對於發生事故的線路，本計畫亦開發主動通知服務功能，以將故障位置等資訊推播 (Push) 到本計畫所研發的智慧型行動裝置應用程式(Application Program , APP)，使工程人員可以直觀地、視覺化地得知故障所在位置，並進一步提供導航及街景功能以協助巡線人員快速抵達事故現場。因此，開發此智慧型故障定位系統之目的為希望能夠以快速且精確的方式定位出事故地點，並以簡單、方便且視覺直觀的操作介面來輔助工程人員找到故障位置，以大幅減少故障排除成本與復電時間，並進一步提昇161 kV輸電系統之供電可靠度與安全性以減少經濟損失，達到符合社會期待電力穩定供應之目的。

Abstract

This project aims to optimize the original fault location system (FLS) of Taiwan Power Company's (Taipower) 161 kV hybrid transmission lines and combining the Internet technology to develop a new webpage-based, cloud-based, and mobile-based intelligent fault location system to provide Taipower engineers convenient functions such as relay raw-data inspection, conversion of relay data format, and line-parameter information management. Not only, the project will design a proactive APP push notification function to upload visualized and intuitive fault event information to the intelligent mobile devices carried on by Taipower engineers for them to quickly identify and arrive at the fault location. The said approach not only helps reduce the cost of troubleshooting and outage time, enhance the reliability and security of 161 kV transmission system, decrease economic losses but also help Taipower to meet social expectation.

關鍵詞 (Key Words)：台電161 kV複合線徑輸電線路 (The Taipower 161 kV Nonhomogeneous Transmission Lines)、多功能故障定位系統(Multifunctional Fault Location System)、雲端化轉移(Cloud Migration)、雲端運算(Cloud Computing)、地理資訊系統(Geographic Information System, GIS)、行動裝置應用程式(Application Program, APP)。

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即時動態模擬系統應用於改善雙匯流排附連絡斷路器之 SEL-487B 保護電驛邏輯

Application of Real-time Simulation Technology in Improving the Logic of SEL-487B Relay for Double-bus with Tie Circuit Breaker

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摘　要

本文旨在介紹應用即時動態模擬應用於改善雙匯流排附連絡斷路器之 SEL-487B 保護電驛邏輯。目前應用於台灣電力系統之 SEL-487B 可分類為舊版及新版，將兩者進行比較及分析，並指出兩種版本邏輯規畫之弱點。本文整合兩種版本並提出改善方法，並以一些模擬及實測結果驗證其於不同情況下之正確性。

Abstract

The purpose of this paper is to introduce the application of real-time dynamic simulation in improving the logic of SEL-487B relay for double-bus with Tie Circuit Breaker. There are two types of SEL-487 relays currently deployed in the power system of Taiwan, namely the old type and the new type. In this study, we compare and analyze the vulnerability of the planning logics of the said two types of relays, and propose ways to improve. Some simulation and empirical results are accompanied for the verification of the correctness under various conditions.

關鍵詞 (Key Words)：即時模擬(Real-time Simulation)、即時數位模擬系統(Real-time Digital Simulation)、保護電驛(Protective Relay)、雙匯流排保護(DoubleBUS Protection)。

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頻率變化率相關應用分析與程序

Application on ROCOF Related Analysis Steps and Procedures

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摘　要

近年來因環保意識抬頭，再生能源成為各國政府致力發展的方向，隨著再生能源佔比的提升，其不穩定及不易預測的特性，將影響機組排程，並對電力系統造成供電品質及可靠度的衝擊，為了解決上述問題，故出現了很多研究議題如：孤島運轉、快速卸載、慣量計算及儲能系統規劃等，這些議題皆是使用 ROCOF 法作為基本理論來源，並對頻率資料進行分析及電力電子設備觸發信號設計。

ROCOF 最主要的目的即是判斷系統發生擾動時，系統頻率下降的速度，進而換算出所謂的系統慣量，系統慣量是能評估系統頻率穩定性的重要參數，因為它是當系統負載不平衡時決定頻率變化的關鍵因素。故本文將利用台電系統 PMU 資料，進行頻率分析，探討 ROCOF 初始點之判斷、合適的頻率資料區間視窗，及不同區域之頻率差異性等並給於頻率資料處理之建議。

Abstract

Due to the rise of environmental awareness in these years, the development of renewable energy has become the primary task of the governments around the world. Nevertheless, high proportion of intermittent renewable energy has not only adverse impacts on generation scheduling, but also the quality of power supply and the reliability of power system. As a result, many research topics, e.g. islanding operation, fast load shedding, inertia calculation, and planning of energy storage, have emerged over the years.

The main purpose of ROCOF is to determine the speed of power system frequency drop in case of disturbance and accordingly calculate the system inertia, an important parameter to evaluate the stability of power system frequency. In this study, we use the power management unity (PMU) data of Taipower for the purposes of (1) performing frequency analysis, (2) making judgments of the initial point of ROCOF, the appropriate window of frequency data interval, and the frequency difference of different regions, etc., and (3) giving suggestions on frequency data processing.

關鍵詞 (Key Words)：ROCOF (Rate of Change of Frequency)、慣量(Inertia)、保護電驛(Protection Relay)。

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更新既設短路試驗室後營運方針與風險研究

A Study on the Operational Policy and Risk Assessment of the SCTL Retrofit

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摘　要

為完成達到更新既設短路試驗室後營運方針與風險研究之目的，本研究預期成果與效益計有下列 6 項。

一、分析歐洲、美國、大陸及韓國大容量試驗室規劃之法規依據、營運模式。二、比較分析 IEC/ANSI/CNS 在高壓配電盤、斷路器、變壓器、負載啟斷開關、避雷器及熔絲之試驗標準差異。三、調查國內重電機產業在大容量試驗之市場需求。四、提出未來大容量試驗室之營運策略。五、短路試驗室(3ϕ/24 kV /25 kA /10 cycles)併聯特高壓系統系衝分析，包含電力潮流、故障電流、臨界清除時間。並且須符合「台灣電力公司輸電系統規劃準則」之需求規定辦理。六、樹林大容量短路試驗室噪音分析與安全防護(含排煙)防治對策。

Abstract

This study aims to update the operational policy of the Short-Circuit Test Laboratory (SCTL) and conduct a risk assessment of the SCTL retrofit. As follows are the expected results/benefits of this study: (1) the analysis of the legal basis and business model related to high-power capacity laboratory planning, selected from applicable cases of Europe, the United States, China and South Korea, (2) the analysis and comparison of the IEC / ANSI / CNS test standards related to high-voltage switchboards, circuit breakers, transformers, switches, lightning arresters and fuses, (3) the investigation of the market demand of high-power capacity tests of the domestic heavy electrical machinery industry, (4) a draft proposal for the high-power capacity laboratory's future operation strategy, (5) the system shock analysis of SCTL (3ϕ/24 kV/25 kA /10 cycles) when connected to the UHV power system (including power flow, fault current, and critical clearance time, and has to be compliant with the requirements of TPC Transmission System Planning Guidelines, (6) the noise analysis and the countermeasures of safety protection (including smoke exhaust) of the Su-Lin high-power SCTL.

關鍵詞 (Key Words)：直接短路試驗(Direct Test)、合成試驗(Syntheic Test)、暫態恢復電壓(Transient Recovery Voltage, TRV)、短路啟斷試驗(Short-circuit Making and Breaking)、開閉試驗(Switching Test)、基本短路責務試驗(Basic Short-circuit Test-duties)、電容性電流(Capacitive Current)。

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智慧綠社區與居家能源管理系統(HEMS)整合應用研究-以興達電廠宿舍區為例

Integrated Application Research of Smart Green Community and Home Energy Management System (HEMS) - Taking the Dormitory Area of Hsinta Power Plant as an Example

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摘　要

本研究重點為透過 Route B 聚合個別 AMI 資訊，展現社區整體用電資訊與即時個別用戶的用電資訊，透過政策推播，實驗節電獎勵效益，掌握用戶節電動機與誘因。於示範場域內建置「社區雲端能源管理」實驗系統，並提供四大主要功能：(1)社區能源管理系統(CEMS)：全社區用電量、住戶節能競賽排行、社區安全監視、台電政策推播。(2)家庭能源管理系統(HEMS)：無線家庭網路、量測即時用電、用電資料行動查詢雲端平台、遠端控制電器、自動需量反應抑低空調需量。(3)社區 Wi-Fi 上網整合建置：全社區 Wi-Fi 訊號涵蓋，上網服務與整合智慧生活。(4)用戶的自動需量反應功能：建立符合 OpenADR 2.0b 自動需量反應國際標準，並提供未來社區需量反應聚合商(Aggregator)之商業模式應用。

Abstract

This research focuses on aggregating individual AMI information via Route B to reveal the electricity consumption information of the community as a whole and the individual household, to master the user's motivation and incentive design for saving electricity. Based on the research results, we recommend to establish a "Community Cloud Energy Management" experimental system to provide the following functions: (1) the aspect of CEMS: electricity consumption information of the community, energy-saving competition & ranking, safety monitoring, and push notification of Taiwan Power Company’s policies , (2) the aspect of HEMS: wireless home network, measuring real-time electricity consumption, mobile query & cloud platform for electricity data, electric appliance remote control, and automated demand response (ADR) for air conditioners, (3) the aspect of community Wi-Fi & internet integration and installation: community-wide Wi-Fi coverage, internet surfing service and smart life integration, (4) the aspect of user ADR function: to establish a model compliant with the international OpenADR 2.0b standard and an aggregator business model applicative for community DR.

關鍵詞 (Key Words)：先進讀表基礎建設(Advanced Metering Infrastructure, AMI)、路徑B(Route B)、社區能源管理系統(Community Energy Management System, CEMS)、家庭能源管理系統(Home Energy Management System, HEMS)、無線網路(Wi-Fi)、2.0b版之國際需量反應通訊協定(OpenADR 2.0b)。

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運用機器學習方法評估能源使用對空污影響-臺中市案例分析

Impact Assessment of Energy Use on Air Pollution by Machine Learning Model- A Case Study in Taichung

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摘　要

合理的電力環保調度需兼顧電力空污排放與穩定供電的平衡點，不應忽略其他重要因素的影響力。本研究主要目的是透過大數據的機器學習方法，探討發電量與交通量對空污 PM2.5 影響強度，期望透過科學化的資訊論述基礎，理性探討空污的影響因子，提出合理的抑制策略，使能源轉型與環境保護取得平衡發展。研究結果顯示：從機器學習的模型驗證及資料散佈圖趨勢來看，燃煤發電量與 PM2.5 二者之間似乎呈現較弱的正相關樣態，而交通量對 PM2.5 的影響呈現較大的敏感度不確定風險。另外，從每季資料散佈圖發現臺灣在第 4 季(冬季，12 月~2 月)期間，燃煤發電呈現下降趨勢，但是，PM2.5 卻呈現上升趨勢，這個現象也許可以歸因於冬季來自境外污染物及氣候的擴散效果。關於氣候因素對 PM2.5 的不確定性分析待未來進一步研究驗證。

Abstract

In terms of environmental protection, power dispatch has to justify the trade-offs between air pollution (PM2.5 and air pollutants of the others) and stable power supply. The main purpose of this research is to explore the intensity of the factors affecting PM2.5 by means of machine learning and big data methods, scientific discussion and rational exploration. As the results of this research show, there is a weak positive correlation between power generation and PM2.5, and the traffic volume presents a greater risk sensitivity uncertainty of PM2.5 in the sight of machine learning model and scatter diagram trend of the research. As the seasonal data scatter diagram shows, although Taiwan's coal-fired generation has a downward trend during the winter (December to February), PM2.5 has an upward trend in the same period. The phenomenon may be attributed to the climate diffusion effect of foreign pollutants in the winter, but the impacts of climatic factors on PM2.5 depends on further research and verification.

關鍵詞 (Key Words)：空氣污染(Air Pollution)、發電(Power Generation)、交通(Traffic)、機器學習(Machine Learning)。

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環境綜合資訊系統應用於台電環保管理之進程

Application of Environmental Integration Information System in Taipower Environmental Protection Management

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摘　要

台電公司於民國 75 年成立環境保護處，隨著台灣社會環境意識的提升，台電肩負著減低電力業對於環境造成衝擊之責任，對於環境保護管理逐漸由早期環境監測、管末處理轉為開發前的環境影響評估、污染源頭改善，而隨著環境保護管理手段的轉變，同時也需回應外界對於各項環境保護管理措施更加公開透明、監測數據更為即時之需求。

而面臨相關轉變，各項環境保護管理作業的流程需更加明確、標準化以增加業務執行效率，同時對於環境監測數據亦需由早期紙本記錄轉為 E 化管理，以便長期監測數據的整合及應用，並且能即時發現環境保護工作所執行之缺失，即時加以輔導改善並對外回應。

因此台電環保處為加強環境自主管理，強化相關環境保護業務整合，近年透過建置「環境資訊綜合管理系統」導入 E 化管理作業模式，以協助各項環境保護業務之執行，以強化整體業務管理之效能，本篇將針對近年台電各項環保業務的 E 化管理作為及各問題透過系統的解決方案，進行介紹。

Abstract

The Environmental Protection Department (EPD) of Taiwan Power Company (Taipower) was established in 1986. With the rise in environmental awareness, the company nowadays is asked has to shoulder more responsibilities in the aspect of alleviating environmental impacts related to electric power infrastructure. Besides, the management thinking of Environmental Protection (EP) has also changed from Early Environmental Monitoring and End Treatment (EEMET) of the early years to Pre-development Environmental Impact Assessment and Source Improvement (PEIASI). Accompanied by the change of EP management methods, the need for a more open and transparent EPM policy to respond to social expectations has become imminent than ever.

In the face of the changes, clear, standardized and efficient EPM operations are indispensable. In addition, environmental monitoring data must transform from paper records to electronic records (aka E-management) for the purposes of long-term environmental data integration & application, early fault detection and immediate improvement.

In order to strengthen management capabilities and to improve business integration and management effectiveness, EPD Taipower established the Environmental Integrated Information Management System to introduce the E-management model.

This article aims to introduce the actions and solutions related to E-management that Taipower EPD adopted in the past few years.

關鍵詞 (Key Words)：環境綜合資訊管理系統(Environmental Integrated Information Management System)、E化管理(E-management)。

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電力批發市場仿電力池設計之模式建置與模擬分析

Modeling and Simulation Analysis Imitating Pool-typed Electricity Wholesale Market

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摘 要

本研究聚焦於建立一套電力批發市場價格評估模式，其參考英國電力池的設計，考量能量價值、容量價值及投資報酬率，並在綜合考量我國法規限制與市場機制後，訂定能量費率及容量費率，進而進行電力機組的投資報酬率分析。本文主要的內容聚焦在電力批發市場模式的建置，並透過實績數據模擬操作上的限制，並綜合考量我國法規限制與市場機制，探討適合我國電力市場的能量費率訂定模式，再結合電力池的設計，進而訂定容量費率。本研究結合 2013 年至 2017 年歷史實際數據，聚焦於探討台灣本島中屬於台電公司的傳統發電機組，進行電力批發市場的模擬，透過能量價值、容量價值及投資報酬率等資料，探討使用該制度對於電力機組的經濟影響。

Abstract

This research aims to establish an electricity wholesale market based price evaluation model. To find out how this pricing model may influence the generators, we refer to the design of UK Power Pool and put domestic regulations and market mechanism into accounts. The energy value, capacity value and return on investment (ROI) of the generators (those in main Taiwan island) are all simulated with actual (historical) data from 2013 to 2017 and generators' operation limits are considered too.

關鍵詞 (Key Words)：電力批發市場 (Electricity Wholesale Market)、系統邊際價格(System Marginal Price)、容量支付(Capacity Payment)、投資報酬率(Return on Investment)、市場機制(Market Mechanism)。

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