台電工程月刊 854 期（10月號）目錄

再生能源：

輸 變 電：

能源與環境：

其　　他：

核能發電：

以資料探勘預測太陽能發電量：龍井太陽能電廠案例

Forecasting Solar Power Generation by Data Mining：
Case of Longjing Solar Power Plant

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摘　要

本研究目的為透過準確的太陽能發電量預測結果，提供當地電力用戶、再生能源發電業者與電力公司可參考的科學數據。

本研究使用台中龍井地區太陽能發電量資料及中央氣象局觀測資料查詢系統之開放資料，選取 2015 年至 2017 年共三年之歷史資料，首先藉由變異數分析、獨立樣本 T 檢定等統計方法分析台灣四季與乾溼季變化對太陽能發電量之影響程度，而後透過支援向量機、倒傳遞類神經網路和隨機森林等演算法，建立太陽能發電量預測模型。接著使用絕對壓縮挑選機制進行天氣變數的特徵選取，找出與太陽能發電具有關聯性之天氣變數，並比較三種演算法之預測準確度優劣。最後藉由敏感度分析探討模型的訓練資料與測試資料之比例，是否會影響模型的預測準確度。

Abstract

This study aims to provide a reliable solar power generation prediction model, which can serve as scientific reference for local electric power consumers, renewable energy providers, and power companies.

Research material for this study comes from solar power generation data of Taichung City's Longjing District and open data on the Central Weather Bureau's CODiS system (CWB Observation Data Inquire System), with the selected recorded period being from 2015 to 2017 - a three-year historical data. The study first applied statistical methods such as analysis of variance and independent samples t-test to analyze the impact degree of different seasons as well as wet and dry seasons in Taiwan on solar power generation capacity. Next, the study establishes solar power generation prediction models based on algorithms such as support vector machine, neural network backpropagation, and random forest. Following that, "LASSO" (Least Absolute Shrinkage and selection operator) is applied to perform feature selection on weather variables in order to identify weather variables related to solar power generation. The three algorithms also undergo prediction accuracy comparison. Lastly, the study employs sensitivity analysis to examine whether the ratio of a model's training data and testing data influences the model's prediction accuracy.

關鍵詞(Key Words)：資料探勘(Data Mining)、機器學習(Machine Learning)、敘述性統計(Descriptive Statistics)、變異數分析(Analysis of Variance)、獨立樣本 T 檢定(Independent Sample T Test)、太陽能發電量預測(Solar Power Generation Forecasting)。

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再生能源結合儲能系統之技術研討

Study of Renewable Power with Energy Storage System

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摘　要

本文探討儲能系統應用於再生能源中太陽能及風能之電池儲能系統。考量各國能源政策及氣候變遷因素，各國對於再生能源在智慧電網之推動下，持續推展智慧電網基礎建設，強化用電運轉之穩定性及靈活性。電力元件中，智慧逆變器及電池結構中都導入先進半導體元件設計及功能於再生能源中，同時，通訊之整合也導入應用於電力公司之遠端監視及控制，使其對於再生能源併網中能快速及有效的調控以保電網穩定性運轉。電池儲能系統中，經由電池量測系統持續監視電池狀態，事先預防電池在放電供給電能時，所發生之電池或電池連接智慧逆變器直流系統中之電壓問題，使其能有效達到太陽能及風能運轉中對輸出電能之穩定性。大型儲能系統應用於電網中，透過電池儲能技術可彈性對電網做快速電力調節；因此，儲能系統在電網中占有重要之角色。

Abstract

This paper is intended to discuss energy storage system and to investigate renewable energy for solar power and wind power with battery storage system functionality. Considering the international energy development strategy and climate change issue, almost all countries around the world have been vigorously promoting the establishment of the infrastructure in smart grid to reinforce grid operation stability and system operation flexibility. Power electronics, smart inverter and battery structure has been introduced as the advanced design and functionality in renewable power with power semiconductor devices. Meanwhile, communication integration for remote monitor and control is also being made available for utility operation to quickly regulate grid power in grid-tie system and ensure its stability. In battery storage system, battery measurement system can predict battery problems in advance and monitor DC power between smart invert and battery loop to reach solar power and wind power operation stability. For large scale energy storage system, it can reach the function for power regulation so quickly that energy storage system currently can play an important role in the power grid.

關鍵詞(Key Words)：智慧逆變器(Smart Inverter)、電池儲能系統(Battery Storage System)、基礎建設(Infrastructure)、智慧電網(Smart Grid)、併網(Grid-Tie)。

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彰濱 E/S 風力發電用配電變壓器運轉狀況

Operation Status of Distribution Transformers for Wind Power Generation at Changbin Extra High Voltage Substation

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摘 要

政府規劃新能源政策目標於2025年提升再生能源發電比例達20%。其中，風力發電長期目標為2025年達成4.2GW，包含陸域風電為1.2GW，離岸風電為3GW。台電配合政府能源政策，自2002年起大力開發風力，並且已建置完成169部陸域風機。其中，台電規劃風力發電第二期計畫之彰工(I)共23部陸域風力機組已於2006年併入彰濱超高壓變電所(Extra High Voltage Substation，簡稱彰濱 E/S) 2號配電變壓器(Distribution Transformer, 簡稱#2DTR)，迄今已運轉12年。由於彰化沿海未來將建置大量離岸風力發電，並藉由升壓站併入彰濱E/S。為瞭解彰工(I)風機及其所併入配電變壓器運轉狀況，本文提出相關量測結果及分析，包含風力發電狀況、配電變壓器之功率因數、電壓頻率變動、電流、電壓閃爍、絕緣油等狀態提供建置離岸風力及維護參考。

Abstract

New energy policy of the government is planning to increase the share of renewable energy generation to 20% by 2025. Among them, the long-term goal of wind power generation is set to be 4.2GW in capacity by 2025, of which 1.2GW is for onshore wind power and 3GW for offshore wind power. In accordance with the government's energy policy, Taipower company has been developing wind power since 2002 and has completed the construction of 169 land-based wind turbines. Of them, Taipower company's the second-phase wind power turbine constructed in Changgong(I) - a total of 23 land-based types - have been integrated into the 2nd distribution transformer of Changbin E/S in 2006 and have been in operation for 12 years. A large number of offshore wind power are being planned to be constructed around Changhua Coast in the future and interconnected to the Changbin E/S through a booster station. In order to understand the working conditions of Changgong (I) wind power generation and its integrated distribution transformers, this paper proposes relevant measurement results and analysis, including wind power generation conditions, power factor, voltage frequency variation, current, voltage flashing, and insulating oil of distribution transformer. Those results can provide a good reference for the construction of offshore wind and maintenance.

關鍵詞 (Key Words)：風力發電(Wind Power Generation)、離岸風力(Offshore Wind Power)、變壓器(Transformer)、功率因數(Power Factor)。

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回頁首

345kV 複合式氣體絕緣開關(GCS)外殼修補應用實例

Practical Improvement Case for Reliable Operation of 345kV Gas Combined Switchgear Encloser Repair

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摘　要

隨著時代的變遷，超高壓變電所內變電設備亦考量安全性及可靠度，傳統開關場內345kV 空斷開關(ABS)，也汰換為複合式氣體絕緣開關(GCS)設備，但是位於潮濕多雨地區，經常有外殼銹蝕現象，甚至有滲氣情形，嚴重影響供電安全。

本文主要就屋外式 345kV GCS 外殼滲氣處查修及冷焊改善實績，進行說明，可供各區變電所維護同仁參考，藉以提升供電品質及設備可靠度。

Abstract

With the changing of the time, we are forced to pay more and more attention to the issues in security and reliability of power facilities in Extra High Voltage Substation. In the traditional switch yards, many 345kV Air Break Switch(ABS) have been replaced by Gas Combined Switchgear(GCS). However, in wet and rainy areas, the cases of enclose corrosion even leakage often occur, which will seriously affect the safety of power supply.

This paper mainly focuses on outdoor 345kV GCS encloser leakage inspection and cold welding improved performance. It is found that the results can be used as good reference to the facility maintenance colleagues and improve their performance for ensuring the power supply quality and equipment stability.

關鍵詞(Key Words)：複合式氣體絕緣開關(Gas Combined Switchgear)、冷焊(Cold Welding)、滲氣(Leakage)。

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宏都拉斯電力系統設備問題探討

The Discussion on the Equipment Problems of the Honduras Power System

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摘　要

台電公司電力調度處蔡文達經理及系統規劃處何秉衡專業工程師奉派赴宏都拉斯電力公司執行為期 3 個月之電力技術協助。本文首先說明中美洲電網互聯系統、其次簡介宏國電力系統概況及尖、離峰負載情況，最後說明宏國電力系統問題，包括變電所匯流排配置、變電所變壓器設置、輸電線路配置、控制盤配置以及發電機運轉功因等。

Abstract

Wen-Ta Tsai, a senior manager of Department of System Operations, and Ping-Heng Ho, a senior engineer of Department of System Planning were sent to Honduras Electrical Power Company (ENEE) to provide a three-month technical assistance in the field of power system. In this paper, the Central American Electrical Interconnection System was introduced firstly. Then, the discussion goes to overviewing the Honduras electrical power system and then to discussing the peak and off-peak load conditions. Finally, the power system problems of Honduras, such as the substation bus-bar configuration, substation transformer settings, transmission lines configuration, and control panel configuration as well as the operation power factor of generator, were discussed, and some recommendation were proposed.

關鍵詞(Key Words)：電力系統(Power System)、PSS/E(Power System Simulator for Engineering)。

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我國電力整合資源規劃模型建置與應用

Application of an Integrated Resource Planning Model for Power System in Taiwan

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摘 要

本研究運用混合整數線性規劃建置我國電力整合資源規劃(TPC-IRP)模型，並運用開放程式碼 *PYTHON* 進行運算程式編譯與運算，再使用 *EXCEL-VBA* 工具建置模型的操作介面與參數資料庫，完成功能完善且維護成本低的電力供需規劃輔助決策工具。TPC-IRP 模型涵蓋我國電力系統現有的發電機組(廠)，目標函數為每年系統總成本最小化，搭配電力供需平衡、技術供應上限、燃料供應上限、環境排放上限、政策目標等限制條件，模擬從基準年至 2030 年的最佳電力供需策略，TPC-IRP 模型可輸出各種情境的模擬結果，包括：電力供應組合、新機組擴增排程、需求端節電量、售電成本、電力碳排放係數、備用容量率等。

Abstract

This study employed the mixed-integer linear programing to establish an Integrated Resource Planning model for Taiwan Power Company (TPC-IRP). The TPC-IRP model was compiled and run by the *PYTHON*. Users can operate the TPC-IRP model and load all parameters by an *EXCEL-VBA* interface. The TPC-IRP model is a well-functioning and low-cost decision support tool for power supply and demand planning. The model covers all existing power generators in Taiwan's power system, with its objective function aiming to minimize total cost of the power system. The constraints of the model include the balance of power supply and demand, up-bounds of power supply for each generator, up-bounds of fuel supplies, emission permits and policy targets. Users can use the TPC-IRP model to plan the optimal power supply and demand strategy from base year until 2030s. The TPC-IRP model can provide various computing results, including the power mix, expansion of new power generators, power saving of EPPs, power selling cost, carbon emission coefficients, reserve margins, etc.

關鍵詞(Key Words)：混合整數線性規劃(Mixed-Integer Linear Programing)、整合資源規劃(Integrated Resource Planning)、電力供需規劃(Power Supply and Demand Planning)。

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石墨烯添加包覆於鋰離子電池負極材料之儲能研究

Study for Energy Storage of Materials Based on the Added Grapheme on the Negative Electrode of Lithium Ion Battery

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摘 要

具優異的高導電特性之石墨烯添加包覆於具儲能之鋰離子電池負極時，可提昇鋰離子電池優異電化學性能和倍率性能及穩定的溫度特性，進而可突破性地提升鋰離子電池的功率密度外，並可顯著地拉高鋰離子電池之大電流放電的能力。

Abstract

The purpose of this study is to use the excellent high conductivity of grapheme, which is to be added on the negative electrode of lithium ion battery to improve the excellent electrochemical performance and rate performance and stable temperature characteristics. As a result, both power density of the lithium ion battery and high current discharge capacity can be increased greatly.

關鍵詞(Key Words)：石墨烯添(Graphene)、鋰離子電池(Lithium Ion Battery)、負極(Negative Electrode)、儲能(Energy Storage)。

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有關變電所自動化 IEC 61850 與新興資通訊標準演變趨勢研析

Analysis on the Evolution Trend of IEC 61850 and Emerging Communication Standards in Substation Automation

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摘 要

配合國家智慧電網總體規劃，台電公司任務為智慧電網之建置與執行，其中規劃與引進 IEC 61850 智慧變電所為公司推動智慧電網之重要執行項目。

IEC 61850 為智慧電網之重要核心標準，IEC 61850 智慧變電所強調不同廠家設備之間互操作性，解決傳統變電所變更不易、僅能使用特定廠家設備之限制。

本文探討 IEC 61850 有關變電所自動化標準演變趨勢並進行研析，亦針對大數據、人工智慧、物聯網、5G 等新興資通訊標準進行討論，可供研究及實際需求參考。

Abstract

In line with the national smart grid overall planning, Taipower is required to build smart grids and implement related projects. Planning and introducing IEC 61850 smart substation are among the important goals for implementation and promotion in the smart grids.

IEC 61850 is an important core standard for smart grids. IEC 61850 smart substation, which emphasizes interoperability between devices provided by different manufacturers, aiming to solve the problem of changing traditional substation and device-specific restrictions.

This article discusses the evolution trend of IEC 61850 on substation automation standards and analyzes them. It also discusses emerging information and communication standards such as big data, artificial intelligence, Internet of Things, 5G, etc., which can be used for research and practical needs.

關鍵詞(Key Words)：IEC 61850、智慧型變電所(Intelligent Substation)、大數據(Big Data)、物聯網(Internet of Things)、人工智慧(Artificial Intelligence)、5G。

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分裂產物傳遞現象研究

The Study of Fission Product Transport Phenomena

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摘　要

核能電廠發生嚴重核子事故時，分裂產物會依嚴重事故之種類與特性以不同之釋出量、速率及物理化學特性由爐心釋出，並透過核能電廠的各種特殊安全設施與深度防禦所建立的多重屏障外釋到大氣環境中，造成不同程度之污染與危害。本研究中介紹分裂產物的傳遞路徑與傳遞機制，並以核一廠三種不同類型的事故為例，使用嚴重事故分析程式MAAP5 為工具，探討分裂產物自燃料棒釋出後，最終外釋到大氣環境過程中的各種傳遞現象。

Abstract

In this study, the fission product transport paths and mechanisms are described. Three different accident sequences of Chinshan NPP are selected as sample cases. The latest MAAP 5 code is used to calculate the source term of each accident sequence. Finally, the fission product transport phenomena and distribution in the containment are discussed.

關鍵詞(Key Words)：嚴重事故(Severe Accident)、分裂產物 (Fission Product)、金山電廠 (Chinshan Plant)、傳遞現象 (Transport Phenomena)、MAAP5 程式。

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