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再生能源及先進發電運維技術發展與應用　專輯

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改善協一機鍋爐燃燒高振動之燃調測試評估研究

Evaluation of Combustion Adjustment Testing for Improving Burner Rumbling on Hsieh-Ho Unit 1

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摘　要

協和發電廠鍋爐自民國 88 年 De-NOx 工程後，於民國 90 年 7 月起在高載運轉時即陸續出現鍋爐燃燒高振動現象，以協一機的狀況較明顯於負載大於 380MW 時會發生鍋爐爐膛高燃振現象(振動峰值超過 600μm)；於民國 106 年 8 月經發電處邀約請綜研所與電廠共組燃調小組後，在 106 年年底大修前即召開會議研商燃調方案及規劃配合工作。

本研究於民國 107 年度上半年以優化燃調方式進行協一機鍋爐調整與測試，於 107 年年中完成改善工作後已成功減緩鍋爐爐膛高燃振，並且釐清 17 年來引起高燃振的主要肇因。經優化燃調後印證於 400MW，可穩定運轉使爐膛燃振峰值調降至 128μm，約為臨界峰值 600μm 的 22%以內並且負載仍然有調昇潛力，原本運轉負載受限問題獲得充份改善後，於 107~108 年夏季「限電」情境下該機組適時減緩公司供電緊繃程度。

Abstract

The currently existing De-NOx systems at Hsieh-Ho Power Plant were mounted and installed in 1999. Starting from July 2001, severe furnace rumblings have been observed during high load time periods of Unit 1. The management echelon of Hsieh-Ho power plant therefore took measures to mitigate the problem but the said situation remained especially when loads were over 380MW. Convened by the Generation Department, TPRI and Hsieh-Ho power plant set up a combustion adjustment working group in August 2017 and a plan had been formulated a plan the end of the year. During the first half of year 2018, rumblings at high loads had been improved due to combustion optimization and identification of the causes of rumbling. A series of combustion adjustments proved that (1)Unit 1 could maintain steady operations at 400MW, (2)the amplitude of furnace rumbling could be reduced to 128μm within 22% of the critical values 600μm, and (3)the load could be further increased. The combustion adjustments of Unit 1 to some degree released the pressure of tight power supply that time.

關鍵詞(Key Words)：序列式優化(Sequential Optimization)、燃燒調整(Combustion Adjustment)、爐膛燃振(Furnace Rumbling)、限電(Limit Power)、鍋爐(Boiler)。

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回頁首

儲煤安全性之研究

A Research on Coal Storage Safety

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摘　要

為紓緩外界對於燃煤機組造成空污問題之陳抗聲浪及善盡社會義務，未來儲煤方式將以室內煤倉為主，然而採用室內方式進行儲煤更容易因煤氧化產生的熱量累積而導致自燃。本研究先建立煤質自燃特性之評估方法，再探討儲煤管理、儲煤自燃之預防及處置策略等課題，可作為研擬儲煤安全管理機制的參考，促使儲煤的安全性提升，降低儲煤發生自燃的機率，進而達成穩定的供煤，將有助於台電穩定供電之目標。

Abstract

To mitigate public protests against air pollution caused by coal-fired generation, indoor coal storage (ICS) has become a common trend. However, ICS is apt to cause spontaneous combustion due to heat accumulation attributed to coal oxidation. This study in the first step establishes an assessment method aiming at the characteristics of coal spontaneous combustion, and then explores the topics of coal storage management, and prevention & disposal strategies for coal spontaneous combustion, as a reference for drafting coal storage safety management mechanisms. The results of this study will not only elevate the safety of coal storage, reduce the chance of coal spontaneous combustion, but also help stabilize the power supply in Taiwan.

關鍵詞(Key Words)：室內煤倉(Indoor Coal Storage)、自燃(Spontaneous Combustion)、熱量累積(Heat Accumulation)、氧化(Oxidation)、儲煤安全(Storage Safety)。

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台中電廠#1 機 BFPT 前四級葉片 CFD 流場分析

The CFD Flow Field Analysis of the 1st to 4th Stages Blades in #1 Boiler Feed Water Pump of Taichung Power Plant

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摘　要

鍋爐飼水泵為火力電廠之重要輔機設備，而驅動泵浦的動力來源為從中低壓汽機中抽取蒸汽推動渦輪機以帶動泵浦維持朗肯循環的持續進行。本研究首先對 BFPT 的操作條件做分析以求得 CFD 的邊界條件，並利用所得的參數探討鍋爐飼水泵汽機前四級葉片流場的流動情形，針對流場及葉片對於整體效率的影響進行 CFD 分析，結果發現舊機組的結構及葉形由理論所得的邊界條件進行分析後每級的焓降差異較大，整體焓降約為 231.59kJ/kg；每級的效率大約在 85%~90%間，整體效率為 89.29%。另外針對後續改進部分也提出了改進葉片形線與增設導流結構的建議。

Abstract

Boiler Feed Water Pumps are important auxiliary devices for thermal power plant operation. Steam drawn from intermediate and low-pressure steam turbines are used to power the turbine (BFPT) of the pump to achieve smooth Rankine cycle operation. This research aims to analyze the operation conditions of BFPT to obtain boundary condition for proceeding follow-up CFD analysis, along with utilizing the parameters thus obtained to study the flow field of 1st stage to 4th stage blades. In addition, CFD analysis are carried out to investigate the influence of flow field and blades upon overall efficiency. The results after analyzing theoretical boundary condition of structure and blade shapes indicates that enthalpy drop at each stage exhibits significant differences. The overall enthalpy drop is 231.95kJ/kg, while the efficiency of each stage is around 85%~90% (overall efficiency 89.29%). Further improvements are suggested such as changing blade profile of airfoil and adding flow-guide structures.

關鍵詞(Key Words)：鍋爐飼水泵(Boiler Feed Water Pump, BFPT)、計算流體力學(Computational Fluid Dynamics, CFD)、台中電廠(Taichung Power Plant)。

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台中港區防風林之風況量測

The Wind Measurement of Wind Break Forest Surrounding Taichung Port

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摘　要

過去對於陸域風場的選址均考慮平坦的西海岸做為風機布機的位置，較少針對複雜地形進一步做分析。然而在現有風機布機位置附近，由於逐漸增加的人群活動，漸漸在風機附近增加許多建築物，或是為了防風需求增加防風林以方便人群的活動需求，使得風機附近的風場條件朝向複雜地形發展。台中地區高美濕地附近為公司風機布機之重要位置，然而附近防風林符合複雜地形的條件，因此探討防風林的風況，進而分析防風林對該處環境的影響，除了能夠進一步了解防風林對風場造成的變化外，也能夠評估對風機造成的不利影響，提前做應有的處置。

本研究利用光達剖風儀進行台中港區的防風林風況量測，並配合中央氣象局的氣象資料做風況的比對分析，除了收集該處風能的相關資料以外，進一步發現防風林與地形交互作用下，入流風受到擠壓加速，使得防風林處的風速會有加速的現象。

Abstract

Formerly, onshore wind farm siting gave priority to flat areas, e.g. west coasts of Taiwan (instead of complex terrain). Due to increase of human activities, there are now more and more buildings close to wind turbines. To meet the derived needs of the increasing human activities, windbreak forests have been built, and cause the nearby wind conditions of flat areas evolve toward complex terrain. Gaomei Wetland in Taichung for example is a crucial site of wind energy, where TPC have installed several wind turbines there. The windbreak forests and wind conditions of the wetland may very well be used to simulate complex terrain. Studying on the wind conditions of windbreak forests and their influences to the environments can help us understand the changes of wind condition due to windbreak forests and their adverse effects to wind turbines, so we may take beforehand actions.

In this study, we employed Lidar to measure wind conditions of windbreak forests surrounding Taichung Port by comparing with meteorological data from Central Weather Burau. It's also found that inflow wind would be squeezed due to the interaction between windbreak forests and terrain and cause the acceleration of wind speed.

關鍵詞 (Key Words)：複雜地形(Complex Terrain)、防風林(Windbreak Forests)、光達(Lidar)、風力發電機(Wind Turbines)、風況量測(Wind Measurement)。

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回頁首

鍋爐材料流動加速腐蝕破損案例分析與預防

A Case Study and Precaution Mechanisms of Boiler Flow Accelerated Corrosion

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摘　要

近年來台灣火力發電鍋爐發生數次流動加速腐蝕破壞，導致機組停機檢修，為減少此類型破壞，本文介紹流動加速腐蝕的機制、國內案例與預防策略。流動加速腐蝕主要是因碳鋼遭受腐蝕輔助的電化學腐蝕過程與質傳效應，在 150℃下氧化膜磁鐵礦溶解速率達到最高值，導致氧化膜減薄與碳鋼管路厚度減少，而發生管路破壞。數起國內單相液流與汽/液雙相流破損案例，符合流動加速腐蝕破壞特徵，在文末提出預防策略，以求降低因流動加速腐蝕所導致的破壞。

Abstract

In recent years, thermal power plants in Taiwan have occurred several times unit shutdown caused by flow accelerated corrosion (FAC) damages. This study aims to introduce the mechanism, domestic cases and precaution mechanisms of FAC. FAC differs from erosion as it is primarily an electrochemical corrosion process aided by chemical dissolution and mass transfer. The dissolution rate of the magnetite reaches its maximum value at the temperature of 150℃, and causes pipe damages jointly due to the thinning of oxide film and pipe thickness. Several domestic single and dual phase damage cases match the characteristics of FAC. Lastly, a precautionary strategy to reduce FAC damages is proposed for reference.

關鍵詞(Key Words)：流動加速腐蝕(Flow Accelerated Corrosion)、磁鐵礦(Magnetite)、馬蹄坑(Horseshoe Pits)。

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大潭 501F 燃燒器之熱流與燃燒模擬技術研發

The Analysis of Fluid Heat and Combustion Simulation of Da-Tan Mistubishi 501F Combustor

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摘　要

台電近年購置之燃氣複循環渦輪機(CCGT)組數目增加，因應近年國際對環境保護空汙排放管制標準訂定更加嚴格，燃氣機組控制 NOx 排放的機制和設備便因應趨勢而開發。而本研究針對燃氣燃燒的核心部位 DLE(Dry Low Emission)燃燒器，進行初步燃燒器機械結構內的模擬分析，如在定性、熱溫度分布區、流場現象、燃燒火焰型態、燃燒產物 NOx 濃度(以環保局訂定之 15% O_2 為計算標準)行為分布…等等。以此累積針對 DLE 構型燃燒器之定性趨勢現象分析經驗，以期未來能提出一改良效率之燃燒器構型。本研究建立之基礎型分析研究技術可供未來在技術移植應用在燃氣機組不同構型燃燒器分析上，還可更進一步藉分析結果之觀察和監控數據搭配，以此提供燃燒調校方面之建議，待技術成熟後，未來期望可據經驗更進一步在燃燒器組件上進行設計改良。

Abstract

To cope with increasingly strict international regulations on air pollution and rapid technological progress of NOx emission of gas-fired generators, the number of gas turbines purchased and owned by Taiwan Power Company (TPC) has also shown a rising tendency. This study aims to simulate and analyze the internal structure of dry low emission (DLE) type combustor of gas turbines developed to lower the NOx production. The contents of this study respectively includes preliminary qualitative analysis, temperature distribution, flow field phenomena, behaviors of combustion flame, and pollutant NOx concentration distribution (following the regulations of Environmental Protection Bureau- quantifying NOx for industrial combustion at 15% dry oxygen[1]), looking forward to bringing up insights for high efficiency combustor design. Furthermore, the results of this study, when cooperated with further analysis result observations and monitoring data, may very well be applied to the analysis/simulation and design improvement of other types of DLE combustors.

關鍵詞(Key Words)：乾式低排放 (Dry Low Emission)、氮氧化物(NOx)、燃燒器(Combustor)、氣渦輪機(Gas Turbine)、模擬分析(Simulation Analysis)。

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回頁首

氣機葉片材料真空重熔精煉之研究與應用

The Research and Application of Vacuum Remelting and Refining of Gas Turbine Blade Materials

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摘　要

電廠提供材質為 Udimet 500 且已報廢的第 3 級動葉片供本所進行真空重熔精煉之研究。經由真空熔煉製程之評估、材料性質計算軟體之估算、熱處理條件之選用，第 1 次實驗進行了 Udimet 500 材質之舊葉片真空重熔精熔，隨後並進行數種不同熱處理及材料試驗分析。研究結果顯示舊葉片經過重熔精煉後，其不同元素會因熔點高低而有不同程度燒損的情形。此外，在重熔精煉後進行數種不同條件之熱處理，其拉伸機械性質均優於熔煉前之報廢舊葉片，且高溫潛變破斷試驗之斷裂時間皆超過 EPRI 的合格標準。以 SEM 亦可觀察出 Udimet 500 鑄錠經 1085℃/4hr + 848℃/4hr + 760℃/16hr 之固溶+兩段時效熱處理，其 coarse γ'粒徑約 0.5μm 且較方正。第 2 次實驗進行了調整成份的熔煉，本所成功以添料熔煉方式將 Udimet 500 調質為 IN738 材料。以上技術未來可持續推廣於各電廠，以進一步進行葉片回收應用。

Abstract

Some scrapped 3rd stage moving blades, made of Udimet 500 from TPC power plants, were provided to TPRI to proceed related researches of vacuum remelting & refining. Preliminary steps such as vacuum melting process evaluation, material calculation software estimation, and selection of heat treatment receipt had been taken before the 1st round experiment, covering remelting & refining and ex ante & ex post verifications began. The results of the experiment indicated that the alloy composition of the blades, due to melting point distinction, presented varied degrees of burn-out condition. Besides, a number of heat treatments along with the experiment indicated that the ex post tensile properties were superior to the ex ante, and the rupture time of the high temperature creep test not just met but exceeded the EPRI eligibility criteria. With the help of scanning electron microscope (SEM), we observed that the size of coarse γ' particle, under the condition of 1085℃/4hr + 848℃/4hr + 760℃/16hr, was about 0.5 μm and square shaped. In our 2nd round experiment, we conducted the smelting with adjusted components and this time it successfully changed Udimet 500 into IN738 by additive melting. We are obliged to promote the aforesaid blade recycling technologies and their applications continuously to TPC power plants in the future.

關鍵詞(Key Words)：重熔(Remelting)、精煉(Refining)、Udimet 500、IN738、Gamma Prime。

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開發陸上風力發電機攜帶式葉片健康狀態巡檢裝置之研究

The Research of Using Portable Wind Turbine Noise Inspection Devices on to Inspect Wind Turbine Blade Damage

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摘　要

風機零部件之保養與維修是風力發電產業在營運過程的重要工作項目之一，因台灣氣候相較於歐美國家較為潮濕炎熱，且夏季常有颱風侵襲，風機葉片在複雜的氣候條件下長期運轉表面會逐漸剝落與破裂，需定期進行葉片狀態之巡檢，且視損傷情況停機進行保養維護。目前台灣風場營運單位仍依賴現場維護人員的視覺與聽覺經驗評估葉片健康狀況，此種傳統的主觀檢測方法仰賴人員的經驗且效率不高。本研究提出利用風機在運轉過程產生的葉片噪音進行損壞檢測方法，開發攜帶式巡檢裝置進行風場快速巡檢。此裝置的優點在於能夠於風機正常運行的狀態下檢查葉片，透過定期的巡檢作業，掌握葉片健康狀態的變化趨勢，事先安排維修時程，降低停機造成的發電損失。預計未來將有效提升台灣風力發電電產業的營運效率。

Abstract

Maintenance and repair of wind turbine blades are crucial work items for wind power industry. Long-term operation under severe weather conditions, e.g. typhoons and hot & humid climate in Taiwan, inclines to cause gradual damages to wind turbine blades. Most wind farm operators in Taiwan nowadays still rely on visual and auditory judgements of the field maintenance staffs to detect the health conditions of the wind turbine blades. Nevertheless, the aforesaid traditional methods depending on human senses are subjective, inefficient and maybe inaccurate. This study aims to propose a new method for blade fault inspection utilizing wind turbine noises and on-site inspection with the help of portable devices. The advantage of the said portable devices is that the inspections may be conducted under normal running conditions of the wind turbine blades, so as they may be applied to routine inspections and ex ante maintenance and repair scheduling. We foresee the technology and application mentioned above may elevate the operation efficiency of the wind power industry in Taiwan.

關鍵詞(Key Words)：風機噪音(Wind Turbine Noise)、葉片損壞檢測(Blade Fault Inspection)、攜帶式巡檢裝置(Portable Device)。

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回頁首

風海觀測塔長期結構振動監測系統

The Structural Vibration Monitoring System of TPC Meteorology Mast and Exploring the Marine Structure

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摘　要

本研究以台電公司設立於王功漁港外海之離岸風海觀測塔為探討對象並因應結構振動研究於規劃階段增設六軸之加速度計進行連續且長期之結構振動監測，為確保監測成果滿足後續結構動力特性分析需求及驗證建置階段之成果，本研究針對目前監測成果進行資料初步分析及特性解析並調校系統。文章內容將涵蓋(1)結構振動監測項目、(2)設備規格、(3)獲取訊號呈現。

Abstract

This study explores a Meteorology Mast set up by TPC in the open waters of Wang-Gong fishing port and six accelerometers have been added at the planning stage to perform continuous and long-term structural vibration monitoring. To make sure the monitoring results meet the following requirements of structural dynamic characteristics analysis and to verify the results of construction stage, we conduct preliminary analysis on the recorded data and system adjustment based on the monitoring results. The contents of this study include: (1) Structural vibration monitoring items, (2) Equipment specifications, and (3) Presentation of acquired signals.

關鍵詞(Key Words)：海氣象觀測塔(Meteorology Mast)、結構振動(Structural Vibration)、特徵解析(Feature Extraction)、長期連續振動監測(Long-term and Continuous Vibration Monitoring)。

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區域太陽光電即時發電量估算系統開發

Development of Real-Time Estimation System for Regional Photovoltaic Power Generation

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摘　要

近幾年政府大力推動太陽光電發展，截至 108 年底全台太陽光電裝置容量已超過 2.6GW，由於現行再生能源發電系統併聯技術要點並未規定裝置容量小於 1MW 的再生能源發電設備須提供即時運轉資料給台電公司[1]，且多數小型太陽光電站發電直接併入饋線，因此台電公司對於各地區太陽光電即時發電量不易掌握，隨著全台太陽光電裝置容量快速的增加，為維持電網的穩定，掌握各地區太陽光電即時發電量的重要性亦越來越高，綜合研究所以機器學習技術開發一區域太陽光電即時發電量估算系統，利用各地區日照量測資料及太陽光電站購電資料推估各地區即時太陽光電發電量。

Abstract

Taiwan government has vigorously promoted the development of renewable energies during these years. By May 2019, the capacity of photovoltaic system in Taiwan exceeded 2.6GW. Under the regulation of the Renewable Energy Development Act, small photovoltaic generation facilities (capacity below 500kW) are exempt from providing generation information to Taiwan Power Company (TPC). Besides, due to most photovoltaic generation facilities are net metering customers of TPC (surplus generation inject directly into the grid), it is not easy to trace/monitor their real time generation. Accompanied with the fast growing capacities of photovoltaic systems, it is urgently important to have a good knowledge of the real time generation information of photovoltaic systems to maintain the stability of the power grid. In view of this, Taiwan Power Research Institute (TPRI) has developed a regional photovoltaic real time generation estimation system based on the technology of machine learning. The system utilizes the information of solar irradiance from various regions and purchased power to estimate the real time generation of photovoltaic generation facilities in various regions.

關鍵詞(Key Words)：太陽光電即時發電量估算(Real-Time Estimation of Photovoltaic Power Generation)、機器學習 (Machine Learning)。

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回頁首

風機發電機故障預判模型之建立

Building a Fault Prognosis Model for Wind Turbine Generator

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摘　要

風力發電系統主要由風能轉換為機械能的風力機和將機械能轉換為電能的發電機兩大部份組成，其中，發電機是整個系統的核心，直接影響風力系統之性能、效率與供電質量，同時也是系統中易發生故障的部份。因此，針對風機發電機進行故障預判研究，儘早發現故障徵兆並進行修護，以確保證風力發電機的正常安全運轉具有重大的實際意義。隨著 AI 技術的發展與進步，利用機器學習方法進行故障預判可獲致良好結果。因此，本研究利用 SCADA 資料，透過機器學習技術如主成分分析、單類支援向量機等，進行彰工 1~6 號風機發電機故障預判，俾利於風力發電機預防性修護工作之進行，而達到降低風機維修成本及提高其運轉效能之目標。

Abstract

A wind power system mainly composes of a wind turbine (converting wind energy into mechanical energy) and a generator (converting mechanical energy into electrical energy). Generator is the center/core of wind power systems, directly affecting the performance, efficiency and power supply quality of the system. Nevertheless it is also the fault-prone part of wind power systems. It is crucial to identify fault symptoms as early as possible to carry out follow-up maintenance to ensure safe operation of wind turbine generators. Along with the development of AI technology, fault prognosis applying machine learning methods help obtain the expected results. In this study, we utilize SCADA data and apply machine learning techniques, such as principal component analysis and one-class support vector machines, to perform fault prognosis for Chang-kung No. 1~6 wind turbine generators.

關鍵詞(Key Words)：主成分分析(Principal Component Analysis)、單類支援向量機 (One-Class Support Vector Machines)、故障預判曲線(Fault Prognosis Curve)。

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回頁首

因應大量再生能源併入下台灣輸電系統視覺化介面開發

Developing Visualized Transmission Interface System to Cope with Mass Renewable Generation

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摘　要

台灣電力系統未來將可能併入大量的再生能源，若能事先進行大規模的系統情境分析，將可以事先洞悉再生能源併入後對於系統運轉的衝擊，例如揭露經常壅塞的線路、電壓異常的區域、以及可能的暫態穩定度衝擊。然而再生能源的出力變化非常快速，且電力系統分析需要處理相當多的數據。除了加速模擬運算的時間外，透過視覺化技術可以快速且準確得知系統運轉的即時狀態，以及協助系統操作者快速一覽系統的操作全貌，了解系統的弱點並提出改善的方法以紓解系統操作瓶頸。

本研究採用實際台灣電力系統參數建立視覺化平台，並可輸入未來不同情境下的再生能源出力進行電力系統穩態與暫態模擬分析。本開發系統視覺化的功能包含顯示輸電線路與變電所的位置、匯流排電壓熱度圖、過電壓與欠電壓表格、傳輸線路承載率狀態、系統潮流縮時顯示、以及穩態與暫態的系統模擬結果波形等。

Abstract

A large amount of renewable energies will be continuingly integrated to the power system in Taiwan. Scenario analysis in advance provides a better knowledge of how renewable energies impact the system (both perspectives of system planning and system operation), e.g. congestions, abnormal voltages, and transient stability. However, due to the volatility of renewable output, the analysis depends on mass data processing. Visualization technology not only accelerates the calculation, but also helps the system operator monitor/control the real-time operation status of power system.

This study applies actual power system parameters, visualized platforms and assumptions of future situations as inputs to carry out steady/transient state power system simulation analysis. The aspects of the visualized display system of this study include : (1)location of transmission lines and substations, (2)heat map of bus voltages, (3)tables of over-voltages and under-voltages buses, (4)carry rate of transmission lines, (5)system power flow, and (6)curves of steady-state and transient simulation results.

關鍵詞(Key Words)：再生能源(Renewable Energy)、情境分析(Scenario Analysis)、壅塞線路(Congestion Line)、視覺化技術(Visualization Technique)。

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太陽光電發電系統故障診斷技術回顧與探討

Review and Discussion on Fault Diagnosis Technology for Solar Photovoltaic Power Generation Systems

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摘　要

太陽光電系統曝露在室外環境以及長時間運轉下可能發生某些局部故障，若未能即時清除這些故障，可能會使整個太陽光電系統產生不可逆的損壞。這些故障可能起因於太陽光電模組本身所造成的，例如二極體、接線盒、或模組故障；或是環境因素造成的，例如遭受長期部分遮蔭效應所產生的熱斑故障，或是電氣性故障，例如開路故障、接地故障、電弧故障、以及線對線故障等。太陽光電系統故障不僅會降低發電量，甚至可能會引發火災，因此，故障的檢測與診斷就變得十分重要。本文回顧了太陽光電系統各種可能的故障類型，以及典型檢測與診斷的方法。藉由文獻回顧與探討，可以比較各種檢測方法的優缺點、評估不同檢測方法可能適用的故障類型、最後提供未來診斷技術的精進方案以及趨勢做為參考。

Abstract

Outdoor environments and operation of long time period inevitably cause failures to solar photovoltaic systems, and delayed clearing of the failures otherwise cause irreversible damages to the entire solar photovoltaic system. The failures are multifold: (1)the solar photovoltaic module, e.g. failures of diodes, junction boxes, or the module of PV systems, (2)environmental factors, such as hot spot failure caused by long time period partial shading effects, (3)electrical faults, e.g. open circuit faults, ground faults, arc faults, and line-to-line faults. The failures not merely cause reduction of PV power generation, but also a fire in the worst case. Therefore, fault detection and diagnosis are crucial. This study introduces the fault possibilities of PV systems, compares & evaluates advantages and disadvantages of various detection methods to help decide the most suitable application for different types of failures, and the last and most important brings up an improvement plan and trend of the future for reference.

關鍵詞(Key Words)：太陽光電系統(Solar Photovoltaic System)、熱斑(Hot Spot)、電氣性故障(Electrical Fault)、故障檢測與診斷(Fault Detection and Diagnosis)。

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