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各國再生能源發電預測技術探討

The Study of Renewable Energy Generation Forecasting Technologies in Major Countries

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摘 要

隨著再生能源併入量增加，電力系統運轉的不確定度將增加。降低系統不確定度的重要方法之一便是執行再生能源發電預測。再生能源預測需要具備高可靠度的量測設備、精確的數值天氣預報模式、適當的輸入變數、以及合適的預測訓練模型。世界各國，特別在歐、美、澳地區目前已經提出許多再生能源預測的模式與工具，本論文的主旨便是彙整目前主要發展再生能源國家的工作重點，包含預測的主管機關、預測模型主要的輸入變數、預測模型的種類與預測程序、預測工作的重點項目、以及未來可能的趨勢。這些彙整的資訊以及分析中衍伸的重要概念可提供我國再生能源預測工作的參考。

Abstract

The increase of grid-connected renewable energies has escalated the uncertainty of power system operation. One of the methods to reduce the aforesaid uncertainty is renewable energy generation forecasting, which requires: (1)highly reliable measurement instruments; (2)accurate numerical weather prediction (NWP) models; (3)appropriate input variables; (4)suitable forecasting training models. A number of countries (e.g. Europe, USA, and Australia) have developed suitable models and tools to forecast renewable energy generation. This study summarizes the key works of renewable energy forecasting in major countries. The contents of this study as a reference for Taiwan include: (1)government authority of renewable energy generation forecasting; (2)major input variables of renewable energy generation forecasting models; (3)types of forecasting models and procedures ; (4)key works of forecasting models; (5) the future trends.

關鍵詞(Key Words)：再生能源 (Renewable Energy)、不確定度 (Uncertainty)、預測(Forecasting)、數值天氣預報(Numerical Weather Prediction)、輸入變數(Input Variable)、預測模型(Forecasting Model)。

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長跨距連接站鐵塔技術之突破

A Breakthrough of Long-Span Junction Tower Technology

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摘　要

本案既設架空線路多處腐蝕，線下並種植高莖作物，且面臨區域快速發展，陳情案件層出不窮。原規劃將既設屏東~潮州白線改接至現有四回線鐵塔線路#9~#27，並將東港溪內原二回線路之線路#28、#29 改建為四回線路，再由#29 連接站鐵塔埋設管路至潮州 S/S。然而由於路徑跨越東港溪，適逢高屏大橋斷橋，河川管理單位尺度緊縮，鐵塔建設計畫履遭退回；在申請堤防用地時，亦因道路興建時程及民意抗爭而無法執行。歷經 4 種方案的申請，最終以工程技術克服 600 米長跨距，透過鐵塔升級及線種更換，達成線下高度 22 米之規定，以最經濟及最有效率的方法完成本工程。另外亦加裝小柱休息平台及圍欄，提供人員安全的作業環境。希望本工程經驗，可供往後類似工程參考。

Abstract

The background factors of this project include: (1)corrosion of overhead transmission lines; (2)high-stem plants under transmission lines; (3)rapid area development; (4)endless petition events. The contents of the original plan include: (1)mount Pingtung-ChaoChou White line to 4-circuit transmission towers; (2)rebuild the 2-circuit towers in Tung-Kang River bed to 4-circuit towers; (3)lay pipelines from #29 junction tower to ChaoChou substation. Since the planned route had to span Tung-Kang River and coincided the event of Kao-Ping Bridge Collapse, the Tower Establish Plan had been rejected by the River Administration Office several times. In addition, the application of embankment sites had not been accepted due to pre-arranged road construction schedule and popular protests. After the hardships of going through four alternative plans, 600 meters long-span proposal stood out. The advantages of the proposal: (1)comply with the 22 meters limit regulation for transmission line; (2)carry out tower and conductor upgrade in most economic and efficient way; (3)retrofit platforms and fences on small column to provide a safe environment. We hope our experience can provide reference for similar projects.

關鍵詞(Key Words)：長跨距 (Long Span)、連接站鐵塔(Junction Tower)、回線擴充(Circuit Expansion)。

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輸電線路用雷擊突波計數器之修復及功能測試作法開發

Developing Repair and Functional Test for Lightning Surge Counter on Transmission Lines

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摘　要

地下電纜線路為免遭雷擊損及設備而影響供電可靠度，常於電纜連接站、屋外式變電所等處裝設避雷器，輸電用 161kV(含)以上避雷器附屬之雷擊突波計數器(Lightning Surge Counter)於平時可顯示雷擊突波之觸發次數與洩漏電流值，供作為絕緣性能良莠判斷之參考；另當避雷器動作則提供突波電流釋放至大地的路徑。鑑於近年台電公司供電單位轄屬計數器常因竊賊偷剪連接站內接地電纜時，連帶扯斷計數器下端鎖固接地電纜之螺栓而造成損壞，故本篇以 SC-13 型計數器為例，率先提出螺栓修復方法以及開發功能測試之作法，進而延長計數器使用壽命以及驗證計數計是否正常動作之盲點，期許本篇成果對日後輸電地下電纜線路維護工作提供助益，並能作為避雷器、突波計數器檢測作業之參考。

Abstract

To avoid equipment damage caused by lightning and negative impact to the reliability of power supply, underground cable lines are often protected by installing lightning arresters in places such as cable connection stations and outdoor substations. Lightning surge counters (LSCs) attached to 161kV (inclusive and above) transmission lines normally may display trigger numbers of lightning strikes and leakage current values (as a reference for judging the performance of insulation) and the path of burst currents. In view of the fact that the LSCs TPC are from time to time damaged by ground cable thefts in connection stations (tearing off the bolt of the lower end lock solid ground cable of the counters), this paper by taking SC-13 type counters as an example presents methods for bolt repair and developing function tests (to extend the service life of LSCs and verify whether the counting is normal or not). It is expected that the results of this paper will benefit the maintenance of underground cable lines in the future and to be used as a reference for lightning protection and burst counter detection operations.

關鍵詞 (Key Words)：雷擊突波計數器(Lightning Surge Counter)、洩漏電流(Leakage Current)、環式比流器(Surround Type Current Transformer)。

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國際溫室氣體減量資訊追蹤及建置電力排碳係數監視機制計畫

The Study of Tracking International Greenhouse Gas Reduction Information and Constructing Carbon Exhaust Coefficient Monitoring Mechanism

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摘　要

為了商討如何共同抵抗日益加劇的全球暖化現象，各國領袖每年於 COP 大會齊聚一堂，經過多年的談判與協商，終於在聯合國氣候變化綱要公約第 21 次締約國會議(Conference of Parties, COP21)通過《巴黎協定》(Paris Agreement, PA)，2016 年 COP22 則聚焦於如何以實際行動落實生效之《巴黎協定》，相關規則於 2018 年 12 月 COP24 會議完成，也宣示全球將邁入一個嶄新的氣候公約時代。

有鑑於上述前提，本研究目的在於追蹤國內外碳市場、溫室氣體減量標準及國際間重要會議之發展資訊，並依據電業管制機關訂定之「電力排碳係數管理辦法」研擬電力排碳係數相關參數之蒐集及管理機制。

本研究計畫具體產出成果包括國際碳市場及溫室氣體減量相關主題報導 5 篇、碳市場雙月刊 9 篇、舉辦本公司內部教育訓練 2 場、優化本公司「溫室氣體監視管理資訊系統」、建置「公用售電業電力排碳係數申報管理系統」等。

Abstract

To cope with the aggravating impacts of greenhouse effect, worldwide leaders after years of negotiations have finally reached series of agreements, e.g. the Paris Agreement of UNFCCC COP21 in 2015, COP22 in 2016 (focusing on real actions to implement the Paris Agreement), and COP24 in 2018 (to complete the related rules). Those agreements have created a new era to mitigate the effects of climate change.

The contents of this study: (1)follow up significant movements regarding greenhouse gases, carbon markets, emission reduction standards (domestic or abroad); (2)build up management system to collect information of related regulation such as the Electricity Act.

The results of this study: (1)five subject reports related to carbon markets and emission reduction have been published; (2)nine bimonthly journals focusing on carbon prices have been published; (3)two training sessions were held; (4)a system optimization project has been accomplished; (5)a new system has been implemented.

關鍵詞(Key Words)：電力業(Electric Industry)、碳資產管理(Carbon Assets Management)、總量管制與排放交易(Cap and Trade)、排放交易機制(Emissions Trading Scheme, ETS)、溫室氣體(Greenhouse Gases, GHGs)。

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回頁首

汰役電池安全標準的內容與說明

Summary of Safety Standards for Repurposing Batteries

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摘　要

隨著電動車輛的推廣與增加，汰役電池開始出現，未來數量將會快速增長，因此成為一個必須要解決的問題。這些動力電池在淘汰時，部分仍然有大約 80% 的容量，顯然可以再次加以利用，例如做為儲能電池之使用。但由於是此類淘汰物品可能出現安全上的問題。Underwriters Laboratories (UL)公司在 2013 年提出電池於儲能系統的安全標準(UL 1973)來因應此問題，但為面對汰役電池推廣之需求，於 2018 年出版二次利用電池安全評估標準(UL 1974)。本文係參考 UL 1973 與 UL 1974 兩個標準，就電池儲能系統的發展現況，將這些標準加以整理與說明，供使用者參考，期能加速電池儲能系統的產業發展。

Abstract

Accompanied by the increase of electric vehicles, repurposing batteries will increase rapidly as well in the future. How to deal with these batteries has become an open-ended question. Some retired power batteries possess about 80% initial capacity. So they can be utilized once again, for example, to serve the batteries in the energy storage system. However, this may cause safety problems. Underwriters Laboratories (UL) published the safety standard for batteries for use in stationary, vehicle auxiliary power, and light electric rail applications in 2013 (UL 1973) to respond to the said issues. To promote wide-ranged applications, UL published the safety standard for repurposing battery evaluation in 2018 (UL 1974). In this paper, we summarize the contents of UL 1973 and UL 1974 as a reference to accelerate the industrial development of battery energy storage system.

關鍵詞(Key Words)：鋰離子電池(Li-ion Battery)、汰役電池(Repurposing Battery)、二次電池(Second-life Battery)、電池儲能系統(Battery Energy Storage System)、二次利用(Second Use)、安全標準(Safety Standard)。

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台電公司轉型控股母子公司初探

A Preliminary Study of the Organizational Transformation of Taiwan Power Company

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摘　要

電業法業於 2017 年 1 月 26 日總統令修正公布。台灣電力股份有限公司(以下簡稱「台電公司」)如何因應電業法規定，成功轉型為控股母子公司經營模式，為本文之探討要項。本文蒐集控股公司學理依據，分析相關法規，探討國內大型集團企業、國際知名電力或能源集團轉型之案例，進而明瞭其轉型過程、對子公司之管控及配套機制，以及可資參考之集團管理特色。綜合前述學理、法規、國內外轉型案例等觀察結果，接續探討台電公司轉型之策略與方向，即於確保履行供電義務之前提下，轉型控股母子公司之思考核心，以及母公司對子公司之管控模式，並據以歸納母子公司應有之功能定位。此外，也就公司轉型配套機制提出相關對策，並對台電控股母子公司之功能架構提出芻議，俾供台電公司因應電業法修正，進行後續組織轉型規劃與推動之參考。

Abstract

According to the Electricity Act (the Act) amended in January 2017, Taiwan Power Company (Taipower) shall transform from a vertically integrated electric utility into one holding company and two subsidiaries, namely one Genco and one GridCo. This study aims to propose a feasible framework as a reference for Taipower to conduct its organizational transformation pursuant to the Act. To achieve the goal, this study explores domestic and abroad cases, e.g. large-scale enterprises in Taiwan and electric utilities/energy companies in France, South Korea, Japan. The highlights of this study: (1)premises of Taipower's organizational transformation (to shoulder the responsibility of stable power supply and get prepared for market competition); (2)principles to implement the organizational transformation; (3)adoptable management measures between the holding company and two subsidiaries; (4)regulation compliance.

關鍵詞(Key Words)：國營事業轉型(Transformation of State-Owned Enterprises)、電力自由化(Electricity Market Deregulation)、組織轉型(Organizational Restructuring)。

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壓水式核電廠安全組件銲接殘留應力有限元素分析

Finite Element Analysis for Welding Residual Stress of Safety-related Components in PWR NPP

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摘　要

一次側應力腐蝕裂紋(PWSCC)為壓水式核電廠反應爐管嘴常見的劣化機制之一。美國機械工程師學會鍋爐與壓力容器規範(ASME BPVC Code)中，以破裂力學為基礎之安全評估標準與方式已被闡述於第 XI 章，內容說明了執行安全評估時需考慮銲接殘留應力，但並未進一步說明如何獲得其值。一般而言，有限元素分析進行銲接製程模擬為計算獲得銲接殘留應力的一種主要方式。然而，因計算時所需考慮的參數眾多，計算上的不確定性就成為影響殘留應力及後續 PWSCC 成長分析結果的重要因素之一，不同的分析人員常因分析觀點不同而選用不同的分析輸入，進而得到不同的分析結果。為解決此問題，美國核管單位(NRC)與業界安全評估專家最近已提出一份銲接殘留應力的有限元素分析指引，期望分析人員日後能夠依此指引而得到較為一致的分析結果。因此，本論文參考此指引針對核三廠重要管嘴進行銲接殘留應力分析及討論，所得的分析結果可提供核三廠後續執行 PWSCC 成長分析所需之資訊。

Abstract

Primary Water Stress Corrosion Cracking (PWSCC) is one of the aging mechanisms commonly seen in the safety related nozzles of Pressurized Water Reactor. American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME BPVC Code) has set forth standards for safety evaluations based on the theory of Fracture Mechanics in Section XI of the code. According to the code, welding residual stress (WRS) is a factor to be considered when performing safety evaluation, but the code itself does not specify how to obtain WRS value. Although finite element analysis (FEA) is an important approach to calculate WRS value, there are many parameters to be considered when calculating WRS value, and uncertainty in calculation would affect the outcome of WRS and PWSCC. Since not all cases apply same evaluation factors in practices, deviations among cases are not rarely seen. To solve the technical gap, representatives from the Nuclear Regulatory Commissioning (NRC) and nuclear industries have recently provided a guidance for FEA of WRS. With the guidance, it is expected that more consistent results could be obtained. By referring to the guidance, this study applies FEA to calculate the WRS of major safety related nozzles in Maanshan nuclear power plant and have a discussion on the results. We hope the WRS analyzed and obtained from this study will provide useful information for subsequent PWSCC evaluation in Maanshan NPP.

關鍵詞(Key Words)：銲接殘留應力(Welding Residual Stress, WRS)、一次側應力腐蝕裂紋(Primary Water Stress Corrosion Cracking, PWSCC)、有限元素分析(Finite Element Analysis, FEA)。

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核能電廠緊急應變計畫區民眾疏散方案規劃與模擬分析

Evacuation Plan and Related Simulation Analysis of NPP Emergency Planning Zone

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摘 要

臺灣目前運轉中之核能電廠，包括位於新北市石門區核一廠、萬里區核二廠，以及屏東縣恆春鎮核三廠，在日本福島核事故後，行政院原子能委員會已修正緊急應變計畫區(Emergency Planning Zone, EPZ)之範圍，由原先半徑 5 公里的範圍擴充至 8 公里。本研究藉由道路路網疏散模式與路網車流模擬模式，考量核電廠緊急應變計畫區範圍內各類人員，包括居民、遊客、學校、弱勢族群…等，於不同時段、不同風向、不同災害嚴重程度、及複合型災害情境之疏散，以完整考量集結點、防護站及收容場所規劃之合適度，除基本之公路疏散外，亦同時分析海上、空中疏散方案之可行性。

Abstract

There are three operational nuclear power plants in Taiwan, namely Chinshan Nuclear Power Plant (Shimen, New Taipei City), Kuosheng Nuclear Power Plant (Wanli, New Taipei City), and Maanshan Nuclear Power Plant (Hengchun, Pingtung County). After the Japan Fukushima nuclear disaster in March 11, 2011, Atomic Energy Council under Executive Yuan in Taiwan has extended the radius of Emergency Planning Zone (EPZ) from the original 5 km to 8 km. This study aims to draw up a plan of gathering, evacuation and sheltering points for people within the EPZ of the nuclear power plants in Taiwan. Network evacuation and traffic simulation models have been developed by considering how to evacuate different types of people (e.g. residents, tourists, students & faculties, vulnerable group) under various scenarios such as time periods, wind directions, severity of disaster, and multi-hazard scenarios, to draw up a plan of gathering points, protection stations and shelters. Besides highway evacuation, the feasibility of seaway and aerial evacuation has also been investigated.

關鍵詞(Key Words)：疏散(Evacuation)、緊急應變計畫區(EPZ)、路網分析(Network Analysis)。

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壓水式反應器低溫水固狀態增壓熱流分析

Thermal-hydraulic Analysis of Low Temperature Water-solid Pressurization Transient of Pressurized Water Reactor

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摘　要

當壓水式電廠反應爐冷卻水系統 (RCS) 運轉於停機低溫狀態，萬一發生增壓暫態時，設計上有低溫過壓保護 (LTOP) 系統，能及時以較低設定點自動開啟調壓槽動力釋壓閥 (PORV) 釋壓，避免 RCS 最高壓力超過 10 CFR 50 Appendix G P-T Limit。

本文以國內馬鞍山電廠為範例，依據給定之 LTOP PORV 設定點與 RCS 溫度之關係圖，訂定分析個案矩陣，考慮 RCS 運轉於低溫水固狀態可能發生之質量加入及熱量加入事件，使用熱流分析程式 GOTHIC，建立模式並進行暫態計算，同時將熱端管最高壓力分析結果與 10 CFR 50 Appendix G P-T Limit Curve 比較，驗證 LTOP PORV 設定點做低溫過壓保護的充分性。GOTHIC 模式包含了 RCS 及蒸汽產生器水固狀態、反應爐冷卻水泵及調壓槽 PORV 運作、充水注入、蒸汽產生器 U 型管熱傳等模擬。

Abstract

This study applies the method of thermal-hydraulic analysis and takes Maanshan plant for an example to analyze pressurization transients of pressurized water reactors, which occur under the conditions of water-solid and low reactor coolant system (RCS) temperature.

Both events of mass and heat inputs are considered. The former assumes that maximum flow rate has injected into the cold leg due to the full opening of charging flow control valve. The latter assumes that a reactor coolant pump (RCP) has inadvertently started due to that the temperature of the steam generator shell side is 50 °F higher than that of RCS. An analysis matrix is established based on a given diagram of low temperature overpressure protection (LTOP) & power operated relief valve (PORV) setpoints vs RCS temperature. GOTHIC thermal-hydraulic analysis model is setup accordingly, by modeling fluid system of RCS and steam generator in conjunction with components such as RCP and PORV.

Then the maximum hot leg pressures (calculated by GOTHIC model for the matrix cases) are used to compare with the 10 CFR 50 Appendix G P-T Limit to verify whether the given LTOP PORV setpoints are adequate for RCS overpressure protection or not.

關鍵詞(Key Words)：壓水式反應器(PWR)、壓力-溫度限值(P-T Limit)、低溫過壓保護(LTOP)、GOTHIC 程式(GOTHIC)。

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