

台電工程月刊875期(7月)目錄

再生能源：

RENEWABLE ENERGY：

臺中港防波堤波浪發電試驗研究蔡清標 等.....(1)

An Experimental Research on Breakwater-integrated Wave Energy Converter-taking Taichung Harbor as an Example.....Tsai, Ching-Piao et al.(1)

配 電：

DISTRIBUTION：

單相二線式模組化低壓智慧電表設計與建置實務.....林哲毅 等.....(14)

The Design and Deployment of Single-phase 2-wire Modular Smart MetersLin, Che-I et al.(14)

資訊與電腦：

INFORMATION AND COMPUTER：

電費核算開票系統升級及功能擴充執行方案規劃研究楊新全 等.....(24)

A Research of Upgrading and Expanding the Functions of the Current Billing SystemYang, Shin-Chuan et al.(24)

工程技術：

ENGINEERING TECHNIQUES：

考量材料老劣化之鋼筋混凝土結構物整體評估方法鍾立來 等.....(41)

Assessment Methods for Reinforced Concrete StructuresChung, Lap-Loi et al.(41)

其 他：

OTHERS：

以智慧公共住宅建構虛擬電廠示範案例之成效分析洪幼倫 等.....(53)

A Benefit Analysis Utilizing Smart Public Housing as a Virtual Power Plant.....Hung, Yu-Lun et al.(53)

新加坡電業改革歷程：新典範與新方向.....王駿旻.....(64)

The Evolution of Singapore Electric Industry：New Paradigms and Directions.....Wang, Chun-Min.....(64)

核能發電：

NUCLEAR POWER GENERATION：

核電廠燃料重填換爐心佈局設計驗證與分析技術提昇葉昭廷 等.....(75)

An Independent Verification of NPP Reload Design and Core Technology Improvement.....Yeh, Jau-Tyne et al.(75)

臺中港防波堤波浪發電試驗研究

An Experimental Research on Breakwater-integrated Wave Energy Converter-taking Taichung Harbor as an Example

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摘要

我國能源進口依賴度達 97% 以上，積極尋找可行之自產低碳能源是國家重要的政策方針。臺灣擁有大量的防波堤，若能配合建置波浪發電，除具有保護堤防功效，亦能將波浪能轉換成電能，替代部分化石燃料並減少二氧化碳排放。臺灣電力公司為積極配合政府能源轉型政策，擬評估開發臺中港可自主且具基載能力之波浪發電可行性。本研究透過大量的資料蒐集及數值模式評估、水工模型試驗分析，考量了波浪能的擷取效率、裝置體的安定性以及施工、操作的便利性之防波堤整合式波浪發電裝置藍圖已完成。透過本研究之水工模型試驗得知，規則波情況下，波浪發電裝置最大有約 83.12% 之波能擷取效率；不規則波則為 61.0%。另該裝置已利用最佳化後的威爾斯渦輪機成功發電，初步測試不規則波發電效率可達 31.6%。此外，在 50 年颱風受力下，本裝置相較於傳統型的 OWC 波能擷取裝置，可降低約 40% 迎波牆面的波壓力。

Abstract

Taiwan relies on imports for more than 97% of its energy. Looking for indigenous low-carbon energy is an indispensable policy for the government. Taiwan has over 245 harbors. A numerous of breakwaters have been built to protect the embankments by absorbing/dissipating the wave energy. If we can turn the wave energy into electric energy, our consumption of fossil fuels for generation may be reduced, the emission of carbon dioxide emissions as well. To comply with the energy transition policy (to achieve the goal of Nuclear-Free Homeland and to reduce the emission of greenhouse gases), Taiwan Power Company started evaluating the feasibility of utilizing wave energy as baseload generation, using the breakwater-integrated wave energy converter. This study evaluates the feasibility of applying oscillating water column (OWC) wave energy converters to achieve the aforesaid goal. The contents of the study includes: (1) collecting and analyzing the meteorological data, sea weather data, and topography data in Taichung harbor, (2) investigating wave energy potential, optimal configurations of the OWC device, the efficiency of the OWC wave energy converter, and (3) storm wave loading on the OWC device utilizing CFD methods and experiments. As the results indicate, there are abundant wave energy along the north breakwater of Taichung harbor, even more extensive than the offshore. The optimization of the OWC device has been done by simulating the situations of Taichung harbor. The optimized OWC device is about 83.12% under regular wave and 61.0% under irregular wave. A self-made wells-turbine had also been tested with the OWC device and the energy conversion efficiency was around 31.6%. Besides, the OWC device could reduce around 40% wave loading on the structure of the embankments under storm wave.

關鍵詞 (Key Words) : 波浪發電裝置(Wave Energy Converter)、再生能源(Renewable Energy)、計算流體力學(Computational Fluid Dynamics)、水工模型試驗(Wave Flume Experiments)。

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單相二線式模組化低壓智慧電表設計與建置實務

The Design and Deployment of Single-phase 2-wire Modular Smart Meters

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摘要

配合國家政策推動智慧型電表基礎建設，2018 年已啟動新型模組化智慧型電表建置作業，迄今已建置近百萬戶，預計 2024 年完成 300 萬戶安裝，目前所布建之智慧型電表表型皆為單相三線式(單三)及三相四線式(三相)模組化電表，而單相二線式電表因數量少且分佈零星，故先前評估並非優先採購範疇。現今隨著建置密度逐漸提高，逐步納入老舊社區公共用電多為單相二線式(單二)電表，但受限於既設電表之使用空間有限，故設計模組化單二電表架構，以補足低壓電表之所有表型，即模組化低壓智慧型電表之最後一哩。另模組化 AMI 電表之供應廠商日漸增加，其電表軟體操作方式皆有所不同，以至台電總處及區處現場人員須熟悉各廠牌之軟體且操作方式不一，造成現場人員操作困擾，再者近期大規模 AMI 電表布建，依標準電表程式化設定流程，需逐具程式，已造成建置進度的困擾，故本研究一併考量跨廠牌及批次程作業之精進作為，大幅減少人工作業(如電號輸入、程式 ID/TOU ID 等)，簡化設定程序及有效縮短程式時間，以利未來大規模布建使用。

Abstract

To comply with the government's AMI policy, modular smart meters have been promoted since 2018, with a goal of installing 3 million meters by 2024, and single-phase 3-wire 3-phase 4-wire low voltage modular meters have been successively developed and installed. Due to the sparseness and sporadicness, single-phase 2-wire smart meters were not the priority procurement item. However, to be in pace with the increase of installed smart meters, it is necessary for us to design single-phase 2-wire modular smart meters to complete the last mile of low-voltage smart meter installation.

Furthermore, more and more AMI meter suppliers have joined in the market and millions of smart meters installed. However, the meter operation softwares, from various providers, are different from each other and are adding burdens to the on-site technicians. In this project, we have successfully developed an operation software, suitable for all kinds of smart meters, to simplify the setup procedures and to reduce the programming time for large scale AMI deployment in the near future.

關鍵詞(Key Words)：智慧型電表 (Smart Meter)、單相二線式 (Single-phase 2-wire)、程式化電表 (Programming Smart Meter)。

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電費核算開票系統升級及功能擴充執行方案 規劃研究

A Research of Upgrading and Expanding the Functions of the Current Billing System

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摘要

台灣電力公司智慧電網建置 AMI 之發展，配合行政院規劃目標，於 2018 年完成低壓用戶 20 萬戶、2020 年達成累計低壓用戶 100 萬戶、2024 年累計低壓用戶 300 萬戶系統建置。現有「電費核算開票系統」將不符應用，因此需要升級，以維持系統穩定運作、降低資安風險、提升開票作業效率、整合購電業務。擬先進行軟硬體升級，並擴充功能俾承接 MDMS 大量 AMI 用電資料，以利需量反應及時間電價應用，期能抑低尖峰負載，提高 AMI 投資價值。同時配合行政院資安法之實施，亦需強化資通安全防護，落實個人資料保護，提升用戶服務。

本計畫將參考國外智慧電網建置 AMI 資訊服務應用案例，及售電、購電、帳務、客戶關係管理資訊系統建置情形，以實地明瞭建置實務，研究規劃符合公司未來營運需求之售購電及客服資訊系統，介接 AMI 資料，精進需量管理，強化購售電業務。

Abstract

To be in line with the objective of smart grid implementation plan set by the Executive Yuan, Taiwan Power Company accumulatively deployed around 200,000 and one million household AMI meters respectively in 2018 and in 2020, and three million household AMI meters will be completed before 2024. The current billing system will not be applicable for future application and will be therefore upgraded according to the following requirements: (1) to maintain stable operation, (2) to reduce the risk of information security, (3) to improve the efficiency of billing operation, and (4) to integrate the business of power purchasing. The software and hardware will be upgraded first, subsequently the mass AMI power consumption data in the meter data management system (MDMS) to couple the applications of demand response (DR) and time of use price (TOU), to clip peak loads and to increase the value of AMI investment. In conjunction with the enforcement of the Cyber Security Management Act, it is necessary to strengthen the protection of information security and customers' personal data.

關鍵詞(Key Words)：電表資料管理系統(Meter Data Management System, MDMS)、智慧電網(Smart Grid)、客戶關係管理(Custom Relationship Management, CRM)。

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考量材料老劣化之鋼筋混凝土結構物整體評估方法

Assessment Methods for Reinforced Concrete Structures

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摘要

本研究目的主要建立一適用於考量材料老劣化後鋼筋混凝土結構物之整體評估方法，包含耐久性能診斷與耐震能力評估。耐久性能診斷包含建築物概要調查、構件劣化度等目視調查為主的初步診斷，以及以材料試驗為主之詳細診斷，如：混凝土抗壓強度、氯離子含量、中性化深度及腐蝕電位等，由診斷結果評定結構物耐久性能等級。透過耐久性能診斷，可得到鋼筋腐蝕重量損失率，藉以對老劣化鋼筋混凝土材料及構件力學行為進行修正，再透過側推分析得到老劣化結構物之耐震能力。

Abstract

The purpose of this research is to establish overall assessment methods, including durability diagnosis and seismic evaluation, for reinforced concrete structures, putting into the consideration of material aging and deterioration. The scopes of durability diagnosis include summary investigation, preliminary diagnosis based on visual investigation, and detailed diagnosis based on material test. Through the above method, the weight loss of steel bar corrosion may be calculated, mechanical behaviors of the deteriorated reinforced concrete materials and components accordingly modified, and the seismic capacity of deteriorated structures projected by the aid of pushover analysis.

關鍵詞 (Key Words) : 老劣化(Aging & Deterioration)、鋼筋混凝土(Reinforced Concrete)、耐久性能診斷(Durability Diagnosis)、耐震能力評估(Seismic Evaluation)、鋼筋腐蝕(Corrosion)。

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以智慧公共住宅建構虛擬電廠示範案例之成效分析

A Benefit Analysis Utilizing Smart Public Housing as a Virtual Power Plant

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摘要

隨著我國整體電力需求的增加及政府大力推動綠色能源，台灣未來能源的穩定供應將面臨巨大壓力，邁入轉型過渡期的同時，也將面對電力供需不平衡之風險。對此，政府已規劃廣泛應用智慧電網技術，以平衡電力供需。臺北市政府選定公共住宅作為讓市民共同參與節能服務及穩定供電的示範標竿場域，隨著公共住宅硬體和軟體設施的導入與啟用，住戶成為可參與需量競價並獲取收益的電力生產型消費者。而藉由電力市場自由化與聚合平台的建置，聚合微小需量的商業模式的發展，也將促使虛擬電廠的擴大設置，預期將有機會解決電力平衡問題，並進一步實現臺北智慧城市願景，為臺北市政府、台電公司和市民創造三贏局面。

Abstract

As we all know, Taiwan is embarking on energy transition (the government's green energy first policy) and facing a risk of power shortage (sharp increase of domestic electricity demand). To greet the challenges, smart grid technology can be used as one of the key solutions. The Taipei City Government selected public housing as a demonstration field allowing its citizens to participate in programs such as energy-saving and power system stabilization. With the accessibility of the modern hardware/software infrastructure of public housings, the role of citizens is changing, from original consumers to prosumers by participating in demand response/bidding programs. The implementation of the Aggregator Business Model (ABM) together with the Trial Electricity Trading Market may contribute to promoting the development of virtual power plants (VPPs) has a good chance to solve the problem of tight power supply and create a win-win-win situation for the Taipei City Government, Taiwan Power Company and the public.

關鍵詞(Key Words)：虛擬電廠(Virtual Power Plant)、智慧電網(Smart Grid)、需量反應(Demand Response)、用戶群代表(Aggregator)。

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新加坡電業改革歷程：新典範與新方向

The Evolution of Singapore Electric Industry : New Paradigms and Directions

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摘要

本文旨在探討新加坡推動電業自由化之四階段歷程。自 1995 年以法人分離為開端，1996~2003 年建構配套之批發電力市場與管制架構，2001~2008 年進一步推動廠網分離及發電公司民營化，2001~2019 年從大用戶逐步開放至全面開放小用戶購電選擇權。整個電業改革過程歷經近 25 年。在管制面透過公用售電業與特定合約機制設計等管制工具，以穩定電價並保障用戶權益。在競爭面則透過市場結構設計，促進發電與售電市場競爭，提升新加坡電業經營效率。國營公用電業在過程中肩負供電義務，善盡電業發展推動者角色，並積極推動智慧化與數位化轉型，提供用戶高效率解決方案。該國電業改革在管制面、競爭面與電業發展面進行整合性規劃，循序漸進，保留彈性作法及公用事業轉型因應策略等，皆深具參考價值，可作為我國電業發展前瞻規劃之借鏡。

Abstract

This paper examines the four-phase electric industry reform in Singapore. The said reform started with legal unbundling (since 1995), subsequently the development of wholesale electricity market and regulatory framework (1996-2003), the unbundling of generation and the grid and the privatization of generation sector (2001-2008), and lastly the opening of retail market (2001-2019). The whole process took 25 years. Regarding the regulatory reform, market support service licensee and vesting contract had been devised and introduced. Regarding the competitive electricity market, the state-owned electric utility is obliged to stabilize the retail prices, ensure reliable power supply, and acts as an enabler of digital transformation. The integrated and flexible deregulation policy and utility transformation strategy of Singapore may serve as reference for Taiwan.

關鍵詞(Key Words)：法人分離(Legal Unbundling)、批發電力市場(Wholesale Electricity Market)、民營化(Privatization)、開放電力市場競爭 (Open Electricity Market)。

核電廠燃料重填換爐心佈局設計驗證與分析技術提昇

An Independent Verification of NPP Reload Design and Core Technology Improvement

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摘要

為確保核電廠的爐心營運安全，台電公司一直致力於自主分析技術的建立與發展、保有一套獨立於廠家的爐心營運分析程式集。每個填換燃料週期都進行爐心設計獨立驗證，確認所有爐心設計安全參數都符合設計限值，而且符合運轉安全規範，確保燃料廠家每個填換燃料週期設計安全無虞。

本研究計畫「核電廠燃料重填換爐心佈局設計驗證與分析技術提昇」期程自一百零六年八月到一百零九年八月，合計三年。計畫所建立電廠爐心分析模式不只可以支援爐心營運其他相關計畫，同時更是核電廠暫態安全分析的基礎。除了完成各個電廠每一個週期填換燃料爐心設計的平行驗證工作外，其他相關成果包括引進用過核燃料分析程式以擴大支援用過核燃料最終處置及除役等後端營運領域、完成核一廠用過核燃料池格架硼片腫脹議題及龍門電廠核燃料濕式貯存池改乾式貯存等之臨界分析、建立核燃料束中子設計技術、完成核電廠用過核燃料運轉歷史重建、以及多次運用分析技術支援電廠運轉緊急需求等。

Abstract

To ensure the safety of nuclear power plants (NPPs) operation, Taipower Company has been committed to retaining an independent program set (different from the vendors) for reactor operation core analysis. The loading pattern of fuel vendors will be verified independently for each reload cycle to make sure all safety parameters in accordance with design criteria and technical specifications.

The Project, titled Independent Verification for NPP Reload Design and Core Technology Improvement, started from August 2017 and ended in August 2020. The analysis modes of reactor core developed in this project can support both the plant operation and the transient analysis. In addition to the completion of independent reload design verification, what follows had also been achieved: (1) introducing SNF code to support the backend management, including final disposal and decommissioning of the spent fuels, (2) completing the criticality analyses of boron sheet swelling of the storage racks for Chinshan plant, as well as changing wet storage to dry storage of the fuels for Lungmen plant, (3) establishing the technology of neutronics lattice design, and reconstruction of the data base of fuel operating history for all nuclear power plants. Besides, the analysis techniques have also been used to support NPP emergency operation several times.

關鍵詞(Key Words)：爐心營運系統(Core Management System)、填換燃料設計(Reload Design)、後端營運(Backend Management)。

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