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寬能隙半導體於再生能源之應用與案例分析

Application and Case Analysis of Wide Bandgap Semiconductors in Renewable Energy

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摘 要

隨著再生能源占比的提升，應用於再生能源的轉換器性能要求也越來越高。其中，功率半導體開關影響了再生能源轉換器的效率。根據半導體的發展，可分為第一代、第二代和第三代半導體。第一代半導體材料，如矽(Si)和鍺(Ge)，發展技術相對成熟，也因價格較低，已廣泛應用於消費性電子產品之中。第二代半導體材料，如砷化鎵(GaAs)與磷化銦(InP)化合物，具有抗輻射與高導熱性等特性，因此，適合應用於雷達、射頻與光纖領域中。第三代半導體，包括碳化矽(SiC)及氮化鎵(GaN)等材料，又稱寬能隙半導體(Wide Bandgap Semiconductor)，其具有更高的載子遷移率及耐高溫特性，在電力電子、通訊設備和發電系統的應用，擁有更廣泛的應用潛力。本研究針對寬能隙半導體之切換頻率、轉換效率、溫度特性以及工作電壓進行研析外，並介紹其於再生能源之應用與案例分析。

Abstract

As the proportion of renewable energy increases, the performance requirements of converters used in renewable energy are also getting higher and higher. Among them, power semiconductor switches have a critical impact on the efficiency of renewable energy converters. In terms of development, semiconductors can be divided into first-generation, second-generation, and third-generation semiconductors. The first-generation semiconductor materials, such as silicon (Si) and germanium (Ge), have relatively mature development technologies and are widely used in consumer electronics because of their low cost. The second-generation semiconductor materials, such as gallium arsenide (GaAs) and indium phosphide (InP) compounds, have properties such as radiation resilience and high thermal conductivity. Therefore, they are suitable for use in radar, radio frequency and optical fiber fields. The third-generation semiconductors, including materials such as silicon carbide (SiC) and gallium nitride (GaN), are also called wide bandgap semiconductors. They have higher carrier mobility and high temperature resistance, are widely used in power electronics, communication equipment, and power generation systems, and have wider application potential. This study analyzes the switching frequency, conversion efficiency, temperature characteristics and operating voltage of wide bandgap semiconductors, and introduces their applications in renewable energy and case studies.

關鍵詞(Key Words)：再生能源(Renewable Energy)、寬能隙半導體(Wide Bandgap Semiconductor)、半導體開關(Semiconductor Switch)、固態技術 (Solid-state Technology)。

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回首頁

能源樞紐發展及氫應用模式探討

On Energy Hub Development and Hydrogen Application Model

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摘 要

全球淨零驅動下，能源樞紐發展逐漸受到重視，各國開始推動各類能源樞紐計畫，並透過區域能資源整合，協助區域或產業聚落推動淨零轉型。台電公司若能借鏡國外能源樞紐推動做法，並將能源樞紐應用導入我國能源系統，預期將有助提升我國整體能資源使用效率與能源供應韌性。國際能源樞紐研析歸納以下三點結論：(1)能源樞紐發展主流類型包涵多元能源供需、電轉氣及智慧化能源系統三大類；(2)多數能源樞紐應用聚焦在產業聚落淨零轉型與氫供應鏈兩大應用領域；(3)能源樞紐模型主要投入在多元微型能源與電轉氣能源系統兩類應用研究。為加速能源系統轉型，參考國外案例做法，本文建議台電公司將來能源樞紐發展流程可依序透過(1)場域評估、(2)資源整合、(3)需求盤點、(4)供需整合及(5)情境分析步驟，並透過能源樞紐示範計畫，評估我國推動能源樞紐應用之可行性，並輔以模型進行經濟效益評估。

Abstract

Driven by the global net-zero trend, the development of energy hubs has gradually received attention. Many countries have begun to promote various energy hub projects and assist regions or industrial clusters in promoting net-zero transformation through the integration of regional energy resources. If Taipower can learn from foreign energy hub promotion practices and introduce energy hub applications into its energy system, it will help improve Taiwan's overall energy resource usage efficiency and energy supply resilience. After research, this project has drawn the following conclusions: (1) The mainstream development of energy hubs includes multiple energy supply and demand, power to gas and smart energy systems (three major types); (2) Most energy hub applications focus on net-zero industrial clusters transformation and hydrogen supply chain (two major application areas); (3) The energy hub model is mainly invested in multiple micro-energy and power-to-gas energy systems (two types of application research). In order to accelerate the transformation of the energy system, this article recommends that Taipower's future energy hub development process can refer to foreign case practices and proceed through the following steps: (1) site assessment, (2) resource integration, (3) demand inventory, (4) supply and demand integration, and (5) scenario analysis. In addition, the feasibility of promoting the application of energy hubs in Taiwan can also be assessed through energy hub demonstration projects, supplemented by models for economic benefit assessment.

關鍵詞(Key Words)：能源樞紐(Energy Hub)、能源供需(Energy Supply and Demand)、產業聚落(Industrial Clusters)、氫供應鏈(Hydrogen Supply Chain)。

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輸電地下電纜多回路之送電容量計算與實例探討

A Case Study on Calculating Multi-circuit Power Transmission Capacity of Underground Cables

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摘　要

輸電地下電纜設計完成後，如採多回路特殊型管路設計時，應先行分析送電容量，並確認是否具有足夠供電能力及符合安全調度之要求。有鑑於此，本文構思計算輸電地下電纜送電容量前，參考輸電工程作業手冊及日本電線工業會 JCS-0501 規範及各電纜特性參數，應用 VB 程式及基因演算法，模擬分析電纜群中之最高溫度電纜，以之作為基準電纜，分析多回路電纜溫昇與管路間距及土壤熱阻抗的關係，透過標準型四回線二管底及四回線四管底進行演算基準電纜位置，完成標準型管路排列驗證，進而套用多回路特殊型管路排列計算送電容量，驗證可依照現場實際管路排列，以快速回饋送電容量數據供電力調度之參考。

Abstract

After the design of underground power transmission cables is completed, if multi-circuit special pipeline design is adopted, the power transmission capacity should be analyzed first and confirmed whether it has sufficient power supply capacity and meets the requirements for dispatch security. In view of this, before conceiving and calculating the power transmission capacity of underground cables, we first referred to the transmission engineering operation manual and the specifications of the Japan Electric Wire Industry Association JCS-05015 and the characteristic parameters of each cable, and then apply VB programs and Genetic Algorithm to simulate and analyze the highest temperature cable in the cable groups and use it as the reference cable. In addition, we analyzed the relationship between the temperature rise of multi-circuit cables, pipeline spacing and soil thermal impedance, and calculated the reference cable positions through standard four-circuit two-tube bottoms and four-circuit four-tube bottoms to complete the standard pipeline arrangement verification. Then, the multi-circuit special pipeline arrangement is used to calculate the power transmission capacity. It is verified that the actual pipeline arrangement on site can be used to quickly feedback the power transmission capacity data to serve as reference for power dispatching.

關鍵詞(Key Words)：輸電地下電纜(Underground Transmission Cable)、多回路(Multi-circuit)、基準電纜(Reference Cable)、基因演算法(Genetic Algorithm)。

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IP-MPLS 及快速重路由方式探討

Discussion on IP-MPLS and Fast Reroute Methods

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摘　要

本公司通信與網路資源因各單位業務需求漸增，為確保能提供公司業務更為穩定，資源更充足且業務能順利推行，本處已於近年陸續建置完成多重通訊協定標籤交換系統，IP-MPLS 在系統可靠度與資源使用率皆優於原系統 NG-SDH，目前已逐漸將原系統開設電路改接至新建系統，可進一步提升電路的品質穩定度與降低網路資源的瓶頸，透過本章我們將會介紹 IP-MPLS 系統與該系統保護電路的技術與機制，以及新舊系統優缺點比較。

Abstract

Taipower's various units have increasing demands for communications and network resources. To ensure company normal operation the Communication Department has successively completed the construction of a new Internet Protocol Multi-Protocol Label Switching System (IP-MPLS) in recent years. The new system is superior to the original Next Generation Synchronous Digital Hierarchy (NG-SDH) system in terms of reliability and resource utilization. At present, circuits established in the original system have been gradually switched to the new system, which can further improve the quality and stability of the circuit and reduce the bottleneck of network resources. The purpose of this article is to introduce the IP-MPLS system and the technology and mechanism of the system's protection circuit, and to compare the advantages and disadvantages of the old and new systems.

關鍵詞(Key Words)：多重通訊協定標籤交換系統 (Internet Protocol Multi-Protocol Label Switching, IP-MPLS)、快速重路由(Fast Reroute)、電力通信(Utility Communication)。

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歐、美及亞太地區電廠 CCUS 發展與挑戰

Development and Challenges of CCUS for Power Plants in Europe, the United States, and the Asia-Pacific Region

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摘 要

碳捕獲、再利用與封存技術(CCUS)在過去幾年快速發展，市場規模逐漸擴大，與發電業的結合也日益緊密。但許多計畫由於政策不確定性、融資困難、運輸和封存許可等問題而被迫暫停。考慮到各地區政策支持度、電廠條件和使用技術的差異，本文將探討歐洲、美國及亞太地區碳捕獲技術的發展現況及面臨的挑戰，評估燃煤和燃氣電廠加裝碳捕獲設備的成本，同時對未來趨勢進行分析。除了歐洲和美國等市場的投資持續成長之外，日本與中國也在推動 CCUS 技術的商業化進程。然而現階段碳捕獲技術的大規模發展仍面臨諸多挑戰，在成本高昂的情況下，政府和企業需要突破技術瓶頸才能說服金融機構提供支持。要實現 CCUS 市場的長期穩定成長，政策支持、技術進步以及經濟可行性必須相輔相成，從而為減碳提供一條可行的途徑。

Abstract

Carbon capture, utilization and storage (CCUS) technology has developed rapidly over the past few years. Its market size is gradually expanding and its integration with the power generation industry is becoming closer. However, many projects have been suspended due to policy uncertainties, financing difficulties, transportation, and storage permit issues, etc. In view of the differences in policy support, power plant conditions, and technologies used in various regions, this article aims to explore the development status and challenges of carbon capture technology in Europe, the United States, and the Asia-Pacific region, evaluate the cost of installing carbon capture equipment in coal-fired and gas-fired power plants, and analyze future development trends. In addition to the ongoing growth of investment in markets such as Europe, the United States, Japan and China are also actively promoting the commercialization of CCUS technology. However, large-scale development of carbon capture technology at this stage still faces many challenges. In the case of high costs, governments and enterprises need to break through technical bottlenecks to persuade financial institutions to provide support. To achieve long-term stable growth of the CCUS market, policy support, technological progress, and economic feasibility must complement each other to provide a feasible way to reduce carbon emissions.

關鍵詞(Key Words)：碳捕獲、再利用與封存 (Carbon Capture, Utilization and Storage, CCUS)、發電業(Power Generation Industry)、成本分析(Cost Analysis)、政策支持(Policy Support)、經濟可行性(Economic Feasibility)。

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國際電業風險管理數位化發展與應用對台電風險管理數位發展規劃之參考

Taipower's Risk Management Digitization Development and Planning from the Perspective of International Electric Industry Applications

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摘　要

鑑於近年國內外重大風險事件如新冠疫情、美國德州大停電、台鐵太魯閣出軌、513 及 517 停電事故等之發生，企業經營必須持續精進風險管理，並加速數位轉型腳步，以因應環境快速變遷及更加嚴峻之新興風險挑戰。爰針對國際電業企業風險管理數位發展及數位科技應用情形進行研析，希冀能對台電公司未來企業風險管理數位發展之藍圖及資訊系統規劃方向提供具體建議，使台電公司風險管理機制接軌「推動數位轉型」之經營策略，透過數位科技輔助風險管理，提高風險管理之效率及效果，並達到風險預警與監控之功能。

Abstract

In view of the occurrence of major domestic and foreign risk in recent years, such as the COVID-19 epidemic, the Texas blackout in the United States, the Taiwan Railway Taroko derailment, and the 513 and 517 blackouts, etc., corporate operations must continue to improve risk management and accelerate the pace of digital transformation to adapt to the rapid environment changes and more severe emerging risk challenges.

In this project, we conduct research and analysis on the digital development of enterprise risk management and the application of digital technology in the international electric industry, hoping to provide concrete suggestions for Taipower's future digital development in enterprise risk management and information system planning direction, so as to align risk management mechanisms with the company's strategy of "promoting digital transformation", and through digital technology to assist risk management, improve the efficiency and effectiveness of risk management, and achieve the functions of risk warning and monitoring.

關鍵詞(Key Words)：法國電力(EDF)、東京電力(TEPCO)、南加州愛迪生電力(Southern California Edison, SCE)、企業風險管理(Enterprise Risk Management)、風險管理數位化(Risk Management Digitization)。

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以開放式創新生態系統推動台電多角化創新創業研究

Study on Promoting Diversified Innovation and Entrepreneurship in Taipower through an Open Innovation Ecosystem

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摘　要

台電公司擁有國營事業資源優勢，並具備深厚的技術底蘊。然在豐沛資源下，其多角化創新創業的商業彈性及創新機制效率仍有提升之空間。故本研究以「開放式創新生態系統」概念，結合外部知識與創新資源導入，加速內部技術商業化創新創業能力。本計畫透過國內外企業開放式創新推動個案研究，參考其它公營事業推動經驗，並結合實際推動台電內部創新經驗，包含創新競賽與課程點燃內部創新氛圍，遴選具潛力新創團隊進行深度輔導與市場驗證並蒐集推動過程中的挑戰及問題，探討適合我國框架下之未來台電內部創新推動機制。同時，提出為推動技術商業化之「內部創新流程」與「創新成熟度」之評估指標，作為台電公司後續推動內部創新之藍圖參考。

Abstract

Although Taipower owns state-owned resource advantages and profound technical foundations, it still has a lot of room for improvement in diversified innovation and entrepreneurship. In this study, we use the concept of “open innovation ecosystem”, and introduce external knowledge and innovation resources to accelerate the company’s commercialization of internal technologies. Through research on open innovation cases of domestic and foreign enterprises, as well as reference to the promotion experience of other government-owned enterprises, we combine the actual experience of promoting Taipower’s internal innovation, including innovation competitions and courses to ignite the internal innovation atmosphere, select potential new startup teams for in-depth guidance and market verification, and collect feedback information regarding the challenges and issues in the promotion process, to explore an internal innovation promotion mechanism suitable for Taipower to adopt. In addition, this study also aims to promote technology commercialization and develop evaluation indicators of “internal innovation process” and “innovation maturity” as a reference for Taipower’s subsequent blueprint for promoting internal innovation.

關鍵詞(Key Words)：開放式創新(Open Innovation)、商業模式(Business Models)、創新創業(Innovation and Entrepreneurship)、市場驗證(Market Validation)、創新成熟度(Innovation Readiness Level)。

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溫室氣體減量相關法規修法研析及因應

Analysis and Response to the Revision of Greenhouse Gas Reduction Regulations

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摘　要

《溫室氣體減量及管理法》自 112 年 2 月修正為《氣候變遷因應法》，將 2050 年淨零排放目標入法，並修正相關規定，包括溫室氣體盤查及查驗、碳權抵換及交易和碳費徵收等。而台電公司身為國營事業，對於我國溫室氣體達成淨零排放扮演至關重要的角色。本研究分析《氣候變遷因應法》關鍵條文與相關子法對於電力業之影響、我國碳權交易所啟動下企業使用國外碳權作為法遵之可行性，以及地方政府溫室氣體減量法規進程等，俾提供電力業規劃淨零策略之參考。

Abstract

In February 2023, The Greenhouse Gas Reduction and Management Act was amended to the Climate Change Response Act. In addition to incorporating the 2050 net-zero emission target, the amendment also revised relevant regulations including greenhouse gas inventory and verification, carbon credit offsets and trading, and the imposition of carbon fee. As a state-owned enterprise, Taipower plays a critical role in achieving net-zero emissions of greenhouse gases in Taiwan. The main contents of this study include analysis of the impact of key provisions and related sub-laws of the Climate Change Response Act on the electric power industry, the feasibility of enterprises using international carbon credit as legal compliance under the launch of Taiwan Carbon Solution Exchange (TCX), and the progress of greenhouse gas reduction regulations legislated by local governments, to serve as reference for the electric power industry in planning net-zero strategies.

關鍵詞(Key Words)：氣候變遷因應法(the Climate Change Response Act)、溫室氣體減量策略(Greenhouse Gas Reduction Strategies)、國外碳權(International Carbon Credit)。

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虛擬工廠於電廠輔助維修與教育訓練之實踐

The Practice of Virtual Factory in Power Plant Auxiliary Maintenance and Education Training

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摘 要

在追求低碳經濟的時代，燃煤電廠逐漸式微，取而代之的是更環保的發電方式，隨著新的機組開始運轉，大量的新進人員加入了電力事業，面對大量的新人，各單位面臨著如何有效的進行教育訓練及經驗傳承的問題。

網路與智慧型手機的普及，已成為這時代人們的基本配備，本計畫的目的是透過手機，協助電氣人員進行日常保養、故障搶修，以及紀錄每一次優秀的檢修經過與心得，使原先要多年經驗累積的技術，能夠更容易的讓後輩傳承、使用。

為實現這目的，我們設計一款以人員使用需求為基礎的手機應用程式，其中包含了資料儲存、設備操作模擬器、客製化的計算機，以及電廠的 3D 地圖等等功能。

Abstract

In the era of low-carbon economy, coal-fired power plants are gradually declining and replaced by more environmentally friendly power generation technologies. As new generating units begin to operate, a large number of new personnel join the ranks of Taipower. Faced with the above situation, each unit of the company is faced with the problem of how to effectively carry out education, training and experience inheritance. The Internet and smartphones have become basic equipment for people in this era. The purpose of this project is to use mobile phones to assist electrical personnel in their daily maintenance, troubleshooting, and record every excellent maintenance process and experience, so that the technology that originally required years of experience can be passed down and used more easily by future generations. To achieve this goal, we designed a mobile application based on personnel needs, which includes functions such as data storage, equipment operation simulator, customized calculators, and 3D map of the power plant.

關鍵詞(Key Words)：智慧型手機 (Smartphone)、數位學習(E-Learning)、發電廠(Power Plant)、虛擬工廠(Virtual Factory)、數位轉型(Digital Transformation)。

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