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太陽光電發電設備併聯輸電系統之功率因數檢討

A Study on Transmission-connected PV Power Factors

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摘 要

配合政府再生能源發展政策，經濟部能源局公告再生能源開發目標，預定 2025 年達到 30.161GW 再生能源裝置容量、2035 年達到 45.161GW 再生能源裝置容量。面對未來大量再生能源併聯，在不影響電網安全前提下，除須加強既有電網外，亦須配合電網相關管理機制及先進電網控制技術等，以確保供電穩定。本文針對現行再生能源併聯系統之功率因數要求進行說明，另針對無效電力補償設備介紹及現行功率因數檢討機制說明，檢討再生能源發電設備併聯後，於責任分界點是否具備足夠之功率因數調整能力，最後以某地區太陽光電發電設備併聯於特高壓系統之案例，進行功率因數檢討分析，依不同的電網條件及情境檢討，分析無效電力能力，並透過無效電力改善措施，如加裝補償設備、固定功率因數模式、固定無效電力模式及夜間模式等，檢討案場無效電力能力，於系統遇偶發事故時，能有足夠能力進行無效電力補償，達成全民、業者及台電公司三贏局面。

Abstract

To cope with renewable energy (RE) development policy of the government, the Bureau of Energy later announced the targets of RE development- 30.161GW in 2025 and 45.161GW in 2035. To allow a great volume of RE connected to the grid, the infrastructure of power system shall be strengthened and more advanced grid control technologies deployed to ensure the stability of power system operation. This article aims to introduce the requirements for power factors and the reactive power compensation facility and management mechanism of RE to be connected to the grid. To verify the reactive power control capability of photovoltaic (PV) facility, case studies of certain areas are discussed in this article. The study of reactive power compensation capacity has been defined in each scenario, and reactive power compensation ability and equipment analyzed. Depending on what kind of reactive power improvement strategy we adopt, the case studies will be comprised of the reactive power compensation equipment model, the active power model, the reactive power model, and the night operation mode. PV systems are capable of providing reactive power to the grid when a system failure occurs. A triple-win situation amid users, RE developers and Taipower may be attained.

關鍵詞(Key Words)：太陽光電(Photovoltaic)、無效電力補償(Reactive Power Compensation)、功率因數檢討(Power Factor Study)、檢討機制(Study Mechanism)。

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風機故障徵兆之大數據分析案例研究

A Case Study of Big Data Analysis on Wind Turbine Failure Symptoms

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摘　要

大數據(BigData)分析與應用是近年來科技發展的重要趨勢，其應用將為經濟及社會各層面帶來各種機會，在物聯網(The Internet of Things, IoT)與數位經濟時代，資料是最重要的核心。台電公司之資料豐富，係公司及社會之重要資產，資料之有效運用有助於電力產業及公司營運之發展，並可促進社會大眾對電業之瞭解與認同，配合政府推動大數據應用政策，加速台電公司大數據發展，創造資料價值。

台電公司於 108 年開始執行「大數據分析應用案例研究」，陸續規劃深化之數據分析案例應用。大數據分析案例應用(深化)即是繼台電公司於 105 年以來，推動各式各樣的資料，黑客松在落實資料治理上不遺餘力。延續資料驅動創新的精神，乃至 108 年舉辦首屆台電內部資料競賽「大數據人才發展營」，期待台電成員得以從中學習，探索資料價值透過資料驗證，探索提昇營運效率或是產品服務創新方法。進而提升台電員工的資料素養，培育團隊合作的大數據人才，促進電力資料之活化應用，鼓勵員工協力共創，探索台電內部之資料價值。

Abstract

Big data analysis and its relevant applications have become an important technology development trend in recent years and will bring opportunities in all aspects to the economy and society.

In the era of Internet of Things (IoT) and digital economy, data is the core of business.

The great amount of data of Taipower is an important asset for the company and the society. Effective use of the data may contribute not only to the development of the electric power industry, but also the operation of Taipower and the public’s understanding and recognition of the industry.

Based on the considerations of coping with the government’s policy of promoting big data applications, accelerating the company’s big data development and creating more data value, Taipower started executing a program named "the Big Data Analysis Application Case Study"

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since 2019 to deepen its applications in data analysis.

Since 2016, when Taipower first started “the Application of Big Data Analysis Case (Deepening) Project”, the project has pushed forward all kinds of data hackathon to put into practice data governance.

To extend the spirit of data-driven innovation, the project held the first Taipower Internal data competition, "the Big Data Talent Development Camp", in 2019. We would like to see the employees of Taipower learn from the camp, explore the value of data, help improve Taipower’s operating efficiency, create more innovative products and services, improve data quality, cultivate big data teamwork talents, promote the applications of power data, and explore the company’s data value

關鍵詞(Key Words)：大數據(Big Data)、物聯網(Internet of Things, IoT)、大數據人才發展營(Big Data Talent Development Camp)。

新建超超臨界火力電廠銲接品管與非破壞檢測

Welding Quality and Non-destructive Testing of Newly Built AUSC Power Plants

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摘　要

台電公司肩負全台穩定安全之供電使命，在能源多元化基礎上，為提升發電效能，民國 101 年規劃在南部興建了兩部 80 萬瓩超超臨界新機組，並於 107 年 2 月起陸續併入系統電網，使全台電力趨於穩定。新機組在 104 年 8 月間鍋爐試水壓時，發現原製造廠(OEM)集管箱廠製銲道有滲漏水。本公司為瞭解破漏肇因，進行銲道破損分析與非破壞檢測，包括切取一處銲體塊材金相/成份/硬度等分析，找出 OEM 在國外授權廠家製程中，錯用銲材的重大品質缺失。在供電吃緊當下，匯集本公司跨單位專業人員(核火工處、發電處、修護處、綜研所)成立專案小組，利用完善的建構銲接品管計劃，與 OEM 共同研擬出完整的修復銲接瑕疵實施策略，包含退回原廠重製、現場銲補、追溯性檢測複查等，利用 PMI、VT、PT、MT、ET、RT 等各種非破壞檢測方法，做妥修復製程管控溯源管理(產製/重製)。讓機組在品質與安全無虞的架構下，併入系統發電，解除當下的限電危機。

Abstract

Taiwan Power Company(TPC)is responsible for the mission of supplying power stably and safely in Taiwan. Based on the energy diversification, to promote the efficiency of electricity generation, TPC planned to build two units of 800 MW AUSC boilers in southern Taiwan in 2012, which were incorporated into the electrical grid in 2018, and then the power supply became stable.

Unfortunately, the boiler tubes leakage was found at the weld bead of PSHI Header during the 1st boiler hydrostatics test of the new unit in August 2015. To find out the root cause, TPC conducted the tube failure analysis and non-destructive testing, which include completing Metallographic/Chemical Composition/Hardness Test on weldment, etc. Finally, it was found that the foreign OEM-authorized company misused welding material on the header, leading to major quality defects. While facing the power shortage, TPC set up the task force with the professional members who were from different departments(DNFPP, NPCO, DOG, PERAM and TPRI)immediately. The task force aimed to draw up a comprehensive welding quality control plan and worked out a complete implementation strategy for repairing welding defects with OEM, including returning to the OEM for remanufacturing, on-site welding repair, and applied various Non-destructive methods, such as PMI, VT, PT, MT, ET, RT, etc., for the repair process control and retroactivity management(production/rework). With the quality and safety ensured, the units were incorporated into the electrical grid, and the crisis of power rationing was relieved eventually.

關鍵詞(Key Words)：超超臨界火力電廠(Advance Ultra-supercritical Power Plants, AUSC)、非破壞檢測(Non-destructive Test)、銲接缺陷(Welding Defect)。

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探討並實測差動電驛保護特性

Investigation and Measurement of Differential Protection Relays' Operation Characteristics

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摘 要

差動電驛在電力系統保護中被廣泛的使用，尤其在電力變壓器中多被做為主保護電驛。差動電驛比較變壓器高低壓兩側經比流器後的二次側電流差值，當發生變壓器內部故障或變壓器外部故障流經大電流使電流差值大於預設值時，差動電驛即時動作，送出跳脫訊號隔離主設備避免衍生嚴重傷害。因此，當一顆差動電驛保護參數被設定後且在正式投入使用之前，如何正確地驗證其差動保護特性是一項非常重要的課題。本文首先探討電驛廠商 ABB 生產的電驛 SPAD 346C，其具備非常典型的三段式差動保護特性，然後用三種測試方法來量測其保護特性，其中兩種是利用已經內建各家廠牌差動保護特性的現成程式，有 Omicron 公司推出的軟體 Test Universe 搭載其測試硬體 CMC356 及 Doble 公司的 F6Test 跟 F6150 的軟硬體組合。第三種為原創的方式，在無內建任何廠牌差動保護特性的 Doble 的 Protest 程式中，經過縝密的實驗設計一步一步實現差動保護特性的量測。

Abstract

Differential protection relays (DPR) have been widely adopted in power system protection-among the applications, especially power transformers. Functionally, DPRs compare the phase currents on both ends of a failed transformer, and send a signal to trip circuit breakers when the differential current exceeds the set value. The transformer in this way may be isolated from the system to prevent a catastrophic accident. Thus, it is crucial to verify the operation characteristic of DPR to make sure the differential protection parameters are properly set. In our study, we applied three different methods to measure the operation characteristics of a DPR, SPAD 346C DPR manufactured by ABB. We carried out two of the methods by using a commercial software (SW), the Omicron's Test Universe with hardware (HW) CMC356, and the Doble's F6Test with HW F6150. The third was an original one- we extracted the operation characteristics step-by-step by a fundamental test macro-PRAMPI in Doble's Protest.

關鍵詞(Key Words)：差動電驛(Differential Protection Relay)、差動保護特性(Operation Characteristics)、SPAD 346C、Test Universe、F6Test、ProTest、PRAMPI。

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綠能新政：歐盟之碳邊境調整機制

EU Green Deal: The EU Carbon Border Adjustment Mechanism

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摘　要

聯合國於 2021 年 8 月發布「氣候變遷」報告，指出未來 20 年，全球溫度將繼續升高 1.5 度以上。報告提出警告，人類若再不控制溫室氣體的排放、減少或阻止全球暖化的速度，世界將很快發生巨大災難。為了因應氣候變遷的挑戰，世界大國紛紛提出加速減碳的願景。例如歐盟提出 2050 淨零排放的策略目標；重視氣候危機的美國拜登總統上任後，也設下要在 2030 前達到溫室氣體排放減半的目標；中國大陸主席習近平也宣布，中國大陸的二氧化碳排放，力爭在 2060 年前實現碳中和。但如何讓快速達到上述目標?以歐盟提出的碳邊境調整機制，即是著重於讓高碳排放量的產業，負擔氣候變遷的外部成本，期望透過市場機制，以讓愈高碳排放量的產業，負擔愈大氣候變遷的成本，進而達到鼓勵減碳的目標。我國政府亦於今年 8 月，納入「2050 年淨零排放」目標。有鑑於此，本文將以歐盟提出的減碳新政：碳邊境調整機制為例，分析整理其內容規定與影響，以期提供臺灣未來規劃碳稅或碳交易相關機制之參考。

Abstract

In a climate change report released in August 2021, the Intergovernmental Panel on Climate Change (IPCC), an intergovernmental body of the United Nations, points out that human activities are responsible for temperature rise of 1.1°C, caused by emission of greenhouse gases since 1850-1900；and in the coming two decades, the global temperature rise will reach and exceed 1.5°C. The report further predicts that when temperature rise reaching 2°C, extreme climate will occur more frequently and cause negative impacts to agriculture and human health. To respond to the imminent threats, countries such as EU and USA have claimed to achieve net zero emissions by 2050, while China by 2060. How to achieve this difficult task in time? EU, USA. and China have come up with carbon pricing aiming at high carbon emission industries. To catch up with the said global trend, Taiwan government has recently claimed Net Zero Emission by 2050. It is crucial for Taiwan to understand the feasibility and effectiveness of carbon pricing mechanisms, been proposed or put into practice around the world. In light of this, we select EU's carbon border adjustment mechanism (CBAM) as an example to analyze to serve as reference for the planning of carbon pricing, either carbon fee or carbon trading, in Taiwan.

關鍵詞(Key Words)：氣候變遷(Climate Change)、減碳(Carbon Cutting)、碳排放(Carbon Emission)、碳邊境調整機制(Carbon Border Adjustment Mechanism)。

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電力市場開放下公用售電業之用戶服務策略與通路規劃

Public Retailer's Customer Service Strategies and Channel Design in a Competitive Market

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摘　要

我國《電業法》於 106 年 1 月 26 日修正公布施行，預期台電公司公用售電業實質利潤將少部分受侵蝕；倘有二階段修法將全面開放售電市場，將面臨新進業者進入市場之競爭。因此，公用售電業為尋求其他營收管道以增加利基市場，於電力市場尚未全面開放前，除須密切注意潛在競爭者動態外，更應強化本身市場競爭力，思考用戶服務多管渠道與異業結盟方式，藉由更多務實可行的服務組合，來確保既有售電市場之利益。本文擬蒐集並參考美國加州、英國、日本及新加坡等主要國家售電業之行銷通路管道及異業結盟策略，參酌國外電業之經驗，在公用售電業國營事業之角色定位及法規限制之下，研擬適合我國公用售電業之行銷策略與具體可行規劃方案。

Abstract

After the revision of the Electricity Act in 2017, it is expected that there will be more new market participants entering the market and the market share and revenue of Taipower, Licensee of Public Retailer (LBR), will be thus diluted. To cope with the new marekt situations, Taipower shall not only pay attention to potential market competition and reinforce competitiveness, but also promulgate diversified customer services and look for strategic alliances to ensure niche markets. The purpose of this study is to collect information regarding common practices of marketing channels and strategic alliances of electricity retailers in major countries, such as California USA, UK, Japan, and Singapore, to serve as reference for Taipower.

關鍵詞(Key Words)：電業自由化(Electricity Deregulation)、行銷策略(Marketing Strategy)、異業結盟(Cross-industry Alliance)。

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應用決策樹分析探討族群居住與電器使用行為對區域能源消耗影響

The Impacts of Living Environment and Appliance Usage Pattern on Regional Energy Consumption：A Study Applying Decision Tree Analysis

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摘要

本研究以台北市為例，運用政府公開數據能源三級發布區空間資料，以及民眾居住能源使用調查資料，運用統計軟體 R 的集群、相關性、決策樹等分析，研析民眾住宅舒適度與電器使用習慣對用電量影響。結果顯示共分四大群，群 1(513 個)與群 4(325 個)為主要族群。相關性顯示所得稅、工商業數、65 歲以上人口具有正相關；樓地板面積與 15~64 歲人口具有負相關。以決策樹結果，顯示不同族群用電量差異大，即使居住於土磚/混凝土建物，或家電時間使用較長與使用非 1 級節能設備者，群 4 的用電量仍低於其他族群，反觀群 1 會因夏天舒適度與家電使用時間有所影響。推測群 4 因社會經濟背景(高所得退休族)與節能意識所導致。此結果在未來可基於行為者主體(ABM)之模擬，探討社會經濟、家電使用、能源需求間關係進行預測，以供住宅部門減碳策略參考，提高住宅節能補助策略施行效益。

Abstract

This study utilized the Level 3 geographical classification open data provided by the government to analyze the impacts of living comfort levels and household electrical appliance usage pattern on energy consumption in Taipei City by applying the statistical functions of R analysis, e.g., clustering, correlation, and decision tree. The results of this study are divided into four major groups. The main findings of this study are as follows. The 1st and the 4th are the predominant groups-respectively 513 and 325 observed values. As the correlation analysis indicated, electricity consumption was positively correlated with the factors of income tax, the number of industries and businesses, and the population aged 65 and above. Nevertheless, the floor area and the population aged 15-64 had a negative correlation. As the results of decision tree analysis indicated, the electricity consumption of various groups were significant different. The 1st group was affected by need for comfort in summer and long-term use of electrical appliances, and the electricity consumption of the 4th group was relatively low due to the socioeconomic background and energy conservation awareness of the residents, despite other influencing factors such as concrete buildings, long-term electrical appliance usage, and not using grade 1 energy efficient appliances. The aforesaid findings together with agent-based model (ABM) simulations may be used to predict the relationships amid socioeconomic status, usage time of electrical appliances, and future energy demand, and serve as reference for the government's housing departments in devising new carbon reduction strategies and improving the effectiveness of residential energy-saving subsidies.

關鍵詞 (Key Words)：居住者行為(Residents' Behaviors)、住宅舒適度(Level of Living Comfort)、電器使用習慣(Household Appliance Usage Habits)、區域能源需求(Regional Energy Demand)、決策樹(Decision Tree)。

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利用 Ingeteam EF-LD 線路保護電驛實現 50+2 過載保護功能

Using Ingeteam EF-LD Transmission Line Relay to Implement 50+2 Overload Protection Functions

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摘要

因應近年來國內用電量持續增加，本公司因變電所及輸電設施擴建困難，為在既有的輸電設備上輸送出最大容量之電力，並兼顧電力系統安全穩定運轉及保護設備之原則下，過載保護設備(50+2)因而被大量使用。本文主要分享如何利用公司近年新購西班牙 Ingeteam 製之 EF-LD 系列電驛實現 50+2 保護功能，並經反覆測試過載條件後驗證本文內容可行，可供各供電區營運處採行參考使用。

Abstract

Accompanied with increasing electricity demand in recent years, TPC has encountered with difficulties in the aspect of substations and transmission facilities expansion. To maximize the power transmission capacity of existing transmission lines, under the premises of ensuring security and stability of power supply and equipment protection, overload protection equipment (50+2) have been used on a large scale. This article aims to introduce our experience in using Spanish-made Ingeteam EF-LD relays to achieve 50+2 protection functions. The functions in this article have been verified to be feasible after repeated testing of overload conditions and may serve as reference for the other power supply branch offices of the company.

關鍵詞 (Key Words)：電驛(Relay)、50+2 過載保護(50+2 Overload Protection)、本地端跳脫(Local Trip)、遠端遙跳(Remote Trip)。

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基本金屬製造業用電分析

Electricity Consumption Analysis of Basic Metal Manufacturing Industry

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摘 要

基本金屬製造業為高用電需求產業，用電量高且集中在少數用戶，本文整理其用電概況與製程特性，運用高壓以上用戶智慧型電表等資料，分析其用電負載型態，觀察期用電特性，另運用分群分析，找出較具移轉用電潛力之用戶類型，再藉由視覺化圖表分析尖、離峰用電情形，並整理需量反應措施執行情形，據以研析產業與系統負載的關係，做為後續規劃與推展需求面管理之參考。

Abstract

The basic metal manufacturing industry (BMNI) is featured with high electricity demand and consumption. Its electricity consumption is concentrated and consumed by a small number of customers. This article summarizes the electricity consumption profiles of BMNI, utilizing smart meter data of high-tension (and above) customers to analyze their load patterns and electricity consumption. The content of this study includes: 1) apply the method of cluster analysis to identify potential customers for further load transferring, 2) analyze and present the customers' peak and off-peak consumption with visual graphs, and 3) utilize the implementation results of demand response measures to analyze the relationship between BMNI and the loads of power system, to serve as reference for the planning and implementing of demand-side management (DSM) programs.

關鍵詞(Key Words)：用電分析(Electricity Analysis)、基本金屬製造業(Basic Metal Manufacturing Industry)、智慧型電表(AMI)。

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放射性廢棄物容器議題研討

Study on the Issues of Radioactive Waste Containers

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摘　要

本研究從法規面來探討各類容器的差異，及盛裝核能電廠除役之放射性廢棄物所需容器，並研析本公司現有容器特性，最後彙整本公司容器使用許可申請經驗，探討容器採購製造時進行破壞性墜落試驗的必要性。

結論有(1)依容器使用目的可區分為貯存容器、包封容器或運送包件、及處置容器。符合貯存與運送法規要求之容器可於貯存後直接運送；符合處置場接收規範之貯存容器或運送包件，可運送至處置場後直接進行處置。可用於處置之貯存容器或運送包件不等同處置容器；處置容器須滿足處置容器法規要求。(2)運送包件可依《放射性物質安全運送規則》進行要求試驗取得使用許可，但盛裝容器或處置容器雖有法規規範，卻無明確試驗方法與標準。(3)各類容器在使用許可書中已載明設計功能、設計圖說及驗證，並品質保證計畫，然於後續採購製造是否仍需進行破壞性試驗仍有待討論。本研究有助於釐清容器分類、容器使用及開發設計。

Abstract

This study aims to explore the differences of various containers and containers qualified for radioactive waste (RW) from decommissioned nuclear power plants (NPPs) from a legal perspective; analyze the characteristics of containers currently in use; and discuss the necessity of destructive drop tests. It is expected that the results of this study may serve as reference for Taipower's practices in RW container purchasing and manufacturing.

The findings of this study are as follows. (1)By purpose, containers may be divided into different categories, e.g., storagecontainer, packaging container or transport package, and disposal container. Containers in complying with storage/transportation regulations can be directly transported after packing. Storage containers and transport packages in complying with the regulations of repository acceptance can be deposited upon their arrival at the repository. Storage containers and transport packages used for disposal do not mean they may be treated the same way as disposal containers. Disposal containers have their own regulations to comply with. (2) According to "the Regulations for Safe Transport of Radioactive Material", transport packages may request testing and obtain license of permission. Nevertheless, current regulations on storage containers and disposal containers do not specify the testing methods and standards. (3) The functions, diagrams and test verification of various containers are specified in their licenses of permission to assure the promise of quality. However, whether destructive tests are necessary for subsequent purchasing/manufacturing practices is pending.

This study is benefit for clarifying container classification, container application and container design.

關鍵詞(Key Words)：盛裝容器(Storage Container)、運送包件(Transport Package)、處置容器(Disposal Container)、放射性廢棄物(Radioactive Waste)。

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2019 至 2020 年核一及核二廠外海底棲動物群落及環境的變化

The Changes of the Macrobenthic Fauna and Environment of Chin-shan and the Kuosheng NPPs' Open Waters from 2019 to 2020

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摘　要

本研究調查自 2019 到 2020 年每季核一廠及核二廠外海的底棲動物群聚及沉積環境因子的變化。結果發現，核一廠的底棲動物群聚，會受到環境的影響。2019 年起停機，並未影響底棲生態環境及其物種。核二廠之沉積環境的特性，像是沉積物的平均粒徑、細泥含量、篩選度等，是決定底棲群聚的豐度及密度之主要因子。且季節與出、入水口之交互作用多受進出水口在生物因子如物種豐度、密度，及環境因子如平均粒徑等之差異所影響，這可能與核二廠為一較封閉之海域，因此海灣內不同的位置之影響會大於季節變化之影響。

Abstract

This study investigated the changes of macro-benthic fauna and the environment of the open waters of the Chin-shan Nuclear Power Plant (the 1st NPP) and the Kuosheng Nuclear Power Plant (the 2nd NPP) from 2019 to 2020. As the results indicated, the benthic fauna of the 1st NPP was influenced by the sediment environment. The shut-down of the 1st NPP had no influence on the benthic fauna. As for the 2nd NPP, the characters of sediment, such as mean grain size, sorting coefficient and silt-clay content, were the main factors influencing the structure of the benthic fauna. The interaction between inlet-outlet and season was mainly influenced by the difference of biological factors, such as species richness and density, and the environmental factors, such as mean grain size among others, between the inlet and outlet. A possible reason is that the 2nd NPP has a relatively enclosed nearshore environment, so that the influence of different positions inside the embayment is higher than that of seasonal changes.

關鍵詞(Key Words)：大型底棲動物群落(Macro-benthic Fauna)、核能發電廠(Nuclear Power Plant)、動物族群結構(Fauna Community Structure)、沉積物特性(Sedimentary Characters)、季節變化(Seasonal Change)、出入水口測站(Outlet-inlet Sites)。

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