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基於 MONEAT 的獨立微電網之規模最佳化與能源管理

Sizing Optimization and Energy Management of Independent Microgrids Based on MONEAT

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摘要

獨立微電網中的規模最佳化與能源管理系統有高度相關，獨立微電網通常有關鍵負載以及非關鍵負載兩種類型，在不同規模下會衍生出不同的能源管理策略。本研究中，我們提出了一個多目標增強拓樸的神經進化方法(Multi-Objective NeuroEvolution of Augmenting Topologies, MONEAT)，同時解決規模最佳化和能源管理策略制定問題。此方法將多目標問題分成兩層，上層是透過基因演算法決定規模參數，在給定規模參數環境後，下層利用強化學習制定最佳的能源管理策略。模擬結果顯示，所提出的方法，其能源管理策略在規模最佳化問題中比現有能源管理方法具有更好的效能，並且規模參數也可以被適當選擇。此外，在系統成本和負載滿足度的目標之間，我們的方法能提供柏拉圖前沿(Pareto Front)資訊，讓系統設計或決策者能在資訊充足的情況下執行獨立微電網系統控制決策。

Abstract

Sizing optimization of independent microgrids is highly relevant to energy management systems. Independent microgrids have two types: critical loads and non-critical loads. Different energy management strategies will be derived at different sizes of microgrids. In this study, we propose a multi-objective neuroevolution of Augmenting Topologies (MONEAT) method to simultaneously solve the problems of sizing optimization and energy management strategy formulation. The proposed method divides the multi-objective problem into two layers. The upper layer determines the sizing parameters through genetic algorithms. After the sizing parameter environment is given, the lower layer applies reinforcement learning to formulate the best energy management strategy. Simulations results show that the energy management strategy derived from the proposed method has better performance than existing energy management methods in the sizing optimization problem, and the sizing parameters can also be appropriately selected. Furthermore, between the goals of system cost and load satisfaction, the method proposed in this study can provide Pareto front information, allowing system designers or decision makers to execute control decisions for independent microgrids with sufficient information.

關鍵詞(Key Words)：微電網(Microgrid)、微電網能源管理(Microgrid Energy Management)、神經進化(Neuroevolution)、規模最佳化(Sizing Optimization)、多目標最佳化問題(Multiobjective Optimization Problem)。

多目標變電所採行部分使用執照模式之案例研討

Case Study on the Partial Usage License Model Adopted by Multi-purpose Substations

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摘要

都會區多目標變電所工程採複合共構方式新建，兼顧供電需求及多目標開發效益下，採用部分使用執照方式辦理，而申請部分使用執照之程序較為繁瑣，以新民多目標變電所統包工程申辦部分使用執照之過程為例，分析研討其中困難點與關鍵部分，期能應用於後續不同採購模式之個案，以達成雙贏之目標。

Abstract

Multi-purpose substation projects in urban areas can take into account the needs of power supply and various development benefits, if they adopt a composite co-construction method. However, the application process for partial usage is relatively cumbersome. This article takes the process of applying for a partial usage license for the Xinmin multi-purpose substation turnkey project as an example to analyze and discuss the difficulties and key issues to serve as reference for subsequent cases of different procurement models to achieve a win-win goal.

關鍵詞(Key Words)： 部分使用執照(Partial Usage License)、多目標變電所(Multi-purpose Substation)、統包(Turnkey)。

彰化一次變電所空斷開關設備鳥害防制研究

Research on Bird Damage Control of Air-Break Switch at Changhua Primary Substation

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摘要

空斷開關用於屋外式變電所，在夏季期間經常有鳥類於空斷開關爪片內築巢，有設備閃絡的風險，本所設計一種內含樟腦丸的驅鳥器放置於 ABS 爪片內，經實驗結果證實，可有效防止鳥類於 ABS 爪片內及導電管上方築巢。

Abstract

The Air-Break Switch(ABS) is used in outdoor substations. During the summer, birds often build nests in the claws of the ABS, and there is a risk of equipment flashover. Therefore, we design a bird repellent containing mothballs and place it inside the ABS claws. It has been confirmed by experimental results that it can effectively prevent birds from nesting in the ABS claws or above the conductive tubes.

關鍵詞(Key Words)：空斷開關(Air-Break Switch, ABS)、變電所鳥害防制(Electrical Substation Bird Damage Control)、驅鳥器(Bird Repellent)。

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2025-2030 年台灣電力系統備轉容量評估之研究

A Study on the Operating Reserve Requirements for Taiwan's Power System from 2025 to 2030

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摘要

在未來十年伴隨著再生能源滲透率漸增及用電需求的成長，台灣電力系統所需要之頻率響應服務及備轉容量亦隨之改變。儲能及系統彈性模型(Storage and Flexibility Model, SFM)中的短期分析模組(Short-term Module, STM)是英國 Energy Systems Catapult (ESC)公司基於其長達十四年的整體能源系統建模專業知識以及三十年的電力系統設計與運轉經驗所開發之分析模型工具。為了推估 2025 年至 2030 年間台灣電力系統的頻率響應服務及備轉容量之合理需求量，本研究案遂先利用 STM 的功能，建置適用於推估台灣電力系統各種能源情境下之客製化分析模型，接著針對 2025 年至 2030 年間各種情境(春季、夏季、秋季、冬季、尖峰)下，以該分析模型去推估全電力系統應準備之合理頻率響應服務及備轉容量。本研究最後再根據模擬結果及英國之經驗，向台電公司提出相關可精進及改善之方向。

Abstract

With the increasing penetration rate of renewable energy and growing electricity demand in the coming decade, frequency response services and operating reserve required by Taiwan's power system could also change accordingly. The Short-Term Module (STM) of the Storage and Flexibility Model (SFM) is based on the British Energy Systems Catapult (ESC) company's 14 years of integrated energy system modeling expertise and 30 years of experience in power system design and operation. This study first uses the functions of STM to develop a model suitable for estimating the reasonable amount of frequency response services and operating reserve required by Taiwan's power system from 2025 to 2030. Then, under various scenarios (spring, summer, autumn, winter, and peak), the analysis model is used to estimate the reasonable frequency response services and operating reserve that the entire power system should prepare. Finally, based on the simulation results and experiences of ESC, this study proposes relevant directions for improvement to serve as reference for Taipower.

關鍵詞(Key Words): 再生能源滲透率(Penetration of Renewable Energy)、頻率響應服務(Frequency Response)、備轉容量(Operating Reserve)、能源系統中心(Energy Systems Catapult)、短期分析模組(Short-term Module)。

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生態檢核作業於輸變電工程之執行現況探討

Discussion on the Current Implementation Status of Ecological Inspection Works in
Transmission Line and Substation Projects

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摘要

行政院公共工程委員會於民國 106 年訂定「公共工程生態檢核機制」(名稱已改為「公共工程生態檢核注意事項」)後，對於涵蓋全台的輸電線路電網工程陸續造成不同程度之影響，為確保公共工程落實生態保育政策，輸變電工程處業於 109 年間研訂相關生態檢核執行作業流程及內容要點，為轄下各區施工處後續辦理生態檢核作業之依循，本文亦提供作業執行範例，以供其他工程單位參考。

Abstract

The Public Construction Commission of the Executive Yuan formulated the “Ecological Inspection Mechanism for Public Construction” (later renamed as the “Ecological Inspection Precautions for Public Construction”) in 2017, which has successively caused varying degrees of impact on islandwide transmission line and substation projects. To ensure that public construction projects implement ecological conservation policies, the Department of Transmission Line and Substation Projects has developed relevant ecological inspection implementation procedures and key content in 2020, which will serve as the basis for subsequent ecological inspection works carried out by the regional construction offices. This article provides relevant construction execution examples to serve as reference for the company’s other engineering units.

關鍵詞(Key Words)：生態檢核作業(Ecological Inspection Works)、公共工程生態檢核注意事項(Ecological Inspection Precautions for Public Construction)、生態專業人員(Ecological Professionals)。

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國際電業對無形資產之加值應用研究

Research on Value-Added Applications of Intangible Assets by International Electric Power Industry

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摘要

全球電業正進行能源轉型與淨零轉型，努力實現技術可行性和成本效益最大化，使技術創新成為電業永續發展的核心。但如何表現技術創新價值、有效保護創新的智慧資產及促使創新價值鏈高值化，是競爭力的關鍵。綠色能源技術創新將有效促進電業無形資產發展，而無形資產之加值應用即是關鍵新技術的移轉和商業化，可將研發創新成果轉化為經濟的戰略、促進技術成本降低、擴大投資規模和水準，進而建立一個完善的技術價值鏈。台電對無形資產加值應用應著重於：綠色技術成熟及普及的合適條件、技術移轉從研究發展到市場流程的主要障礙、促進技術快速商業化的關鍵等，特別應關注政府技術研發的促進政策、融資、智慧財產權保護及管理策略等領域。

Abstract

The global electric power industry is undergoing energy and net-zero transition, striving to realize technical feasibility and maximize cost-effectiveness, so that technological innovation may become the core of sustainable development of the industry. However, how to express the value of technological innovation, effectively protect innovative intellectual assets, and promote the high value of the innovation value chain is the key to competitiveness. Green energy technology innovation will effectively promote the development of intangible assets in the electric power industry, and the value-added application of intangible assets is the transfer and commercialization of key new technologies, which can transform R&D innovation results into economic strategies, promote technology cost reduction, expand investment scale and level, and then establish a complete technology value chain. Taipower's value-added application of intangible assets should focus on: the appropriate conditions for the maturity and popularization of green technologies, the main obstacles to technology transfer from research and development to the market process, and the key to promoting rapid commercialization of technologies. In addition, special attention should be paid to areas such as government technology research and development promotion policies, financing, intellectual property rights protection and management strategies.

關鍵詞(Key Words)：能源轉型 (Energy Transition)、淨零轉型 (Net-zero Transition)、無形資產 (Intangible Asset)、低碳技術(Low-carbon Technology)。

電纜洞道物聯網應用示範及無線網路建置評估

Cable Tunnel IoT Application Demonstration and Wireless Network Construction Evaluation

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摘要

本研究係一示範試辦 Proof of Concept (PoC)專案，旨在於應用物聯網、智慧感測以及行動終端等資通訊技術，導入於新高港-高雄段 345 kV 地下電纜線路潛盾、明挖、推管洞道，以符合局限空間所需之職業安全、場域及設施安全等監控需求。在 PoC 場域中，無線通訊系統訊號涵蓋範圍從 EA9K+350 到 EB1K+900，其平均連線速度達 8Mbps 以上、訊號覆蓋範圍 99%以上及連線可靠度達 99.99%以上；人員定位系統之定位範圍從 M23 到# 5 直井附近，其人員定位精準度在 5 公尺以內；導入智慧手環，可即時查看巡檢人員的生理狀態；導入通訊監控系統，可即時監控無線通訊和定位器等通訊設備運作狀態和通訊流量。最後，本研究應用 the Connect All Things Platform(CAT)平台結合其他生態系統，讓各式裝置與系統的資料可快速介接上傳，並整合在一個網站中呈現，讓場域監控人員能快速掌握整個區域的人員、操作狀況、設備等即時狀態，以利局限空間整體場域監控之進行。

Abstract

This research is a proof of concept (PoC) project, which aims to apply information and communication technologies such as the Internet of Things (IoT), smart sensing, mobile terminals to the 345kV underground cable tunnel operating area and related facilities in the Kaohsiung Port-Kaohsiung section to meet the requirements for occupational safety, site and facility safety monitoring in confined spaces. The PoC applications include: a wireless communication system with wireless communication ability from EA9K+350 to EB1K+900 with 99% signal coverage, 99.99% reliability and up to 8 Mbps data rate; an indoor positioning system to provide personnel locations from M23 to # 5, positioning error under 5 meters; the smart bracelets to monitor the physiological status of inspection personnel in real time; a communication management system to monitor the operating status of equipment and the communication flows of wireless communication. In addition, we apply a Connect All Things (CAT) platform, which is an IoT application enablement platform, to integrate the aforementioned subsystems so that data from various devices and systems can be quickly uploaded and integrated into a web server, allowing site manager to quickly grasp the entire real-time status of personnel, operation, and equipment in the local area to facilitate the overall field monitoring in confined spaces.

關鍵詞 (Key Words)：無線網路規畫(Wireless Network Plan)、即時通訊(Instant Messaging)、物聯網(Internet of Things)、局限空間(Confined Space)、室內定位系統(Indoor Positioning System)。

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