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# 臺灣東北角海域波浪發電技術評估研究

Assessment of Wave Power Generation Technology for the Waters of Taiwan's Northeast Corner

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## 摘要

本研究主要內容為波浪能場址與機組篩選，為了加速研究與台電現有資源的再利用，以台電公司在我國東北臨海之五處電廠作為假想波浪發電應用區域，位置由西到東分別為核一、核二、協和、深澳與龍門五處場址。本研究依據國際開發主流的三種機組(點吸收式、振盪衝擊式與振盪水柱式三型)與五處場址之環境特性進而篩選出兩處場址與對應之最適波浪發電機組。評估結果發現，核一與龍門兩地是五處場域中較適之開發海域。如以發電性能考量，振盪衝擊式是三種機型中最佳的選擇，但考量近岸的環境法規限制所造成的推動阻力及建置相關成本因素，核一場址的未來投入方向建議為點吸收式發電機組，龍門場址則為振盪水柱式發電機組。

## Abstract

This study aims to assess and select appropriate wave energy converter (WEC) technologies and wave sites for the waters of Taiwan's Northeast corner. To accelerate the study and make good use of Taipower's existing facilities, five coastal power plants, the 1st Nuclear Power Plant, the 2nd Nuclear Power Plant, the Hsieh-ho Power Plant, the Shen-ao Power Plant, and the Longmen Power Plant) are chosen as the targets of wave site evaluation. Two wave sites and the optimal WEC technologies corresponding to the sites, based on the environmental characteristics of the five sites and three dominant WEC technologies worldwide- namely, point absorption, oscillating wave surge converter, and oscillating water column. As the results of the assessment show, the wave sites of the 1st Nuclear and Longmen Power Plants out of the five sites are most suitable for development. From the viewpoint of efficiency, the technology of oscillating wave surge converter stands out. However, restricted by near-shore environmental regulations and the consideration of installation costs, the most appropriate technologies for the 1st Nuclear Power Plant and the Longmen Power Plant are point absorber and oscillating water column respectively.

**關鍵詞 (Key Words)**：波浪能(Wave Energy)、場址篩選(Site Selection)、點吸收式(Point Absorber)、振盪衝擊式(Oscillating Wave Surge Converter)、振盪水柱式(Oscillating Water Column)。

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# 雲林地區再生能源加強電力網併網規劃檢討

A Review on RE Interconnection and Grid Reinforcement Planning in Yunlin

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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，其中太陽光電占20GW，含地面型12GW，其餘8GW為屋頂型。面對未來大量再生能源業者併網需求，台電公司已規劃併網所需之電網建設並強化輸電能力。因雲林沿海一帶再生能源發展潛力佳，屬再生能源開發熱區，然而雲林地區69kV輸電系統環路特性，於長期發展的過程中，將有部分線路開始出現電網瓶頸，進而影響區域併網能力，本文針對大量再生能源併入北港一次變電所(Primary Substation，以下簡稱P/S)轄區進行檢討分析，說明系統概況及潛在弱點，再進一步說明為滿足再生能源併網需求，台電公司針對潛在弱點規劃之加強電力網工程，最後針對改善後之輸電系統進行模擬，在符合輸電系統規劃準則之前提下，觀察再生能源併網對系統之輸電線路、變壓器等設備之影響，評估加強電力網工程可提升之最大併網容量，以確保電網在安全無虞下，滿足北港P/S轄區69kV輸電系統之再生能源併網需求。

## Abstract

To promote the development of renewable energy (RE), the Bureau of Energy, MOEA set a target of 30.161 GWs of RE installed capacity, to be achieved by 2025- among the capacity, 20 GWs will be PVs, 12 GWs ground mounted, 8 GWs small sized. In the face of huge RE connection demand, Taiwan Power Company has thus planned to reinforce its grid infrastructure to enhance transmission capability. Owing great potential of RE development, the coastal area of Yunlin is a hot spot for RE connection. However, some lines of the loop path of Yunlin 69kV transmission system may encounter grid connection bottlenecks for the longer term and affect the overall interconnection capability of the entire region. Therefore, we take the bottleneck of Beigang Primary Substation (P/S) as an example, to introduce the major contents of the aforesaid grid reinforcement project. When the project accomplished, the RE interconnection capability of the grid and the stability of power supply will also be greatly improved.

**關鍵詞(Key Words)**：再生能源(Renewable)、電網瓶頸(Grid Bottleneck)、加強電力網(Grid Reinforce Project)。

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# 金門地區 PV 通訊閘道器(含智慧變流器)功能標準之研究

Research on the Functional Standards of PV Communication Gateways and Smart Converters in Kinmen

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## 摘要

政府近年大力提高再生能源發電占比量，惟傳統太陽光電(PV)變流器潛藏著大量瞬時跳脫風險，電力系統勢必面臨著高穿透太陽能和頻率穩定性所帶來的運轉與挑戰。美國、德國—等先進國家均建議 PV 變流器應具有故障穿越控制、電網電壓支持和無功功率補償等功能。

國際電工委員會(International Electrotechnical Commission, IEC)所定 IEC 61850 國際標準，將常見分散式能源資料自源頭端進行標準化(Standardization)，另透過分散式能源管理系統進行資料收集，更彈性運用相關資訊並與即時調度整合。

本專案蒐集國際電力公司相關分散式能源管理系統(DERMS)、太陽光電案場閘道器(PV Gateway)及智慧變流器(Smart Inverter)等功能性標準、通訊介面及實際案例，並開發模擬器進行 IEC 61850、SunSpec 通訊轉換及變流器控制測試，提供未來金門地區分散式能源管理系統及智慧變流器調控機制之參考，同時也針對高占比分散式能源管理與運用進行鋪路。

## Abstract

In recent years, Taiwan government has been dedicated to increasing the proportion of renewable energy (RE) generation. Traditional photovoltaic (PV) inverters have a large amount of potential instantaneous tripping risks; therefore, power systems are susceptible to frequency instability posed by high penetration of solar energy. Researches of advanced countries such as the United States of America, Germany, etc., suggest that PV inverters shall possess the functions of fault ride-through control, grid voltage support, reactive power compensation, etc.

IEC 61850, developed by the International Electrotechnical Commission (IEC), not only standardizes common data of decentralized energy from the source; by the aid of decentralized energy management system, it also enables more flexible information utilization and may apply to real-time dispatch. IEC 61850 has been widely used in smart grids with complex data models, such as distributed energy management platforms.

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In addition to collecting useful information, such as functional standards, communication interfaces and worldwide cases of distributed energy management system (DERMS), along with PV gateways and smart inverters, in this project we also aim to develop a simulator and carry out IEC 61850 related communication and dispatch tests, to serve as reference for the development of future distributed energy management system and smart converter regulation mechanism in Kinmen, and pave the way for the management and operation of high DE penetration.

**關鍵詞(Key Words)**：標準化(Standardization)、資料模型(Data Model)、分散式能源管理平台(DERMS)、閘道器(Gateway)、智慧變流器(Smart Inverter)。

# 系統負載擾動對燃氣機組控制影響之改善研究

The Effect of Load Disturbance on Gas Turbine Control and the Improvement

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## 摘要

當輸電線路上電力潮流劇烈變化，會使發電機組轉子間發生搖擺現象，即所謂的電力系統低頻振盪，此現象會造成發電機輸出功率產生劇烈的變化。以大潭一、二號機組三菱公司 M501FMK8 型氣渦輪機為例，裝置容量 154 MW，設計的負載升降載率為 10.2 MW/min (0.17 MW/sec)，但低頻振盪所引發的負載瞬間變化量卻高達 15 ~ 34 MW / 0.8 sec，遠遠超過氣渦輪機的負載升降載率，這樣的現象會導致氣渦輪機的負載控制過度反應，使得運轉所需的燃料與空氣無法匹配而造成燃燒不穩定，甚至引發機組保護跳脫。此研究案係針對三菱公司氣渦輪機所提出，在不影響機組的保安下，規劃設計負載控制斜率限制器來限制用於控制的負載信號變化率，和緩來自系統端所造成的負載變化對氣渦輪機組控制的影響，避免機組控制機制的過度反應而造成燃燒不穩的情形發生，增加機組運轉的可靠度，穩定供電。

## Abstract

Drastic change of power flow on transmission lines will cause a power swing phenomenon in the rotor of a generator, also known as power system low frequency oscillation, and drastic output change of the generator. Taking unit 1 and unit 2 (gas turbines of Mitsubishi M501FMK8, 154 MW) of Datan Power Plant as an example, the designed ramping rate for these turbines is 10.2 MW/min (0.17 MW/sec), but the instantaneous changing load, when affected by low frequency oscillation, may be as high as 15 ~ 34 MW/0.8sec, far more higher than the designed ramping rate. This will lead to over control of the gas turbines; mismatch between the fuel and the air required for gas turbine operation; and unstable combustion, even tripping of generators. To ensure the security of the generators, we may use Active Power Rate Limiter for Control to limit the changing rate of the load signals used for control, so as to moderate the influences caused by low frequency oscillation on gas turbines, to avoid excessive control and ensure reliable generation and stable power supply.

**關鍵詞(Key Words)**：負載控制斜率限制器(Active Power Rate Limiter for Control)、搖擺方程式(Swing Equation)、電力系統低頻振盪(Power Systems Low Frequency Oscillations)、電力系統穩定度(Power System Stability)、氣渦輪機(Gas Turbine)。

# 輸電塔基採用機械式鋼筋續接器及擴頭鋼筋之可行性研究-以懸臂梁之實驗與分析為例

A Feasibility Study on the Use of Mechanical Splices and Headed Deformed Bars in Transmission Foundation-A Case Study of Cantilever Beam

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## 摘要

本研究以實驗及分析方式，探討 SA 級摩擦壓接式鋼筋續接器及擴頭鋼筋，兩者在鐵塔基礎結構之適用性。根據土木 401-110 混凝土結構設計規範並參考單筒十字梁基礎型式，設計本實驗之 6 座縮尺懸臂梁試體。研究變數包括：於梁中央處(固定端)之鋼筋為搭接、同位續接、錯位續接；梁兩端處(自由端)鋼筋為標準彎鉤或擴頭鋼筋。實驗採對稱配置並以均佈單向加載，實驗過程中紀錄破壞模式、及梁中央之垂直力與垂直變位。經實驗成果得知，採續接器及擴頭鋼筋之試體，其表現與採鋼筋搭接和標準彎鉤之試體試驗結果相當，皆可提供約略 1.3 倍之標稱彎矩強度，且具備良好之變形能力。由分析結果顯示，壓拉桿模式採壓桿破壞控制時可有效預測實驗最大載重。整體而言，本研究已完成大型實驗與分析驗證，並考量現場作業環境給予施工注意事項，目前已有相關案例，可增進現地施工性與工作安全性。

## Abstract

This research aims to assess the viability of using SA-mechanical splices and headed deformed bars in transmission towers. The actual single pile-cross beam foundation structure and the latest Concrete Structural Design Specification 401-110 were used to make six scaled-down cantilever beam specimens. The experimental variables include whether the rebar in the middle of the beam uses lap splices or mechanical couplers with or without a 60 cm dislocation and whether the rebar at both ends of the beam uses standard hooks or headed reinforcement. Flexural tests demonstrate that the failure mode of the beam, vertical force and vertical displacement at the center of the beam is subjected to unidirectional and uniformly distributed loading. The results of the tests show that specimens with SA-grade mechanical splices and headed deformed bars work just as well as the current practice mode, which uses a lap splice and a standard hook. The above design arrangements

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can provide 1.3 times the nominal bending moment strength and have good deformation ability. Analytical results demonstrate that the strut-and-tie model reasonably predicts the total vertical loading. This study summarizes experimental and analytical results for large-scale cantilever beams with SA-grade mechanical splices and headed deformed bars. The preliminary outcomes indicate that the results of this study may help improve the quality and safety of on-site constructions, as well as their compliance with relevant design specifications and standards.

**關鍵詞(Key Words)：** 機械式鋼筋續接器(Mechanical Splices)、擴頭鋼筋(Headed Deformed Bars)、懸臂梁(Cantilever Beam)、壓拉桿模式(Strut-and-Tie Model)。



# 我國未來電動載具發展趨勢與策略研析

Research on the EV Development Strategy for Taiwan

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## 摘要

近年來全球溫室氣體排放量不斷上升造成氣候變遷，而全球溫室氣體的排放佔比中運輸部門 CO<sub>2</sub> 排放佔比約在 2 成，其中公路運輸更是運輸部門中高達 74.5% 的 CO<sub>2</sub> 主要排放來源；電動載具被視為降低溫室氣體排放的有效手段之一，但隨著電動車的推廣，充電設施與車輛使用可能對國內電力系統與負載型態產生影響，對於台灣電力公司為重要課題。未來國內電動車的數量如持續增加，充電行為與時機將直接衝擊我國電網之安全與穩定，有必要提早預估與提出充電相關配套措施。因此，本研究協助蒐集國內外電動車發展趨勢，研析各式充電站與電能交換站技術發展趨勢與經營模式，期能在考量未來電動車與充電站技術與需求成長情形下，評估電動車對電力系統尖峰負載影響與衝擊，對我國電動載具發展提出相關策略供參。

## Abstract

In recent years, the emission of global greenhouse gases has continued to increase and results in dramatic climate change. About 20% of the total CO<sub>2</sub> emission is from the transportation sector, especially the road transportation, as high as 74.5%. Thus, electric vehicles (EVs) are regarded as one of the most effective ways to reduce CO<sub>2</sub> emissions. However, along with the promotion of electric vehicles, increasing use of charging facilities may have strong impacts on the domestic power system and load patterns. How to handle this situation is an important task for Taiwan Power Company. Therefore, this research aims to collect the evolving trends of EVs, analyze the technology development and business models of various charging and power exchange stations, and evaluate their impacts on power system peak loads.

**關鍵詞(Key Words)**：電動載具(Electric Vehicle)、電動車充電站(EV Charging station)、快速充電(Fast Charging)、充電站營運模式(Business Model of Charging Station)、電力系統影響評估(Power System Impact Assessment)。

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# 核電廠於營運中、準備除役等階段之緊急計畫演習 評核研究

A Study on Exercise Evaluation for NPP Emergency Response Plan During the  
Operation and Preparation-for-Decommissioning Stages

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## 摘要

台灣電力公司為了保障核能發電的安全性以及緊急應變計畫的可實施性，每年度皆對三座核能電廠之相關運轉人員和緊急應變計畫執行人員進行訓練以及電廠演習，以此驗收並監督核能電廠各年度進行之緊急應變計畫及相關訓練是否合乎規範及訓練要求。

本計畫為期三年，由本單位組成相關學者的評核團隊，在 108~110 年度緊急應變計畫演習前後參與評核作業與劇本之討論，對演習成效進行評估並提出評核意見。其中，針對演習方案之真實性、合理性以及演習過程中之規範標準，適時地更新資訊並檢討。此外，本計畫亦協同台電緊執會專家發展通用之演習評核表。

演習劇本涵蓋天災導致喪失外電、因各種原因導致的喪失反應爐冷卻水事件(LOCA)、反應爐喪失移熱能力、以及用過燃料池喪失移熱能力，其演習結果顯示電廠相關人員能夠熟練的應對複合性災害事故，也驗證了台電公司的事故處理程序能讓電廠恢復至安全狀態。

## Abstract

To ensure the safety of nuclear power plants and the practicability of Emergency Response Plan (ERP), the related personnel of the nuclear power plants subordinate to Taipower are required to perform trainings and exercises corresponding to the ERP every year to comply with applicable regulations. This project lasts for three years; the evaluation team invites scholars of related fields to participate in the discussions regarding the procedures and criteria of the evaluation, e.g., rationality, reality and standards of the exercises. In addition, this project helps Taipower staff develop a new generic evaluation form. The exercises postulate natural disasters, e.g., typhoons, earthquakes, lightning strikes, and situations, e.g., loss of AC power, LOCA, accidents of spend fuel pools. As the results show, the related personnel are proficient in dealing with compound accidents of the like, and verify that Taipower's accident handling procedures are sufficient to bring the situation back to normal.

**關鍵詞 (Key Words)**：緊急應變計畫(Emergency Response Plan)、台灣電力公司(Taipower)、核能電廠(Nuclear Power Plants)、核能安全(Safety)、核安演習(Exercises)。

# 核設施除役廢棄物解除管制之國際發展現況及其影響 評估

International Status and Impact Assessment of Waste Clearance of Nuclear Facility  
Decommissioning

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## 摘要

核設施除役與拆除將產生大量的廢棄物料，其中大部分的材料並不具放射性或僅具有非常低的放射性，經過適當地處理及解除管制之後，可以採有條件或無條件的方式進行回收及再利用。回收/再利用的作法提供極有價值的解決方案，可以最大限度地減少除役產生的放射性廢棄物，也可有效地回收仍具有價值的材料。本文針對除役廢棄物解除管制之回收/再利用方案進行研析，概述目前可供遵循的國際管制規範，並藉由案例分析汲取各國在回收/再利用方案的經驗和做法。由回收/再利用與處置/替代兩種方案對於健康、環境及社會經濟面向的影響評估可知，回收/再利用方案在健康風險與環境衝擊方面具有極大的優勢。本文係初探國際除役廢棄物解除管制之現況與做法，相關的經驗與議題可作為國內的設施經營者與管制機關在擬定廢棄物解除管制之做法與管制策略時的參考。

## Abstract

Decommissioning and demolition of nuclear facilities is expected to generate a large amount of scrap materials. Most of them are non-radioactive or low-level radioactive, and can be removed from the facilities by means of conditional and unconditional clearance for further recycling and reuse, when properly treated. Options such as recycling and reuse provide valuable solutions to the minimization of radioactive wastes and the maximization of recovering valuable materials. The major contents of this paper include an overview of the aforesaid two options; regulations and practices worldwide adopted; experiences of foreign institutions and organizations in recycling and reuse, to serve as reference for case studies. In addition, from the assessment of the recycling/reuse and disposal/replacement options and their impacts on health, environment, and socio-economic aspects, we can understand that the former (recycling/reuse) has great advantages in terms of health risks and environmental impacts. This paper provides a preliminary investigation on the current status of international regulations, practices, and risk assessment on waste clearance of nuclear facility decommissioning, to serve as reference for domestic licensees of nuclear facilities and regulatory authorities to formulate their practices and strategies.