台電工程月刊 852 期（8 月號）目錄

再生能源：

火力發電：

輸 變 電：

能源與環境：

其　　他：

風力發電機結構設計回顧與探討

Review and Discussion Concerning the Structure Design of Wind Generators

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摘　要

風力發電是再生能源發展中非常重要的一環，特別是國內現正積極發展離岸風電，有關離岸風電系統以及併網技術值得重視。除了電力系統分析外，風力發電機本身的結構設計與原理，以及如何改善風機性能的可能方法也是值得研究的議題。風力發電機可採用多種不同型式的發電機，例如永磁同步發電機，永磁磁阻發電機，磁通切換發電機，超導發電機等，各種發電機有不同的特性以及用途。本文將探討各種風力發電機型式的優缺點，並回顧過去風力發電機結構設計的考量因素，包括發電效率、頓轉轉矩、轉矩漣波、輸出功率、材料、成本、以及可靠性等。這些因素可供未來設計風機定轉子結構以及提高性能的重要參考。

Abstract

Wind power generation is a very important part of renewable energy development. In particular, as Taiwan is currently striving to develop offshore wind farms, the issues concerning the offshore wind power systems and technologies of integrating the produced power into grid-system are worth paying attentions. In addition to analysis of the power system, the structural design and principle of a wind generator and possible ways to improve the performance of a wind generator are also worthy of study. Wind power can be generated using a variety of generators, such as permanent magnet synchronous generators, permanent magnet reluctance generators, flux switching machines, superconducting generators, etc. Various generators have different characteristics and applications. This article aims to discuss the advantages and disadvantages of various types of wind power generators, and to review the considerations having been given to the structural design of a wind generator in the past, including power generation efficiency, cogging torque, torque ripple, output power, materials, cost, and reliability. These factors can be used as an important reference for designing the structure of stator and rotor of a wind generator and improving its performance in the future.

關鍵詞(Key Words)：風力發電(Wind Power Generation)、結構設計(Structural Design)、永磁同步發電機(Permanent Magnet Synchronous Generator)、永磁磁阻發電機(Permanent Magnet Reluctance Generator)、磁通切換機(Switched Reluctance Generator)、超導發電機(Superconductor Generator)、頓轉轉矩(Cogging Torque)。

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民營電廠購售電合約最適期限探討

The Optimal Time Period of Power Purchase Agreement for Independent Power Producer

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摘　要

新電業法已於 106 年 1 月 26 日公布施行，台電公司為符合法定備用供電容量義務，須依電業管制機關公告之供需預測，當評估有外購電力需要時，須依政府採購法辦理電能採購作業。本次修法(第一階段修法)僅開放綠能轉供或直供售電予用戶，傳統火力發電業僅能售電予台電公司，爾後(第二階段修法)待管理配套、法制運作順暢、市場成熟穩健發展之後，再開放傳統火力電廠可直供或轉供售電予用戶，屆時業者可自由售電，其售電對象不限台電公司。然電業改革開放時程具不確定性，現階段民營電廠與台電公司倘僅簽訂 10 年期購售電合約，將面臨融資困難等風險，進而影響投資意願，恐致台電公司無法達成法定備用供電容量義務。

基於上述研究課題，本研究蒐研國內外民營電廠購售電合約期限與考量因素，及合約期限對民營電廠融資之影響，綜合評估在我國現行電業市場環境、台電負擔法定備用供電容量義務及業者融資等情況下，台電公司與民營電廠購售電合約之最適期限，供台電訂定購售電合約之參考。

Abstract

Under the Electricity Act that took effect on January 26, 2017, Taiwan Power Company (Taipower) is required to comply with the obligation of keeping statutory reserve margin based on the forecast results for power supply-and-demand announced by the government’s regulatory authorities. While the conditions of the needs for acquiring outside power resources emerge, Taipower should undertake the electricity procurement from outside based on the Government Procurement Act. However, according to the amendment to the Electricity Act to date, direct sale or indirect transfer of the produced power to customers is open merely to the sector of renewable energy, although it is still expected that the electricity coming from thermal power plants can be directly sold to customers in the future - as the complementary measures and relevant regulations are put in place and the power market become mature. But there still exist high degree of uncertainty in fulfilling the intended goal of electric sector transformation in Taiwan. At the present, the contract term for a power procurement agreement between independent power producers and Taiwan Power Company are set to be ten years, which may lead to some difficulties for independent power producers’ financing or even make them withdraw from the power bidding market. Under this case, it could also affect the ability of Taiwan Power Company to comply with obligation of keeping statutory reserve margin capacity.

Considering these issues mentioned above, this study aims to make research on the issue of contract period and relevant factors in signing a power purchase agreement with independent power producers, and to collect domestic and foreign experiences and the impact of setting up a contract period on the project

financing for the independent power producers. Furthermore, this study proposes the optimal period for power purchase agreement between Taiwan Power Company and independent power producers, which can be used as a reference for signing power purchase agreement in the future.

關鍵詞(Key Words)：購售電合約(Power Purchase Agreement)、民營電廠(Independent Power Producer)。

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以 345kV 深美~冬山線 #80 為案例應用於鐵塔監測即時預報系統

Automatic Monitoring Transmission Tower for 345kV Shen-Mei to Dong-Shan #80 Transmission Tower

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摘　要

當鐵塔長期處於惡劣的環境狀況下，劣化不易被發現而導致災害發生，此時可運用監測系統加以防範，做為判斷鐵塔安全性的依據，並採取適當的應變措施，目前監測採人工作業方式如下：(1)第一節水平斜撐對角距量測(2)傾斜管人工監測。但目前台灣有 2 萬座鐵塔，對我們是艱鉅的任務。本文係以 345kV 深美~冬山 #80 鐵塔自動化監測案例，撰寫相關自動化監測之台電的鐵塔維護方法與應變機制。

Abstract

It is not easy to detect deterioration of transmission towers caused by long-term exposure to harsh environmental conditions. Yet, severe deterioration of a transmission tower may lead to disastrous results. Fortunately, incidents can be avoided through the preventative monitoring. Data collected through monitoring can be used to judge the safety condition of a transmission tower, and to help take an appropriate contingency measure while the tower is at risk. Currently, two factors are considered in the monitoring of towers: (1) Measurement of the distance of horizontal braces, and (2) Inclinometer casing. Since there are approximately twenty thousand transmission towers across Taiwan, monitoring of all the towers is indeed an arduous task. This research project initiated the real-time monitoring at the 345kV Shen-Mei to Dong-Shan #80 transmission tower. Data obtained through the monitoring can be used in creating a proper tower maintenance plan and a coping mechanism for the Taiwan Power Company.

關鍵詞 (Key Words)：自動化監測系統(Automatic Monitoring System)、坡地災害(Landslide Hazards)。

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161kV 輸電線路保護電驛標置自動核對系統

161kV Line Protection Relay Setting Automatic Check System

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摘　要

161kV 輸電線路停電或復電時，為使送電中的線路保護電驛能夠發揮正確的保護功能，而必須依保護協調原則重新計算線路保護電驛標置，電驛維護人員再依計算後的電驛標置對運轉中的電驛做標置變更，而電驛標置變更後其標置是否設定正確，目前是由『人』去做核對。電驛標置若設定正確，於線路發生事故時電驛將準確的動作並隔離事故點，停電範圍僅限制在發生事故的線路，反之將使電驛無法正確的隔離事故點，導致停電範圍擴大，因此電驛標置設定是否正確，將直接影響到線路發生事故時的停電範圍。

有鑑於此，本處使用 Python 程式語言自行開發「161kV 輸電線路保護電驛標置自動核對系統」，將本處所轄 161 kV 線路電驛的標置設定值，與供電處每個月在電驛標置組網頁所公佈的最新「161kV 輸電線路保護電驛標置.txt」 檔案內的標置值進行核對，核對後輸出表單檔案提供電驛人員確認及修正，本系統完成開發後，電驛標置除了由『人』核對外，還可以交由『電腦』再次核對，以確保電驛的標置正確。

Abstract

When a 161kV transmission line is de-energized or re-energized, its line protection relay settings must be recalculated and changed to make the relays operate correctly. After the settings are changed, the relay will be checked by humans. When a power line fails, the correct relay settings will make the relay operate correctly and isolate the fault. Otherwise, if the relay can't correctly isolate the fault, and the power outages may expand into other areas.

In view of this, we developed the "161kV transmission line protection relay setting automatic check system" by using the Python programming language. The system compares the settings of the relay with the correct relay settings file and stores the system comparison results in the file. Maintenance personnel use the system comparison results to confirm and modify the relay settings. In addition to the relay settings being checked by humans, it can be re-checked by the computer to confirm that the relay settings are correct.

關鍵詞(Key Words)：網路交換器 (Switch)、Python 程式語言(Python Programming Language)、輸電線路保護電驛(Line Protection Relay)。

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我國中長期能源發展情境之衝擊影響評估

The Impact Evaluation of Medium and Long-term Energy Scenarios in Taiwan

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摘　要

本研究運用美國商會之國際版能源安全風險指標、歐盟永續能源系統、投入產出模型及網路問卷評估我國能源發展情境之能源安全、環境、經濟及社會衝擊程度，並運用核能研究所之能源工程模型與能源經濟模型，共同模擬從 2015 至 2050 年之參考與政策兩情境為評估標的，再透過五位專家協助制訂各衝擊面向的平均權重，計算能源發展情境未來至 2050 年的整體衝擊影響程度。研究結果顯示：專家認為最重要的衝擊面向為能源安全衝擊，重要性最低的衝擊面向為社會衝擊。最後，再將各衝擊面向之正規化評估值與專家權重進行加權，政策情境 2020 年前的加權衝擊值略低於參考情境，但 2020 年後，政策情境的加權衝擊值則略高於參考情境，此為政策情境中 2020 年後經濟衝擊大幅擴大所致。

Abstract

This study employed a variety of information and study resources to evaluate the impact levels of our nation's energy policy scenarios from the respective of energy security, environment, economy and society from 2015 to 2050 - including the USCC international index of U.S. energy security risk, EU cost assessment for sustainable energy system, input-output model and online questionnaire. Both Reference and Policy scenarios simulated by the INER-TIMES model with INER-GEMEET model were assessed. Five experts were invited to assist in designating weighting-indexes for the four impact items. According to the weighting by the experts, energy security impact and social impact are the most important and unimportant respectively among the four impact items. Each impact item undergoes a process of normalization to become a dimensionless impact value and is weighted as an overall impact value. Overall impact value for Policy scenario is lower than Reference scenario before 2020 but higher than Reference scenario after 2020 because the economic impact of Policy scenario is projected to be expanding significantly after 2020.

關鍵詞(Key Words)：能源情境(Energy Scenarios)、能源安全(Energy Security)、環境(Environment)、經濟(Economy)、社會(Society)。

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台灣家庭用電消費暨節能推動策略

A Survey of Electricity Consumption and Construction of Energy Conservation Strategies for Household sector in Taiwan

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摘　要

本研究以一般住戶為調查對象，除蒐集國內外相關能源消費調查經驗作為參考外，亦透過調查蒐集住宅用電設備資訊及用電資料，採「分層多階段比例抽樣方法(Stratified Multi-stage Probability Proportional to Size Sampling)」,以入戶(In-house Visit)面對面訪問方式(Face to Face)，於 2018 年完成 1,800 份有效樣本，在 95%信心水準下，抽樣誤差在±2.31%以內。

調查結果發現，我國家庭平均一戶家庭家電總台約有 29.33 台，相較 2015 年 26.36 台成長 2.97 台，顯示家中電器日趨多元化。另根據台電統計資料換算，家庭月均用電每月約為 422 度電，夏月月均用電為非夏月用電的 1.4 倍。

調查資料顯示，冷氣(27.86%)為全年用電電器最大消耗來源、其次為冰箱(13.89%)及照明(11.81%)。其中家庭冷氣機超過 11 年以上的比例占 43.75%，電冰箱更高達 45.53%，顯示家庭普遍存在老舊家電問題。反觀家庭 LED 燈雖有逐年提升趨勢，但省電燈泡占比亦達 37.58%，建議可將家中省電燈泡逐步汰換成高效率 LED 燈泡，以加速提升家庭能源效率及降低家庭用電量。*

Abstract

With the research target focusing on the household users of Taiwan, this study adopt a survey methodology of “stratified multi-stage probability proportional to size”(PPS) sampling and in-house visit. In addition to collecting domestic and international experience of the survey on energy consumption as a reference, the research also collects information on residential electrical equipment and energy consumption. In 2018, the research collected a total of 1,800 valid samples, with the confidence interval being 95% and the sampling error being within the range of ±2.31%.

The research shows that the average number of appliances per household increased by 2.97 units from 26.23 units in 2015, showing a trend of home appliance utilization being towards diversification. Besides, the average monthly electricity consumption of the family is about 422

kWh per month according to the data from Taiwan Power Company. In summer, the monthly electricity consumption is 1.4 times that of non-summer electricity consumption, of which air conditioning (27.86%) is the largest proportion of the total electricity consumption for the whole year, followed by refrigerator (13.89%) and lighting (11.81%).

The survey data also showed that the proportion of household air-conditioners that have been used since initial procurement for over 11 years accounted for 43.75%, while the refrigerators of same condition accounted for 45.53%, indicating the fact that use of electric appliances with low operation efficiency is a commonplace problem among users. Moreover, though the number of LED lights has been increasing year by year, the proportion of the compact fluorescent lamp still stands at a level of up to 37.58% to date. It is recommended that the compact fluorescent lamps should be replaced with high-efficiency LED bulbs to accelerate the improvement of household energy efficiency and reduce household electricity consumption.

關鍵詞(Key Words)：住宅部門(Household Sector)、入戶調查(In-house Visit)、電力消費(Electricity Consumption)、能源效率(Energy Efficiency)、節能宣導(Energy Saving Promotion)、節能策略(Energy Saving Strategies)。

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時間電價宣導工具設計

Tools Design for Marketing “Time of Use” Power Pricing

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摘 要

台灣電力公司自民國 68 年實施時間電價至今已近 40 年，除高壓以上用戶適用時間電價，低壓電力用戶與用電規模較大之住商用戶亦可選用時間電價。本研究規劃藉由多元化之網路及平面推廣方式，促進國人對於時間電價之瞭解，並透過用戶體驗及互動，進而改變其用電行為，達到抑低用電量之目的。本研究以表燈、低壓與高壓等 3 類用戶作為宣導對象，透過時間電價之宣導文宣、插畫、懶人包、宣導影片及廣告等工具，宣導用戶於夜間時段(或離峰時段)使用電器，達到移轉用電之效果，及加深各界對於台灣電力公司時間電價政策之活潑印象。研究結果顯示，透過前述各類時間電價宣導工具，可有效提升台灣電力公司時間電價措施之能見度，以表燈與低壓電力時間電價廣告為例，其總曝光量達 2,595 萬次、總點擊量達 4.8 萬次。

Abstract

Taiwan Power Company (TPC) has been implementing the pricing program of “Time of Use (TOU)” for nearly 40 years since 1979. In addition to implementing TOU among high-voltage and low-voltage users, residential users with large amounts of electricity consumption could also opt to use TOU. In this study, in order to promote people’s understanding of TOU, we planned to use a variety of Internet and print media venues - along with utilization of users’ experiences and interaction - to change the users’ behavior in electricity consumption and reach the goal of power demand reduction. This study selected power users of meter-rate-lighting, low-voltage and high-voltage as the target audience for the TOU promotional activities. With the efforts being made through the TOU digital marketing, illustrations, short versions for dummies, videos and advertising, we were trying to promote power users to use their electrical appliances during time slots at night (or off-peak time) with an aim of shifting the behavior of users’ electricity consumption and creating a lively impression among the readers toward the TOU policy of TPC. As shown in the research results, through the tools designed to market TOU, it can effectively raise the visibility of TOU measurement. Take the advertising intended for meter-rate-lighting and low-voltage users as an example. The total exposure rate reached 25.95 million times, and the total click-through rate reached 48 thousand times.

關鍵詞(Key Words)：時間電價(Time of Use)、表燈(Meter Rate Lighting)、低壓電力(Low Tension)、移轉用電(Shifting Electricity Consumption)。

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我國電業轉型下公用售電業之因應策略建議

The Study of Adaptive Strategies of Public Electricity Retailer under Power Industry Transformation

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摘 要

我國最新通過之電業法將電業劃分為發電業、輸配電業及售電業，並開放綠能發電業與綠能售電業市場。開放分兩階段進行，第一階段採綠能先行，開放再生能源可以躉售、轉供及直供方式售電予用戶。第二階段則自電業法修正條文公布後 6 至 9 年後必須廠網分離，容許台電由原綜合電業型態轉型為控股母公司，其下分別設有發電子公司與輸配售電子公司，在管理配套、法治運作順暢、市場成熟穩健發展後，再進行修法，開放傳統發電業與一般售電業進入市場自由購、售電，並允許傳統發電業可透過轉供與直供售電。

基此，公用售電業面臨市場開放之競爭壓力，對於事業經營與用戶需求之各項議題須重新思考，以擬定最適策略，避免開放用戶購電選擇權後，出現用戶大量流失情形。本研究即在針對公用售電業面臨售電市場及用戶購電選擇權之開放後，可能面臨的問題提出因應對策，以防止用戶流失及增進經營效率。

Abstract

The new Electricity Act divides the electricity industry into the sector of generation, transmission & distribution and retailing; and opens the market to generation and retail service in the sector of renewable energy. Power industry transformation is designed, according to the Act, to be carried out in two phases. The first phase of the reform, which is called the policy of "green energy goes first", opens up the renewable energy market, where the retailer of the renewable energy (green-energy) is able to wholesale, wheel, or direct supply the "Green Electricity" to the users. The second phase is set to be enforced 6 to 9 years after the Electricity Act was issued. Under the present government policy, Taiwan Power Company (Taipower) is required to unbundle its vertically integrated business operation, although allowing Taipower to act as a holding company that is designed to control the running of two subsidiary companies: generation and transmission/distribution/retailing.

Based on this policy, the public electricity retailer will be facing the soaring competitive pressure from the market opening. The issues surrounding the business operation and users' demand must be carefully rethought so as to allow the operators to formulate an optimal strategy and to prevent the possibly large loss of their users as the result of opening purchase-switching-option among the users. To prevent the operator from losing large amounts of users and to improve the operator's operational efficiency, this study proposes some countermeasures to cope with the problems that may emerge after the public electricity retailer faces the opening of the electricity sales market and purchase-switching-option for the users.

關鍵詞(Key Words)：電業轉型(Power Industry Transformation)、售電業(Electricity Retailer)、競爭策略(Competitive Strategies)。

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