子項目五：微電網監控、管理及全面保安
Subtopic 5: Microgrid Monitoring, Management, and Comprehensive Security

微電網發電調度的在線算法
Online Energy Generation Scheduling for Microgrids

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針對問題 Problem to be Solved

微電網 (Microgrid) 是一個小型的發電及配電系統，一座大樓、一家醫院、以至一個小區都可以建構一個屬於自己的微電網 (圖一)。 此系統可同時採用太陽光等再生能源及小型燃氣發電機來提供電力，可以並網或離網運行。微電網能有效提升電力系統穩定性、能源轉換效率、以及再生能源使用比例。美國、日本、德國、丹麥都在積極推動微電網的發展。但再生能源受天氣影響，供應量不穩定，營運商也難以準確預測微電網的負荷，從而無法運用基於預測的傳統發電調度算法。因此，微電網運營的最大挑戰，在於如何安排外部電網和本地能源供電的調配，使之既可滿足電力需求，又能減低營運成本。

Microgrid is a local electric power system with both generation and distribution sub-systems (Fig. 1). A building, a hospital, and even a district can build a microgrid of their own. The network uses solar or other renewable energy generation; it can also use small gas generators to provide electricity in grid-connected or islanded modes.

Microgrid can effectively improve power system stability, energy conversion efficiency, and the percentage of renewable energy integration. The United States, Japan, Germany and Denmark are actively promoting the development of microgrid. Renewable energy generation, however, is affected by weather and thus intermittent in nature, the operator also faces difficulty in accurate prediction of the local electricity and heat/cooling demand. As such, conventional energy generation scheduling solutions based on accurate generation/load prediction fail to work in microgrids with the unique generation/load characteristics. Therefore, the key challenge in microgrid operation is to optimally orchestrating external energy supply and local energy generation to meet both power and heat/cooling demands with optimized costs.
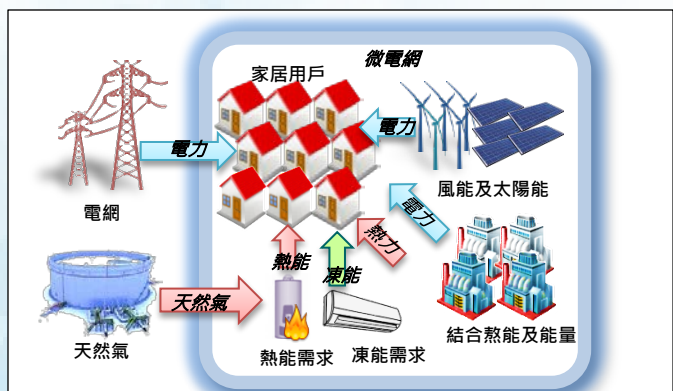

圖一. 微電網運作圖示。(由本項目合作伙伴及中大校友Masdar學院周志健教授、本項目經理謝雯小姐、以及陳名華教授聯合製作)
Fig. 1 Schematic diagram of microgrid operation. (Collaboratively contributed by a TRS collaborator and CUHK alumnus Prof. Sid Chau from Masdar Institute of Technology, Project Manager Miss Mandy Tse and Prof. Minghua Chen.)

項目說明 Project Description

團隊就微電網 營運研發出嶄新的「微電網發電調度的在線算法」，解決再生能源不穩定性帶來的發電調度新挑戰，實現既高效節能又融合再生能源的微電網系統。方案即將結合太陽能採集及存儲之新技術，於中大和聲書院實驗使用，見證效益。

The team developed a paradigm-shift online algorithm for cost-minimized energy generation scheduling in microgrid. The algorithm addresses a key and unprecedented scheduling challenge caused by the intermittency of renewable generation in microgrids, achieving effective cost-saving performance and enabling integration of high-percentage renewable generation in microgrids.
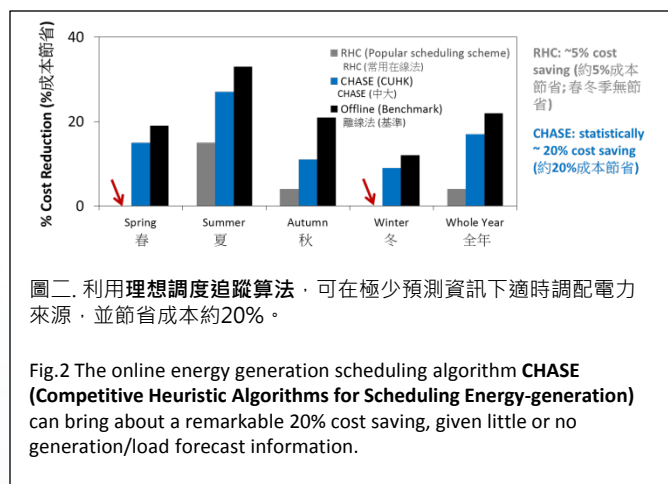
圖二. 利用**理想調度追蹤算法**，可在極少預測資訊下適時調配電力來源，並節省成本約20%。

Fig.2 The online energy generation scheduling algorithm **CHASE (Competitive Heuristic Algorithms for Scheduling Energy-generation)** can bring about a remarkable 20% cost saving, given little or no generation/load forecast information.

團隊打破基於預測的傳統調度框架，提出一套名為 **CHASE (Competitive Heuristic Algorithms for Scheduling Energy-generation)** 的理想調度追蹤算法。研究團隊將CHASE算法應用在美國三藩市的模擬微電網案例中，在沒有或極少預測信息的情況下，僅靠過往用電趨勢智能追蹤理想調度，適時調配電力來源，滿足用電需求，**在沒有或極少預測信息的情況下帶來約20%的成本節省 (圖二)**，成效顯著。理想調度指預知未來一切發電及負荷信息後形成的調度方案。最近，CHASE算法的可行性和性能在香港理工大學微電網實驗室得到進一步驗證。大數據量的實驗結果表明，CHASE算法的成本節省接近理想調度所能達到的最低值，兩者相差少於10%。

Professor Minghua Chen and his team broke through the conventional prediction-based scheduling paradigm and proposed an online algorithm called **CHASE (Competitive Heuristic Algorithms for Scheduling Energy-generation)**, which is based on intelligent tracking of the behaviors of perfect dispatch. In a case study of a virtual microgrid based on traces in San Francisco area, with little or no generation/load forecast information, **CHASE algorithm was able to bring about remarkable 20% cost saving (Fig. 2)**. Here, perfect dispatch refers to the optimal scheduling solution assuming full knowledge of all future generation and load information. Recently, the feasibility and performance of CHASE algorithm have been further validated at the Hong Kong Polytechnic University Microgrid Laboratory. Extensive experimental results show that the cost saving performance of CHASE algorithm is close to that of the lowest value reached by perfect dispatch, off by less than 10%.

陳教授指出，研究的下一階段是在中大和聲書院進入實地試驗，當技術成熟後，陳教授認為香港的離島是一個合適的試點。

The next stage of the research is to carry out field test in Lee Woo Sing College at CUHK, commented by Prof. Minghua Chen. When the technology is mature, he believes that it provides a viable solution for providing electricity in Hong Kong's outlying islands.

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More information

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