Half Day Workshop On Energy Storage Applications In Smart Power Systems

by Dr Siow Chun Lim

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The Electrical Engineering Technical Division (EETD) has successfully organised a **HALF DAY WORKSHOP ON ENERGY STORAGE APPLICATIONS IN SMART POWER SYSTEMS** on 5th November 2017 at Penang Skills Development Centre. The workshop aims to inform participants on the knowledge of realisation of a low carbon society, smart grid power system's reliability, and energy storage applications. This workshop is also the first activity organised between EETD and Institute of Electrical Engineers of Japan (IEEJ).

The registration started at 8:30am. A total of 15 participants from KL, Penang and Kedah have registered. Then, Prof. Toshihisa Funabashi from Nagoya University started off the workshop with a presentation on "Introduction: Renewable Energy Sources and Smart Power Systems". Under the topic on small scale power systems, he talked about battery energy storage systems (BESS). In Japan, the frequency of power supply is either 50 or 60Hz with typical voltage levels at 100V and 200V. BESS offers the flexibility in controlling frequency and voltage supply. He then stressed that renewable energy (RE) sources are good for environment and energy security. However, large integration of variable output RE may affect power system operations due to their output fluctuations. These generation of variable output will generate large fluctuation and is weather dependent.

As the result, challenges in terms of frequency and voltage fluctuation as well as backup generation and demand and supply control of surplus power have to be addressed. BESS has advantages such as fast charging and discharging, easy to install compared to pumped hydro and offers the flexibility of controlling AC power. These charge/discharge patterns have to be matched with the supply-demand for balancing. Prof. Funabashi concluded his presentation by stating that BESS can be used as countermeasure for frequency fluctuation, surplus power, supply and demand adjustment, and microcontrolling voltage fluctuation in distribution system.

Next, Prof. Masahide Dojo presented on "Stabilisation of Small-Scale Power System by Inverter Control". Due to high penetration of RE, power generation only depends on resource, not demand. Hence it is difficult to keep the power balance especially in small scale grid. Application of self-commutated converter to connect RE to grid may weaken the synchronising torque in small-scale grid. Therefore, Prof. Dojo introduced the concept of virtual synchronous machine. This machine equips the synchronising torque to the static power converter. It adds theoretical dynamics of rotating machine to the converter's controller.

It decides the phase angle of inverter output voltage according to the swing equation. Voltage phase behaviours are analysed. This concept is suitable for short time power balancing at constant frequency operation. Output voltage phasor of converter is modified to improve the power quality in a microgrid. It is able to realise good active power trade to reduce frequency fluctuation.

The third speaker was Associate Professor Ryoichi Hara. His topic was "Energy Storage Applications in Microgrids". He first defined microgrid as a local power and energy supply system with distribution, generation, energy storage system and ICT based demand side contribution. The functions of microgrid are to improve efficiency by shortening supply length hence reducing ohmic losses as well as incorporating RE and Combined Heat Power (CHP) systems and to harmonise RE by using battery storage to suppress fluctuations in RE. Reliability improvement also results from microgrid. Rapid response of battery helps for quick and smooth recovery of voltage especially important and critical facilities. He cited an example at Aichi microgrid where fuel cell is used with solar PV system. He also highlighted the importance of optimal scheduling by energy management system. Battery has the merits of good controllability and scalability as well as being a well-developed technology.

However, it is still a costly technology. Hence, he proposed power to gas (P2G) technology as energy storage system. P2G converts excess electricity from RE to hydrogen gas by electrolyzer for easier storage. Thus, it increases the hydrogen demand for fuel cell vehicle and residential use. However, this technology is still low on conversion efficiency (50-70%) in the electrolysis process. Re-conversion of gas to electricity has an even lower efficiency of about 40%. Response time or ramp-speed performance is also not well studied yet. Another technology proposed was power to heat (P2H). this technology combines cogeneration system and heat pump. Compared with BESS, it requires low investment cost but complicated control and system design. As his concluding remark, he emphasised that energy storage is key in RE but battery is costly and this warrants other alternatives such as P2G and P2H.

The last speaker was Dr. Yoshinobu Ueda. He presented on "Energy Storage Applications In Rural Power Systems". He cited the project at Laos at which small-scale independent hybrid power supply system consisting of solar PV and micro hydropower was constructed. The technical challenge was the poor response of microhydro which cannot follow the rapid fluctuation of PV generation. Therefore, a frequency stability control using electric double layer capacitor (EDLC) was developed. ELDC detects output fluctuations of PV directly and cancels the part which exceeds the allowable charge rate. It runs on power change and frequency change control.

The project is easily operable and maintainable requiring only small number of engineers due to its distance from large cities. Without any countermeasure, frequency of 50Hz with variance of 2% was achieved. With the completion of this project, 10 villages are powered 24 hours daily as opposed to only 4 with time-limited power supply using diesel engine generator initially.

Group photos of all participants

Token of appreciation to Prof. Funabashi