GRID-WIDE INTERMITTENCY MANAGEMENT BY AGGREGATION OF DISTRIBUTED ENERGY STORAGE SYSTEMS

PROJECT SUMMARY

The increasing deployment of large-scale Photovoltaic (PV) generation systems in Singapore may cause stability issues to the electrical grid due to the intermittent nature of solar PV. Implementing Energy Storage System (ESS) could be a feasible solution for mitigation of large power fluctuation because the energy storage devices can essentially behave as “energy buffers” to balance the generation and load demand in the power system.

However, the challenge for ESS is to respond fast enough to handle the uncertainties and large fluctuation of PV output power. The ESS shall also be controlled in an optimal manner so that its implementation cost can be minimised and competitive to that of the conventional operating reserves. This project aims to develop and test-bed cost-effective Distributed Energy Storage Systems (DESSs), which can be deployed at HDB blocks for solar intermittency management and power system frequency regulation. The DESS technology may allow an increased capacity of solar generation in the power grid without compromising the grid stability, contributing to a clean and sustainable energy future.

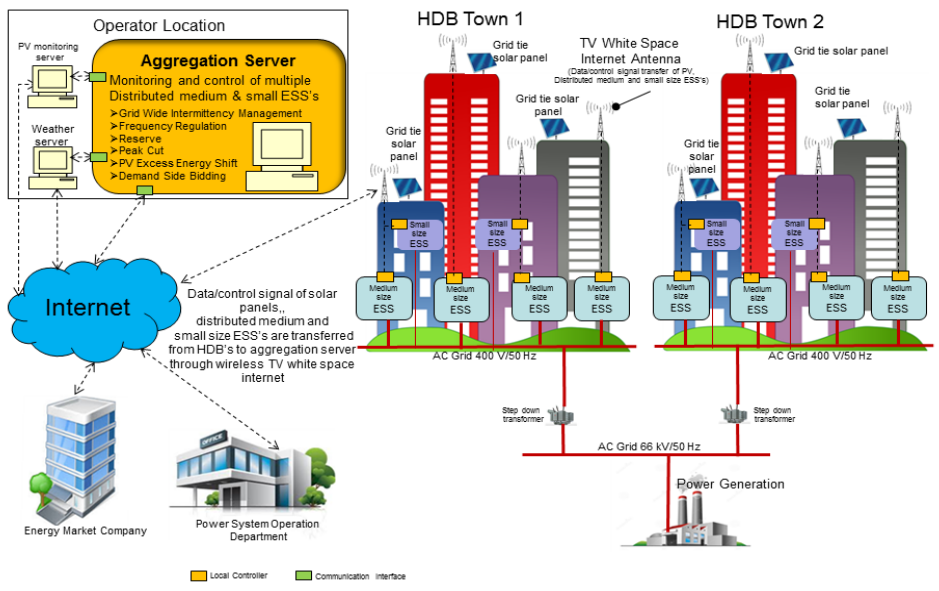

Figure 1: DESS implementation at HDB blocks

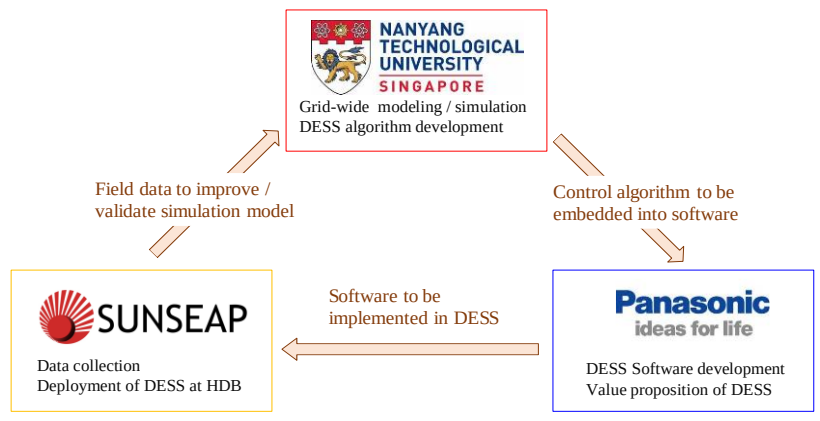

Figure 2: Project work scope and collaboration

PROJECT OUTCOMES

The project team has developed an advanced control algorithm to manage the distributed ESSs deployed at 5 HDB blocks. The algorithm can aggregate multiple ESS across different sites and intelligently dispatch their stored energy in response to the variability of solar power generation. This will help to manage solar intermittency and reduce the stress on the power network, which is critical to the reliable and secured operation of the power system as we scale up solar deployment.

The control algorithm enables DESS to implement two applications, i.e., PV intermittency management and frequency regulation, which can be scheduled in the Energy Management System (EMS) installed at the cloud server.

i. For PV intermittency management, PV data is transmitted to the cloud server and the aggregation controller will determine the power commend for each DESS. The field test results showed that DESS could limit the ramp rate of solar PV within 10% of the rated capacity per minute.
ii. When scheduled for frequency regulation, DESS could respond quickly to the grid frequency deviations and help to balance supply and demand in the power system.

The following has been achieved as part of the project outcomes.

- 50% increment in Singapore's Intermittent Generation Threshold (IGT) as compared to the current value of 600 MWac (i.e., achieve 900 MWac IGT). This was successfully demonstrated via Simulation, by using the proposed DESS technology.
- 10% reduction in frequency deviation by using the proposed DESS, compared to the current threshold for frequency deviation of 0.2 Hz, for grid resilience enhancement via Simulation.
- 20% reduction in both the operation and capital expenditure for PV intermittency management at distribution networks with the proposed DESS as compared with centralised ESS.
- 20% increase in the value of DESS gained from ancillary services by integrating multiple applications of DESS (e.g., frequency regulation, intermittency management).

The developed DESS technology provides a promising solution to PV intermittency. Our industry collaborator Sunseap is working with both public and private building owners to optimise existing building spaces for deployment of ESS.

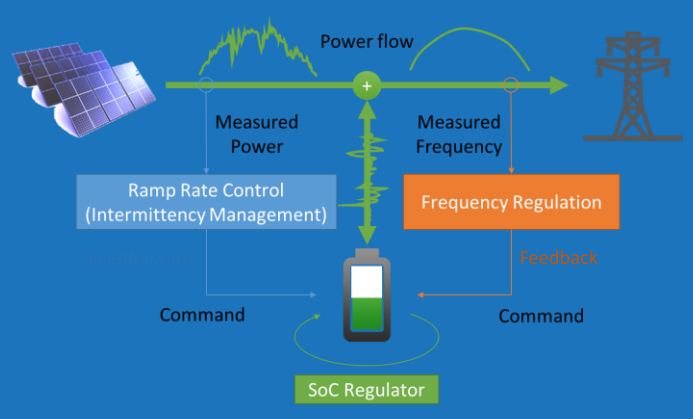

Figure 3: Aggregation control for DESS

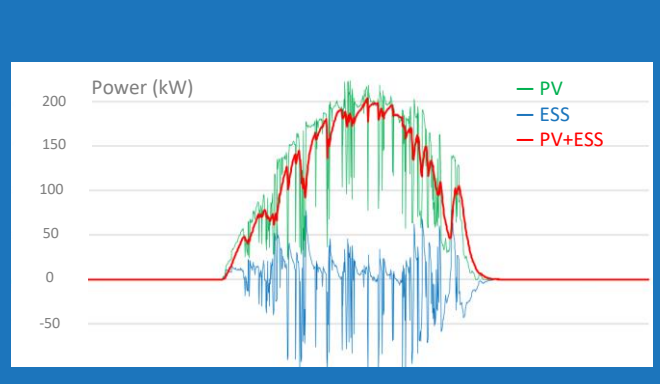

Figure 4: Results of PV intermittency management

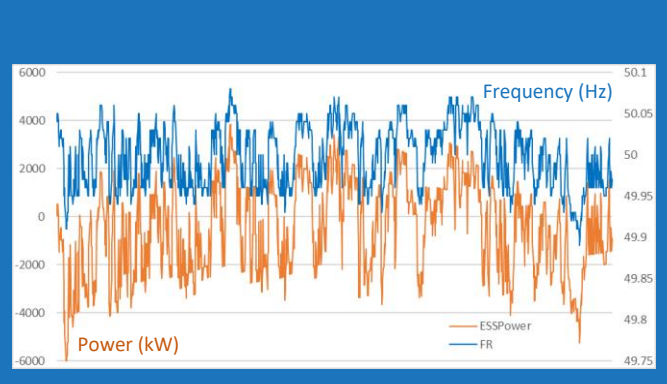

Figure 5: Results of frequency regulation

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