**I. INTRODUCTION**

The applications in which energy storage systems can be used hold considerable value to energy producers, grid operators and in turn, energy consumers. Battery Energy Storage Systems’ (BESS) technology (out of different energy storage technologies) is suitable for applications that improve dynamic stability, transient stability, voltage support [3], area control/frequency regulation, transmission capability [4, 5] and power quality. These characteristics are suitable for performing the intended applications of this project. These applications include electric energy time shift (ETS), voltage support, and renewable capacity firming [1, 2].

**II. METHODOLOGY**

The project setup consists of the BESS connected in conjunction with a 1MW PV station. The PV station is controlled to operate at unity power factor. The battery capacity is 0.25 MW and the inverter capacity 1MVA. Fig. 1 shows the regions of ESS controllability. The studied control scheme relies on using an inverter with a relatively high capacity compared to that of the battery. This capacity difference is used for reactive power dispatch to allow voltage support capability.
Fig. 2 Block diagram schematic for PV station capacity firming, energy time shift and voltage support applications.

Area A₁ in Fig. 1 shows the ESS power capability. This is also the power output region for zero active power output from the PV station installed at the point of common coupling (PCC). As the PV station output increases, the controllable region is shifted to the right till it becomes A₂ at maximum (PV) output. A₄ shows the control regions used during PV station capacity firming (PVCF) application.

III. SIMULATION RESULTS

A. PV Capacity Firming

Fig. 3 shows results for PVCF

![Graphs showing simulation results for PV capacity firming.](image-url)
B. Combined PVCF & ETS for a Single Day

As shown in Fig. 4. After performing PVCF with maximization of SoC taken into account, the remaining energy in the battery (95% SoC) was sufficient to allow effective peak load shifting.

C. Voltage Support

Fig. 6 shows the results of voltage support
IV. CONCLUSION

The devised algorithms were found efficient in performing their respective purposes.

V. REFERENCES


