

# Recent deployments of vanadium redox flow battery storage systems in South Korea

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## Introduction

H2, Inc. has been recently deployed three vanadium redox flow battery storage system in South Korea (1.6 MWh total). All three systems are integrated with PV, two in AC and one in DC. This paper provides detailed information on the recent projects, including its applications and performances.

## H2, Inc.'s vanadium redox flow battery

H2, Inc. develops, manufactures and delivers modular vanadium redox flow battery systems, *EnerFLOW 400* series, to the global market. A module consisting stacks, electrolytes, BMS and BOP is packaged in a 20-ft container to facilitate the delivery and installation.

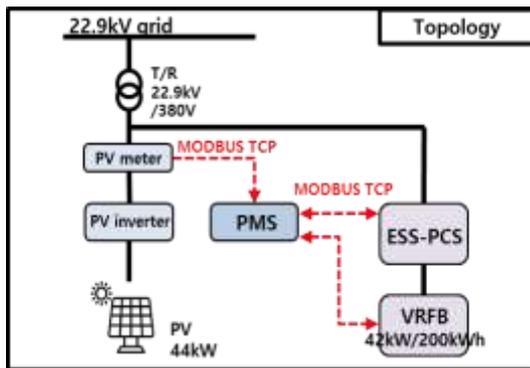


Figure 11 System topology of the Gochang project

One system is installed in Kepco, Korea Electric Power Corporation site in Gochang, South Korea as a demonstration project of the renewable energy integration. A 40 kW / 200 kWh VRFB ESS and a 44 kW PV are AC coupled as in Figure 11. Several operation scenarios were tested including the output power stabilization,

*EnerFLOW 430*, the most recent model, has acquired SPS-C KBIA-10304-02-7386 certification (Flow battery system for battery energy storage systems – performance and safety requirements), which would be the first certification on the performance and safety of a redox flow battery module ever issued in the world.

## Project overview

H2, Inc. has delivered three VRFB systems in South Korea since 2019. The recent deployments include a 200 kWh system in Gochang (2019), an 810 kWh system in Naju (2020) and an 810 kWh system in Ulsan (2020).

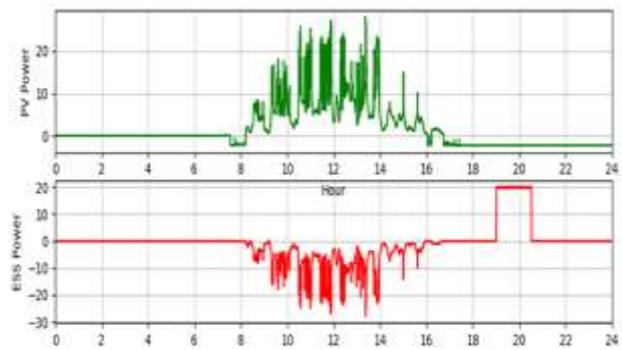


Figure 12 Power profile on a cloudy day

smoothing and constant net power control. Figure 12 shows an operation data of the system on a cloudy day with the zero net power control during the day and the scheduled constant power discharge during the night. The system follows the PV profile making the net power zero.

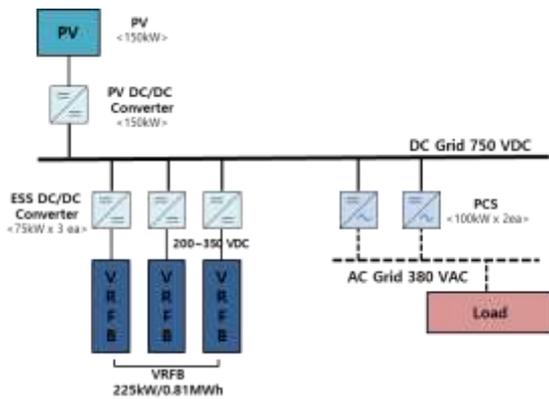


Figure 13 System topology of the Naju project

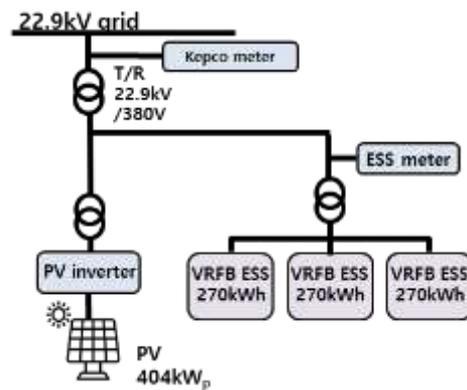


Figure 14 System topology of the Ulsan project

The Naju project consists of three 270 kWh VRFB modules connected to a 750 V DC grid. A 150 kW PV and two 100 kW PCSs are also connected to the DC grid. The PCS controls the DC grid voltage and provides energy to the load. The VRFB ESS works as a current source and store excessively generated PV energy during the daytime and discharge during the night when the load requires power.

The Ulsan projects is a commercial project integrating total 810 kWh VRFB ESS with 404 kWp PV. The PV generated electricity is stored on the ESS during the peak hours from 10:00 to 16:00 and sold at off-peak hours from 16:00 to 10:00. By selling the ESS-stored energy one can get additional REC of 4.0 thanks to the Korean government's incentive program to promote the integration of ESS with the renewable energies. Previously, lithium ion battery ESS was the only battery time that were eligible for the additional REC program. Starting February 2020, however, VRFB ESS with SPS-C KBIA certification has been included on the list. The installed VRFB ESS is the first-ever VRFB ESS in South Korea to acquire the SPS-C KBIA certification and the first eligible ESS other than LiB for the PV+ESS additional REC incentive program. The 20-year profit is expected to be around 1.25 million USD.

## Conclusions

H2, Inc. has delivered total 1.6MWh VRFB ESS systems since 2019 in South Korea. The all three systems operate well regardless of the system topology (DC-coupled and AC-coupled) and the application (PV following, smoothing, power stabilization, schedule operation etc.) Our latest model, *EnerFLOW 430* acquired the first certification for the performance and safety of a VRFB module and accredited as the first VRFB ESS eligible for the PV+ESS REC incentive program.