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GRANT AGREEMENT No. 875613

HIGREEW – Deliverable Report

D3.4 – Report on HIGREEW stack and BoP performance including predictions on performance / cost of an optimised system

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Publishable summary

The HIGREEW project set out to design, build, and demonstrate a prototype of a new high energy density generation of Aqueous Organic Redox Flow Battery (AORFB), based on a water-soluble low-cost organic electrolyte, and featuring low-cost components and long service life.

This deliverable report (D3.4) provides a summary of the performance of the stacks produced in work package 3 for optimizing and characterizing the divided HIGREEW chemistry in an energy storage system. The stack design was based on the chemistry and materials defined in work package 2 along with the verification and modelling work in work package 3.

The aim of work package 3 in HIGREEW was to produce prototype stacks for testing the performance of the HIGREEW electrolyte at scale, increase understanding of the performance of an energy storage system based on the HIGREEW electrolyte (stack plus balance of plant systems) and to increase understanding in how to design flow battery stacks for similar organic chemistries.

Work package 3 uses the divided form of the HIGREEW chemistry with separate positive (ferro/ferri cyanide) and negative (viologen) electrolytes which offers a higher cell voltage and energy density than with the mixed electrolyte used in Work packages 4 and 5.

Testing was carried out of the stacks on instrumented balance of plant to determine DC electrical characteristics under a wide range of more realistic operating conditions considering effects of temperature, flow rates, current density and power on performance.

Stack scale up from a laboratory single cell (20 cm^2) to commercial stack scale (20-unit cells of 600 cm^2) operating on full balance of plant was successful achieved with reproducible performance across all scales.

It was demonstrated that stacks designed for vanadium redox flow batteries could be used with simple modification of the fluid distribution design to give good performance for the HIGREEW chemistry (and other organic systems with similar properties). Pressure drops could be reduced while keeping shunt currents low.

It was shown that the differing anolyte and catholyte viscosities in the divided HIGREEW chemistry could be readily accommodated through stack designs and individual electrolyte flow / pressure control. It was shown that flow rate control based on state of charge could improve performance and usable electrolyte capacity.

The system was operated successfully between 15 and 40^oC with the best performance at higher temperatures (25 to 40^oC). Current efficiency was almost always close to 100% and voltage efficiency was 65 to 70% at current densities around 50 mA/cm^2 and power densities around 30 mW/cm^2.

Comparisons were made with the most common flow battery system (vanadium) and predictions of CAPEX / OPEX costs were made relative to VRFB. CAPEX and OPEX are currently higher than for the more mature VRFB technology but areas for improvement of the HIGREEW system were identified which could significantly improve the HIGREEW system performance and reduce costs.

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Project partners:

#	Partner	Partner Full Name
1	CICe	CENTRO DE INVESTIGACION COOPERATIVA DE ENERGIAS ALTERNATIVAS FUNDACION, CIC ENERGIGUNE FUNDAZIOA
2	GAMESA	GAMESA ELECTRIC SOCIEDAD ANONIMA
3	UAM	UNIVERSIDAD AUTONOMA DE MADRID
4	CNRS	CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS
5	C-TECH	C-TECH INNOVATION LIMITED
7	UWB	ZAPADOCESKA UNIVERZITA V PLZNI
8	PFES	PINFLOW ENERGY STORAGE, S.R.O.
9	UNR	UNIRESEARCH BV
10	SGRE	SIEMENS GAMESA RENEWABLE ENERGY
11	FRAUNHOFER	FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E. V.