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Affordable High-Performance Green Redox Flow Batteries

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HIGREEW – Deliverable Report

D3.2 – CFD and shunt current models for cell and stacks

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Publishable summary

The goal of the HIGREEW project is to design, build, and demonstrate a prototype of a new high-energy density generation of aqueous organic redox flow battery based on a water-soluble low-cost organic electrolyte featuring low-cost components and long service life. To achieve this goal, every aspect of the battery from material selection to battery management system must be optimized.

In WP2, a single cell composed of chosen materials was successfully tested. The next step is to scale up this single cell to the battery stack in industrial size. However, the experimental development of the battery stack design would be very costly and time consuming, as a lot of different designs would need to be manufactured. Therefore, in this report, the development of two mathematical models, the CFD model of pressure losses and flow distribution, and the analytical model of shunt current and pressure losses, is described. These models enable cell design optimization to be done much more efficiently and allow easy prediction of larger system behaviour. The mathematical approach allow also to react on partial changes in chemical composition of electrolyte. With the use of the analytical model, the basic parameters of optimal cell geometry (length, width, and depth of the guide channels) might be estimated with respect to pressure and shunt current losses, and these obtained parameters might be further used as input parameters to the CFD model, and with the use of the CFD model the optimal shape of main guide channels might be found. These two models are introduced and described in this report and validated with experimental data.

The results of these models show that the pressure losses in the felt electrode are more significant than the pressure losses in the guide channels. This result shows that a significant part of the pressure losses cannot be lowered by optimizing the guide channels. However, relatively high pressure drops in the felt electrode help to homogeneous flow distribution in the cell.

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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
6	HEIGHTS	HEIGHTS (UK) Limited (Termination report ongoing)
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 ICT

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