Towards solid oxide electrolysis plants in 2020

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The goal of the project is to further improve performance and durability of solid oxide electrolysis cells (SOECs) and stacks targeting applications specifically for regulating the future Danish power system with a high amount of fluctuating renewable energies, and at the same time enhance the cost competitiveness and environmental friendliness of the SOEC technology.

Denmark’s ambitious plan to rapidly increase the fraction of renewable energy supply towards 100% over the coming 35 years will lead to huge changes in the electricity grid and a need for large-scale energy storage due to the intermittent nature of wind and solar power. SOEC is a unique energy conversion technology that can provide regulating services to the electrical power grid by efficient storage of electrical energy as fuels. The fuels can be converted back to electricity by running the SOEC in the reverse power generation mode.

A key player in the transition to renewable energy available from around 2020. The current project is based on the previous line of SOEC-focused ForskEL projects (ForskEL 10609 “Development of SOEC cells and stacks” and ForskEL 12013 “Solid oxide electrolysis for grid balancing”), of which ForskEL 12013 was awarded with the ForskEL award as the best finalized ForskEL project in 2015.

The project is structured into five technical work packages (WPs). WPs 1-4 focus on the SOEC technology development, covering from SOEC single cells, stack components, to stacks and systems, while WP 5 provides analysis on energy system level and gives inputs to WPs 1-4.

Some of them have already been implemented in the SOEC production at HTAS, such as the improved SOEC stack and SOEC-CORE designs. The results obtained by DTU Energy, in particular improvements in performance and durability of cells and stack components, improved understanding of degradation mechanisms, and fruitful degradation mitigation strategies will be transferred to HTAS. The power converters developed by DTU Elektro will be transferred to companies specialized in this area. The results obtained in the series of ForskEL projects including the current project played a key role in achieving the development targets necessary for commercialization of the Danish SOEC technology.

As compared to the previous projects, significant progresses have been achieved in this project with respect to the SOEC technology development.

- With the 2014 generation technology, we have demonstrated stable electrolysis operation for more than one year, both at the cell level and at the stack level.
- We have also shown that the cells and stacks can be operated in a stable manner under grid balancing related conditions, with a realistic wind power production profile.
- By introducing electrocatalysts into the Ni/YSZ electrode, we were able to push the operating point for SOEC cells from -1.25 A/cm² to -1.33 A/cm² with on-going cell tests running for more than 6000 h.
- At the stack level, we have further improved the gas flow distribution and the interface adherence and the new stack design is now implemented in HTAS stack production.

The results obtained in this project are in line with the Danish national strategy and roadmap on SOEC and has further contributed to the commercialization of the Danish SOEC technology at HTAS.

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