1. Publishable summary

Summary description of project context and objectives

SUMMARY Project LASER CELL brought together experts in advanced manufacturing, carbon technology, laser processing, computational modelling, life-cycle analysis, Hydrogen and fuel cells in order to improve the production of substrates for alkaline fuel cell electrodes. The partners set out to achieve a novel alkaline fuel cell (AFC) and stack that deliver competitive performance and economical volume production for large-scale stationary applications. To achieve this objective, an additive and a subtractive manufacturing route and two different material sets were assessed by the partners. Laser sintering and laser drilling were compared; significant advances were achieved in each. Two distinct material sets were investigated for the substrates: (ii) metals, due to high electrical conductivity and chemical resistance; and (ii) polymer matrices combined with conductive carbons and metal powders, which are more responsive to laser excitation, and allow faster manufacturing speeds. Modelling was undertaken to evaluate the relationship between AFC performance and substrate type. Applying the latest modelling techniques to AFC technology in novel ways led to a substantial increase in the understanding of the fundamental science driving the alkaline fuel cell. At the start of the final year of the project, a manufacturing method and material had been selected from which the prototype stack was then built. In the selection process, technology readiness proved to be the deciding factor; the more mature technologies were chosen: i.e. laser drilling of metal substrates. It is noteworthy, however, that the partners obtained outstanding results with the other two technology areas investigated, and further work in these areas was also conducted during the final year of the project. A prototype stack, built from selected technological advances resulting from the project, was found to have performance and longevity equivalent to AFCEN's contemporary technology. To give the prototype electrodes the best chance of fulfilling all project objectives, modifications to the design and function of the fuel cell technology were made; most notably by reducing shunt currents in the electrolyte circuit using an ingenious, ionic decoupling method. Significant modelling and analysis was carried out to evaluate the environmental, economic and market implications of the project's results. Improved global warming score and stack costs are reported. An assessment of potential market penetration within the EU was conducted. Although it concluded there is a need for regulatory incentives to encourage the use of by-product hydrogen, it also showed real potential for these technological advances to be capitalised upon. The key outcomes of each phase of the project can be summarised below. PRIMARY OUTCOMES: RESEARCH PHASE: - Laser Drilling selected as best processing method - Metal selected as best candidate substrate material PRIMARY OUTCOMES: PROTOTYPING PHASE - Fully-functioning prototype stack tested HIGHLIGHTED OUTCOMES: RESEARCH PHASE - Increased laser drilling speeds - Improved laser sintering process - AFC model developed, refined and tested - Electrode evaluation methods & test quality improved - Production process for carbon/metal/polymer composites refined - Conductivity of carbon/metal/polymer composites increased HIGHLIGHTED OUTCOMES: PROTOTYPING PHASE - Shunt current reduction (by ionic decoupling) prototyped and tested - Technology shown to provide Environmental benefit over current Alkaline Fuel cells in stationary applications - Technology shown to significantly reduce the cost of Alkaline fuel cells in this application - Priorities for market adoption using by-product Hydrogen identified The partners improved manufacturability and cost of AFCs

by combining improvements to manufacturing processes, refinement to materials and design modifications with economic analysis, life cycle analysis and computational modelling.
The partners further increased the impact of the project by sharing results in scientific papers and conferences and by running workshops for interested parties. The Coordinator has taken the results from LASER-CELL into projects ALKAMMONIA and POWER-UP, in which the technology will be demonstrated on industrial scales.