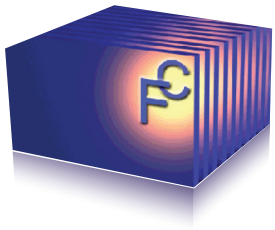

International Energy Agency (IEA) Advanced Fuel Cells

Implementing Agreement

KEY MESSAGES

June 2014

iea Energy Technology Network

Key messages from the Advanced Fuel Cells Implementing Agreement

The Advanced Fuel Cells Implementing Agreement (AFC IA) is part of the Committee on Energy Research and Technology (CERT) of the International Energy Agency (IEA). The AFC IA was set up as a programme of research, development and demonstration on advanced fuel cells that began in 1990. It currently has 13 member countries – Austria, Denmark, Finland, France, Germany, Israel, Italy, Japan, Korea, Mexico, Sweden, Switzerland and the USA. Its aim is to advance the understanding of all members in the field of advanced fuel cells.

The AFC IA is in a unique position to provide an international overview of the status of fuel cell technology, deployment, and the opportunities and barriers faced in member countries. Its focus is to improve and advance fuel cells technology through members working together and sharing knowledge.

The messages below form part of the AFC IA's annual reporting cycle, and can be found in its Annual Report. The messages reproduced there are in a short and easily digestible format to make them more accessible to international experts, members of the IEA's Working Party on End-Use Technologies (EUWP) and CERT, and policy makers. It is hoped, these people will be interested in the messages and recommendations of the AFC IA.

Fuel cell systems have a proven, long-term stability, which enables commercial use of this technology. The acceptance of fuel cells is increasing rapidly through demonstration programmes that take place under real conditions.

In the longer term, hydrogen and fuel cell technologies can be part of the solution to convert and store energy, so contributing to the integration of fluctuating renewable energy in energy systems.

The key messages from the AFC IA Annual Report 2012 are detailed below.

KEY MESSAGES BY ANNEX

The AFC IA comprised seven active Annexes – three technology-based Annexes (polymer electrolyte fuel cells (PEFC), molten carbonate fuel cells (MCFC) and solid oxide fuel cells (SOFC)), three application-based Annexes (stationary, transportation and portable applications) and a systems analysis Annex that encompassed all of these areas.

Each Annex is a separate working group of international experts. Therefore, the key messages from each Annex are specifically tailored to these areas.

ANNEX 22

KEY MESSAGES FOR POLYMER ELECTROLYTE FUEL CELLS

- The successful development of hydrogen pressure tanks and system improvements has enabled fuel cell electric vehicles (FCEV) to demonstrate a range of 560km. The cold weather performance of FCEV is now equivalent to that of gasoline-powered vehicles.
- Looking to the near future, a number of automobile manufacturers are planning to launch fuel cell vehicles, targeting widespread commercialisation by 2015. Hence, the demand for fuel cells (typically PEFC) is expected to increase in the automobile sector.
- The demand for portable fuel cells (mainly direct methanol fuel cells (DMFC)) is also expected to increase, especially in the consumer and industrial electronics sectors.
- New cathode catalysts based on platinum-yittrium bimetallic alloys achieved four times higher catalytic activity than the common platinum (Pt) catalyst used in PEFC.

- The operation of an integrated 5kW high-temperature PEFC stack that uses synthetic kerosene reformate and targets auxiliary power units (APU) applications has been demonstrated successfully. It reached the project goal – electric power of 5kW at 0.5A/cm² and 160°C.
- A low-loading membrane electrode assembly (MEA) was developed and achieved, for the first time, 1,700 hours of operation with no degradation during the first 700 hours.

ANNEX 23

KEY MESSAGES FOR MOLTEN CARBONATE FUEL CELLS

- An 11.2MW (four 2.8MW DFC3000®) fuel-cell park was installed at Daegu City in South Korea and a 14.9MW fuel-cell park is being built in Connecticut, USA.
- The world's largest fuel-cell park, a 59MW facility comprising 21 DFC3000® power plants, is being built in Hwasung City, South Korea.
- MCFC research groups are focused on improving fuel processing, such as lower cost systems to clean impurities from natural gas or biogas and fuel processing systems for alternative fuels, including liquid fuels.
- Members of Annex 23 believe the new golden age of gas will be a big opportunity for fuel cells, particularly MCFC.

The 60MW Gyunggi Green Energy fuel cell farm in Seoul, South Korea (POSCO Energy)

ANNEX 24

KEY MESSAGES FOR SOLID OXIDE FUEL CELLS

- The Callux Programme in Germany and the Ene-Farm products in Japan, both for domestic-scale combined heat and power (CHP) provision from fuel cells, have started installing SOFC systems.
- Large-scale installations provided by Bloom Energy in the USA, have achieved significant adoption and deployment in a number of US states by large companies. Bloom Energy has maintained the California headquarters and manufacturing site, and has expanded production to the east coast of the USA.

ANNEX 25

KEY MESSAGES FOR STATIONARY FUEL CELLS

- Installations of stationary fuel cells and their successful application accelerated dramatically in 2012, with over 40,000 domestic installations in Japan and nearly 1,500 back-up power installations operating. Some of these back-up systems provided excellent service during Hurricane Sandy in the USA.
- In the USA, industry has planned the further purchase of more than 1,300 fuel-cell powered emergency back-up installations, each of these without any US Department of Energy (DOE) subsidy.
- The strongly increasing volume of stationary fuel cells is enabling improved automatic industrial production, and that increases the quality and reliability of the systems. It also improves the possibility of achieving the target prices that will be competitive on the market.
- Subsidies are still important for the growing deployment of stationary fuel cells on the markets.
- The Callux project in Germany continues to develop stationary fuel-cell applications, with up to 800 micro-CHP fuel-cell systems. The Ene-Field programme in Europe is taking off with 1,000 micro-CHP fuel-cell systems.
- Stationary fuel cells systems exist that have been in operation for over 10 years with the same stack.

ANNEX 26

KEY MESSAGES FOR FUEL CELLS FOR TRANSPORTATION

- FCEV have achieved more than twice the efficiency of today's gasoline vehicles with an average refuelling time of five minutes for 4kg of hydrogen (US DOE Controlled Hydrogen Fleet and Infrastructure Validation and Demonstration Project).

- The 2nd generation buses in the US fuel-cell electric bus programme are achieving double the fuel economy of conventional buses and meeting the target of 8 miles per diesel gallon equivalent. The average availability is 53% and improving, and the miles between road calls have shown a 38% improvement over the 1st generation buses.
- Ballard's 150kW HD6 stack for fuel-cell buses has demonstrated a 12,000-hour lifetime that has been validated through accelerated testing in the laboratory. The next-generation HD7 stack is projected to have a lifetime of more than 25,000 hours.
- The capital cost of fuel-cell buses has shown a cost reduction from €3 million to €0.75-1.25 million between 2003 and 2013. A further decrease to €0.35-0.55 million is expected by 2018/22, mainly driven by manufacturing breakthroughs and high-volume manufacturing. The total cost of ownership is anticipated to be competitive with trolley buses for new routes in 2015/20 and diesel buses in 2025.
- Diesel-based PEFC APU are showing stable performance of the internal reformer and fuel-cell stack. The auto-thermal reformer is able to maintain carbon monoxide (CO) levels within the allowable limits during power transients. The 2nd generation stack has significantly reduced reversible and irreversible voltage degradation of the cells.
- Use and deployment of fuel-cell-powered fork-lift trucks was a real success story in 2012, with several thousand being used in the USA and deployment beginning in Europe.

ANNEX 27

KEY MESSAGES FOR FUEL CELLS FOR PORTABLE APPLICATIONS

- Applications of fuel cells in the military continue to grow, taking advantage of the silent operation and low emission characteristics.