

IEA Advanced Fuel Cells Implementing Agreement

End-of-Term Report

2004-2008

January 2009

INTERNATIONAL ENERGY AGENCY

IEA Advanced Fuel Cells Implementing Agreement End-of Term Report (2004-2008)

1. INTRODUCTION

This End-of-Term Report has been prepared to support a request from the IEA Advanced Fuel Cells Executive Committee (ExCo) for endorsement of an extension to the Implementing Agreement from a Programme of Research, Development and Demonstration on Advanced Fuel Cells (AFC IA). The current programme will end on 28 February 2009¹ and the ExCo has unanimously approved an extension to the programme for a further five years, to 31 December 2013.

This report comprises four sections in addition to this introduction:

2. Overview of the AFC IA
3. Achievements of the Programme 2004-2008
4. Programme for the Period 2009-2013
5. Review of the Programme against the CERT Criteria

The ExCo Chairman presented a draft version of this End-of-Term Report to the IEA End-Use Technologies Working Party (EUWP) on 26 March 2008. The report was received positively and the EUWP has supported our request for an extension in its recommendations to the CERT. This revised version of the report incorporates changes suggested by the EUWP and includes some new information on achievements from the current programme of work.

Further details of the current programme and its achievements can be found in the programme's Annual Reports, available from www.ieafuelcell.com.

Further details of the proposed strategy and work plan for the period 2009-2013 are available from the programme's Draft Strategic Plan, which will be circulated to CERT members.

2. OVERVIEW OF THE AFC IA

Aim of the programme

The aim of the AFC IA is to advance the state of understanding of all Contracting Parties in the field of advanced fuel cells. It achieves this through a co-ordinated programme of research, technology development and system analysis on Molten Carbonate (MCFC), Solid Oxide (SOFC) and Polymer Electrolyte Fuel Cell (PEFC) systems and application tasks in the stationary, transport and portable power areas. There is a strong emphasis on information exchange through annex meetings, workshops and reports. The work is undertaken on a task-sharing basis with each participating country providing an agreed level of effort over the period of the annex.

The first term of the Implementing Agreement originally ran from 1990 until December 1995 and has been extended for three further terms. The programme has over the years initiated twenty-one annexes in total.

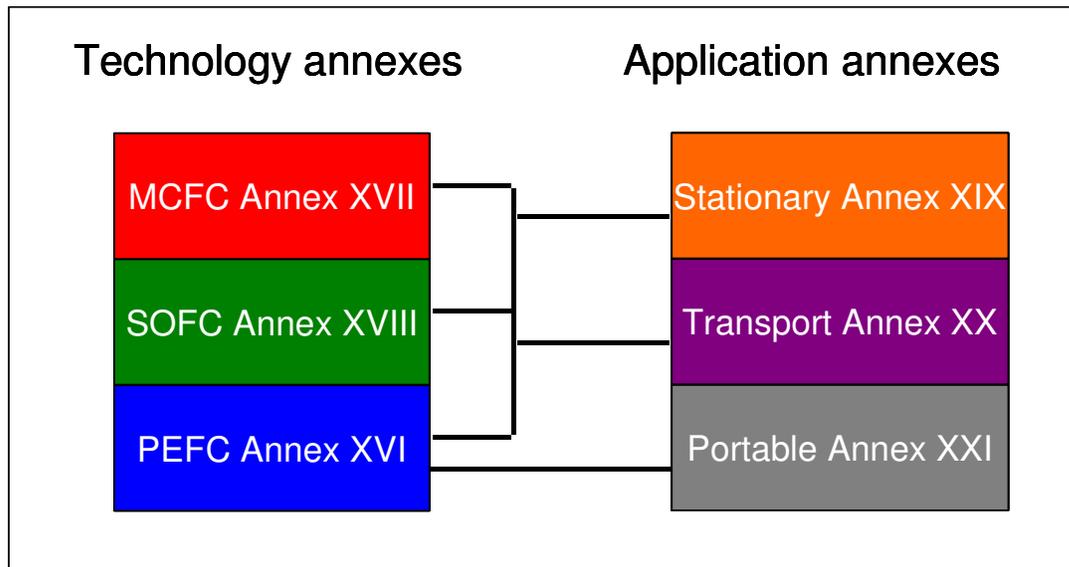
Scope and structure of the programme

The fuel cell area consists of many sub-areas where extensive development takes place. This can be summarized in the following matrix where all tasks within the Implementing Agreement can be found.

¹ The original end date was 31st December 2008 and CERT approved a 2 month extension to allow the Implementing Agreement to present its case for an extension at the CERT meeting in February 2009.

Information Management	Implementation and Application Issues	Technology Development
Internal and external network	Reduction of barriers	Stationary, Transport and Portable MCFC, SOFC, PEFC
Co-ordination within the Implementing Agreement Co-ordination with other Implementing Agreements Public awareness and education	Market issues Environmental issues Non-technical barriers (e.g. standards, regulations) User requirements and evaluation of demonstrations	Cell and stack - cost and performance - endurance - materials - modelling - test procedures Balance of Plant - tools - availability - data base Fuel processing Power conditioning Safety analysis

The existing programme follows the overall structure shown below.



This structure has been in place for the last period. Previously the structure was similar but without the portable applications annex.

Tasks

Six annexes have been in progress during the last period. According to the plans all of them will end during 2008. The Annexes are (Operating Agent in bracket):

Annex XVI	Polymer Electrolyte Fuel Cells (US DOE, Argonne National Laboratory)
Annex XVII	Molten Carbonate Fuel Cells (KIST, Korea)
Annex XVIII	Solid Oxide Fuel Cells (varies between the member countries)
Annex XIX	Fuel Cells for Stationary Applications (Eon, Sweden)
Annex XX	Fuel Cells for Transportation (ECN, Netherlands ²)
Annex XXI	Fuel Cells for Portable Power (Forschungszentrum Jülich, Germany)

Together these six annexes form an integrated programme of work, comprising three technology-based annexes (MCFC, SOFC and PEFC) and three application-based annexes (stationary, portable and transportation applications). Application-oriented activities are becoming more important as fuel cells move into the demonstration phase prior to market deployment.

Participation

Seven countries signed the Implementing Agreement for a programme of research, development and demonstration on advanced fuel cells on April 2nd 1990 in Paris. Since that time, a further thirteen countries have signed the Implementing Agreement, with one subsequently leaving the Agreement. The following nineteen IEA member countries currently participate in the Implementing Agreement.

Country	Signatory Party	Month of Signature
Australia	Ceramic Fuel Cells Limited (CFCL)	November 1995
Austria	Austrian Energy Agency (EVA)	September 2004
Belgium	VITO	November 2002
Canada	Natural Resources Canada	November 1991
Denmark	Risø National Laboratory	September 2004
Finland	National Technology Agency (TEKES)	May 2002
France	L'Agence de l'Environnement et de La Maîtrise de l'Energie (ADEME)	August 1996
Germany	Forschungszentrum Jülich	December 1992
Italy	Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA)	April 1990
Japan	New Energy and Industrial Technology Development Organisation (NEDO)	April 1990
Korea	The Korea Electric Power Corporation (KEPCO)	April 1998
Mexico	Energy Secretariat	June 2006
Netherlands	Netherlands Energy Research Foundation (ECN)	April 1990
Norway	Research Council for Norway	April 1990
Sweden	Swedish National Energy Administration (STEM)	April 1990
Switzerland	Office Fédérale de l'Energie (OFEN)	April 1990
Turkey	Tübitak Marmara Research Center Energy Institute	June 2007
United Kingdom	Department of Business, Enterprise and Regulatory Reform	September 1990
United States	Department of Energy	May 1995

Austria, Denmark, Mexico and Turkey joined during the current phase of the programme. There are ongoing contacts with other new countries interested in being involved in the work. These include China and Russia who have both sent experts to observe Annex meeting during the current phase of work. Brazil and South Africa have also shown interest and have been sent further information and invitations to observe future meetings.

² Operating Agent for Annex XX was TU Berlin, Germany until November 2006

Links with other Implementing Agreements

The programme has links with several other Implementing Agreements (IAs), notably:

Hydrogen IA: There is cross-representation with the Hydrogen IA, both at ExCo level and in relevant annexes. A joint ExCo meeting was held in Spring 2004 and further joint meetings are planned. The Secretary of the Hydrogen ExCo has accepted an invitation to present at the next AFC ExCo meeting, where we will discuss opportunities for further strengthening our collaboration.

Electric & Hybrid Vehicles IA: This IA has a new annex on fuel cell vehicles and there has been close liaison with the Advanced Fuel Cells IA to ensure there is no overlap and to maximise synergies between the two programmes.

There are also links with the Bioenergy IA and the IEA Clean Coal Centre, although the contacts during the period only have been limited.

We note that it is sometimes difficult to establish substantial collaboration with other Implementing Agreements even where there are corresponding technical interests because of the different stakeholders involved.

We have also participated in a number of meetings and workshops organised by the IEA Secretariat, and contributed text and comments to IEA publications such as Energy Technology Perspectives.

3. ACHIEVEMENTS OF THE PROGRAMME 2004-2008

This section describes the technical achievements of the programme and the wider benefits achieved through collaboration.

TECHNICAL ACHIEVEMENTS

The following paragraphs summarise the main technical achievements of each of the annexes operational during the period 2004-2008. Further details are available from the programme's Annual Reports at www.ieafuel.com.

Annex XVI: Polymer Electrolyte Fuel Cells

Technical achievements in Annex XVI have included new methods for making lower-cost, higher durability platinum electrodes, the development of an ammonia-fuelled PEFC, the development of an 80kW system for fuel cell locomotives, improved understanding of the degradation mechanisms involved when cells are started up and shut down, and when they are exposed to sub zero temperatures, the development of a PEFC stack simulator for system studies, studies on the effect of air impurities on the performance of cell components, and the performance modelling of high temperature PEFCs.

Annex XVII: Molten Carbonate Fuel Cells

The latest R&D data on MCFC stack and system performance have been presented and discussed at annual workshops. Discussions have centred on reducing stack degradation rates and costs through better design and improved materials. Technical achievements reported by participants have included the demonstration of an MCFC system under real operating conditions for over 25,000 hours and bench-scale cell tests of over 60,000 hours.

Annex XVIII: Solid Oxide Fuel Cells

Annex XIII has held a series of successful annual workshops to exchange information on SOFC cells, stacks and systems. Workshops held to date have addressed low cost manufacture and design; low temperature operation; systems, and; modelling of cell and stack operation and electrode processes. They have also provided an opportunity to share information on national programmes and industry activities.

Annex XIX: Fuel Cells for Stationary Applications

A study has been completed on the market prospects for fuel cells in different countries based on the latest available information regarding the development of and the market conditions for stationary fuel cell systems. One of the important outcomes from this market study is that the different conditions in different countries and regions like energy prices, grid stability, demand pattern for heating and cooling domestic energy sources etc are very important for the introduction of fuel cells. The conditions are not at all the same and this is especially valid for the small stationary fuel cells. For the larger fuel cells it is not so sensitive as they operate for longer periods with base load characteristics and can ideally use locally produced fuels. In that case is the investment costs not that important but the high efficiency and reliability of the fuel cells plant are major advantages. The environmental advantages are also one of the major factors for the decision to invest in a stationary fuel cells plant.

The Annex XIX subtask describing fuels for fuel cells has developed a comprehensive library of different possible fuels for stationary fuel cells. In almost any country or region, biofuels and waste gases can be used with significant advantage in stationary fuel cells. Biogas produced from anaerobic digester plants based on sewage or agriculture waste, manure etc can be used in high temperature fuel cells with significantly higher efficiency than other conventional technologies. This technology is now demonstrated at several sites in different countries. The biogas as such is an aggressive greenhouse gas that now can be as fuel for production of electricity and heat.

About two thirds of the costs for a fuel cell plant is related to the balance of plant. As a significant cost reduction is needed if stationary fuel cells are to be commercially competitive, the costs of balance of plant components must be reduced. Annex XIX has started to investigate if this is feasible. It was a

difficult task, as the developers of fuel cell systems and components considered this to be proprietary information. The focus of the task was then changed to concentrate more on the specification of balance of plant components.

Annex XX: Fuel Cells for Transportation

Information has been shared on targets, status and projections for automotive fuel cell systems, including results from a study of the cost breakdown of components of a PEMFC stack. A review has been undertaken of hydrogen storage options and their status, characteristics and challenges. Information has been exchanged on the progress and future plans of fuel cell vehicle development programmes in participant countries. This Annex has made slower progress than originally hoped because the original Operating Agent was unable to fulfil his obligations. This was resolved by the intervention of the Executive Committee, who appointed a new Operating Agent, and the Annex is active once more. We expect the follow-on work of this Annex to play an important role in the success of the new planned programme from 2009.

Annex XXI: Fuel Cells for Portable Applications

Two expert meetings were held in 2005 and 2006, at which information was exchanged on system analysis, system, stack and cell development, and materials innovation. Since then the Annex has struggled to make progress and the 2007 expert meeting was cancelled due to lack of participants. A new Operating Agent has recently been appointed and we hope to reinvigorate the work in the coming months. If this does not prove possible, this Annex will be discontinued at the end of 2008.

WIDER BENEFITS

One of the most important features of collaborative work between the countries and the companies/organisations involved is the possibility to build up networks between persons engaged in the fuel cell area. It is also recognised that the collaboration gives the opportunity to open discussions between the parties and this in turn will enable achievements that not have been possible without working together. A survey of programme participants has provided the following quotes and examples of benefits from IEA collaboration, edited slightly for conciseness and for language improvement:

- “The benefit for Austria from the participation in the IEA-AFC and its Annexes is the establishment and maintenance of strong and personal contacts to experts in Fuel Cell RD&D not only within the EU, but also in other countries, especially USA, Japan, Korea and Canada. With a very fruitful information exchange several technical problems could already be solved and from the ongoing intensive discussions new ideas for future actions are born. Periodic meetings give the excellent opportunity to achieve an overview about the progress in worldwide fuel cell development. As a result of the excellent and intense cooperation in Task XVI and Task XXI an exchange of research staff with I.T.A.E. in Messina, Italy was organised and Markus Perchthaler of TU Graz spent one month in the laboratory of I.T.A.E. in 2007.” – *Markus Thaler, University of Graz, Austria*
- “For the Netherlands, the IEA AFC Program is a very important mechanism of information exchange on a global basis. The IEA work has enabled us to shape the hydrogen and fuel cell program in the Netherlands. This program is managed by Senter Novem and executed by ECN together with Dutch Industry. The many personal contacts in the ExCo and in the various Annexes in which the Netherlands is represented are a catalyst for cooperation with other organizations. In this way, it helped ECN to establish a bilateral cooperation with Forschungs Zentrum Juelich in Germany on the topic of liquid fuel reforming and a bilateral cooperation with VTT in Finland on SOFC”. - *Dr. Frank de Bruijn, ECN, The Netherlands*
- “The benefits for Belgium being involved in the AFC IA were the personal contacts one can realise during Annex and ExCo meetings, and the opportunities for a small country and institute to be informed about the on-going R&D on fuel cells and its applications. Also the ease/possibility to be able to make some publicity about our own fuel cell work is very beneficial to improve/increase our visibility in the fuel cell world.” – *Dr. Gilbert van Bogaert, VITO, Belgium.*

- “The primary benefit from participating in the Implementing Agreement is that you get a true international network within fuel cells. There are no other forums where you can cooperate with Japan, USA, Canada, etc. unless you make bilateral cooperation. It is really strong that the top Fuel Cell competencies in the world can meet and exchange experiences. The AFC IA annexes are a really good platform for establishing international projects.” - *Inger Pihl Byriel, Danish Energy Agency*
- “Participation in Annexes 14 and 17 for MCFC enabled POSCO (a Korean steel maker) to start new fuel cell business with FCE of USA. An MCFC factory with capacity of 50MW/year production will be completed August 2008. Without this fuel cell Implementing Agreement, the joint venture between POSCO and FCE would not be seen today.” – *Dr. Tae-Hoon Lim, KIST, Korea*
- Annex XVI has been successful to create a friendly and open atmosphere leading to creative discussions in an informal way. This has in turn led to an exchange of ideas and catalyzing a chain of thoughts which would have been impossible without the physical meetings. The annex has also bridged the gap between the various disciplines and also through its composition with people from different backgrounds tied fundamental and applied research together. Being a multi-disciplinary research area fuel cells need to be cross-fertilized by people from different laboratories around the world. The solution is often around the corner, but sometimes you need a small direction to turn the right one. - *Professor Lars J. Pettersson, KTH, Sweden*
- One feature is the possibility to build up networks between persons engaged in the fuel cell area, especially for young scientists (PhD students). Another feature is the possibility and opportunity to see the labs and the technical infrastructure from different institutions which are involved in fuel cell development.” – *Annex XIV/XXI participant, Germany*
- “As part of the Canadian Department of National Defence, Defence R&D Agency, we are extremely interested in portable electrical power for current and future requirements in many applications and it is one of our major R&D investments. Annex XXI is of benefit as it allows us to track and share R&D advances in this area, gauge the technology readiness level of portable fuel cells and help develop useful products for commercial use. – *Annex XXI participant*
- “About the benefit of participation to the IEA annex, I think that the most important feature is the possibility to compare advancement and the research programs and to create collaboration opportunities between participants. The IEA annex meeting, due to the restricted number of participants, allow a real discussion about the progress in the annex focus and about strategies. This is not possible in conferences.” – *Annex XXI participant*
- “The IEA Annex workshops have many advantages over other (larger) fuel cell conferences: The lack of big industry delegations always ensures that the discussions are at a satisfactory technical level (where presentations present real science and not company sale pitches) and I feel that the level of openness and personal contact is superior to bigger conferences. It was due to an IEA Annex XVI meeting that the University of Surrey we able to obtain a letter of support from VITO for a fuel cell research program grant application. The IEA Annex workshops offer excellent, and rare, discussion between Europe, the Americas and Asia.” – *John Varcoe, University of Surrey, UK*
- “The workgroup is an excellent forum to discuss fuel cell related issues with people working with similar topics. On the basis of the contacts obtained at the workgroup it has been possible to discuss new project plans to be financed by EU programs. The workgroup also gives visibility for the participating countries, companies and institutes which promotes all kinds of co-operation.” - *Jari Keskinen, VTT, Finland*
- “Participating in IEA-AFC, either in Ex-Co or in different annexes, is one of the best ways to give France an opportunity to be aware of the major technological breakthroughs in the field of fuel cells all over the world - and not only for the major countries involved but also for emerging countries and to have fruitful exchanges between French and foreign scientific experts. It is also an opportunity to have a good overview of the different national programmes and policies related to the development of a future hydrogen and fuel cell economy. So, IEA-AFC gives France real accurate and up to date information about fuel cells which allows French actors to able to build a national road map consistent with the other national or international initiatives.” - *Thierry Priem, CEA, France*

4. PROPOSED PROGRAMME FOR THE PERIOD 2009-2013

It is currently proposed that the current structure of the programme is maintained, providing there is sufficient interest from participants to continue with the annex on portable power applications. This annex was only started in 2004 and has struggled to get going, in part because of the confidentiality issues associated with such near market applications. There has been little activity in the last year and a decision will be made following the next Annex meeting whether to continue or not.

The application annexes will concentrate on implementation and application issues and the technology annexes will focus on research and technology development. There will also be a central co-ordination role for the ExCo including information management, knowledge sharing between annexes and liaison with the IEA Secretariat and other Implementing Agreements.

Although the Annex structure is planned to remain much the same, it is proposed also to focus on issues that will help the further development of the different technologies as well as issues that will facilitate realistic market introduction of the technologies. It is therefore appropriate that the programme should expand its work on application- and market-orientated issues, whilst continuing to address technology development and information management.

Follow-on activities of existing annexes

We expect the following issues to be addressed in follow-on activities based around the existing annexes. For convenience, these annexes are described by the numbers given for the programme 2004-2008; new numbers may assigned as the new Annexes are agreed and established.

Annex XVI: Polymer Electrolyte Fuel Cells

- ◆ Identification and development of improved stack materials: membranes, electrode catalysts, bipolar plates, cells and stack assemblies.
- ◆ Resolution of stack and system issues such as contaminants, humidification and thermal management, operating environments and duty cycles, rapid-start, durability, freeze-thaw cycling, and characterisation of materials and components.
- ◆ R&D on direct fuel polymer electrolyte fuel cells, e.g. Direct Methanol Fuel Cells, including cell materials research, investigation of effects of operating conditions and stack/system modelling.

Annex XVII: Molten Carbonate Fuel Cells

- ◆ Improvement of performance, endurance, and cost effectiveness, for cells and stacks.
- ◆ Development and optimisation of MCFC system for various applications by evaluating performance of previous demonstrations or early market products.
- ◆ Identification of present and envisaged problems to be solved for rapid and further market penetration.
- ◆ Identification of possible opportunities for collaboration.

Annex XVIII: Solid Oxide Fuel Cells

- ◆ Continuation and intensification of information exchange on SOFC through annual workshops and topic meetings, focusing on durability and costs of SOFC stacks and systems.

Annex XIX: Fuel Cells for Stationary Applications

- ◆ Evaluation of major demonstration projects.
- ◆ Identification of new early commercial applications for stationary fuel cells.
- ◆ Fuels for fuel cells, including locally produced fuels.
- ◆ Economic factors for market introduction.

Annex XX: Fuel Cells for Transportation

- ◆ Advanced Fuel cell systems for transportation
- ◆ On-board Hydrogen storage
- ◆ Hydrogen infrastructure
- ◆ Technology validation and economics

Annex XXI: Fuel Cells for Portable Applications

- ◆ System analysis and hybridisation
- ◆ System, stack and cell development
- ◆ Codes and standards
- ◆ Fuels and fuels packaging
- ◆ Lifetime enhancement

The detailed workplans for each Annex have yet to be confirmed as discussions are still ongoing between the proposed Operating Agents and their experts.

NEW ACTIVITIES DURING 2004-2008

In addition to the topic areas mentioned above, ExCo members and experts within the existing annexes have suggested the following items:

- Alkaline Fuel Cells
- Fuels for fuel cells
- Biofuel cells

It is not yet decided which of these additional topics will be addressed or how they will be addressed. Some may be suitable for inclusion within existing Annexes, e.g. Alkaline Fuel Cells could be addressed in the PEFC Annex, while others may be better suited to one-off events such as collaborative workshops, or even to the establishment of new annexes. This will be discussed further at the next ExCo meeting in Spring 2009.

CO-OPERATION WITH OTHER IMPLEMENTING AGREEMENTS

Where this is of value, the Advanced Fuel Cells IA will co-operate with other IAs covering issues with close links to this agreement. Relevant IAs are likely to include:

- Hydrogen
- Bioenergy
- Hybrid & Electric Vehicles
- Clean Coal Centre

There is already work on-going in the area of hydrogen, but fuel cells also fit in where a system view may be taken, e.g. Distributed Electricity Production, Energy Storage and similar areas. Such contacts will be initiated during the period, where they have not already been made.

Contacts have been made with all the above-mentioned IAs and we expect these contacts to continue and develop during the next programme period. Particular priority will be given to cooperation with the Hydrogen and Hybrid & Electric Vehicles (H&EV) Agreements. We will be discussing the best way to enhance co-operation with the Hydrogen IA at our next ExCo meeting, and have invited the Secretary of the Hydrogen ExCo to join these discussions. We hope to arrange a similar meeting with the H&EV Agreement in the near future.

6. REVIEW OF THE PROGRAMME AGAINST THE CERT CRITERIA

This section reviews the programme to date and the planned programme for 2004-2008 against the criteria for Implementing Agreements set by the IEA's Committee of Energy Research and Technology (CERT):

- (a) Strategic Direction
- (b) Scope
- (c) Contractual and Management Requirements
- (d) Contribution to Technology Evolution / Progress
- (e) Contribution to Technology Deployment / Market Facilitation
- (f) Contribution to Environmental Protection
- (g) Contribution to Information Dissemination
- (h) Added Value

(a) Strategic Direction

Fuel cells offer the prospect of much higher efficiency and much lower emissions than conventional technologies for power generation and transportation. Accordingly the commercial development of fuel cells would make a large contribution to the energy and environmental goals of IEA Member countries. The work programme of the IA fits well with the strategy of the CERT and the EUWP, and also contributes to the longer-term goal of the Working Party on Fossil Fuels (WPF) of bringing zero emission technologies for power generation into commercial use.

(b) Scope

The work programme of the IA focuses on those technologies most likely to achieve commercial success in the short to medium term – PEFC, SOFC and MCFC. It also addresses longer-term fuel cell technologies such as the Direct Methanol Fuel Cell (DMFC) and intermediate temperature SOFC (IT-SOFC) under existing annexes. The applications annexes already address all the main areas of possible application: stationary (CHP, power generation), portable and transportation.

Most of the countries in the IA participate in more than one of the annexes, as shown in the table overleaf. Each participant meets or exceeds a minimum obligation of man months set out in the annex, and there have been no complaints from Operating Agents about the level of participation during this latest period (2004-2008) except for the difficulties with the new portable power annex. Most of the participants in the technology annexes come from universities and research laboratories, which is appropriate for this type of collaboration. There is a much higher level of industrial involvement in the applications annexes, including utility companies and vehicle manufacturers.

We believe that this IA is an important component of the IEA's energy technology collaboration programme. Without it, the IEA would have the only significant international or national energy programme without a fuel cell component.

Participation in the current annexes

	Annex XVI	Annex XVII	Annex XVIII	Annex XIX	Annex XX	Annex XXI
Australia			X	X		
Austria	X			X	X	X
Belgium	X			X		
Canada	X		X			X
Denmark	X		X	X	X	
Finland	X		X	X	X	X
France	X		X	X		
Germany	X	X	X	X	X	X
Italy	X	X	X	X	X	X
Japan	X	X	X	X		X
Korea	X	X	X	X	X	X
Mexico	X					
Netherlands	X		X	X	X	
Norway	X					
Sweden	X		X	X	X	
Switzerland			X	X		
Turkey	X	X				
UK	X		X			
USA	X	X	X	X	X	

(c) Contractual and Management Requirements

The IA fully meets its contractual and management obligations to the IEA. Annual workplans are developed for each annex and presented for approval by the ExCo. Annual reports are produced in the first quarter of each year and sent to the IEA Secretariat. We also send bi-annual contributions to the EUWP Associate Chair for transportation related IAs.

(d) Contribution to Technology Evolution / Progress

The list of technical achievements in Section 3 is comprehensive and impressive, ranging from basic materials research through technology demonstration to system and market studies. These achievements show clearly that the technology annexes of the IA are adding significant value to technology evolution. This has been recognised by citation of results at many fuel cell conferences and in relevant journals. The results have been widely used by the participants within the IEA programme, within other international collaborations such as EC projects, and in national projects.

Information from the IA is shared with other IAs – hydrogen, hybrid & electric vehicles – leading to spill-over effects to other energy technology areas. Further collaboration is envisaged for the future programme, including at least one joint workshop with the Hydrogen IA.

(e) Contribution to Technology Deployment / Market Facilitation

The strategy and the work programme address the need to reduce the barriers to commercial development of fuel cell systems. Activities under the three applications-based annexes make a direct contribution to reducing these barriers by defining market requirements, undertaking system and market studies, and encouraging fuel cell developers to collaborate with end-users in defining application requirements. We are confident that these activities will accelerate deployment and facilitate markets in the longer term but there are no significant examples of this to date, due to the early development status of the fuel cell technologies concerned.

Industry participation in the applications-based annexes helps to specify application requirements that, in turn, feed through to the technology development activities in the technology-based annexes. The

level of industrial participation is very high, with car manufacturers, fuel suppliers, utility companies and component developers fully engaged in the programme.

(f) Contribution to Environmental Protection

Fuel cells can make a major contribution to environmental improvements as they offer much lower emissions of nitrogen oxides, particulate matter and noise than competing engine-based systems. The cost-effectiveness of these environmental improvements will depend on the capital and operating costs of the systems; the IA is working towards cost reduction for fuel cell stacks and systems.

(g) Contribution to Information Dissemination

Annual reports from the programme are made available to participating countries, IEA Member countries and non-Member countries through the programme's web site at www.fuelcell.com. This web site also provides a short description of the programme and of fuel cell technology, a list of contacts and links to other relevant web sites. A members' only section of the web site is used to share ExCo meeting papers, including annual reports on highlights of R,D&D in member countries.

There is further information dissemination to member countries through presentations at ExCo meetings and other events. Most of the technical reports from annexes are confidential to participating countries, as would be expected for any task-shared programme. However Annex XVII has recently published a report on MCFC and it is planned to produce more publicly available technical reports in the new phase of work.

(h) Added Value

The added value of the IA is highlighted in the discussion of wider benefits in Section 3. Many participants have reported great benefits from the networking associated with IEA participation, including collaborative projects that came about as a result of meeting partner organisations at an IEA event, national research projects that saved time and effort by learning from others through IEA participation, the development of international test standards, and cross-fertilisation of ideas leading to technological advances. These benefits are clearly demonstrated by the enthusiasm of all contracting parties to continue with the programme.