SOFC SUPPORT PROGRAMMES BY THE EUROPEAN COMMISSION

E. Ponthieu

European Commission,
Directorate General for Science, Research and Development
DG XII, JOULE programme
Rue de la Loi, 200; MO 75 6/4
B-1049 Brussels
Belgium

ABSTRACT

Since 1986, the EU is supporting research, development and demonstration activities in the field of fuel cells. These activities were predominantly of a R&D nature, with an emphasis on basic material research and the development of cells and stacks. If all types of fuel cells were initially considered for funding, the European Commission established in 1995 a 10-year fuel cell strategy restricting the scope to four fuel cell technologies, from which SOFC is part. In the current Fourth Framework Programme (FP4) of research and technological development (1994-1998), fuel cell research and demonstration activities are supported through three different programmes: BRITE-EURAM and JOULE for the research component and Thermie for the demonstration one. The funding allocated to SOFC in FP4 amounts to 10,45 MECU, originated from the JOULE and BRITE-EURAM programmes. No demonstration activity was initiated so far with the support of the Commission.

FUEL CELL ACTIVITIES IN EUROPE

Fuel cell development in Europe started in the sixties when a number of large fuel cell programmes started in the Netherlands (MCFC), Germany (SOFC) and Belgium, France and Germany (AFC). All these activities, with the exception of AFC in Belgium and Germany were stopped around 1976. Interest in fuel cells was revived in 1985. At that time Europe was lagging far behind the US and Japan, where large fuel cell R&D programmes had been going on for 20 years. EC fuel cell research in JOULE, which started in 1985, played a major role in triggering interest for fuel cells in Europe. Following the EC, national FC R&D programmes initiated in the Netherlands (1986), Italy (1987), Spain (1989) and industrial programmes started from 1988. EC research at present is well coordinated with European national and industrial fuel cell R&D programmes. Total funding for fuel cell R,D&D from both public authorities and industry funds is estimated to be around 70 MECU per year.

At present Europe is well placed in small scale fuel cell development (e.g. for road traction) but needs to make progress in large scale applications where the US and Japan are strong and Europe is lagging 3 to 4 years behind.

FUEL CELL ACTIVITIES WITHIN THE EUROPEAN COMMISSION

Fuel cell research, development and demonstration (R,D&D) in the EC is presently carried out in different programmes: JOULE and BRITE-EURAM in DG XII and Thermie in DG XVII. Fuel cell activities in these three programmes are complementary. JOULE focusses on basic research and on stack and system development with the aim to demonstrate their technical feasibility. BRITE-EURAM deals with the development of production processes for systems and materials. Thermie allocates funds for the demonstration of the economic feasibility of new technologies.

In the period 1992 to 1994 (Third Framework Programme), the overall EC contribution to fuel cell R,D&D amounted to around 32 MECU. As the EC generally contributes around 50% of the total cost...
of projects, the total cost of this research amounted to around 64 MECU.

In JOULE, during the period 1992-1994, around 23 MECU were allocated to 22 projects. The focus was first put on MCFC and SOFC where basic research was carried out to improve the lifetime (corrosion problems) and reduce the cost. In addition, a series of projects aimed at scaling up MCFC and SOFC stacks were also supported; starting with small cells in 1985, this research led to projects which develop ER-MCFC stacks of 100 kW, IR-MCFC of 10 kW and SOFC of 20 kW. In 1993, the emphasis moved from basic research and stack development to prototype and systems development. This led to projects with first generation PAFC and balance of plant (BOP) projects for SOFC and MCFC. PAFC are expected to be commercial in 3 to 5 years and are believed to be very important as a market opener for second generation MCFC and SOFC, in which European manufacturers are strongly involved.

In the BRITE-EURAM programme, around 7 MECU were allocated to five projects in the field of SOFC. In Thermie, around 7.3 MECU were allocated to six projects. Thermie focussed especially on PAFC and MCFC to demonstrate the economical viability and technical feasibility of the innovative technologies. MCFC projects mainly concern IR-MCFC (Internal Reforming Molten Carbonate Fuel Cells) cogeneration plants from 90 up to 300 kWe.

Fuel cell R,D&D in Europe is carried out in different national, industrial and EC programmes. Although EC funding for fuel cell R,D&D in Europe forms only a relatively small part of the overall fuel cell funding, EC programmes play an important role in bringing about a collaboration and information exchange between most of the fuel cell programmes in Europe. Due to the condition that a project should have several partners from different EC member states, each EC project on the average consists of three to four partners and in the 30 ongoing EC fuel cell projects, around 100 organizations participate which are also involved in national and industrial fuel cell activities. Regular EC fuel cell contractor meetings assure a continuous contact and information exchange between major fuel cell groups in Europe.

EUROPEAN NATIONAL AND INDUSTRIAL PROGRAMMES

Fuel cell R,D&D in Europe is carried out in national, industrial and EC programmes which are strongly interconnected: organizations from different countries often participate in the same project and funding for a project may come from national, industrial and EC sources. Due to this strong interconnection, a description of European fuel cell activities per country is not very practical.

In the German national fuel cell programme, SOFC is presently emphasized. The budget of the German fuel cell programme in 1992 was around 5 million $. A four year fuel cell programme focussed on SOFC and SPFC was started by that time. The total budget was around 30 MECU of which 50% will be funded by industry. Since 1986, fuel cell efforts in the Netherlands are predominantly focussed on the development of ER and IR MCFC; the available budget for a period of 5 years 1992-1996 amounted to 40 MECU; the Dutch government and utilities contributed financially to this project. In Spain, a 15 MECU 5 year programme is carried out by Spanish utilities for the development of MCFC. In Italy, fuel cell R,D&D is carried out since 1987; the budget for the period 1994-1996 amounted to 40 MECU; both government and industry contributed to this programme. The main effort is here directed towards the development of a 1 MW PAFC plant; also work on MCFC and SPFC received considerable funding. Denmark's national programme aims at establishing technologies to make planar stacks, spending 14 MECU for the 1993-1996 period. Since 1992, the UK government started a fuel cell programme which focussed on SOFC and SPFC; public funding amounted to around 2 MECU per year. Apart from the fuel cell activities in the European Community, research is carried out on SOFC in Norway and Switzerland.
SOFC ACTIVITY WITHIN THE EUROPEAN COMMISSION

In the Fourth Framework Programme (FP4), the budget that was so far allocated to SOFC amounts to 10.45 MECU. JOULE is financing three research projects led respectively by RISO National Laboratory (DK), CERAM Research (UK) and Siemens (DE); BRITE-EURAM is financing a project led by RISO National Laboratory (DK) (Table no.1). The main objective of these projects is to reduce the cost of SOFC by improving the durability or/and by reducing the operational temperature (the so-called intermediate temperature SOFC technology). It is worthwhile to note that these projects allow to cover three of the four main short-medium-long term objectives of the 10 year fuel cell strategy (Table no.2). Only the feasibility study of a 2-5 MW network is not presently investigated by an European research consortium.

NATIONAL AND INDUSTRIAL SOFC PROGRAMMES

A project carried out since 1992 by Siemens-D, ECN-NL and Imp. College and GEC from the UK is developing a flat plate SOFC with metallic bipolar plates and with a multiple cell array. A 1kW SOFC stack with multiple array cells has been successfully tested. Work on the development of a 20 kW SOFC plant is presently going on. The funding for this project is estimated to be around 20 MECU of which 50% is paid by the EC.

A second project carried out by British Gas, ICE (UK), Riso (D) and TNO (NL) is aiming at a 1 kW SOFC with a structure which is a mixture of tubular and flat plate concepts. This project receives funding from the EC and the UK government.

Research is also carried out on the development of a flat plate SOFC unit with ceramic bipolar plates. This project aims at kW size SOFC units. Dornier (D) is carrying out this research and receives funding from the German government and the EC; Cookson (UK) participates in this project.

Two collaborative EC projects deal with SOFC material research. The main objective is the development of new materials in particular electrodes which will allow the operation of SOFC at 850°C instead of the present operating temperature of 1000°C. This is expected to lead to a strong cost reduction due to the fact that at 850°C less costly materials can be used for auxiliary equipment such as heat exchangers, piping, etc. These basic material research projects are carried out by Riso, Denmark with 6 partners and INPG, France with 4 partners.

A Danish SOFC project with 7 MECU for 1990-1992 is developing technical know-how on the manufacturing of cells and stacks (bipolar flat plate). In addition basic materials research is carried out to improve SOFC components.

In Switzerland the original HEXIS concept is being developed by Sulzer; a 1kW SOFC stack has been put into operation.

In Norway two major programmes exist for the development of flat plate SOFC. A project of Statoil (1993-1995), with a budget of 3 million $ per year, aimed at a 5-10 kW planar SOFC plant in 1995. In another collaborative project five Norwegian groups are carrying out a 3 year research programme (1991-1994) which should lead to a 3-4 kW unit. For this programme around 7 million $ was available for the three year period.

PROSPECT FOR FUEL CELL SUPPORT WITHIN THE EUROPEAN COMMISSION

The European Commission is presently defining the structure and the content of its Fifth Framework Programme (1998-2002). In that context, the Commission has launched in January 1997 a wide debate on the need to update the 10 year fuel cell strategy. Past and current contractors of BRITE-EURAM,
JOULE and Thermie programmes which consider the strategy document to be inadequate were invited by letter to make written submission indicating the reasons for this conclusion together with their proposal for its reformulation. A notice was also published in a widely-diffused newsletter of the Commission (Cordis-focus) to get opinions from organizations which do not traditionally cooperate with the Commission. As a follow up of that debate, the Commission could further organize a meeting in Brussels with key representatives, should such a meeting prove necessary.

It is important to note that the 10 year fuel cell strategy document, in its present state or in the updated format, will serve as a reference base from which to define the content of the future FP5 programmes related to fuel cells. It is therefore too early to present the structure and the content of the future fuel cell related activities that will be supported by the Commission, as well as the budget available. Nevertheless, it is confidently expected that SOFC will continue to be a RTD priority.

ACKNOWLEDGEMENTS

Eric Ponthieu would like to thank his colleagues from BRITE-EURAM (Mr.J-C.Toussaint) and Thermie (Mr.G.Lequeux) for their contribution to the present document.

REFERENCES

"Fuel Cells: RTD actions, including demonstration, supported over 1992-1995 in: JOULE, BRITE-EURAM, THERMIE", European Commission.

"A ten year fuel cell research, development and demonstration strategy for Europe", European Commission.
| Programme      | Number      | Title                                                                 | Coordinator          | Starting Date | Duration (in months) | EC funding (in MECU) |
|----------------|-------------|----------------------------------------------------------------------|----------------------|----------------|----------------------|----------------------|
| JOULE          | JOE3-CT95-0005 | Improving durability of SOFC stacks                                | RISO National Laboratory (DK) | 1/01/96        | 36                   | 2.5                  |
| JOULE          | JOE3-CT95-0008 | Evaluation and Scale up of Intermediate Temperature SOFC            | CERAM Research (UK)  | 1/01/96        | 36                   | 1.25                 |
| JOULE          | JOE3-CT95-0015 | Development of 50 kW Class SOFC System and Components               | Siemens (DE)         | 1/02/96        | 36                   | 4.8                  |
| BRITE-EURAM    | 3111        | Low-cost Fabrication and Improved Performance of SOFC Stack Components | RISO National Laboratory (DK) | soon           | 36                   | 1.9                  |
|                |             | TOTAL EC FUNDING:                                                   |                      |                |                      | 10.45                |
### Table 2:

Coverage of RTD activities foreseen in the strategy by JOULE programme

| RTD activities                                      | Timing quoted | Actually supported in JOULE programme |
|------------------------------------------------------|---------------|---------------------------------------|
|                                                      |               | JOE3-0008 | JOE3-0015 | JOE-005  |
|                                                      |               | Ceram | Siemens | Risoe |
| a) Material research and cost reduction (lower temperature, increased cell surface,...) | Year 0-10 | X     |         | X      |
| b) Internal reforming and balance-of-plant           | Year 0-10 | X     |         |        |
| c) Manufacturing of simple stacks                    | Year 3-6 |         | X        |        |
| d) Feasibility study of a 2-5 MW network             | Year 0-2    |        |         |        |