

# **IEA Advanced Motor Fuels Implementing Agreement**

## **End-of-Term Report 1999-2004**

### **SUMMARY**

The AMF Programme has always been a very active and successful programme. The number of participating countries has developed from four to ten countries. Nearly five million USD have been invested in 26 annexes, including three million USD on 12 projects during 1999-2004.

The AMF Executive Committee is an active and authoritative group, representing independent organisations. Thus, it is possible to supply governments participating in the AMF Programme with results of studies that are objective and not biased by industrial or political interests.

Transport fuels and related environmental issues as well as energy security aspects are today even more burning than when the programme was started in 1984 on the initiative of Sweden (STU) and USA (DOE).

The Executive Committee therefore feels that the Implementing Agreement is active, dynamic, efficient, and a worthwhile venture which has every reason to carry on.

## 1. INTRODUCTION

In 1984 the "Implementing Agreement for a Programme of Research, Development and Demonstration on *Alcohol and Alcohol Blends as Motor Fuels (AMF)*" was signed in Paris. During the first period 1984-90 the Agreement focused on alcohols (such as methanol, ethanol, and higher alcohols) and related oxygenated hydrocarbons (such as MTBE, and ETBE).

In 1990 it was broadened to address also other alternative motor fuels and was renamed "Implementing Agreement for a Programme of Research, Development and Demonstration on *Alternative Motor Fuels (AMF)*".

The "Strategic Plan for 1999-2004" was adopted in 1998. This resulted in a further change in strategy, and the name of the Implementing Agreement was changed in 1998 to "Implementing Agreement for a Programme on Research and Demonstration of *Advanced Motor Fuels (AMF)*." Note that the word "Development" (interpreted in a narrow sense as "technical or product development") was removed as development of new technology was considered to be for private industrial activity rather than for international governmental cooperation. In this context Development was.

This "End-of-Term Report for 1999-2004" covers activities of AMF up to and including the ExCo 29 meeting 26-28 January 2004.

## 2. PARTICIPATION

The following ten IEA member countries participate in the Implementing Agreement.

<i>Country</i>	<i>Contracting Party</i>	<i>Year of signature</i>
Canada	Department of Natural Resources Canada (NRC)	1984
Denmark	Technical University of Denmark (DTU)	2001
Finland	Technical Research Centre of Finland (VTT)	1989
France	Agence de l'Environnement et de la Maîtrise de l'Énergie (ADEME)	2000
Italy	AgipPetroli Centro Ricerche ERURON	1988
Japan	1. New Energy and Industrial Technology Development Organization (NEDO)	1985
	2. Organization for the Promotion of Low-Emission Vehicles (LEVO)	1998
Spain	Institute for the Diversification and Saving of Energy (IDAE)	2002
Sweden	Swedish Energy Agency (STEM)	1984
UK	Department for Transport, Local Government and the Regions (DTLR)	1994
USA	US Department of Energy (DOE)	1984

The number of participating countries has developed from four countries in 1984 to eight in 1992, and ten since 1998. Switzerland is intending to join in 2004, raising the number of participating countries to eleven.

Since 1984, three countries have left the Implementing Agreement: Belgium (1991 - 2002), New Zealand (1984 - 1995), and The Netherlands (1991 - 2001). These countries left as a consequence of changing R&D priorities and changing allocation of domestic R&D resources. During the same period four countries have joined the programme: France (in 2000), Denmark (in 2001), Spain (in 2002), and soon Switzerland (in 2004).

Observers from other IEA member countries as well as from developing countries have been invited to and attended recent ExCo meetings. Hopefully, some of these countries will join the programme in the future.

### 3. EXECUTIVE COMMITTEE

During the period 1999-2004 the Executive Committee (ExCo) has had 6 meetings:

	<i>Date</i>	<i>City</i>	<i>Chairman</i>
ExCo 24	99/6	Espoo/Helsinki	Nils-Olof Nylund (FIN)
ExCo 25	00/6	Toronto	Nils-Olof Nylund (FIN)
ExCo 26	01/5	Copenhagen	Arie Brouwer (NL)
ExCo 27	02/5	Milano	Nils-Olof Nylund (FIN)
ExCo 28	03/3	Paris	Nils-Olof Nylund (FIN)
ExCo 29	04/1	Linköping/Stockholm	Stephen Goguen (USA)

Claës Pilo (Sw) has served as secretary during this period.

### 4. PROJECTS/ANNEXES

#### 4.1 Projects/annexes over time

For the first three periods are shown the number of projects, the number of years per project, and the number of participants per project:

<i>Period</i>	<i>Number of projects/annexes</i>	<i>Years per project</i>	<i>Number of participants</i>
1984-1992 (9 years)	4	4.8	6.0
1993-1998 (6 years)	7	4.6	6.6
1999-2004 (6 years)	12	3.7	6.3
Running projects	6	3.2	6,3
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<b>TOTAL</b>	<b>29</b>		

**Conclusion:** The number of projects has grown during recent years. At the same time the duration of the projects has been reduced. While the projects in earlier years were carried out in several phases the trend during recent years has instead been to start new annexes. This has led to a more dynamic way of operating the Implementing Agreement. The number of participants per project has remained unchanged.

The following 12 projects/annexes were completed during 1999-2004

<b>Annex</b>	<b>Title</b>	<b>Run time</b>	<b>Operating Agent</b>	<b>Participating Countries</b>
<b>Annex IX</b>	Automotive Fuel Information Service (AFIS)	1995 – 1999	Innas (NL) Atrax (S)	7
<b>Annex XIII</b>	Emission Performance of Selected Biodiesel Fuels	1997 – 1999	VTT (FIN) ORNL (USA)	7
<b>Annex XIV</b>	Feasibility of DME as a Fuel in Diesel Engines	1997 – 2000	TNO (NL)	7 +4 sponsors*
<b>Annex XV</b>	Implementation Barriers of Alternative Fuels	1998 – 1999	Innas (NL)	5
<b>Annex XVI</b>	Biodegradable Lubricants	1998 - 2003	DTU (DK)	6
<b>Ann XVII</b>	New Technologies for Heavy-Duty Vehicles	1998 - 2000	VITO (B)	7
<b>Ann XVIII</b>	Future Greener Diesel Fuels	1997 - 2002	Battelle (USA)	7
<b>Annex XIX</b>	New Fuels for New Engines	2000 - 2001	Innas (NL)	5
<b>Annex XX</b>	DME as Automotive Fuel II	2000 – 2002	TNO (NL)	7
<b>Annex XXI</b>	Deployment Strategies	2000 – 2002	Innas (NL)	4 from AMF 7 from HEV
<b>Annex XXII</b>	Low Temperature Particles	2000 - 2003	VTT (FIN)	6
<b>Annex XXV</b>	Non-Road Engines	2001 - 2003	VTT (FIN)	4

\* Sponsors: AVL (Austria), IFP (F), PSA (F), and Renault (F)

## 4.2 Financial commitments

Financial commitments and budget per project are summarized for the first periods:

<i>Period</i>	<i>Financial contributions 1 000 USD</i>	<i>Budget per project 1 000 USD</i>
1984-1992 (9 years)	1 193	298
1993-1998 (6 years)	1 379	197
1999-2004 (6 years)	3 018	252
Running projects	1 252	209
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<b>TOTAL</b>	<b>6 842 USD</b>	<b>236 USD</b>

**Conclusion:** The AMF programme has developed considerably during recent years. The average budget per project has remained stable. Most of the annexes have been cost shared.

Participation and financial commitments  
for the 12 projects/annexes completed during 1999-2004  
(€ denotes the Operating Agent)

Annex	Participating Countries and their Contributions													Total
	€ denotes the Operating Agent. Amounts are given in 1 000 USD.													
	B	CA	DK	ES	FIN	FR	I	J	NL	NZ	S	UK	US	
<b>IX Information Service AFIS</b>	35	30			45				€ 108		124	68.4	67.7	478 – 5 years
<b>XIII Biodiesel Fuels</b>	32	32			€ 75			39.7	32		42		95	348 - 3 years
<b>XIV DME as Fuel I</b>		110	90		20			40	€ 85		180		80	787 * - 4 years
<b>XV Implementation Barriers</b>					13			13	€ 13		13		13	66 – 2 years
<b>XVI Biodegradable Lubricants</b>			€ 62.7		27.7		20	20	7.7		27.7		32.7	199 – 6 years
<b>XVII Heavy-Duty Vehicles</b>	€ 80				40		0**	40	40		40		40	280 – 3 years
<b>XVIII Future Greener Diesel Fuels</b>		5			10	10		10	10		10		€ 10	65 – 6 years
<b>XIX New Fuels for New Engines</b>		8			8				€ 8		8		8	40 – 2 years
<b>XX DME as Fuel II</b>			10		10	30	10	10	€ 20		10		10	150*** - 3 years
<b>XXI Deployment Strategies</b>					X			X	€ -		X		X	275 – 3 years
<b>XXII Particle Emissions</b>		22.5			€ 91.5		22.5	22.5			28.5		22.5	210 – 4 years
<b>XXV Non-Road Engines</b>					€ 60	20					20		20	120 – 3 years
<b>TOTAL</b>														<b>3 018</b>

\* In the sum USD 787 000 are included also contributions from the Sponsors IFP (F), PSA (F), Renault (F) with USD 55 000 and AVL (Austria) with USD 32 000. The pending member country Norway contributed USD 95 000 (Norway halted the process to join in 1999).

\*\* Italy contributed to this annex on a task sharing base carrying out engine tests.

\*\*\* In the sum USD 150 000 are also included contributions from the Sponsors PSA (F) and Renault (F), TNO (NL) and Helvoet (NL) with each USD 10 000.

### 4.3 Current projects/annexes

The following 6 projects/annexes are presently running.

Annex	Title	Run time	Operating Agent	Participating Countries*
<b>Annex XXIV</b>	Information Exchange IEA AMF/AFIS	2000 – 2004	Innas (NL)**	10
<b>Annex XXVI</b>	Oxygenates in Diesel	2002 – 2004	Befri (S)	4
<b>Annex XXVII</b>	Standardisation of Alternative Motor Fuels Phase 1 Phase 2	2002 – 2003 2003 – 2004	Atrax (S)	6 4
<b>Annex XXVIII</b>	Alternative Motor Fuels Information & Web Site	2004 – 2005	VTT (FIN)	10
<b>Annex XXIX</b>	Heavy-Duty Text Cycles	2004 – 2006	VTT (FIN)	4-5
<b>Annex XXX</b>	Health Effects of Animal Fats	2004 – 2005	ATFCan (CA)	3

\* Situation January 2004 \*\* Despite Netherlands leaving the Implementing Agreement in 2002 the Dutch Innas remains Operating Agent until 30 June 2004.

Participation and financial commitments for the six presently running projects/annexes  
(OE denotes the Operating Agent)

Annex	Participating Countries and their Contributions												Total
	B	CA	DK	ES	FIN	FR	I	J	NL	S	UK	US	
XXIV Information Exchange IEA AFIS	X	X	X	X	X	X	X	X	OE X	X	X	X	58 k\$ - 5 years
XXVI Oxygenates in Diesel		10					10	10		OE -	10		40 k\$ - 3 years
XXVII Standardisation Alt Motor Fuels Phase 1		8			10	15		15		OE 15		14	77 k\$ - 2 years
Phase 2		17						14		17		17	65 k\$ - 2 years
XXVIII Information Service & Web Site	X	X	X	X	X	X	X	X	X	X	X	X	20 k€ - 1 year
XXIX Heavy-Duty Test Cycles		X			X	X				X?		X	446 k€ - 3 years
XXX Health Effects		X			X	X?						X	321 k€ - 2 years
<b>TOTAL</b>													<b>974 k€ ≈ 1 252 \$</b>

#### 4.4 Workshops

Number of workshops completed during the first periods:

<i>Period</i>	<i>Number of Workshops</i>
1984-1992 (9 years)	0
1993-1998 (6 years)	6
1999-2004 (6 years)	10
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<b>TOTAL</b>	<b>16</b>

**Conclusion:** To render the activities more effective a growing number of workshops have been organized within the projects/annexes during recent years.

#### 4.5 Published reports

Number of published reports during the first periods:

<i>Period</i>	<i>Number of published reports</i>
1984-1992 (9 years)	35 ca
1993-1998 (6 years)	14 ca
1999-2004 (6 years)	26 ca + 3 newsletters/year
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<b>TOTAL</b>	<b>75 ca</b>

**Conclusion:** A high number of reports were produced within the initial projects focused on information gathering and information distribution. The number of published reports has grown during recent years. It should be noted that many recent reports contain first-hand experimental data generated within AMF.

#### 4.6 Orientation of programme

Number of projects with main focus on Information Gathering and Analysis, Research & Development, Demonstration, and Market Facilitation (for details see Appendix 1) during the first periods:

<i>Period</i>	<i>Info</i>	<i>R&amp;D</i>	<i>Demonstration</i>	<i>Market facilitation</i>
1984-1992 (9 years)	4	0	0	0
1993-1998 (6 years)	3	3	0	1
1999-2004 (6 years)	3	6	0	6
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<b>TOTAL</b>	<b>10</b>	<b>9</b>	<b>0</b>	<b>7</b>

**Conclusion:** During recent years the orientation of the Implementing Agreement has moved from initially mainly information gathering to R&D and market activities. No projects related to demonstration (e.g. field testing) of new technology have been carried out. The R&D projects have resulted in both valuable scientific data and new test methods and evaluation procedures necessary to describe the performance of various fuel alternatives, thus paving the way for future market introduction of new types of fuels and vehicles. Annexes like Implementation barriers, Deployment strategies and Standardization were directly targeted at facilitating future market introduction. Technical product development as well as direct actions or financial support for market introduction of new vehicles/fuels are not within the framework of AMF.

#### 4.7 Involvement of Industry

Industrial companies have been strongly involved in the following projects/annexes:

<i>Company</i>	<i>Nationality</i>	<i>Industrial branch</i>	<i>Annex</i>
Amoco Corp	USA	Fuels	XIV, XX
AET	CDN	Fuels	XIV, XX
Akzo-Nobel	NL	Chemicals	XIV, XX
AVL Powertrain Techn	USA	Vehicle engineering	XIV, XX
Ford	USA	Vehicles	XXII
Fortum Oil and Gas Oy	FIN	Fuels	XXV
Haldor Topsøe A/S	DK	Catalysts	XIV, XX
Honda R&D Europe	GER	Vehicle engineering	XXII
Ecocat Oy*	FIN	Catalysts	XXV
PSA	FR	Vehicles	XIV, XX
Renault	FR	Vehicles	XIV, XX
Sisu Diesel Oy	FIN	CI engines	XXV
Statoil	N	Fuels	XIV, XX
Volvo Truck	S	Vehicles	XIV, XX

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\* Formerly Kemira Metalkat Oy

#### 4.8 Links with other Implementing Agreements

Annex XXI has been carried out in cooperation with the Implementing Agreement on Hybrid & Electric Vehicles (HEV). This was the first joint Annex for IEA Implementing Agreements, and required some modifications to the administrative procedures. Discussions to start a common project/annex with the IA on Hydrogen have taken place.

The Vice-Chairman N-O Nylund and the Secretary have during the current period participated in meetings organized by the End-Use Working Party (EUWP) and the IEA Secretariat.

## 5. ACHIEVEMENTS OF THE PROGRAMME 1999-2004

### 5.1 Covered areas

The AMF programme has during the current period covered different areas, such as:

#### *Annexes*

• General information	IX, XXIV, XXVIII*
• New fuels	XIV, XVIII, XIX, XX, XXV
• Emissions – particles	XIII, XXII, XXV
• Health effects	XXX*
• Test procedures	XVII, XXIX*
• Lubricants	XVI
• Non-road engines	XXV
• Standardization	XXVII
• Implementation	XV, XXI
• Operational experience	XXVI

\* Annexes to be started up (decision of ExCo January 2004)

### 5.2 Technical achievements

See Appendix 2.

### 5.3 Benefits

Some key persons involved in the AMF programme have summarized their opinions about the benefits and advantages they have experienced from the international cooperation within the AMF Implementing Agreement.

- The Implementing Agreement (IA) on Advanced Motor Fuels forms an excellent and independent platform for international co-operation. Since 1984 it has brought together experts from all over the world to share information on the research and the implementation of conventional and advanced motor fuels. The IA has succeeded in contracting independent and well know research institutions and has stimulated their close co-operation. It offers the possibility of participating in research with fewer financial resources than would be needed were the work undertaken independently. Sharing such costs and maintaining a low entry cost means the threshold for participation is very low. Through the years the IA has produced a great number of reports, they have been found authoritative and well received by policy makers all over the world. In short: the IA has proven its value and participation is very rewarding and recommendable. (B. van Spanje, chairman AMF 1997-1999)
- The IA-AMF did bring a number of added value aspects to the Netherlands, such as
  - bringing information from all over the world and knowledge transfers among experts,
  - lots of networking possibilities in the automotive technology world,

- well-informed overview of the future of automotive and fuel technology,
- use of the best public sector laboratories in the world, and exposure of Dutch laboratories to the world.

As Transport is one of the major issues in the reduction of energy usage and reduction of harmful emissions to the environment this kind of collaborative work under the umbrella of the IEA is very important.

I enjoyed the international collaboration and the working principles of the IA-AMF, and made good friends in the world of automotive technology.(Arie Brouwer, The Netherlands, chairman AMF 2000-2001).

- As a Belgian institute we were involved in the AMF-work for several years. The international platform with researchers and independent consultants was beneficial in developing our understanding of alternative motor fuels. The ExCo is also a good place to exchange ideas on AMF and to develop personal collaborations on an international level. Working on a cost shared base, the method used within this group, is an excellent way to achieve the goals set within the ExCo. It also gives the opportunity to the participants to deliver useful reports for third parties (e.g. the AFIS studies, the VTT-studies on emissions, ...). (Dr. Dirk De Keukeleere, Head of Dep of Energy Technology, Vito, Belgium)
- In the planning and conduct of the Annex XVIII work, the international perspective allowed the selection of fuels and tests that addressed a broader base of technical concerns. For example, based on inputs from the AMF committee, the fuel matrix was broadened to reflect the properties of a Canadian oil sands diesel and European «city diesel», in addition to a fuel typical of diesel fuels in the U.S. (Dr. Michael Murphy, Battelle Institute, USA)

We have also received the following comments from Observers to our last ExCo meeting in January 2004:

- I can make following statement after the first participation at AMF as Swiss observer: The AMF activities offer excellent possibilities for exchange of information, for coordination of common research, making it more efficient and pointed at right objectives. This is perfect networking based on good personal relationships. I appreciated very much the possibility of participation and I hope, that a continuous collaboration with Swiss participation will result. (Prof. Jan Czerwinski, Switzerland)
- It was an excellent opportunity to be invited as an observer. I would like to thank the Group and suggest a different form of participation for developing countries without available funding. The network provided by AMF is a vital space to be shared for technology transfer, capacity building and other forms of information exchange. The IEA countries also have benefits to reap from broadening their influence. The think tank AMF Group has an extremely important role in terms of diffusing the importance of biofuels as a tradeable energy to achieve global sustainable development. The AMF is invited to have their next ExCo Meeting in São Paulo, where we sincerely expect to bring good news about joint projects with Canada on biodiesel, a result of the contacts made during last ExCo meeting in Linköping. (Dr. Oswaldo Lucon, São Paulo Environmental Secretariat, Brazil)

## **6. REVIEW OF THE PROGRAMME AGAINST THE CERT CRITERIA**

### **6.1 Strategic direction**

The use of fossil fuels in transport is the fastest growing energy sector around the world. This leads to local emission problems in cities as well as growing emissions of greenhouse gases. The development in countries like China, India, Mexico, etc, is of particular concern.

Limited oil resources and the expectation of higher prices of transport fuels also raises interest in alternative fuels. Highly topical issues will be to study different ways to improve current transport fuels, to develop new fuels, to study biofuels, to standardise new fuels, to measure emissions, to test new types of engines for improved efficiency, etc. The AMF Programme is entirely in line with the strategies of the CERT and EUWP and contributes to the IEA Member Countries' energy technology policy goals.

### **6.2 Scope**

*Substantive and comprehensive?* The AMF Programme is both substantive and comprehensive. Near 5 million USD have been invested in 26 projects/annexes - of which 3 million USD on 12 projects during 1999-2004. These projects have covered a broad number of areas.

*Broad participation?* The number of participating countries has developed from four to ten countries (eleven shortly). Repeated efforts have been made to involve additional countries, such as a technologically strong country as Germany and developing countries. These efforts will continue - hopefully with active support from CERT and EUWP.

*Transaction costs?* The transaction costs for this international collaboration are low, shared, and are considered very well justified.

*Contributes to quality?* The AMF Programme has always been a very active and successful programme, which has contributed positively to the quality of the IEA's energy technology collaboration programme. Some of the AMF reports have received wide international recognition.

### **6.3 Contractual and management requirements**

*Meets obligations?* The AMF Programme meets the contractual and management obligations to the IEA. Each annex/project is well handled by an Operating Agent and supervised by the Executive Committee.

*Strategic Plan, etc?* A new Strategic Plan 2005-2009 defining current and future objectives is annexed to this report. Current work programmes are decided at each ExCo meeting and are well in place.

*Annual Report?* An Annual Report is published each year. The report for 2003 was distributed in January 2004 to all concerned including the IEA Secretariat.

## **6.4 Contribution to technology evolution / Progress**

*Value to technology evolution?* The various projects/annexes within the AMF Programme have resulted in substantial and important R&D achievements in a number of key areas, such as those summarized in chapter 5.1 above. More details about the results are given in Appendix 2.

*Cited in literature?* Many reports have been spread widely and most of the achieved results have been presented at international conferences. See Chapter 6.7.

*Used in participating countries?* One example is Japan where AMF is used as an important channel for collecting current information from various parts of the world. Thus, all reports and documents produced within AMF are translated into Japanese and circulated widely. Another example is Finland where the AMF has been purposely used as a platform for developing bilateral R&D contacts with i.a. Japan and USA.

*Success stories?* One of many examples is “DME as Automotive Fuel” (Annex XIV and Annex XX) with a heavy involvement of industry and which resulted in the foundation of the International DME Association and in a EU project about the development of a DME fuelled truck.

*Spill-over?* There are potential spill-over effects to the IAs on Advanced Fuel Cells (production and use of hydrogen), Bioenergy (production and use of biofuels), Greenhouse Gas R&D Programme (reduction of greenhouse gases by production and use of new transport fuels), and Hybrid & Electric Vehicle Technologies (market introduction of new transport fuels). See also chapter 4.8 above.

## **6.5 Contribution to technology deployment / Market facilitation**

*Market relevant?* The AMF Programme is highly market relevant. But it must be kept in mind that the programme is a long-term programme. However, the large-scale implementation of alternative fuels is closer than ever as a consequence of the huge interest in gaseous fuels (natural gas, biogas) and liquid biofuels (European Biofuels Directive 2003/17/EC).

*Deployment accelerated/facilitated?* Standardisation of fuels (Annex XXVII) is just one example of what is needed to facilitate future market introduction.

*Industry guidance? No need of government?* It is obvious that industry must be involved and it is just as crucial that government is deeply involved. As a matter of fact large-scale introduction of new transport fuels on the market will be impossible without a close long-term co-operation between government, fuel industry and vehicle industry. The work of AMF has been relevant to the vehicle and fuel industries. This is evident from the financial contributions received.

## 6.6 Contribution to environmental protection

Transport fuels and related environmental issues are today even more burning than when the programme was started in 1984. The AMF Programme is today very much focused on the environmental aspects of transport. It makes a clear contribution to cost-efficient reduction of environmental impact.

## 6.7 Contribution to information dissemination

*Results disseminated?* An AMF web site ([www.iea-amf.vtt.fi](http://www.iea-amf.vtt.fi)) has been set up in 1999 and will be further developed. All information on the AMF Programme is found there, such as descriptions of the various projects/annexes, obtained results, published reports, annual reports, links to other relevant web sites, etc. On an area restricted to the Participants is found agendas, minutes and other ExCo meeting papers, economic data, etc.

An Annual Report is printed each year and distributed not only to the IEA Secretariat, Delegates, Alternates, and Operating Agents but also to potential Observers, such as key persons in government, industry and research in not participating countries.

*Contribution to acceptance?* The AMF programme contributes definitely to the acceptance of the needs for new technical and market solutions of the energy and environment problems of transport.

*Contribution to communication channels?* Several of the reports published within the various annexes are restricted to the Participants. But many reports have been distributed widely and most of the achieved results have been presented at international conferences, such as SAE (Society of Automotive Engineers) meetings. AMF has also actively participated in the Windsor Workshops - Transportation Technology & Fuels Forum.

## 6.8 Added value

There is no doubt that the annexes carried through have had high added values in various forms. The AMF international cooperation has opened doors for

- Getting access to national analysis, R&D results, practical knowledge and market experiences in the participating countries
- Getting access to fuels and fuel additives from the participating countries and testing them internationally
- Getting access to advanced vehicles as well as laboratory equipment in the participating countries and comparing test results internationally
- Getting access to advanced R&D teams in the participating countries
- Developing international standards for new fuels
- Involving industry in pre-competitive as well as current market activities
- Facilitating future market introduction
- Reducing national costs by collaborating internationally
- Creating valuable international contacts between government, industry and science and thus opening for future (AMF and non-AMF) co-operation

## Classification of AMF Annexes

Some changes have been introduced compared to the classification in the “Strategic Plan for 1999-2004”. Thus, Annex XVI has been moved from Information gathering to Research & Development and Annex XIV from Research & Development to Market issues.

### Information Gathering and Analysis

- Annex I	1984-1986	3 years	
- Annex II	1986-1992	7	
- Annex III	1987-1992	6	
- Annex IV	1987-1994	8	
- Annex VI	1990-1992	3	
- Annex VII	1992-1997	6	
- Annex VIII	1994-1998	5	
- Annex IX	1995-1999	5	
- Annex XIX	2000-2001	2	
- Annex XXIV	2000-2004	5	
- Annex XXVIII	2004-2005	1	(To be started)

### Research & Development

- Annex V	1990-1995	6 years	
- Annex X	1995-1997	3	
- Annex XII	1996-1997	2	
- Annex XIII	1997-1999	3	
- Annex XVI	1998-2003	6	
- Annex XVII	1998-2000	3	
- Annex XVIII	1997-2002	6	
- Annex XXII	2000-2003	4	
- Annex XXV	2001-2003	3	
- Annex XXIX	2004-2006	3	(To be started)
- Annex XXX	2004-2005	2	(To be started)

### Market Facilitation (Originally: Preparations for market introduction)

- Annex XI	1995-1996	2 years	
- Annex XIV	1997-2000	4	
- Annex XV	1998-1999	2	
- Annex XX	2000-2002	3	
- Annex XXI	2000-2002	3	
- Annex XXVI	2002-2004	3	
- Annex XXVII	2002-2004	3	

## **Technical Achievements**

Technical achievements of the work during the current period are here summarized for each annex.

Complete descriptions of the individual annexes and obtained results are found on the AMF website ([www.iea-amf.vtt.fi](http://www.iea-amf.vtt.fi)) and in the AMF Annual Reports 2002 and 2003.

### **Annex XIII Emission Performance of Selected Biodiesel Fuels**

The work generated an extensive analysis of the exhaust emissions using biodiesel in new diesel engines. Generally, the biodiesel fuels had higher NO<sub>x</sub> emissions but lower values of HC, CO, and particulates. Unregulated emissions varied greatly between fuels and engines. VTT's tests showed that the particulates generally seemed to be less harmful for neat bioesters than for diesel fuel. The changes in emissions were not as significant when 30 % bioester blends were compared with EN590 or RFD as when neat esters were used. No major differences were seen in emission performance between RME, SME (soy bean oil methyl ester) and UVOME (used vegetable oil methyl ester), even though some benefit was seen for the UVOME fuel regarding CO, HC and aldehyde emissions with the TDI vehicle. The ethanol emulsion fuel gave some emission benefits regarding particulates. The hydrated tall oil blend gave worse emission figures than the other fuels, which is believed to be due to differences in the base fuel.

### **Annex XIV Investigation into the Feasibility of Dimethyl Ether as a Fuel in Diesel Engines**

See Annex XX.

### **Annex XV Implementation Barriers of Alternative Fuels**

The report that has been produced under this annex presents an overview of the practical barriers associated with the introduction of an alternative fuel and analyses alternative fuels in broad terms with respect to these practical barriers. Fuels addressed in the report are: LPG, natural gas, ethanol, methanol, biodiesel and hydrogen. Also electric vehicles are included. Some remarks are made on the barriers that may be expected for dimethyl-ether.

## **Annex XVI Environmental and Economical Aspects of Implementing Biodegradable Lubricants in Vehicle Engines**

The results of emission tests will be evaluated together with results of biodegradability tests. A detailed discussion will be carried out and conclusions will be drawn regarding the emissions from vehicles using biodegradable lubricants. A detailed discussion with conclusions regarding biodegradability of new and used lubricants will be carried out as well. The future of biodegradable lubricants for engine applications will be evaluated based on the test results obtained. The annex will soon be closed.

## **Annex XVII Real Impact of New Technologies for Heavy Duty Vehicles**

Within this project, three city bus technologies were selected to compare emissions and fuel consumption in real traffic (city and rural), in several vehicle test cycles (CBDC, DUBDC, De Lijn) and in the main official engine test cycles (ESC, ETC, US-FTP, Japan 13-mode). The purpose was to look for clear relations between these test procedures.

The three buses were a Euro-2 diesel bus, a natural gas bus with stoichiometric fuel control and three-way catalyst and a natural gas bus with lean burn fuel control.

The stoichiometric natural gas bus reached very low emission levels compared to the diesel bus (regulated emissions were about 10 times lower). The lean burn natural gas bus needed some adjustments in the lambda control settings to lower its relatively high NO<sub>x</sub> emissions.

The test results showed that there is no unique relation between real city traffic emissions and the different engine or vehicle test cycles. The relation depends on engine technology, gearbox (and gear shifting strategy), and the engine load vs speed distribution during the test cycle.

## **Annex XVIII Future Greener Diesel Fuels**

Diesel fuel oxygenates have been reported to reduce engine-out emissions, especially of particulate matter. In order to support the use of oxygenates in diesel fuels, this annex provided data on the miscibility, flash point, cloud point, water tolerance, vapour pressure, and ignition quality over a range of diesel fuel-oxygenate blends and environmental temperatures through laboratory tests with diesel fuel and oxygenate samples.

The diesel fuels included a USA reference diesel, a Fischer-Tropsch diesel, and an oil sands diesel. Seven different oxygenates were tested.

Oxygenate blend levels were 0 (diesel only), 5, 10, 30, and 100 (oxygenate only) volume percent. Test temperatures ranged from -30 to 30 C. Vapor pressure measurements were made using a gas chromatographic technique that distinguished fuel and oxygenate contributions to the total vapour pressure. Ignition quality measurements were made using the IQT constant volume combustion apparatus.

## **Annex XIX New Fuels for New Engines**

The final report describes homogeneous charge compression ignition (HCCI) operation in four-stroke, two-stroke and free piston engines. The relation between fuel characteristics and HCCI operation is discussed. The report contains an extensive list of references and also lists organisations working on HCCI engines. Outside AMF the report has been distributed within the Clean Diesel III consortium, co-ordinated by South West Research Institute (SwRI) in the USA.

## **Annex XX DME as an automotive fuel II**

The annex has dealt with

- Technical research in the area of DME fuel injection systems.
- Support for international cooperation to stimulate the development of DME as a new fuel.

The work has been supported by organising workshops and distributing newsletters.

The work has also resulted in the foundation of the International DME Association and in a EU project about the development of a DME fuelled truck.

Technical work :

- A test procedure to test material (wear) properties with DME
- Advise on wear resistant coatings for DME fuel injection system parts
- Selection of elastomers suitable for sealing DME fuel systems
- Determination of influence of additives on DME lubricity and viscosity.

Annexes XIV and XX received sponsorship form several automotive manufacturers.

## **Annex XXI Deployment Strategies for Hybrid, Electric and Alternative Fuel Vehicles**

In the last years the harmful effects and the greenhouse gases resulting from the use of conventional vehicles caused many concerns on continuing in the same direction. Hybrid or electric vehicles and alternative fuels like natural gas, ethanol or hydrogen are considered an essential element in reducing urban pollution and greenhouse gases. But only a wide dissemination of „clean vehicles and fuels“ can have noticeable effects on the environment. Therefore governments, in addition to the support of research and development, more and more implement measures with the aim of promoting the market introduction of these new vehicle technologies – with different approaches and various effects.

Between 2000 and 2002 an international task force collected information on more than 100 programmes run in 18 countries. Evaluations and analyses of case studies showed that some approaches are successful, but they also identified weaknesses that are often repeated. The report provides elaborated recommendations on the base of conclusions drawn by the analyses. They will help government officials responsible for administering fleets, incentives and regulations with assessing the most promising strategy for their country for the market introduction of hybrid, electric and alternative fuel vehicles.

## **Annex XXII Particle Emissions at Moderate and Cold Temperatures Using Different Fuels**

The effect of temperature was dependent on the engine technology. Significant increase in particle mass and number emissions was seen with some technologies when -7 °C temperature was compared to normal test temperature. Some engine technologies were rather insensitive to ambient temperature, e.g. the CNG car did not show any significant particle emission at normal or low temperatures.

If an increase in particle emissions was seen, it typically appeared immediately after the cold start. Ambient temperature had only a minor impact on the performance of a warmed-up engine. In some cases RME indicated more particles and/or a shift to lower mean diameter at low temperatures after the cold start than in the tests at normal temperature.

Financial contributions and technical support was received from Ford Motor Company and Honda R&D Europe. The Annex was closed in January 2004.

## **Annex XXIV Information Exchange IEA AMF/AFIS**

Each year three annual newsletters on automotive fuels are produced. The newsletters describe the latest worldwide developments on automotive fuels, with emphasis on activities that are covered by the Advanced Motor Fuels Implementing Agreement.

## **Annex XXV Fuel Effects on Emissions from Non-Road Engines**

The objective of the Annex was to study emissions from non-road engines with different fuels and after-treatment systems. The experimental work (base matrix) was completed in December 2002. Measurements with small gasoline engines were done in the engine laboratory of Agricultural Engineering Research (Vakola, Finland). The experiments with diesel engines were carried out in VTT's facilities. In the autumn 2002, an interim report was published and the final report was published in June 2003. The public versions of the reports are available on IEA AMF web pages. The results have shown that the sulphur and aromatics content of fuel has an obvious effect especially on particle emissions from non-road engines.

A fuel provider, a manufacturer of diesel engines and a manufacturer of exhaust catalysts supported the project both technically and financially. The Annex was closed in January 2004.

## **Annex XXVI Evaluation of Practical Experiences of ongoing Projects around the World using Alcohols/Ethers as Oxygenates in Diesel Fuels**

By collecting data from ongoing and reported tests and projects and systematically compare them, we will try to get a picture of today's practical results and experiences of using alcohols/ethers as components in existing diesel fuels for existing diesel engines. This study of options that have reached commercial maturity is complementary to Annex XVIII "Greener Diesel Fuels" where scientific data are produced from laboratory tests.

The results of the proposed project will be valuable in guiding future research and development of oxygenates for diesel fuels.

## **Annex XXVII Standardization of Alternative Motor Fuels**

The objective of phase one of the annex was primarily to:

- Investigate, analyse and describe the state of the art on standards for alternative fuels in the participating countries and in international standardization organizations such as CEN and ISO
- To get a first reaction from CEN and ISO concerning a future contribution from IEA/AMF to these organizations' work caused by the growing international interest as well as international demand on standardization of alternative fuels

The objectives of phase two of the annex are primarily to:

- Further work on the role that IEA/AMF could play in international work on standardization of alternative fuels under the frame of CEN's Technical Committee 19 "Petroleum Products, Lubricants and Related Products" and ISO's Technical Committee 28 "Petroleum Products and Lubricants".
- Further work on how IEA/AMF on request of CEN/TC 19, ISO/TC 28 or on its own could act as an arranger of international workshops and seminars on standardization of alternative fuels.

This work will be carried out in discussion with representatives from CEN and ISO and when proper also national representatives. The discussions with CEN and ISO aims to present a proposal for how and under which conditions IEA/AMF could co-operate with CEN and ISO in the form of liaison.

The responsible person at the Operating Agent is also appointed chairman of CEN Technical Board's Working Group 19 on "Standardization of gaseous and liquid alternative fuels" which facilitates the contacts between IEA/AMF Annex XXVII and CEN. Contact has already been established between the Operating Agent and people in charge at ISO TC 28 as well as CEN TC 19.

## Abbreviations

AFIS	Automotive Fuels Information Service
AMF	Advanced Motor Fuels IA
ASTM	American Society for Testing and Materials
CEN	Comité Européen de Normalisation
CERT	(IEA) Committee on Energy Research and Technology
CNG	compressed natural gas
CO	carbon monoxide
DME	di-methyl ether
DOE	US Department of Energy
ETBE	ethyl tertiary butyl ether
EUWP	(IEA) End Use Working Party
ExCo	Executive Committee
HC	hydrocarbon
HCCI	homogenous charged compression ignition
HEV	Hybrid and Electric Vehicles IA
IA	Implementing Agreement
IQT	ignition quality test (according to ASTM Standard D 6890)
ISO	International Standardisation Organisation
MTBE	methyl tertiary butyl ether
NO <sub>x</sub>	nitrogen oxides
RFD	Scandinavian reformulated diesel
RME	rapeseed methyl ester (biodiesel)
SAE	Society of Automotive Engineers
SME	soy bean oil methyl ester
STU	National Swedish Board for Technical Development
TC	Technical Committee
TDI	Turbo-charged direct-injection diesel
UVOME	used vegetable oil methyl ester
VTT	Technical Research Centre of Finland