



IEA Advanced Motor Fuels Implementing Agreement

End of Term Report – 2005-2009

SUMMARY

The Advanced Motor Fuels Program (AMF) continues to be a very active and successful program. The number of participating countries has grown from a beginning of four countries in 1984 to fourteen countries in 2008. Over 35 annexes (projects) have been initiated by the Program over the years.

The AMF Executive Committee is an active and creative group, representing independent organizations and agencies in the different countries. Thus, it is possible to supply governments participating in the AMF Program 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 challenging than when the program was started. Recent world events related to demand, supply and price of transportation fuels have only helped to emphasize the need for international cooperation as is represented in the AMF.

The Executive Committee therefore feels that the AMF Implementing Agreement is important, dynamic, efficient, and is making real contributions to solving the challenges of motor fuels. For those reasons, the Executive Committee feels that there is every reason to continue the AMF with another five-year period.

Introduction:

The Advanced Motor Fuels Implementing Agreement has a long and rich history in contributing to the knowledge base in alternative motor fuels as well as advanced petroleum-based fuels. Starting with four countries in 1984 as the ***“Implementing Agreement for a Programme of Research, Development and Demonstration on Alcohol and Alcohol Blends as Motor Fuels,”*** the Agreement now encompasses participation of 14 countries and a healthy program of research and demonstration in “Advanced Motor Fuels.” In between the Agreement was at one point referred to as the ***“Implementing Agreement for a Programme of Research, Development and Demonstration of Alternative Motor Fuels.”*** The same acronym, **AMF**, has been used throughout the Agreement’s history. The official name now for the Agreement is, ***“Implementing Agreement for a Programme of Research and Demonstration of Advanced Motor Fuels.”*** The word, “Development,” was dropped from the name in 1998 since “development” in the strict sense is usually considered to be the province of private industry.

The activities of AMF relate to R&D, deployment and dissemination of advanced motor fuels. AMF looks upon transport fuel issues in a systemic way, taking into account production, distribution and end-use related aspects. As fuels, engines and exhaust after-treatment systems have to be considered as interactive systems, the scope of AMF also covers propulsion systems (vehicles) using advanced motor fuels.

Within AMF, “Advanced Motor Fuels” have been defined as fuels fulfilling one or more of the following criteria:

- Low toxic emissions
- Improved life cycle efficiency
- Reduced greenhouse gas emissions
- Enabling fuels for new propulsion systems
- Fuels contributing to sustainability in transportation
- Fuels contributing to security of supply

The Executive Committee, which consists of the delegates representing the individual participating countries, has a very important role in directing the work of the Agreement and generating new activities. The delegates also come from a wide range of organizations including government agencies, universities, research institutes, and industry.

The work of the ExCo is carried out within individual projects or Annexes. Over the years, more than 35 Annexes have been initiated. A number of different fuels have been covered in these annexes including:

- Reformulated fuels (gasoline and diesel)
- Biofuels (ethanol, biodiesel etc.)
- Synthetic fuels (methanol, Fischer-Tropsch, DME etc.)
- Gaseous fuels (natural gas, biogas, LPG, hydrogen etc.)

This End-of-Term Report for the period 2005-2009 covers the period up to and including the ExCo 36 held in Osaka, Japan in December 2008.

1. Objectives and Strategy:

The Strategy and Objectives as laid out in the Strategic Plan for the period, 2004 – 2009 were as follows:

Mission of AMF: The AMF mission is to become a leading international player in the promotion of international collaboration in R&D, deployment and dissemination of clean, energy efficient and sustainable fuels and related vehicle technology. It will continue to provide a fuel neutral platform for co-operative R&D, deployment and dissemination, make use of the multifaceted expertise of its partners and networks, and provide a respected clearing-house for information facilitating the wide spread deployment of technologies for sustainable transport.

AMF has defined three **Strategic Objectives:**

Objective 1 (Information & Membership): To gather, evaluate and disseminate information on advanced motor fuels and to act as a clearing-house on related information. To provide an easy-access platform for interested parties to join AMF as members.

Objective 2 (Co-operative R&D, deployment and dissemination): To create, maintain and make use of networks among partners involved in research, development, demonstration and deployment related to advanced motor fuels.

Objective 3 (Markets and general co-operation): To facilitate large-scale market deployment of advanced motor fuels by removing technical, economical and political barriers.

2. Participation of Countries:

Table 1 below lists the current participating countries, their Contracting Parties, and the year of their joining the AMF. The AMF started in 1984 with four countries and now enjoys the participation of 14 countries. Note that three new participating countries were added in 2008 – Austria, Thailand, and China.

Table 1 - Participating Countries, Contracting Parties, and Year of Joining AMF

Country	Contracting Party	Type of Organization	Year of Signature
Canada (CA)	Natural Resources, Canada (NRC)	Government	1984
Sweden (SE)	Swedish Energy Agency (STEM)	Government	1984
United States (US)	Department of Energy (DOE)	Government	1984
Italy (IT)	AgipPetroli Centro Ricerche EURON	Industry	1988
Japan 1 (JP)	New Energy and Industrial Technology Development Organization (NEDO)	Research Institute	1988
Finland (FI)	Technical Research Centre of Finland (VTT)	Research Institute	1989
United Kingdom (UK)	Department for Transport	Government	1994
Japan 2 (JP)	Organization for the Promotion of Low-Emission Vehicles (LEVO)	Research Institute	1998
France (FR)	Agence de l'Environnement et de la Maîtrise de l'Énergie (ADEME)	Government	2000
Denmark (DK)	Technical University of Denmark (DTU)	Research Institute	2001
Spain (ES)	Institute for the Diversification and Saving of Energy (IDAE)	Research Institute	2002
Switzerland (CH)	University of Applied Sciences – Bern (AFHB)	University Research	2004
Austria (AT)	Austrian Agency for Alternative Propulsion Systems (A3PS)	Government	2008
China (CN)	China Automotive Technology and Research Center (CATARC)	Research Institute	2008
Thailand (TH)	National Science and Technology Development Agency (NSTDA)	Government (Research)	2008

3.0 Executive Committee Meetings

During the period 2005 - 2009 the Executive Committee (ExCo) has had 7 meetings (ExCo 30 was not included in the previous End-of-Term Report):

	<i>Date</i>		<i>City</i>
ExCo 30	October	2004	Sao Paulo, Brazil
ExCo 31	November	2005	Prague, Czech Republic
ExCo 32	October	2006	Beijing, China
ExCo 33	April	2007	Detroit, USA
ExCo 34	November	2007	Honolulu, USA
ExCo 35	May	2008	Vienna, Austria
ExCo 36	December	2008	Osaka, Japan

4.0 Projects / Annexes

4.1 Annexes Completed and Created During 2005-2009 Period – listed by ExCo Meeting

ExCo 30 - Sao Paulo – October 2004

Closed **Annex XXVII - Standardization of Alternative Fuels**

Created Annex XXXII - Future Fuels for Road Transport

Created Annex XXXIII - Particle Emissions of 2S Scooters. Reduction
Technology and Inputs for Legislation

ExCo 31 – Prague – November 2005

Closed **Annex XVI - Biodegradable Lubricants**

Closed **Annex XXVI - Alcohols and Ethers as Oxygenates**

Closed **Annex XXX - Bio-safety Assessment: Animal Fat in Biodiesel**

ExCo 32 – Beijing – October 2006

Closed **Annex XXXII - Future Fuels for Road Transport**

Created Annex XXXIV – Biomass-derived Diesel Fuels: Task 1 –
Analysis of Biodiesel Options

ExCo 33 – Detroit – April 2007

Closed **Annex XXXIV - Evaluation of Duty Cycles for Heavy-Duty
Urban Vehicles**

Closed **Annex XXXI - Production and Use of Synthetic Vehicle
Fuels Made by the Fischer-Tropsch Technique**

Created Annex XXXV - Ethanol as Motor Fuel

ExCo 34 – Honolulu – November 2007

Closed None

Created Annex XXXVI - Measurement Technologies for Hydrocarbons, Ethanol and Aldehyde Emissions from Ethanol Powered Vehicles

ExCo 35 – Vienna – May 2008

Closed None

Created Annex XXXVII - Fuel and Technology Alternatives for Buses

ExCo 36 – Osaka – November 2008

Closed Annex XXXIV - Biomass Derived Diesel Fuels: Task 1 – Analysis of Biodiesel Options

Created Annex XXXIV – Biomass Derived Diesel Fuels: Task 2 – Algae as a Feedstock for Biofuels: An Assessment of the State of the Technology and Opportunities

4.2 Projects / Annexes over time

For the first four periods of the AMF the numbers of projects / annexes, numbers of years per project, and numbers of participants in each project are shown below:

<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
2005-2009 (5 years)	14	3.2	5.2
Current Projects	6	2.8	7 +

As is evident in above, the numbers of annexes continue to grow with each AMF period; they are accomplished in less time; and the numbers of participants in each annex is growing. This level of progress and productivity is consistent with a very active and vigorous Implementing Agreement. The AMF continues to contribute to the international discourse on transportation fuels and continues to pursue project concepts that are truly in the mainstream of fuels technology development.

Eight annexes were completed during the period 2005 – 2009, and seven annexes were started. The details of those annexes completed along with the numbers of participants are summarized in Table 2 below. Details of those annexes that are being carried through to the next five-year period are summarized in Table 3 .

Table 2 - Participation in Annexes completed during 2005 – 2009

Annex	Title	Run time	Operating Agent	Participating Countries
Annex XVI	Biodegradable Lubricants	1998-2007	DTU (DK)	6
Annex XXVI	Oxygenates in Diesel	2002 – 2004	Befri (SE)	4
Annex XXVII	Standardization of Alternative Motor Fuels Phase 1 Phase 2	2002 – 2003 2003 – 2004	Atrax (SE)	6, 4
Annex XXIX	Duty Cycles for Heavy-Duty Urban Vehicles	2004 – 2006	VTT (FI)	4-5
Annex XXX	Health Effects of Animal Fats	2004 – 2005	ATFCan (CA)	3
Annex XXXI	Fischer-Tropsch Fuels	2004 – 2007	Atrax (SE)	3
Annex XXXII	Future Fuels for Road Transport	2005	Atrax (SE)	3-4
Annex XXXIV Sub-task No 1	Analysis of Biodiesel Options	2007 – 2008	FEEC (US)	5

Table 3 - Details of the annexes continuing into the next period

Annex	Title	Run time	Operating Agent	Participating Countries
Annex XXVIII*	Information Service & AMF Website (AMFI)	2004 - - - -	TEC (FI)	15
Annex XXXIII	Particle Emissions of 2-S Scooters	2004 – 2009	AFHB (CH)	6 + EU
Annex XXXIV Sub-task No 2	Algae as Feedstock for Biofuels	2009 – 2010	Sentech, Inc. (US)	Not yet determined
Annex XXXV Sub-task No 1	Ethanol as a Fuel for Road Transportation	2007 – 2009	DTU (DK)	15
Annex XXXVI	Measurement Technologies for Ethanol (METEV)	2008 – 2009	SRA (SE)	4
Annex XXXVII	Fuel and Technology Alternatives for Buses	2008 – 2010	VTT (FI)	6 + IA?

* Note that Annex XXVIII is the Information Service for AMF, and as such all member countries participate via the annual membership dues

4.3 Published reports

There are 21 reports representing 12 different annexes available for download from the AMF website (www.iea-amf.vtt.fi). In addition, there is information on the website about every AMF annex, including the current annexes. Annual reports for 2002 through 2007 are also there, as well as the previous End-of-Term Report and Strategic Plan. The AMFI newsletters are available for download for the years 2002 through 2008. It is worth noting that the Outlook report (“Outlook for Biofuels, Advanced Motor Fuels, and New Vehicles”), produced under the auspices of Annex XXVIII – Information Service and AMF Website, has been downloaded from the AMF website over 50,000 times since it was made available online earlier in 2008.

4.4 Orientation of the annexes over time

In the early years of the AMF the annexes dealt largely with information exchange and information gathering. Also in those years, the subjects of the annexes were limited to alcohol fuels. Eventually, the AMF moved to more research oriented annexes, and the fuel focus was enlarged over time from alcohols to alternative fuels in general and now also includes advanced motor fuels, which includes advanced petroleum-based fuels. The listing below places annexes into categories of orientation and shows the evolution of the subjects of annexes over time.

Subject Matter	Annexes
General information (about fuels, new developments, drivers for new fuels, etc.)	I, II, IX, XXIV, XXVIII
New fuels (alt. fuels, synthetic fuels, advanced petroleum-based fuels)	VI, X, XIV, XVIII, XIX, XX, XXV, XXXIII, XXXIV, XXXV, XXXVII
Emissions – particles	V, XII, XIII, XXII, XXV, XXXIII, XXXVI, XXXVII
Test procedures	XVII, XXIX, XXXIII, XXXVI
Health effects	XXX
Environment	VII, XXXVII
Standardization	XXVII, XXVIII
Non-road engines	XXV
Life cycle analysis	XXXI, XXXIV, XXXVII
Lubricants	XVI, XXXIII

4.5 Links to other Implementing Agreements

The AMF continually reaches out to other Implementing Agreements by inviting their representatives to AMF Executive Committee meetings and by representing AMF at meetings of other Implementing Agreements. During the period covered by this report, there have been observers from other Implementing Agreements at AMF meetings. In addition, AMF tries to involve other Implementing Agreements in annexes that deal in subjects of common interests. In one annex, **Annex XXXVII – Fuel and Technology Alternatives for Buses**, being carried over to the next period the AMF is teamed with the HEV, Bioenergy, AFC, AMT, and Combustion Implementing Agreements.

5.0 Achievements of the Program: 2004 – 2009

5.1 Technical achievements (See Appendix 1)

5.2 Benefits

Some key persons either involved in the AMF program or having observed an ExCo meeting have summarized their opinions of the benefits and advantages they have experienced from the international cooperation within the AMF Implementing Agreement. These are excerpted below.

“As the liaison member of IEA Bioenergy Task 39, Liquid Biofuels to the IEA Advanced Motor Fuels Implementing Agreement, I attended the IEA AMF ExCo Meeting in Vienna in Spring 2008. I was heavily impressed by the broad and deep work that was presented during that meeting and I am convinced that IEA AMF will continue to generate important contributions to the advancement of sustainable fuels and their application in the transport sector also in the future. After the meeting I had a lot of good and fruitful contacts with some members of IEA AMF. This demonstrates that IEA AMF pursues highly actual topics and has knowledgeable and cooperating personalities in its membership. I will appreciate and support the further cooperation of IEA Bioenergy Task 39 with IEA AMF.”

Axel Munack (Observer at ExCo 35 and representative of Biomass Implementing Agreement), Institute for Agrarian Technology and Bio-system Engineering
Braunschweig, Germany

“CATARC has found the Advanced Motor Fuels International Agreement to be valuable in understanding the policies and research programs in transportation fuels that are being pursued by other member countries. The AMF is a very effective means for the international exchange of technical information.”

Jinhua Zhang, Vice President, China Automotive Technology & Research Center

"The AMF's consideration of a range of advanced fuels, from those already established in some markets to fuels that are still in development, and the simultaneous consideration of both renewable and fossil based fuels is valuable for policy makers. I also consider it beneficial that the AMF investigates a wide range of issues from production options to environmental impacts and vehicle compatibility. In attending ExCo 36 as an observer I was impressed by the robust approach taken in regard to initiating new annexes."

Andrew Saunders (Observer at ExCo 36), Senior Policy Analyst, Ministry of Economic Development, New Zealand

"For Thailand, becoming a member of IEA AMF is deemed honorable and valuable. The objectives and activities of AMF have been aligned with His Majesty's vision on biofuel implementation as transportation fuel over two decades ago. Since then, Thailand has been trying to introduce biofuel into the domestic transportation fuel market in order to reduce the net import of crude oil for domestic consumption. Since Thailand is blessed with various biofuel feedstocks, there are abundant opportunities for research and development, not only within Thailand but also internationally among AMF members. With the past few participations of Thailand in IEA AMF meeting as observers, Thailand is very excited to join AMF. Moreover, Thailand's representative and alternate representative have known many AMF members before from the international alcohol fuel forum. Thailand is really looking forward to many fruitful collaborations among AMF members in the future."

Nuwong Chollacoop, Ph.D., National Metal and Materials Technology Center, Thailand

6.0 Review of the Program Against the CERT Criteria

6.1 Strategic Direction

Events during the period covered by this report have highlighted the need for international cooperation and exchange with regard to transportation fuels and the need for sustainable and affordable alternatives to petroleum. With rising economies such as China and India there has been a serious strain on world oil supplies and prices. As we enter the year 2009 there is a worldwide downturn in the economic situation, and one result has been a lessening of pressure on oil prices. However, when economic growth restarts, then the fundamental challenge with demand and supply of oil will re-appear, and the dilemma will return. So, we cannot afford to take a respite with R&D on fuels.

The AMF continues to press on with the research agenda to make real contributions to the technologies that will bring sustainable (and, hopefully, permanent) solutions to the challenges. AMF will continue to provide a fuel neutral platform for cooperative R&D, deployment and dissemination, make use of the multifaceted expertise of its partners and networks, and provide a respected clearing-house for information facilitating the wide spread deployment of technologies for sustainable transport fuels.

6.2 Scope

Substantive and comprehensive? The AMF Program is both substantive and comprehensive. Over 35 annexes have been initiated in total, and these projects have covered a broad number of areas. Eight annexes were closed during the period 2005-2009, and seven more were created, of which, six are carrying forward into the new period, 2009-2013. These annexes have covered a broad spectrum of fuels and represented different points along the fuels R&D spectrum from resource development, to fuel production, and to end-use.

Broad participation? The number of participating countries has grown from the original four in 1984 to fourteen countries in 2008. Three new countries joined AMF during the term now ending. Continuing efforts are made to involve additional countries, and these efforts are producing results with three countries having been added in the past year.

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

Contributes to quality? The AMF program has always been a very active and successful program, and it has contributed positively to the quality of the IEA's energy technology collaboration program. Most AMF reports are posted on the AMF website and have broad exposure to researchers worldwide.

6.3 Contractual and management requirements

Meets obligations? The AMF Program 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 2009-2013 defining future objectives is annexed to this report. Current work programs are decided at each ExCo meeting.

Annual Report? An Annual Report is published each year. The report for 2008 will be distributed in early 2009 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 Program have resulted in substantial and important R&D achievements in a number of key areas, such as those referenced in Appendix 1.

Cited in literature? Many reports have been spread widely and most of the achieved results have been presented at international conferences - see 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. Circulation of reports widely within the countries participating in any annex is a common practice.

Success stories? One example is the “Outlook” report, produced under Annex XXVIII which, by December 2008, had been downloaded over 50,000 times since it was placed on the website in 2008.

Spill-over? There are potential spill-over effects to the Implementing Agreements on Advanced Fuel Cells (production and use of hydrogen), Bioenergy (production and use of biofuels), Greenhouse Gas R&D Program (reduction of greenhouse gases by production and use of new transport fuels), and Hybrid & Electric Vehicle Technologies (market introduction of new transport fuels). AMF maintains communications with all of these other Implementing Agreements on a regular basis, and is involving them in joint annexes.

6.5 Contribution to technology deployment / Market facilitation

Market relevant? In today’s fuels environment, there is no question that the AMF is relevant. With the AMF work in biofuels, future fuels, harmonization of standards, emission measurement technologies, and new fuels for new engines, relevancy is assured. Biofuels (ethanol and biodiesel) and natural gas are making measurable progress in displacing petroleum fuels, and the AMF has produced research reports on these fuels that have contributed to the progress.

Deployment accelerated/facilitated? Direct contribution by AMF to deployment or facilitation of new fuels is difficult to establish. However, continually pushing the concepts, providing the bases of policy decisions about deploying new fuels, and showcasing research results are the contributions of AMF, and those contributions indirectly help to facilitate the deployments of new fuels.

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

Most AMF annexes deal at least in part with the environmental aspects of fuels because it is one of the overriding criteria that determine the efficacy of any fuel. AMF is extremely mindful of the need for all fuels to meet environmental requirements, not just for local environment but also for global environmental concerns.

6.7 Contribution to information dissemination

Results disseminated? AMF excels in dissemination of results. The AMF has maintained a web site (www.iea-amf.vtt.fi) since 1999 where the public can access all of the AMF’s public documents, including annual reports, annex reports, special reports, etc. The site also includes descriptions of the various projects/annexes, obtained results, published reports, annual reports,

links to other relevant web sites, etc. One area of the site is restricted to the participants where they can see meeting agendas, minutes of meetings, and other AMF-specific information.

AMF also produces 3-4 AMFI (Advanced Motor Fuels Information) newsletters each year which are available to the public and found on the web site. These newsletters deal with the latest news and developments in fuels worldwide.

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 program 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 eventually 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

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) and in the AMF Annual Reports 2005, 2006, 2007 and 2008.

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

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

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, researchers formed 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 are 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 were 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 was carried out in discussion with representatives from CEN and ISO and when proper also national representatives. The discussions with CEN and ISO were aimed at presenting a proposal for how and under which conditions IEA/AMF could co-operate with CEN and ISO in the form of liaison. Results of the work were reported in a final report in August 2004. It is available for download from AMF's website – www.iea-amf.vtt.fi.

Annex XXVIII Information Service & AMF Website (AMFI)

AMF has been running an Information Service called IEA AMF/AFIS (Automotive Fuels Information Service) under two previous Annexes, Annex IX and Annex XXIV. Annex IX produced, among other things, five volumes of the "Automotive fuels survey" for AMF. In 2000-2004 Annex XXIV produced three yearly Newsletters on the subject of automotive fuels and related issues. Both Annexes were handled by Innas BV of Holland. Since 1999, VTT Processes (Finland) has been maintaining a website for AMF.

AFIS was replaced a new information system, AMFI (Advanced Motor Fuels Information, Annex XXVIII) in 2004. AMFI now combines an electronic Newsletter service and maintaining the AMF website.

NEWSLETTER AND WEBSITE - Sharing and providing information are very important elements in IEA cooperation. The new information system AMFI makes use of electronic communication. AMFI comprises the production of four yearly electronic Newsletters and the maintenance of the AMF website. AMFI/Annex XXVIII is a low budget Annex, and its costs are shared by all participants of the AMF Agreement.

AMFI provides four yearly electronic Newsletters describing developments in transportation fuels, vehicles and energy and environmental issues in general. Each issue covers a list of fixed themes: Natural gas and LPG, ethanol, bioesters, synfuels and sunfuels, other advanced fuels (hydrogen, DME etc.). In addition, each issue is focused on one particular theme with a special article, e.g.

- Policies on alternative fuels, biofuels, and energy efficiency
- Process technologies on alternative fuels, Coal to liquids, Biomass to liquids, hydro treatment of oils and fats
- Plant oils as feedstock and their sustainability (jathropa, palm oil, algae)
- Development of emission regulations
- Engines and fuels go hand in hand into the future

The Newsletters can be freely downloaded on the AMF website. All material presented in the Newsletters is assembled in a special restricted Newsletter database on the website. The AMF website serves both the general public interested in transportation fuel related issues and also the Members of the Advanced Motor Fuels Implementing Agreement. For the Members, a special password protected area is provided.

AMF OUTLOOK - A highly topical “Outlook Report” on projections for transportation energy, vehicle technology and advanced/alternative fuels was distributed as a restricted version to the Executive Committee in February 2007. A condensed version of the "AMF Outlook" report was prepared in co-operation with EU Bioenergy NoE, and this report is now publicly available (<http://www.vtt.fi/inf/pdf/tiedotteet/2008/T2426.pdf>). As of December 2008 this document had been downloaded from the AMF website over 50,000 times since it was made available online earlier in 2008.

FUEL STANDARDS - Sub-task No 1 “Fuel Standards” Björn Rehnlund, Atrax, has earlier presented proposals on “Co-operation with ISO and CEN on Standardization” and “International Standard for Fuel Ethanol” (Annex XXVII). In October 2006 it was decided to include this work with modified content in the AMFI Annex XXVIII in the form of a Sub-task No 1 “Outlook on Standardization” prepared by Atrax and published on the AMFI website. Thus, all the member countries were be involved. Atrax, under the AMFI Annex XXVIII, carried out the work and prepared the reports. Results from this task were reported in October 2008 (available from the AMF website). The report presents information about national and regional standards for alternative fuels and, where available, standards on a global level are described and discussed. Global standards are becoming necessary because of the international trade and shipping of large quantities of alternative fuels such as ethanol and biodiesel.

Annex XXIX Evaluation of Duty cycles for Heavy-Duty Urban Vehicles

Three laboratories, VTT, Environment Canada and West Virginia University measured standard size urban buses driving various duty cycles on chassis dynamometers. Both European and North American diesel and natural gas vehicles were represented. Environment Canada performed a comparison of a conventional diesel vehicle and a diesel-electric hybrid vehicle. The fuel consumption and exhaust emissions varied not only by test cycle, but also by vehicle technology. In the most cases, vehicles emissions can be directly proportioned to the amount of fuel consumed. However, NO_x-emissions from SCR-vehicles form an exception, as well as particle emissions from vehicles producing very low absolute particle emission levels. Scaling factors to be used for comparing emission results generated with different duty cycles were developed. Most of the evaluated test cycles provide coherent fuel consumption and emission results. Some specific test cycles result in abnormalities, and must therefore not be considered representative for buses.

Annex XXX Bio-safety Assessment: Animal Fat in Biodiesel

Annex XXX of the IEA’s AMF began in 2004 and was completed in 2006. The final report “Biodiesel from Specified Risk Material Tallow” resulting from the biodiesel workshop and research concluded that biodiesel made from specified risk material tallow, such as tallow potentially contaminated with bovine spongiform encephalopathy (BSE), poses negligible risk

to human and animal health. The potential for BSE contamination of bovine tissues has led government regulatory agencies to designate certain high risk tissues as specified risk material (SRM), and prohibit their inclusion in either human or ruminant food, or in various other products such as pharmaceuticals, medical devices, cosmetics and fertilizers. Subsequently, a substantial tonnage of animal tissue that would otherwise have been used in commercial enterprises is destroyed. The use of SRM to produce tallow for biodiesel production is one possible means to recoup at least some of this lost resource. The report, written by leading experts on transmissible spongiform encephalopathies (TSE) and BSE, animal rendering, and vehicular emissions, provides an in-depth study of BSE, from the first incident until 2006. It then examines the biodiesel production process using SRM-infected tallow, and the potential effects of using the end product (biodiesel fuel manufactured from specified risk material). As the BSE concern is constantly changing around the world, an addendum is included in the report, which can be obtained by emailing biodiesel@atfcan.com or from the AMF website. Also identified in the study were several gaps in current knowledge where additional research would be beneficial prior to undertaking a quantitative risk assessment. To supplement the data currently available, the University of Toronto is developing a methodology for testing various biodiesel production processes, to assess deactivation capabilities. A screening method for proteins in non-aqueous media is also being developed at Queen's University. This methodology should become a valuable tool for confirming the absence of TSE-inducing agents in biodiesel produced from SRM and other animal waste products. In a separate segment of work, the Saskatchewan Research Council is creating new in-house capacity to produce protein materials for use in related research programs.

Annex XXXI Production and use of Synthetic Vehicle Fuels Made by Fischer-Tropsch Technique

In October 2004, at its 31st ExCo-meeting, IEA/AMF decided to start a project concerning production and use of synthetic vehicle fuels produced by Fischer-Tropsch (FT) technology. The project was carried out as Annex XXXI, with financial support from Denmark, Finland and USA. Atrax Energi AB was appointed as Operating Agent for Annex XXXI. The work in the annex was carried out in co-operation with TFK, Sweden and DTU, Denmark. The final report was delivered to Denmark, Finland and USA in June 2007. In the report the possibilities to produce synthetic gasoline and synthetic diesel oil from biomass, and also from natural gas, by FT-technology are analyzed and discussed. After an introduction of the technology as such, environmental aspects and the life cycle perspective of synthetic gasoline and diesel oil are discussed. To visualize the effect on the logistic system that a future large-scale biomass based production system will have, four different scenarios are assessed in terms of, e.g., the number of production plants needed and truck arrivals to the plant. - Denmark and Poland, with a feedstock of cultivated energy forest (*Salix*), - Finland from forest residues - USA from natural gas. Furthermore vehicle emission tests with synthetic gasoline carried out at DTU are described and discussed in the report. Based on the result of the analysis and the vehicle emission tests presented in the report, a first SWOT analysis of Fischer-Tropsch technology is presented, and finally some main conclusions are drawn. During the execution of the Annex the following installations were visited: Sasol in South Africa, Nykomb Synergetics in Sweden, Chemrec in Sweden, the Technical University of Denmark, VTT in Finland, the Värnamo gasification research project in Sweden, and the Black liquor gasification project in Piteå, Sweden.

Annex XXXIII Particle Emissions of 2-S Scooters

The serious health effects of particle emissions from traffic are known from the discussions about diesel engines technology and legislation. In this context the particle emissions of small 2-S (2-cycle) engines without recirculation of the lubricant cannot be neglected any more. A particular concern is about the 2-S scooters, which in several countries are used very much in congested city centers.

According to the participation of different partners there are following objectives of the activities:

- basic research of the 2-S aerosols, their composition with different lube oils and fuels and with different engine technology
- study of sampling and measuring procedures for particle mass and particle size distribution
- research of improvements of exhaust gas after-treatment systems
- toxicity and new methods of health effects research
- new inputs for industrial partners concerning their products
- new inputs for the legal authorities

This annex has produced three reports in October 2005, January 2007, and January 2008. All are available on the AMF website. Conclusions noted in the 2008 report include:

- Considerable R&D is done each year on gasoline 2-S and 4-S engines in 2- and 3-wheelers
- A number of improvements in both engine and exhaust gas aftertreatment technologies are possible
- To reduce sustainably the emissions of the 2-wheeler fleets the technical improvements in the new vehicles is not enough
- Further legal and political steps are necessary to increase the awareness of users and to promote control and maintenance of vehicles

Annex XXXIV Biomass-derived Diesel Fuels – Task 1: Analysis of Biodiesel Options

Use of fatty acid methyl esters (FAME) as a substitute diesel fuel is on the rise around the world. In the US, for example, the volume of biodiesel used in transportation has grown by a factor of 6 to 7 times in four years, and in Europe the situation is similar. Such a rosy outlook for biofuels is not without technical hurdles, though. Methyl esters face some serious technical barriers, i.a. poor oxidative stability, incompatibility with some elastomers, low-temperature flow properties, and higher NO_x emissions.

The transesterification process is limited in feedstocks to using oils derived from vegetable, animal, and waste fats. If we are to achieve greater impact of bio-derived fuels, we must utilize all varieties of feedstocks and produce a broader slate of fuel choices, ranging from gasoline replacements to diesel replacements. Therefore, the world's attention is turning to concepts of

more diverse manufacturing processes, and the notion of a flexible biorefinery is coming into being.

This annex took a thorough look at today's 1st generation biodiesel fuels (made from vegetable oils and animal fats) and evaluated their attributes as well as their shortcomings. The analysis also took a look forward at 2nd generation biodiesel fuels that would be made from more general biomass resources and made by newer processing technologies. The result was a 150-page final report that covered considerable material related to biodiesel fuels and biodiesel processes. The report should be very helpful for those who need to make decisions about future investments in fuels and fuel processing.

Annex XXXIV Biomass-derived Diesel Fuels – Task 2: Algae as a Feedstock for Biofuels – An Analysis of the State of Technology and Opportunities - NEW in 2009

In the last year there has been a great rise of interest in the concept of using algae as feedstock for biofuels, and there are many reasons why we should be interested. Algae can be a very efficient producer of oils like vegetable oils or starches for making ethanol, for example. Algae consume CO₂, nitrogen, and sunlight, and produce potentially valuable resources for potential fuels markets. They are prolific and can produce a crop every day as opposed to once per growing season as is the case for many ethanol and biodiesel feedstocks. As a result, algae have the potential to produce 30 to 50 times as much feedstock from a given area as the conventional feedstocks.

The growing interest in algae can be seen on many fronts. There are new industry partnerships and new trade organizations, and millions of research dollars are beginning to flow to R&D projects devoted to algae. There is currently so much interest in and activities in algae that it is difficult for researchers and policy-makers to keep up with the developments and to sort out the most promising developments. Therefore, the objective of this annex is to inventory and assess the important R&D activities in the area of algal fuels and to make recommendations about the most promising pathways to success in making large quantities of transportation fuels from algae. This will require literature searches, discussions with researchers, and visits to promising activities in algae. The goal will be to develop recommendations intended to aid governments and policy-makers in their decisions on funding R&D that will produce the most fruitful results.

Since AMF considers the entire fuel cycle, from resource to fuel production and to end use, as its domain of interest, it is reasonable for AMF to pursue such a topic. The project will be completed within one year of its start. At the time of this writing, funding commitments from member countries are being sought by the proposers.

Annex XXXV Ethanol as Fuel for Road Transportation - NEW in 2009

Ethanol is an excellent alternative fuel for road vehicle application. If the application of ethanol is going to increase, there is a demand for rather technical, but easily understood, information about the applicability of ethanol as an engine fuel. This is necessary in order to eliminate the skepticism among people, who do not know about this fuel.

The purpose of this project is to provide an easily read technical report about the applicability of ethanol as an engine fuel. The report should describe the potential for ethanol application in the member countries participating in this annex. The results from the investigations of the member countries' situations should be extrapolated to recommendations for worldwide implementation in a near future.

The main project is inspired by the discussions from the IEA/AMF Executive Committee discussions in addressing the following questions:

1. "Gasoline/Ethanol blends. How much ethanol can be tolerated by gasoline vehicles?"
2. "True performance of FFV vehicles?"
3. "Conceptual studies for optimized ethanol engines"
4. "Diesel/ethanol blends?"
5. "The need for ethanol blended fuels"
6. "Differentiation of bio from mineral derived ethanol"
7. "How ethanol blends perform in GDI vehicles"
8. "The need for fuel specifications for ethanol blended fuels"

The main report will be followed up by individual implementation reports from the member countries.

Annex XXXVI Measurement Technologies for Hydrocarbons, Ethanol, and Aldehyde Emissions from Ethanol Powered Vehicles - NEW in 2009

In recent year's hydrocarbon, aldehyde and alcohol tailpipe emissions from flexible fuelled vehicles fuelled by alcohols have received an increased attention in Europe together with an increased and expanding interest in alternative fuels for vehicle propulsion. Due to the fact that alcohol fuel blends have different fuel properties compared to conventional fuels such as gasoline/diesel, it is important to study factors, which affect the reproducibility and repeatability of the HC measurements from such vehicles. Aldehyde and alcohol tailpipe emission measurements need to be further evaluated i.e. comparing different measurement methods.

The aim of the project is to provide crucial information for developing the methodology for measuring HC, aldehyde and alcohol tailpipe emissions from ethanol-powered vehicles. The project also aims to find a simplified method using today's legislative measurement technology that can account for differences in harmfulness between exhausts from gasoline and ethanol powered vehicles.

The project is divided into three different tasks:

Task 1: Fact finding (literature and interviews): Regulation (including EU), Measurement specification (level, sensitivity, cost indication, time etc), Lab experience, Question area

Task 2: Measurement and Correlation study of HC and ethanol

1. FID measurement of ethanol, propane calibration gases with different concentration and oxygen content in carrying gas.

2. Measurement of ethanol and propane calibration gases in bags with different waiting time.
3. Using different type FID and individuals for measuring ethanol, propane calibration gases.
4. Using FID at different sampling and detector temperature for measuring ethanol, propane calibration gases.
5. Comparing MS, Photoacoustic and FTIR for measuring ethanol calibration gas.
6. Ethanol and propane bomb test in CVS system.
7. Measurement of an unknown gas bottle with ethanol and propane mixture in different labs.
8. Analyse ethanol solutions at different labs.

Task 3: Vehicle tests

1. Emission tests at different temperature (22°C, -7°C, -15°C).
2. Emission tests with different CVS flow.
3. FTP tests and NEDC tests
4. Emission tests with different fuels.
5. Comparing FTIR with MS for ethanol measurement
6. Comparing photoacoustic with MS for ethanol measurement
7. Comparing two MS for ethanol measurement
8. Comparing FTIR and cartridge for aldehyde measurement
9. Comparing different cartridge setup and sampling flow rate for aldehyde measurement.

The tasks will be performed at different test labs. Some tasks may be combined and performed simultaneously.

Annex XXXVII Fuel and technology alternatives for buses - NEW in 2009

The objective of the task is to bring together the expertise of IEA's transport related implementing agreements to access overall energy efficiency, emissions and costs, both direct and indirect costs, of various technology options for buses. The technology options variations in engine technology, powertrain technology and fuels.

The various Implementing Agreements have expertise and knowledge in the following areas: • Advanced Fuel Cells AFC: automotive fuel cells • Advanced Motor Fuels AMF: alternative fuels in general and fuel end-use • Advanced Materials for Transport AMT: light-weight materials • Bioenergy (specifically Task 39): production of biofuels • Combustion: new combustion systems • Hybrid and Electric Vehicles HEV: hybrid and electric powertrains • Hydrogen: the use of hydrogen as an energy carrier

The outcome of the task will be unbiased and solid IEA sanctioned data for policy- and decision-makers responsible public transport using buses.