

AMFI Newsletter is prepared for the members of the Implementing Agreement on Advanced Motor Fuels of the International Energy Agency (IEA/AMF).

AMFI provides four yearly electronic Newsletters describing recent news on advanced motor fuels, vehicles, energy and environmental issues in general. AMFI Newsletter is available on the AMF website:

www.iea-amf.vtt.fi

The loss of excess oil production capacity due to problems in Iraq and Venezuela combined with natural disasters and growing demand explains steep rise of crude prices. (www.wtrg.com)

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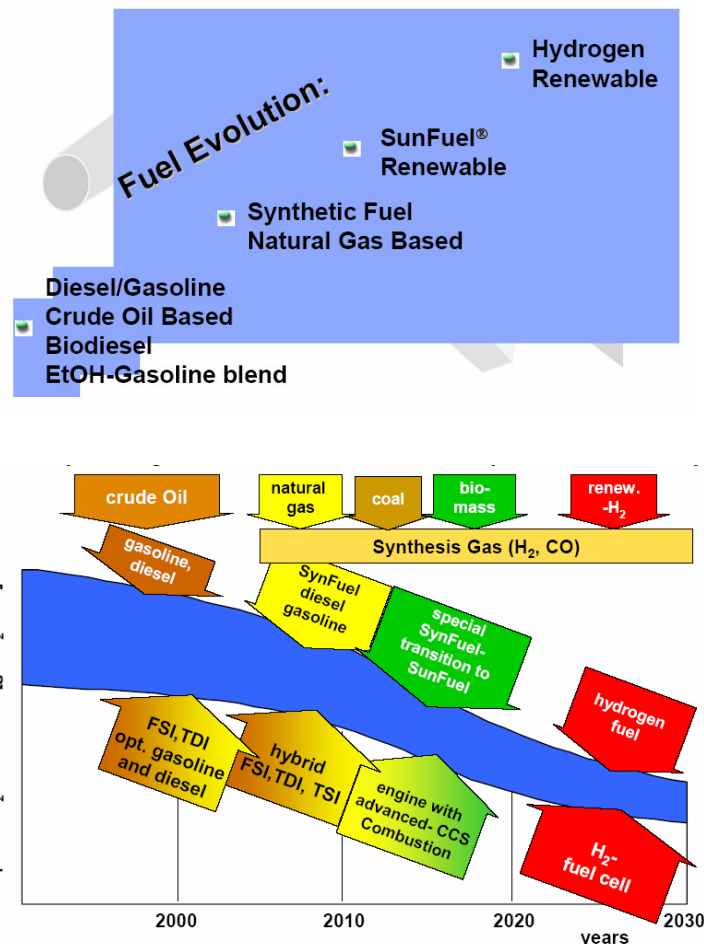
Engines and fuels go hand in hand into the future

Inevitably, development automotive technology and fuels go hand in hand. In the beginning, compression ratios of spark-ignition engines were drastically poor, below 4:1. There was a great need to improve efficiency with higher compression ratios, but this was not possible before the octane numbers of gasoline increased. Development of lead additives in 1920's by GM researchers started a new era of high octane numbers and high efficiency engines. Later on, a number of new refinery processes, components and additives have enabled new development steps for automotive engineering. The latest example is removal of sulfur from fuels to introduce new aftertreatment devices for vehicles.

Today, the automotive world is living an interesting period. For sure, our world of transportation is going through major changes concerning energy sources, energy carriers and end-use applications for transportation. One can ask, which and who are the leaders to guide this development? Some automotive technologies set strict requirements for fuels and infrastructure. This means that tailored fuels are needed on market. On the other hand, limitations on energy sources (feedstock), production processes and infrastructure determine the availability of energy carriers (fuels), and all this has to be taken into account by automotive engineers. In addition, these factors are not in harmony world-wide: the conditions vary from country to country. Thus in coming years, we may see a variety of solutions, vehicles running on CNG or LPG, on ethanol or conventional biodiesel, or on synthetic liquid fuels (mainly Syn&Sun diesels), and of course also on fossil fuels ("the last drop of fossil fuels will be used in transportation"). Combinations of these, e.g. gaseous fuels for captive fleets and liquid fuels for other transport applications, are likely. The complicated fuel mix on market will be challenging!

When we are looking ahead today, there are some clear perspectives for alternative fuels in future. The share of biofuels will grow due to well-known reasons: fuel security, economical stability and issues of global and local pollution. After 2010 share of 2nd generation biofuels will become important. Before that, the share of biofuels will probably be low, because ethanol or bioesters can be used only in low concentrations, around 5-10%, in conventional vehicles. The share of natural gas will grow, e.g. in Europe a target of 10% is set for 2020. Natural gas will be used also indirectly in the transport sector through Fischer-Tropsch based fuels. Synthetic fuels in general will be important already within the next few years. Gas-to-Liquids plants (GTL) are built in increasing numbers and Coal-to-Liquids (CTL) technology is studied intensively in many countries, especially in China. Challenging targets for alternative fuels might well be obtained, e.g. 20% in Europe by 2020, but probably with higher share of synthetic fuels and 2nd generation biofuels than estimated originally.

When automotive technology is considered, we are expecting advanced combined combustion systems (CCS) for vehicles. So far, it seems that fuel requirements of CCS technologies differ significantly from those set by conventional engines for gasoline and diesel: cetane number should be around 40-45 and distillation range around 150-210 °C. In general, this fuel seems to be close to kerosene. This will require, again, a new direction of development of production processes of liquid fuels, and a new distribution infrastructure. Another path was presented by Toyota and Shell at a SAE Conference (SAE 2005-01-3763). The diesel engine could be optimized to use Syn&Sun Fuels with superior diesel properties e.g. by decreasing compression ratio. Hybrids and Fuel Flexible Vehicles provide some benefit for fuel saving/fuel substitution. However, these technologies probably will cover only limited areas, because hybrids are efficient mainly in urban driving, and wide-scale E85 distribution infrastructure is not expected.



F. Seyfried et al., Volkswagen, ISAF XV conference, Sept. 2005, San Diego, California.

The potential of hydrogen will grow beyond 2020. Policy actions to promote alternative fuel are becoming stronger year by year. Support for development of hydrogen technologies is extensive and prioritised in e.g. US, Japan and Europe. However, there will be a long way before a significant market share of hydrogen will be visible on market. Before that we'll see a mixture of different fuels and engine technologies world-wide. Hopefully some selections will take place as a complex pool tends to reduce overall efficiency.

F. Seyfried et al., Volkswagen, Renewable Fuels for Advanced Powertrains. ISAF XV conference, Sept. 2005, San Diego, California.
Premtech II report, Final report "Efficient and low emitting propulsion technologies (PREMTECH II)", Contract G3RT-CT-2001 05028
K. Kitano et al. Effects of GTL Fuel Properties on DI Diesel Combustion. SAE Technical Paper 2005-01-3763.

NATURAL GAS AND LPG (and biogas)

New NGV targets, France, Germany, UAE

In France, a five year protocol to encourage natural gas use has been signed by government, NGV Association, vehicle manufacturers, fuelling station operators and energy companies. The goal is to increase natural gas use in heavy- and light-duty vehicles, and bring home refueling equipment commercially available. The target is to double NGV bus fleet, to triple NG carbage trucks and to have 100,000 NG cars running in France by 2010.

Germany: Progress report of German federal government concludes that a realistic potential for natural gas in transportation is around 4% by 2020 instead of the target of 10% set by European Commission. There are 600 natural gas fuelling stations and almost 35,000 NGVs including some 1,100 buses and 4,000 trucks in Germany today. The first biogas refueling station in Germany opens in Jameln.

United Arab Emirates: UAE is setting a target for 20% of natural gas to be used as road transport fuel by 2012.

Top four NGV countries in Europe: Italy 382,000; Ukraine 67,000; Russia 41,780, Germany 35,000. The world leader is Argentina with 1,439,000 NGVs. *ENGVA news, number 7, July 2005.*

CNG home refueling in France

Gaz de France and Peugeot Citroën launch gas powered vehicle with technology that will allow home refueling. The cars will be equipped with small scale compressors to convert household gas to the required pressure. The 500 € cost of the compressor will be covered by Gaz de France and Peugeot Citroën during the initial two-year project trial phase. This is seen as a major step forward for CNG development in Europe. (www.ngvgroup.com)

CNG road sign

Two-years discussions on international standard CNG road signage was concluded at the United Nations (WP 1, Road Traffic Safety) in September 2005. The group agreed on the sign with a blue fuel pump as shadow behind the black gasoline fuel pump, and letters CNG. The WP1 also indicated that nationally recognised set of letters or word(s) could be added for clarification. Following the lead of ENGVA, the European LPG Association (AEGPL) submitted its version of fuelling station sign. The ENGVA/IANGV-proposed amendment now becomes a "consolidated resolution" and is a legal basis for all countries to begin using the fuel station signage. The consolidated amendments as a package will go to the UN for final ratification and amended to the 1968 Vienna Convention on Road Signature. *NGV Global September 28, 2005 & ENGVA News, August & September 2005.*

Biogas for Volvo busses in Switzerland

A transport company has ordered 32 new Volvo 7700 busses, which will run on biogas in Bern, Switzerland. These busses are equipped with stoichiometric CNG engines whereas previous CNG engines from Volvo have been lean-burn engines. *DieselNet News, September 2005.*



Source: NGV Global September 28, 2005.

ETHANOL

ISAF XV – The International Symposia on Alcohol Fuels and other renewables

ISAF XV conference was held in September 2005 in San Diego, California (www.eri.ucr.edu). 67 presentations were given in the biennial ISAF conference. The program included sessions on general perspectives and specific topics dealing with production of fuels, automotive technology, environmental and energy issues, economics, policy, regulations etc. Presentations on production included thermochemical and biotechnical processes, as well as biorefineries. Choren's process based on gasification to produce Biomass-to-Liquids (BTL) fuel ("Sunfuel") was presented. Swedish presentations focused on ethanol and gasification of black liquor. Main interest from China was on coal based syngas, mainly methanol and DME. A new Swedish diesel emulsion, called Agrodiesel 15, was claimed to fulfill diesel specifications (Mr Golubkov). Several studies on ethanol, methanol/gasoline, and emission were shown. Mr Seyfried from Volkswagen presented VW's strategy with synthetic fuels (Synfuel, Sunfuel). It was also mentioned that VW FSI (gasoline direct injection

technology) is not applicable for FFV cars. US EPA has developed a spark-ignition ethanol engine with over 40% efficiency based on VW's diesel engine (Brusstar). In USA, around 5 million FFV cars could use E85 fuel, but availability of E85 fuel is very limited, e.g. in California only one filling station sells E85. FFV cars are popular in USA due to CAFE (Corporate Average Fuel Economy) rule: fuel consumption is taken into account only partly for FFV cars regardless of the fuel in the tank. *Source: ISAF VX material from N-O. Nylund.*

Saab 9-5 Bio Power cars, the first order

400 SAAB 9-5 Bio Power was ordered by rental car company Avis. SAAB 9-5 Bio Power is powered by both ethanol and gasoline. Using the E85 fuel will give the engine 180 bhp and an additional 30 bhp when using petrol. *Sources: Miljöfordon Newsletter 5-05 (from BAFF, Ny Teknik).*

BIOESTERS

Updated figures on biofuels

Production of biodiesel and ethanol in Europe has increased dramatically in past years. However, even now biofuels represent below 1% of the total gasoline and diesel consumption in 25 Member States of European Union.

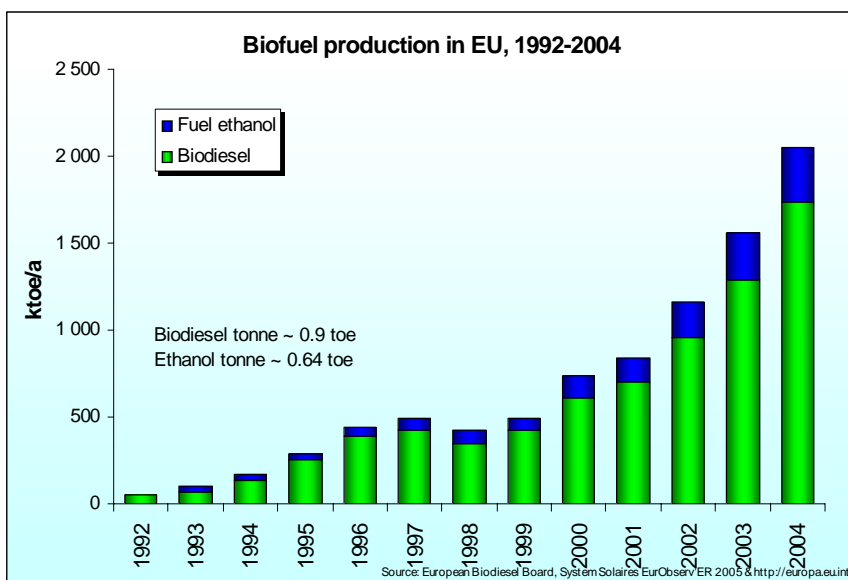
New biodiesel facilities

- Cargill plans to invest in a new 200,000 t/y facility in Mainz, Germany. Production would start in 2006.
- ADM will build two biodiesel plants, one in Germany (270,000 t/y) and one in USA (ND, 50 million gallons/y).
- A new joint venture, Diester Industrie International, is expected to produce 430,000 t/y biodiesel in Germany, Austria and Italy.
- In Philippines, coconut diesel plant opened in Quenzon City. Production of "Enviroted Biodiesel Premium" is 15,000 t/y, and expected to increase up to 180,000 t/y in 2008. Price is \$0.55 per liter (diesel \$0.53 per liter).
- Malaysia plans to use 5% palm oil biodiesel blend to reduce diesel imports by 500,000 t/y. Raw palm oil costs are \$345 a ton compared to \$450-530 a ton for imported diesel
- Malaysia will invest on three palm oil biodiesel plants with total capacity of 180,000 tons/y.
- Indonesian oil company Pertamina plans to produce biodiesel from the jatropha tree aiming at 100,000 t/y production

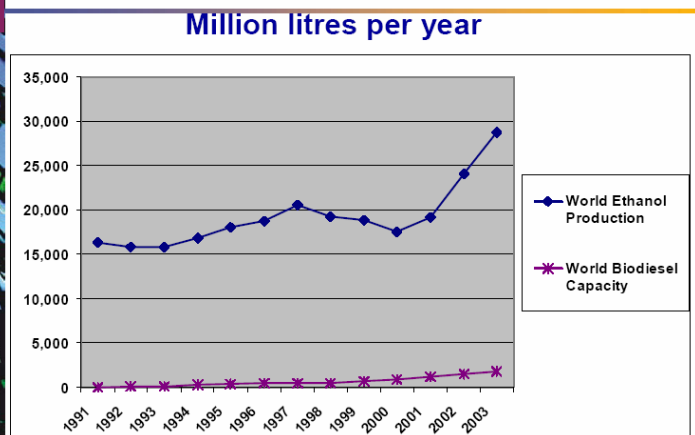
DieselNet News, August, Sept. and October 2005.

DPF and biodiesel

CARB has extended verification of CRT diesel particulate filter to using biodiesel B20 blends (20% vegetable oil ester and 80% diesel with sulfur content up to 15 ppm). *DieselNet News August 2005.* It was referred in the August issue of AMFI Newsletter that German car makers don't accept neat biodiesel (vegetable oil esters) in DPF equipped cars due to concerns about increased oil film dilution during post-injections, but biodiesel blends are allowed. *DieselNet News, May 2005.* It is also reported that with particulate traps, the extra injection used to increase emission temperatures for the regeneration of the particulate trap will dilute the engine oil when using RME as fuel. This dilution can give increased wear of the engine. A minor admixture of RME in conventional diesel will not give rise to this problem. *Source: Miljöfordon Newsletter 4-05 (from www.ufop.de, www.all4engineers.com).*



Worldwide, Biofuels Production Growing Rapidly Since 2000



Upper Figure: Biofuels in Europe. Sources: European Biodiesel Board, System Solaires Eur Observ'ER 2005 & http://europa.eu.int.

Lower Figure: Lew Fulton, Transport Energy Specialist, IEA "IEA assessment of future transport fuels use and biofuels potential", IEA Workshop "Assessing the Biofuels Option" (www.iea.org)

SYN- AND SUNFUELS (GTL, BTL)

Paradiesel in Sweden

In Sweden, a blend of GTL diesel and biodiesel (vegetable oil or animal fat ester) called "Paradiesel" was launched by FramTidsbränslen AB on 14th September 2005. GTL has been demonstrated for five years in various vehicles within BioFuel Region (the two counties of Västernorrland and Västerbotten, see www.biofuelregion.se). Emission tests (ESC cycle) made on pure GTL on a Euro-2 engine with a mounted DeNOx-system showed 8 % less NOx, 30 % less PM and up to 90 % less toxic emissions than Swedish Environmental Class 1 fuel, which has been the world's cleanest diesel fuel so far. Paradiesel containing 5 % biodiesel reduces CO₂ emissions 4-10 %. Paradiesel has the benefits of GTL diesel fuel, meaning e.g. good cetane number and cold flow properties and fully soluble with ordinary diesel, in all mixing ratios. Currently four Scania diesel busses are running in daily traffic in Sundsvall using Paradiesel.

Imported GTL diesel has been on market in Sweden since 2002. A GTL pilot plant (5 MW) is planned to be built up in Sundsvall using industrial off-gases in 2007 and later on a biomass gasifier using wood waste is to be connected. Then the whole BTL production chain can be demonstrated and evaluated before scaling up.

Sources: www.framtidsbranslen.se, *Miljöfordon Newsletter 5-05*.
Discussion with Bengt Aldén from FramTidsbränslen.



Source: www.framtidsbranslen.se

Shell partners with CHOREN with the SunFuel (BTL)

Shell Deutschland Oil GmbH has acquired a stake in CHOREN Industries GmbH, Freiberg/Saxony. CHOREN, supported by Volkswagen and DaimlerChrysler, builds up the world's first commercial BTL facility to gasify biomass into high-quality synthetic fuel, SunFuel (see AMFI Newsletter April 2005). Greenhouse gas emissions from BTL Fuel are less than 10 per cent of those from fossil fuels. *Shell News & Media releases, 17/08/2005* (www.shell.com) Pilot plant of 15,000 tons/year capacity is expected to be completed in 2006, then production would start in 2007. Large-scale production with full-scale plants is expected to start from 2009 onwards (target up to 200,000 tons/year). *T. Blades et al. Sustainable SunFuel from CHOREN's Carbo-V® Process. ISAF XV, September 2005, San Diego, California.*

Sasol is investigating on GTL projects

Sasol (South Africa) is investigating new projects in the USA and Algeria. Pre-feasibility study is going on in USA on Coal-to-Liquids projects. In Algeria, Sasol has submitted tender on GTL facility with Chevron targeting to 34,000 barrels a day production. Sasol's 34,000 barrels a day GTL plant in Qatar will start production in 2006. In 2009, in joint venture with Chevron, a plant in Nigeria will be completed. Sasol plans 540,000 barrels a day GTL capacity in 2014. In addition to this, Sasol studies 16,000 barrels per day production possibilities in China. *DieselNet News, October 2005.*

OTHER ADVANCED FUELS (HYDROGEN, DME), HYBRIDS

Hydrogen technology research centre, Hytrec, in Norway

Statoil (oil), Statkraft (hydropower) and DNV (classification) are planning a hydrogen technology research centre (Hytrec). A project of some 7 million € will start up in Trondheim by 2007. The project covers hydrogen production by electrolysis and reforming of natural gas, a pressurized hydrogen filling station, a fuel cell cogeneration plant and a visitor information centre. *ENGVA news, number 7, July 2005* referring to www.hytrec.no.

Hydrogen storage in tablets – Danish invention

Technical University of Denmark (DTU) has invented a new technology: a hydrogen tablet that stores hydrogen in an inexpensive and safe material. "Should you drive a car 600 km using gaseous hydrogen at normal pressure, it would require a fuel tank with a size of nine cars. With our technology, the same amount of hydrogen can be stored in a normal gasoline tank", says Professor Claus Hviid Christensen, Department of Chemistry at DTU. The hydrogen tablet is safe and inexpensive. The tablet consists of ammonia absorbed in sea-salt. Ammonia is produced by a combination of hydrogen with nitrogen from the surrounding air. Hydrogen is stored in tablet, and when needed, ammonia is released through a catalyst that decomposes it back to free hydrogen. When the tablet is empty, it is

"refueled" by a "shot" of ammonia. The researchers have founded the company Amminex A/S focusing on the further development and commercialization of the technology. *Source: Technical University of Denmark (www.dtu.dk)* Editor's Note: New nano-material based hydrogen storage system by Nanomix and porous-material based system by UK researchers are referred in AMFI Newsletter January, 2005. There are also other new hydrogen storage technologies, like one based on magnesium alloys developed by Hydrexia Pty Ltd in Australia (www.uq.edu.au)

Hybrid buses and locomotives

San Francisco Municipal Railway has ordered 56 diesel-electric hybrid buses, Charlotte NC two hybrid buses, Memphis transit authority four hybrid buses. In addition, Shell tests GTL in a Hino hybrid diesel bus. Union Pacific orders 10 "Green Goat" hybrid locomotives to be used in Southern California. *DieselNet News, August 2005.*

Hybrid buses – study on emissions and fuel economy

A new study by the University of Connecticut found that PM mass and number emissions from hybrid diesel-electric busses were statistically similar to comparable diesel buses. The tests were carried out on actual roadways, not with laboratory dynamometers. Fuel economy was from 10 to 15% better with hybrids than with diesel busses, which is modest compared to claimed 50% reduction. The driving in Connecticut contains substantially suburban driving, whereas hybrids give benefit only in under urban stop-and-go driving. *DieselNet News, September 2005*

MISCELLANEOUS

Fuel for mixed-mode HCCI

HCCI combustion tends to be problematic at high loads. Mixed-mode means HCCI at low loads and conventional diesel mode at high loads. The pre-mixed combustion of HCCI engines would benefit of fuels with mid-high volatility, low cetane, low octane. *D Foster, University of Wisconsin, DEER conference (presentation).*

Emissions

California's NO_x limits. First, the California Air Resources Board (CARB) voted to retain the 0.2 gram/bhp-hr NO_x limit (same as US 2010 limit) for Californian transit agencies for 2007-2009. The decision was reversed only one week after voting. The tighter limit was seen as a positive decision for the NGV industry. *NGV Global News, 26 October 2005.*

NO₂ emission: Additional information on NO₂ issues (AMFI Newsletter, April 2005) points out that sulfur content may play a role in formation of NO₂ in aftertreatment devices, e.g. in oxidation catalysts or CRT particle filters. Oxidation of fuel sulfur into SO₃ is stronger reaction than formation of NO₂. In Europe, sulfur-free fuels, below 10 ppm sulfur content, are today widely available. Without strong competitive reaction, NO₂ formation becomes primary reaction in oxidation catalyst, and may increase NO₂ concentrations. *Source: Bengt Johansson, Volvo CE Components.*

Urea-SCR seems to be selected the first choice for meeting 2010 emission standards by all heavy-duty manufacturers who discussed about NO_x reduction technologies in DEER 2005 conference (including GM). *DieselNet News, August 2005.*

EU's Air Pollution Strategy is proposed within EU's Sixth Environmental Action Programme (6EAP). Under this Thematic Strategy regulation on fine particles (PM_{2.5}) is proposed. Special attention is given also to ground level ozone. According to referred modeling the Strategy would reduce number of premature deaths related to fine particles and ozone from 370,000 to 230,000 by 2020. *DieselNet News, September 2005.*

Activists against SUVs in Paris A group called "The Deflated" are fighting against SUVs in Paris by deflating tires (w/o damage), smearing doors with mud, and putting handbills on windshields saying that the vehicles are dangerous, polluting behemoths that do not belong in the city. "We use the mud to say that if the owners will not take the four-wheel-drives to the countryside, we will bring the countryside to the four-wheel-drives," said Marrant, the mysterious leader of group. The deflators are on the fringe of a movement that has considerable support at City Hall, which is governed by an alliance of the Socialist and Green parties. City leaders don't accept vandalism, but officials have gone as far as proposing that Paris ban SUVs. In France, SUVs represent about 5% of the market (in USA 25% of sales). *Los Angeles Times, 10 Oct 2005 (www.wbcsd.org).*

IEA & IEA/AMF News

IEA Workshop: "Assessing the Biofuels Option"

IEA Seminar, "Assessing the Biofuels Option" was held in Paris, 20-21 June 2005. IEA, UN Foundation and the Brazilian Government organized the event, 100 persons representing 20 different countries participated, also IEA/AMF Secretary, Claës Pilo. The IEA seminar explored the near-term and longer-term global prospects for biofuels, focusing mainly on the development of new markets. The Brazilian

model for development of a national biofuels market was highlighted, as well as perspectives from other countries. The seminar explored the elements of a sound national strategy, and addressed not just biofuels for transport, but also the socio-economic/sustainable development component which involves rural community development, environmental impacts, income generation and the foreign currency potential. Finally, the seminar sought to clarify the opportunities for international cooperation to expand biofuels production and use on a cost-effective, environmentally-sustainable basis.

Brazil supported by the IEA Secretariat made a strong effort to sell Brazilian competence in production and transport use of ethanol to developing countries in Africa and Asia. The reactions were in general positive. Though some countries such as Kenya seemed not to be convinced about the advantages of introducing ethanol fuels for transport, having more urgent problems to deal with. The Indian representative Mr. Ashol Khosla, Chief Executive Officer of TARAhaat Information Marketing Services Ltd, who presented the following list of energy services in order of importance for India: Irrigation, Cooking, Lighting, Heating, Machines, and as least important Transport. Presentations of the Workshop are available on web (http://www.iea.org/Textbase/work/workshopdetail.asp?WS_ID=224)
Claës Pilo, IEA/AMF Secretary

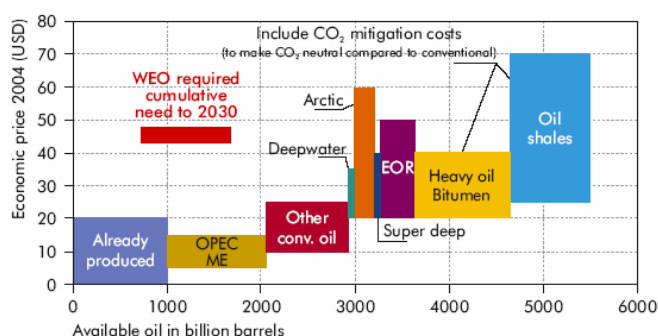
Update of AMF website

IEA/AMF 31st ExCo Meeting will be held in Prague, 7-9 November 2005 – information in Member area.

PUBLICATIONS

- ◇ IEA report: Resources to Reserves -- Oil and Gas Technologies for the Energy Markets of the Future, September 2005, (www.iea.org)
- ◇ IEA report: Key World Energy Statistics, 2005 edition, free download (www.iea.org)
- ◇ IEA report: Renewables Information 2005 -- with 2004 data (www.iea.org)
- ◇ IEA Workshop: "Assessing the Biofuels Option", presentations available on web (www.iea.org)
- ◇ DEER 2005, Diesel Engine Emissions Reduction: Papers and posters available on web (www.eere.energy.gov)

Figure 7.1 • Oil cost curve, including technological progress: availability of oil resources as a function of economic price



Source: IEA.

IEA/AMF Delegates

Canada

Natural Resources Canada
 Mr. A. Beregszaszy
 tel: +1 613 996 8557
 aberegsz@nrccan.gc.ca

France

ADEME, Valbonne
 Mr. P. Coroller
 tel: +33 4 9395 7932
 patrick.coroller@ademe.fr

LEVO, Tokyo
 Mr. K. Tanigawa
 tel: +81 3 3359 8461
 k-tanigawa@levo.or.jp

Switzerland

University of Applied Sciences
 Mr. J. Czerwinski
 Tel: +41 32 331 6426
 jan.czerwinski@hti.bfh.ch

Denmark

Technical University of Denmark (DTU)
 Mr. J. Schramm
 +45 45254179
 js@mek.dtu.dk

Italy

Agip Petroli Centro Ricerche EURON
 Mr. F. Giavazzi
 tel: +39 02 5205 6421
 fulvio.giavazzi@euron.eni.it

Spain

IDAE, Madrid
 Mr. C. López-López
 tel: +34 91 456 4994
 carlopez@idae.es

United Kingdom

Department for Transport
 Mr. C. Parkin
 tel: +44 20 7944 2958
 chris.parkin@dft.gsi.gov.uk

Finland

VTT, Espoo
 Mr. N.-O. Nylund
 tel: +358 400 703715
 nils-olof.nylund@vtt.fi

Japan

NEDO, Tokyo
 Mr. S. Tonomura
 tel: +81 44 520 5280
 tonomurasga@nedo.go.jp

Sweden

STEM, Eskilstuna
 Ms. A. Kempe
 tel: +46 16 544 2092
 alice.kempe@stem.se

USA

DOE, Washington, DC
 Mr. S. Goguen
 tel: +1 202 586 8044
 stephen.goguen@hq.doe.gov

Contact information – AMFI Newsletter:

TEC TransEnergy Consulting Ltd., Ms. Päivi Aakko, Tekniikantie 14, FIN-02150 Espoo. Tel +358 9 251 72360, e-mail: info@teconsulting.fi, Website: www.teconsulting.fi