ERIA Research Project Report 2008
No. 8-3

Benchmarking of Biodiesel Fuel Standardization in East Asia

Edited by
Shinichi Goto

2009

Acknowledgement

The author would like to acknowledge all members of ERIA Working Group for the Benchmarking of Biodiesel Fuel Standardization in East Asia, who has rigorously contributed to the successful activities throughout fiscal year 2008. Particular thanks must go to the financial support by ERIA that brings all biodiesel experts from East Asia and ASEAN countries to discuss and shape up the biodiesel fuel standardization scheme.

Dr. Shinichi Goto,
Director, Research Centre for New Fuels and Vehicle Technology (NFV),
National Institute of Advanced Industrial Science & Technology (AIST)

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1. BACKGROUND AND OBJECTIVES

The Kyoto Protocol emphasized the concept of “carbon neutral” – that vehicle emissions of carbon dioxide (CO_2) are offset by using biofuels produced from plant materials absorbing CO_2. The use of biofuels contributes to the prevention of global warming.

Asian countries are actively promoting the introduction of biofuels due to soaring oil prices and increased energy consumption. The utilization of biofuels is also important from the viewpoint of energy security and alternative fuels.

However, the low-quality biodiesel fuel raises serious concerns regarding the effect on engine performance caused by fuel impurities and the oxidation. Therefore, it is anticipated that biodiesel fuel standards will be established in each country to promote more distribution in the region.

In FY2007, a benchmark standard of biodiesel fuel in East-Asia was established and launched. Some topics including oxidation stability, however, have remained as tasks to be solved in FY2008. As for this, the continuous discussion is necessary with more data for determining how to control the biodiesel fuel quality in real market of each country member. In addition to this, feasibility study of new

biodiesel feedstock, which is inedible biomass, will be conducted. These activities will bring us a “Biodiesel Fuel Trade Handbook” as a result of FY2008.

2. METHODOLOGIES

The methodologies to deliver the Biodiesel Fuel Trade Handbook are mainly focused on interactive discussions among expert members in the meetings, which were held four times during FY2008. During each meeting, specific topics have been addressed, and often the meeting invited other local experts to share their experiences. Furthermore, technical visits were arranged for expert members to see the real things. Lastly, the content of the handbook has been discussed and assigned to respective member experts for contribution with periodic updates. In summary, there are three steps.

(1) Discussion

- Continuous discussions: Oxidation stability (6-10 hr.), Iodine number, Polyunsaturated FAME and so on.
- Determination of how to control the biodiesel fuel quality on each country's real market

(2) Feasibility study

- New inedible feedstock for biodiesel fuel was introduced via technical site visit (Jatropha curcas

nursery, experimental plantation plus small scale processing in Indonesia)

- Survey the possibility of inedible materials, e.g. Jatropha, Micro-Algae

(3) Making a “Biodiesel Fuel Trade Handbook” to include all results of discussion and feasibility study conducted over the year.

3. IMPLICATION/ EXPECTED RESULT/ FUTURE DEVELOPMENT OF THIS STUDY

As results of the WG discussion in FY2008, the WG will draft a “Biodiesel Fuel Trade Handbook”, with tentative contents as follows:

(i) Introduction

(ii) Energy Situation in the World
- ✓ Increase of Energy Demand
- ✓ Trend of International Energy Prices
- ✓ Global Environmental Problems
- ✓ Biofuels

(iii) Biodiesel Fuel Standardization Activities
- ✓ EAS-ERIA Biodiesel Fuel Standard
- ✓ World Wide Fuel Charter – Biodiesel (B100)
- ✓ Measurement Method of Biodiesel Fuel Characteristics

(iv) Biodiesel Fuel Quality
- ✓ Oxidation Stability
- ✓ Fluidity

(v) Potential of Other Feedstocks
- ✓ Jatropha Curcas L.
- ✓ Rice Bran

- ✓ Microalgae

(vi) Importance of Quality Control and Market Acceptance (Case Studies in Member Countries)

(vii) Current Status of Biodiesel Fuel in East Asia and ASEAN Countries

(viii) Trade and Market Dynamics of Biodiesel

(ix) Future Vision

- ✓ Next Generation Biofuels
- ✓ Sustainability of Biofuels

4. RESEARCH SCHEDULE

There are a total of 3 regular WG meetings conducted during FY2008. After WG3 meeting, WG activities and handbook were presented at 27th ASEAN Ministers on Energy Meeting (AMEM) and Associated Meetings, including 11th Meeting of the EAS Energy Cooperation Task Force (ECTF) and 3rd EAS Energy Ministers Meeting, in Mandalay, Myanmar during 28-29 July 2009.

WG1: November 11-12, 2008 in Jakarta, Indonesia:

- ✓ Information exchange about situations of checking biodiesel fuel qualities in each East-Asian country
- ✓ Discussion about making “Biodiesel Fuel Trade Handbook”
- ✓ Discussion about how to control the biodiesel fuel quality on real market
- ✓ Technical tour to Jatropha nursery and biodiesel fuel lab.

WG2: February 22-23, 2009, in Kota Kinabalu, Malaysia:

- ✓ Discussion about how to control the biodiesel fuel quality on real market
- ✓ Discussion of the handbook and the draft WG report.
- ✓ Technical tour to Yanmar biodiesel fuel lab.

WG3: June 29-30, 2009, in Tsukuba, Japan:

- ✓ Checking of the draft handbook
- ✓ Technical tour to NFV, AIST.

After WG3: July 29-30, 2009, in Mandalay, Myanmar:

- ✓ Present WG activities and handbook at 11th Meeting of the EAS Energy Cooperation Task Force (ECTF)
- ✓ Present WG outcome as part of ECTF Biofuels Workstream in front of 16 Energy Ministers from ASEAN+6 Countries during 3rd EAS Energy Ministers Meeting

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5. MEMBERS

ERIA Working Group for the Benchmarking of Biodiesel Fuel Standardization in East Asia is composed of experts from Japan and other East Asia/ASEAN countries, as shown in Figure 1.

Australia
Dr. Lesley Dowling & Dr. Daniel Sheedy
Fuel and Used Oil Policy Section, Department of Environment and Water Resources

China
Prof. Wugao Zhang
Shanghai Jiao Tong University

Indonesia
Dr. Tatang Hernas Soerawidjaja
Chairman, Indonesian Biodiesel Forum/Head, Center for Research on Natural Resource Utilization, Institut Teknologi Bandung
Mr. Soni Solistia Wirawan
Head of Institute for Engineering and Technology System Design, Agency for the Assessment and Application of Technology

Malaysia
Mr. Harrison Lau Lik Nang
Research Officer, Engineering and Processing Research Div., Malaysia Palm Oil Board (MPOB)

New Zealand
Ms. Philippa Blunden
Policy Analyst, Fuels & Crown Resources Group, Ministry of Economic Development

Philippines
Ms. Zenada Ygnacio Monsada
Oil Industry Management Bureau, Department of Energy

WG leader (Japan)
Dr. Shinichi Goto
National Institute of Advanced Science and Technology (AIST)

Singapore
Dr. Rong Yan
Institute of Environmental Science and Engineering, Nanyang Technological University

South Korea
Dr. Young Jae Lee
Leader, Transportation Energy Research Center, Korea Institute of Energy Research

Thailand
Ms. Peesamai Jenvanitpanjakul
Deputy Governor (R&D), Thailand Institute of Scientific and Technological Research (TISTR)
Dr. Nuwong Chollacoop
National Metal and Materials Technology Center (MTEC), National Science and Technology Development Agency (NSTDA), Thailand

India
Dr. O.S. Tyagi
Indian Institute of Petroleum (IIP), Council of Scientific & Industrial Research (CSIR)

Vietnam
Ms. Hoang Thi Tinh
Vietnam Standards and Quality Center, Directorate for Standards and Quality (STAMEQ)

Myanmar **(to be confirmed)**

Black characters: Members from 2007
Red characters: New members from 2008

(a)

*Dr. Shinichi Goto (***WG leader)**
National Institute of Advanced Science and Technology (AIST)

Mr. Shoichi ICHIKAWA
Representative of Japan Automobile Manufactures Association (JAMA), Toyota Motor Corporation, Japan

Dr. Takashi HOSHINO
Representative of Japan Automobile Manufactures Association (JAMA), Isuzu Motors Limited, Japan

Prof. Koji YAMANE
Representative of Academia, University of Shiga Prefecture, Japan

Mr. Akio IMAI
Representative of Petroleum Association of Japan (PAJ), Showa Shell Sekiyu K.K., Japan

Mr. Takao IKEDA
New and Renewable Energy Group, Strategy and Industry Research Unit, Institute of Energy Economics, Japan

Prof. Mitsuru KONNO
Representative of Academia, Ibaraki University, Japan

Dr. Yuji YOSHIMURA
National Institute of Advanced Science and Technology (AIST)

Dr. Mitsuharu OGUMA
National Institute of Advanced Science and Technology (AIST)

(b)

Figure 1 (a) Oversea and (b) Japanese members of ERIA BDF WG

6. RESULTS

This chapter will describe in details the activities and output of all three regular WG meetings and two special ERIA meetings.

6.1 WG1 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 5th Meeting (1st of FY 2008)

November 11-12, 2008 in Jakarta, Indonesia

6.1.1 Participating countries

China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam

(-without participation from Australia, India, Malaysia and New Zealand)

6.1.2 November 11: Technical tour of Pakuwon Jatropha Plantation, Indonesian Center for Estate Crops Research and Development (ICECRD)

Former Director of ICECRD Dr. Bambang Prastowo (bprastowo@gmail.com) gave a presentation on the overview of Pakuwon Jatropha plantation site, followed by the on-site explanation of various Jatropha breed and its mechanized facility, e.g. de-husking machine, screw-press oil extractor, biodiesel reactor, biogas reactor and customized stoves, as shown in Figure 2. Important findings are as follows.

The front gate

Top view of Jatropha plantation site

Group photo

Group discussion

Jatropha de-husking machine

Jatropha oil extractor (screw-press)

Biogas reactor from Jatropha residue

Biodiesel processing reactor

Special stove with Jatropha derived fuel

Various stoves designed to use biogas

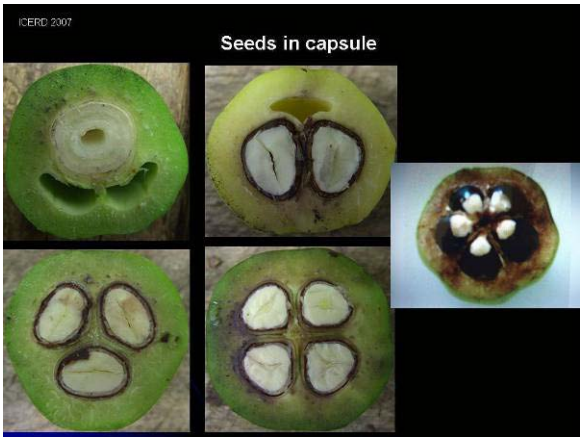
Various Jatropha products on display

Various Jatropha products on display

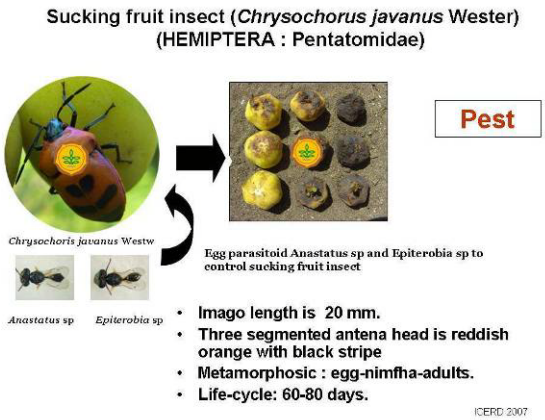
Figure 2 Technical visits of ICECRD

This Jatropha plantation site was established in 2005 by Ministry of Agriculture with the purpose to improve yield of Jatropha seed production. Initially, nine Jatropha breeds were collected from all over Indonesia during the exploratory phase, and planted in a 50 ha area of the

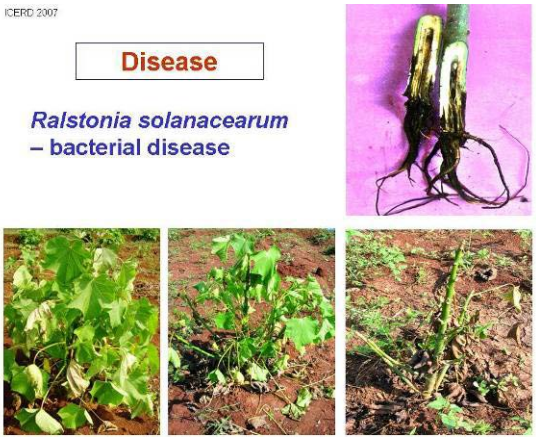
Pakuwon site. This original population yields about 25-30 capsules/shrub or average 1st year yield of 0.3-0.4 ton/ha. The first Improved Progression population (IP-1) was developed in 2006 with more than 200 capsules/shrub or average 1st year yield of 0.9-1.0 ton/ha in a 30 ha plantation area. Then, the second Improved Progression population (IP-2) was further developed in 2007 with more than 400 capsules/shrub or average 1st year yield of 1.9-2.2 ton/ha in a 25 ha plantation area. For each IP population, there are also slight various for dry (IP-1A), medium dry (IP-1M) and wet (IP-1P) area. In addition, other Jatropha research activities include genetic control on number of seeds in Jatropha fruit, pest control, disease control, certification of distributed seed and inter-crop selection, as shown in Figure 3.



Genetic control on number of seeds



Pest control

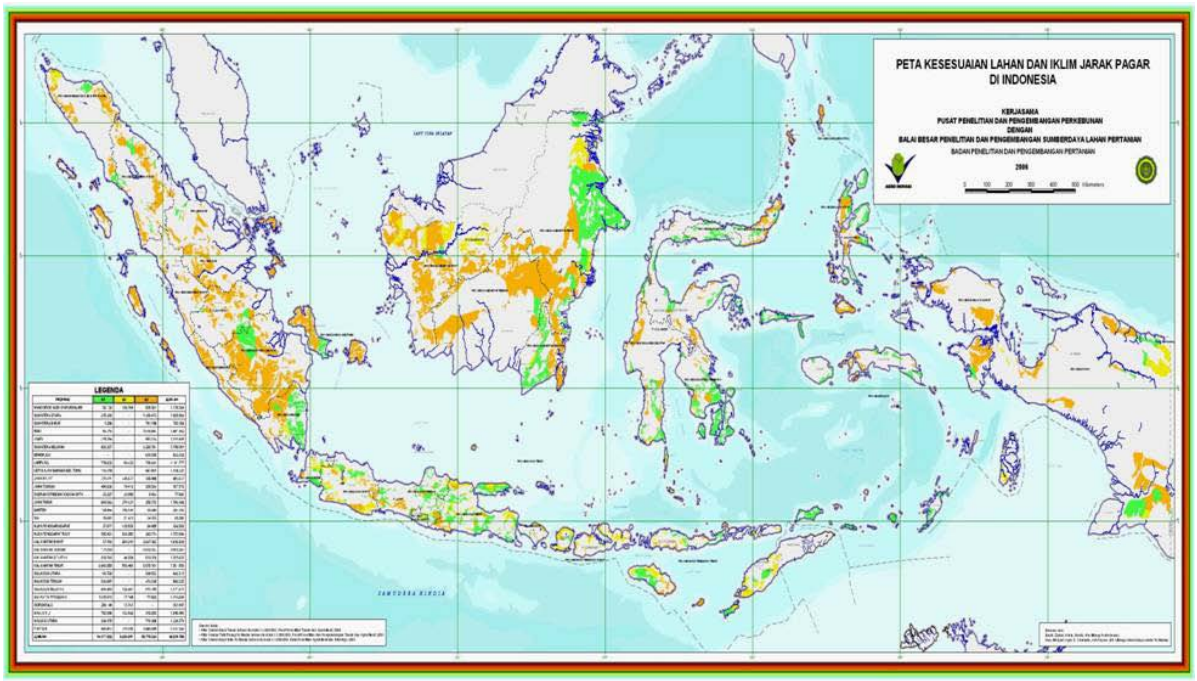


Disease control

Certification of distributed seed

Figure 3 ICECRD information on Jatropha

Currently, there are about 5.5 million ha area that has been identified suitable for Jatropha plantation in Indonesia, as shown in Figure 4, with the target of 1.5 million ha planted with Jatropha by 2010. Thus far, this Pakuwon Jatropha plantation site has identified the best breed, which has fruits at the top for easy mechanized harvesting.



5.5 millon ha suitable area for Jatropha plantation in Indonesia

Dr. Goto with special Jatropha breed yielding fruit at the top for easy mechanized harvesting

Label of this special Jatropha breed

Figure 4 ICECRD Jatropha nursery

6.1.3 November 12: Working Group Meeting

Figure 5 ERIA BDF WG meeting

The working group meeting was held at new spacious ERIA annex office, as shown in Figure 5, started with welcome remark by team leader Dr. Goto on the joint Ministerial statement, which highly recognized the outcome of 1st year ERIA project. Then, Dr. Goto kindly introduced new members of this 2nd year including Dr. Yoshimura from AIST/Japan, Mr. Shoichi Ichikawa from Toyota JAMA/Japan, Mr. Takao Ikeda from IEE/Japan, Mr. Soni Solistia Wirawan from BPPT/Indonesia, Ms. Hoang Thi Tinh from TCVN/Vietnam and Dr. Nuwong Chollacoop from MTEC/Thailand. Dr. Goto also appraised Dr. Oguma for his

administrative help in this ERIA project since the secretary has left AIST. In the future, Dr. Chollacoop will be helping Dr. Oguma for the administrative work, especially on the biodiesel fuel trade book. Finally, Dr. Goto has introduced Prof. Fukunari Kimura to speak about ERIA.

Prof. Kimura was in Faculty of Economic, Keio University but now is a full-time Chief Economist at ERIA. The ERIA has officially started in February 2008 with the first board meeting in June 2008. ERIA has a small office in ASEAN Secretariat building so ERIA has decided to have an much more spacious annex office at Senayan building instead. Currently, ERIA has only 2 full-time researchers, and are now seeking for applicants. The underlying three pillars of ERIA policy research agenda are deepening integration, narrowing the development gap and sustainable development, in which this project is under the 3rd pillar. The ERIA projects from last year will continue this year with the new incoming projects such as “Sustainable automobile society” and “Comprehensive East Asia environmental policy review”. Also, Prof. Kimura has mentioned that Ms. Monsada and Dr. Chollacoop will be presenting and discussing this ERIA biodiesel project in front of many economists at the 11th International Convention of the East Asian Economic Association (EAEA11) in Manila,

Philippines on 15-16 November 2008, in which ERIA has two special sessions to publicize the outcome of six ERIA projects.

Next is the self introduction of all current and new members including the observers Dr. Tirto Prakoso from ITB/Indonesia and Mr. Yohan Soelaiman from Indonesian BDF processing company. Dr. Goto has mentioned about ERIA invitation program, which currently has 5 researchers in his group and 2 researchers in Dr. Yoshimura's group. Dr. Goto further encourage all members to nominate his/her interested researchers for the 2nd call for invitation, including Dr. Tirto Prakoso and Thai researchers from TISTR and MTEC for Thailand-Japan workshop next February.

The meeting has mainly 3 agenda. First, the current status of biodiesel fuel was presented for WWFC (World Wide Fuel Charter) and Vietnam. Second, the content of biodiesel fuel trade book was discussed. Third, the new topics were presented on partial hydrogenation, and the viewpoint from energy economics.

1. Session I –Introduction of current status of BDF from WWFC and Vietnam-

WWFC: Mr. Shoichi Ichikawa

In 1998, the first WWFC was published through co-effort of ACEA, AAM and JAMA with the 4th edition in 2006. The WWFC committee is composed of 15 countries, 9 of which are from East Asian and ASEAN countries as shown in Figure 6 below.

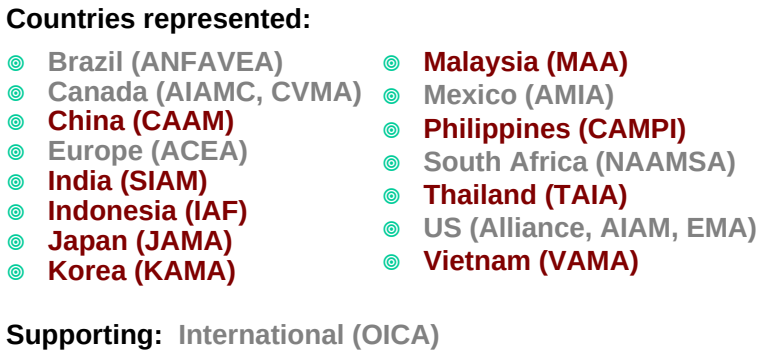
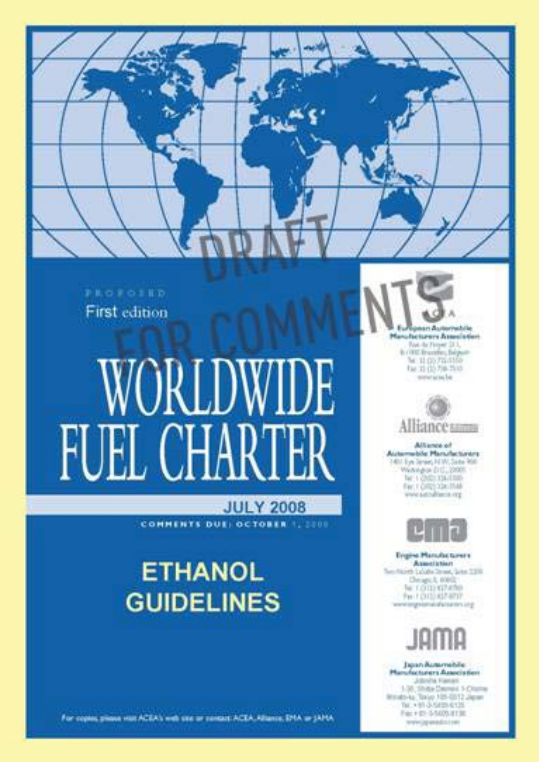
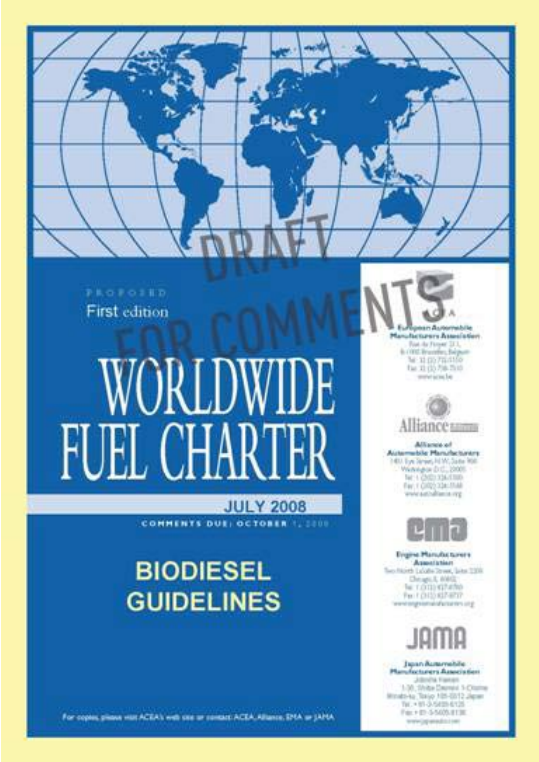


Figure 6 Members of WWFC

The goal of WWFC is clearly to set fuel specification and/or its test method for current and future emission control. Since biofuel is deemed as alternative fuel for fossil, some guidance on fuel with current engine technologies is needed. As shown in Figure 7, bio-ethanol (E100) and biodiesel (B100) guidelines have been drafted for comments among members with goals to benefit consumers, simplify fuel markets, facilitate international trade and help guide governmental public policy. This guideline is for E10 and B5 blends based on engine performance regardless of biofuel feedstock.





E100 guideline B100 guideline

Figure 7 WWFC biofuel guidelines

Focusing on biodiesel, some key comparison between WWFC and ERIA are shown in Table 1 as follows.

Table 1 Comparison of biodiesel fuel specification between WWFC and ERIA

Property	Unit	ERIA	WWFC	Notes
Viscosity	[mm²/s]	2.0 - 5.0	2.0 - 5.0	Feedstock neutral
Flashpoint	[C]	100 min	100 min	Methanol presence
Carbon residue 100% or 10%	[mass %]	0.05 max 0.3 max	0.05 max	Impact on CCD (WWFC only specify 100%)
Sulfated ash Ash	[mass %]	0.02 max (not specify)	0.005 max 0.001 max	Impact on injector deposits Not harmonized
Water &	[vol %]	(not	0.05	Risk of filter

Sediment		specify)	max	plugging Not harmonized
Oxidation stability	[hrs]	10 min	10 min	Risk of tank corrosion (JAMA request)
Iodine number		Report	130 max	Risk of sludge formation Not harmonized
Poly-unsaturated FAME	[mass %]	N.D.	1 max	Risk of sludge formation Not harmonized
Mono-glyceride	[mass %]	0.8 max	0.8 max	Risk of filter plugging Need more discussion
Phosphorous	[ppm]	10 max	4 max	Impact on catalyst Not harmonized
Metals (Na + K) Metals (Ca + Mg)	[ppm]	5 max 5 max	5 max 5 max	Impact on injector deposits Impact on catalyst

With remaining issues on

- Sludge (and also soap) formation tendency: not yet adequate test method for sludge formation (iodine number & poly-unsaturated FAME) and its relation to oxidation stability
- Impact on advanced engine & emission control system: need severe control of metals, ash/sulfated ash and phosphorous
- Filter plugging tendency: consider lower mono-glyceride content limit

At the present, the WWFC draft was issued out in July 2008 for comments. 15 commenters from US, EU and Asia

(including MPOB) has been received and reviewed at WWFC committee meeting on 7 November 2008 in Chicago. Feedback document is now under preparation to meet the final target of January 2009. JAMA has emphasized on the quality of biodiesel and its blend since characteristics of BDF depends on both raw material and refining process. The harmonization of standard is needed with discussion based on technical data.

Comment by Dr. Yan: Organic and inorganic phosphorous may have different effects so need to check which phosphorous should be measured.
Comment by Ms. Jenvanitpanjakul: Should get some technical data for metal contamination. Also, should focus on other properties for discussion like oxidation stability last year.
Comment by Dr. Soerawidjaja: Possible to specify density be measured above CFPP instead of 15 °C to prevent the problem of biodiesel with low CFPP?

Vietnam: Ms. Hoang Thi Tinh

Vietnam is an agriculture based country with over 80 million populations. Two main sectors with high energy

consumption are industry and transport, as shown Figure 8 below.

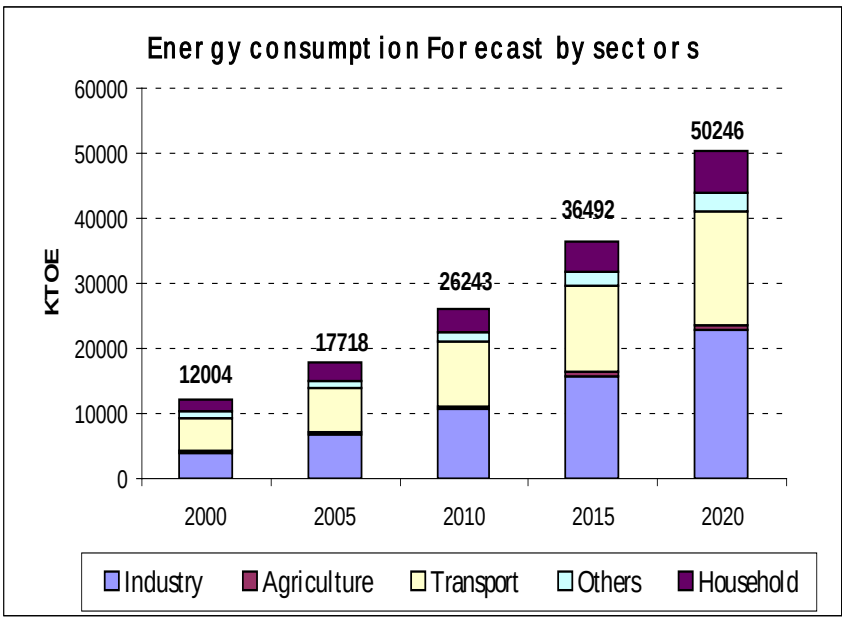


Figure 8 Domestic energy consumption in Vietnam by sectors

Even though Vietnam exports crude oil, it imports all the petro-products so biofuel could potentially help decreasing the import. Most of biofuel projects are still under development with small productions. Biodiesel is produced from catfish fat (Basa fish) while ethanol is produced from cassava and sorgo (sweet sorghum). Difficulties in promoting biofuel are lack of basic research and advanced technology, as well as a big gap between imported fuel and import vehicles. Last year, the government of Vietnam (by

Ministry of Science and Technology) has issued national standard for both ethanol (TCVN7716: 2007, Denatured fuel ethanol for blending with gasoline: E100) and biodiesel (TCVN7717: 2007, Biodiesel fuel blend stock: B100), as shown in Table 2 below.

Table 2 Vietnam standard for biodiesel fuel (TCVN7717: 2007)

Property		limit	Test method
1.Ester, % m/m	min	96.5	TCVN(ASTM)
2.Density,15 ^{o}C, kg/m^3		860-900	TCVN(ASTM)
3.Flash point, ^{o}C	min	130.0	TCVN(ASTM)
4.Water and sediment, %v/v	max	0.05	TCVN(ASTM)
5. Viscosity, 40 ^{o}C, mm^2/s		1.9-6.0	TCVN(ASTM)
6.Sulphated ash, % m/m	max	0.020	TCVN(ASTM)
7.Sulfur, % m/m	max	0,05	TCVN(ASTM)
8.Copper strip corrosion		No. 1	TCVN(ASTM)
9.Cetane number	min	47	TCVN(ASTM)

10.Cloud point, ^{o}C	max	Report	TCVN(ASTM)
11. Carbon residue, % m/m	max	0.050	TCVN(ASTM)
12.Acid number, mgKOH/g	max	0.05	TCVN(ASTM)
13.Iod value, g iod/100g	max	120	TCVN(ASTM)
14.Oxydation stability, h	min	6	TCVN (EN)
15.Free Glycerin, %m/m	max	0.020	TCVN(ASTM)
16.Total Glycerin, % m/m	max	0.240	TCVN(ASTM)
17.Phosphous, % m/m	max	0.001	TCVN(ASTM)
18.Distillation, 90%,^{o}C	max	360	TCVN(ASTM)
19. Na and K, ppm	max	5.0	TCVN(ASTM)

Additional effort from Prime Minister in November 2007 was approving Decision 177/QD-TTg for biofuel development by 2015, with prospect to 2025. By 2010, Vietnam plans to complete 5 biofuel plants with total

production of 100,000 tons/year of ethanol (cassava and sugarcane) in E5 and 50,000 tons/year of biodiesel in B5, in order to meet 0.4% of national demand. The first ethanol plant will be built by Petrovietnam's Oil Group in the northern province of Phu Tho at a cost of $85 million, and will start operation next year with an annual production of 100 million liters. Other plants include 40 million liters/year of ethanol production by Saigon Biofuel Company and the Dung Quat ethanol plant by PV Oil Group. By 2015, ethanol and biodiesel outputs are expected to reach 250,000 tons/year to meet 1% of national demand. Last month, PV Oil Group began selling gasohol E5 to motorcycle and taxi within Hanoi area but it was stopped after 1 week since some engine test and E5 specification are needed.

Comment by Dr. Chollacoop: Would the Dung Quat refinery produce enough ethanol for domestic consumption? Ms. Tinh replied only 30%.

Comment by Ms. Monsada: Any incentive for biofuel for this initial stage of biofuel devlopment? Ms. Tinh replied no, just a standard only.

Comment by Mr. Wirawan: Pricing is a key issue for biofuel promotion

Comment by Dr. Soerawidjaja: There is a worry on ethanol 92.1 % (v/v) for denatured ethanol fuel to be blended with gasoline.

Discussion on oxidation stability and other issues

Comment by Ms. Jenvanitpanjakul: From last meeting on the topic of JAMA recommendation to increase induction period from 6 to 10 hours, Thailand reported that Thailand would not yet conclude on this request, and would conduct further test with JAMA guideline/suggestion. Up till now, there is no report of such test due to high cost, and the testing organization did not have budget. Furthermore, the results from Japan are quite complete. Note the biodiesel feedstock in this region, such as palm oil, coconut oil and Jatropha oil, already possesses higher than 10 hours oxidation stability, except for some processing problems. Nonetheless, if biodiesel has lower oxidation stability than 10 hours, anti-oxidant can be added. Hence, the 10 hours oxidation stability is acceptable in EAS-ERIA standard.

Comment by Dr. Soerawidjaja: Oxidation stability depends on photocatalyzed acid, dissolved acide and acid formation from blending with diesel. Need to look at this issue in details.

Comment by Prof. Yamane: There is a linear correlation between B5 and B100. When the oxidation stability of B5 is to be measured, it can be calculated from B100 oxidation stability, which would take much shorter time.

2. Session II – Biodiesel fuel trade handbook -

Japan: Prof. Koji Yamane

Prof. Yamane presented the research plan of FY2008 categorized as follows.

- Working Group meeting with discussion on
    - Specific properties like oxidation stability, iodine number, polyunsaturated FAME
    - Biodiesel fuel quality control in each country's real market
- Feasibility exploration on new inedible feedstock for biodiesel fuel such as Jatropha, micro-algae
- Publication of "Biodiesel Fuel Trade Handbook" to include all results of discussion and feasibility exploration

The draft content of the biodiesel fuel trade handbook was presented with various comments and suggestions from the WG members as follows. Further comments can be sent to both Prof. Yamane and Dr. Oguma.

Comment by Dr. Goto: Tentative draft of BDF trade handbook will be presented at Ministerial meeting in August 2009. The handbook is planned to be published in English and Japanese, with welcome for other languages of WG member's countries.

Comment by Prof. Zhang: Might be good to add property-engine relationship since BDF properties depend on feedstock.

Comment by Dr. Soerawidjaja: Suggest to include a section on 2nd generation BDF and a comparison of various oils. Also for the micro-algae section, the handbook should focus on optimizing oil from micro-algae rather than conversion technology of micro-algae oil to biodiesel. For section on unused feedstock, a Moringa [1] tree should also be considered.

Comment by Ms. Jenvanitpanjakul: Content in Chapter 5 is suitable for future trend of biodiesel, and further support that section on micro-algae should focus on the oil production instead of BDF conversion.

Comment by Dr. Yan: Agree on the content of Chapter 1-4 but Chapter 5 would be for potential feedstock. Other

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1 http://www.hendrycreekhideaway.com/Moringa%20Miracle%20Tree%20of%20Life.html

important contents are sustainability issue, quick method to check % blend of BDF and cultivation of algae with high oil content and improved extraction method.

After the session, the revised draft content of BDF trade handbook is as follows.

1. Introduction (Dr. Goto)
2. Energy Situation in the World (Mr. Ikeda)
3. Biodiesel Fuel Standardization Activities
    3.1 EAS-ERIA Biodiesel Fuel Standard: 2008 (Dr. Oguma)
    3.2 World Wide Fuel Charter - Biodiesel Guideline: July 2008 (Dr. Hoshino)
4. Upgrading Technologies of Biodiesel Fuel Quality
    4.1 Oxidation Stability (Mr. Imai or Dr. Hoshino)
        4.1.1 Additives (Antioxidant) (Dr. Hirotsu, AIST)
        4.1.2 Upgrading of FAME by Partial Hydrogenation (Dr. Yoshimura)
        4.1.3 Second Generation Biodiesel (BHD, BTL....)
    4.2 Fluidity
        4.2.1 Low Temperature Fluidity
        4.2.2 Normal Temperature Fluidity
5. Utilization Technology of Unused Feedstock

5.1 Jatropha curcas (Dr. Tatang, Dr. Iman)

5.2 Rice Bran (Prof. Yamane)

5.3 Micro Algae 1: Triglyceride to FAME (Dr. Yan)

5.4 Micro Algae 2: Extraction of Hydro Carbone

5.5 Karanja Tree and Neem Tree (India?)

5.6 Calophyllum inophyllum, Moringa oleifera

3. Session III –Presentation of New Topics

Japan (AIST): Dr. Yuji Yoshimura "Upgrading of FAME by Partial Hydrogenation"

Dr. Yoshimura presented the research work on improving oxidation stability of FAME without sacrificing too much on the cold flow property by the technique partial hydrogenation. To improve oxidation stability of biodiesel, antioxidant additive or partial hydrogenation can be used. Possible oxidation mechanism of FAME shown in Figure 9 below is often a result of unsaturated FAME.

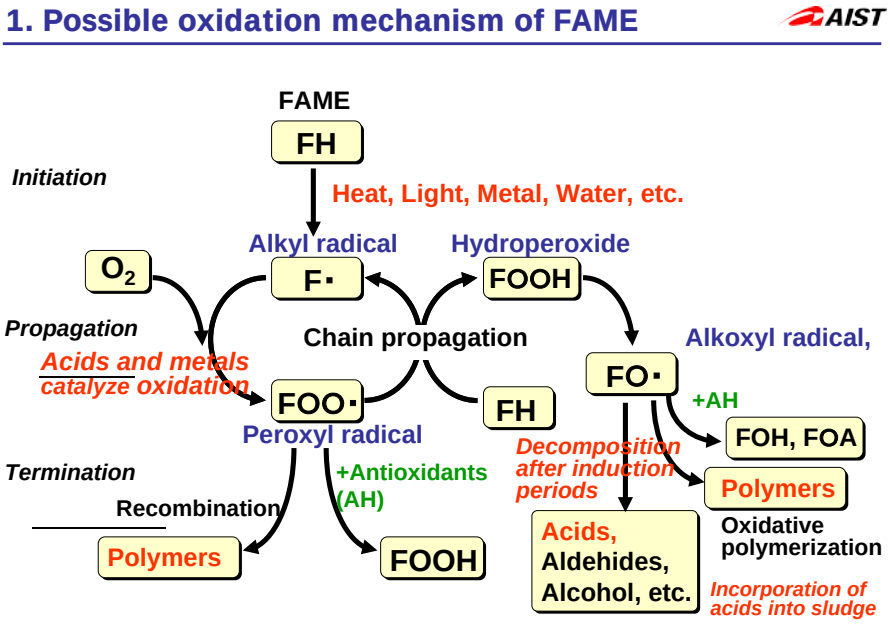


Figure 9 Possible oxidation mechanism of FAME

Considering the relative oxidation rates of unsaturated FAME C18 component, C18:1 : C18:2 : C18:3 = 1: 41: 98. Even though it is best for methyl stearates (C18:0) in term of oxidation stability, methyl oleates (C18:1) is not so bad given that the cold flow property is not much worsen. Interesting finding was that when biodiesel is blended with diesel with high sulfur content (S = 410 ppm), the increment in AV[2] (acid value) of C18:2 and C18:3 is not as bad if compared with the blending with low sulfur diesel (S = 6ppm), as shown in Figure 10 below. The reason is that sulfur compound and aromatic can act as antioxidant.

[2] Acid Value (AV) is an indicator for oxidation stability of biodiesel. Mandatory specification for B5 blending in Japan is $\Delta AV < 0.12$ mgKOH/g

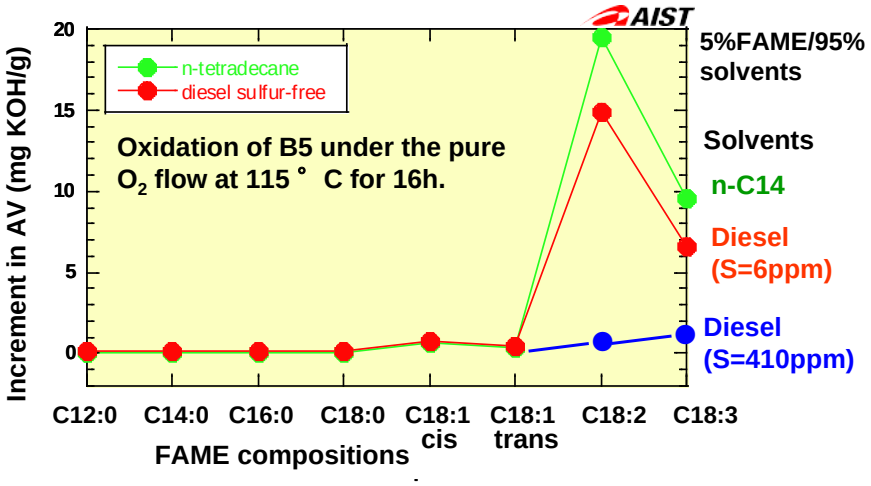
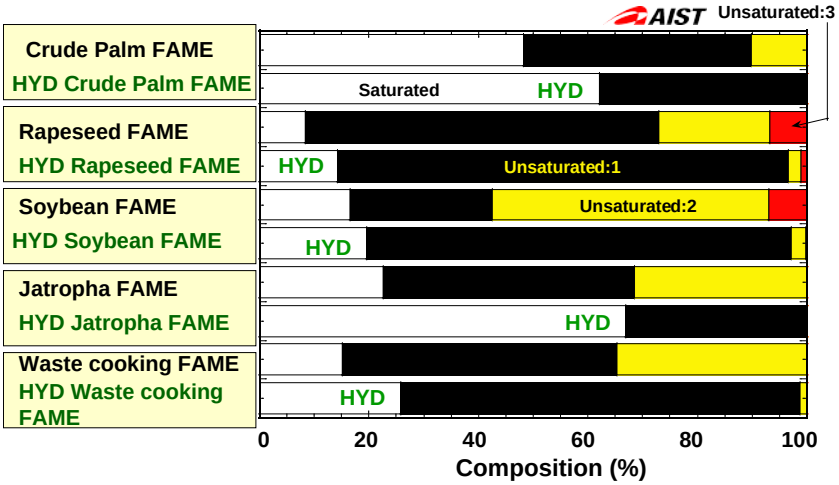


Figure 10 Oxidation stability behavior of various FAME components in B5 blend

Thus, partial hydrogenation to minimize unsaturated FAME component like C18:2 and C18:3, while allowing C18:1 to be present, can compromise both oxidation stability and cold flow property of biodiesel. The catalyst was developed for atmospheric pressure hydrogenation so that

- the hydrogenation reaction does not need high-pressure facility (easy incorporation with existing conventional transesterification process or local communities),
- the hydrogenation reaction only needs low temperature to minimize thermal degradation of FAME
- the biodiesel is intrinsically stable for long-term storage and transportation

Furthermore, hydrogenated BDF can help minimize sludge formation after oxidative polymerization, which can give flexibility in mixing BDF from various oils. Figure 11 below shows that partial hydrogenation of various FAMEs can really decrease the fraction of unsaturated components.



Hydrogenation conditions: H_2 pressure = atmospheric, Temperature= 100 °C, Reaction time = 1h

Figure 11 Effectiveness of partial hydrogenation on % unsaturated FAME component

In addition, hydrogenation is effective enough to allow B20 blend from palm FAME to meet oxidation stability specification, as shown in Figure 12 below.

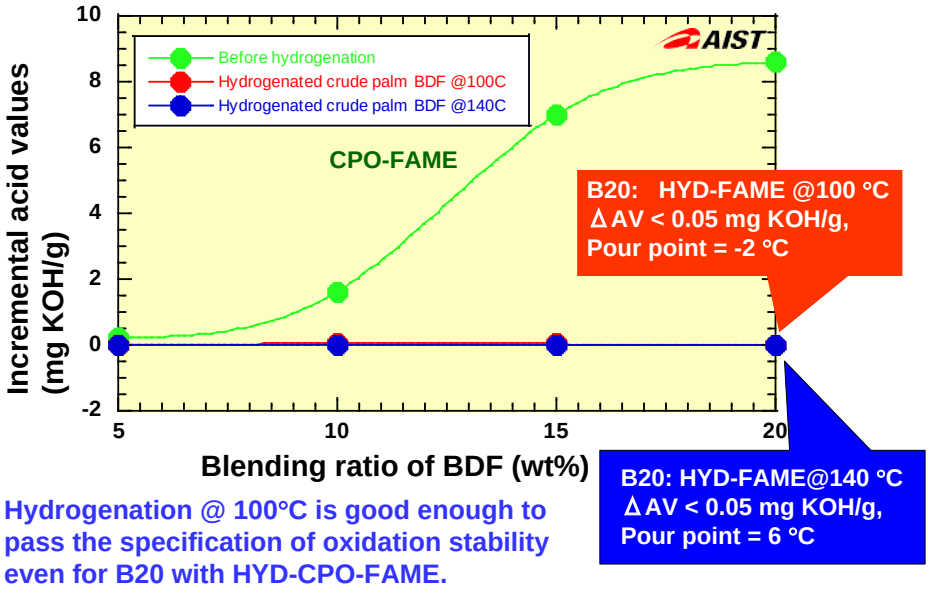


Figure 12 Oxidation stability of B20 with HYD-CPO-FAME/Diesel (S = 6ppm)

Japan (IEE): Mr. Takao Ikeda "Japanese Biofuel Introduction Policy, Resource and Development Plan"

Mr. Ikeda presented the current situation of biofuel in Japan, along with the biofuel introduction policy and development plan in Japan. Up to 3% of ethanol can be blended with gasoline (E3) since August 2003 while up to 5% of biodiesel can be blended with diesel (B5) since March 2007. For E3, oil industries only distribute ethanol-blending gasoline in a form of ETBE at 50 service stations in April 2007 to 100 service stations in 2008. E3 direct blended gasoline is limited for demonstration project since oil industries are insistently worried about ethanol water-

absorbing and water-solubility properties in the water contamination in distribution process. On the other hand, usage of biodiesel in Japan is only limited to some municipalities and local companies ("local production and local consumption").

Other Japanese law and target for biofuel are

- New National Energy Strategy (May 2006) has set a long-term target to introduce 20% of transport fuel (other than gasoline and diesel oils) in 2030.
- Kyoto Protocol Target Achievement Plan has set a target of 500,000 kL COE (crude oil equivalent) of biomass-derived fuel for transportation in 2010.
- Oil industries have set a target of 210,000 kL of bio-ethanol as a form of ETBE in 2010.
- Tax reduction of 1.6 Yen/L for ethanol blended gasoline was set forth in May 2008 for 9 months.
- Biofuel law of Ministry of Agriculture, Forestry and Fisheries started in October 2008 (e.g. 50% reduction of fixed asset tax for biofuel plant)

Figure 13 below shows the target of New and Renewable Energy in Japan

New Energy Introduction Target		FY2005	FY2010 target
Power generation field	Photovoltaic power generation	347,000 kl (1,422,000 kW)	1,180,000 kl (4,820,000 kW)
	Wind power generation	442,000 kl (1,078,000 kW)	1,340,000 kl (3,000,000 kW)
	Waste power generation + Biomass power generation	2,520,000 kl (2,010,000 kW)	5,860,000 kl (4,500,000 kW)
Thermal utilization field	Solar thermal utilization	610,000 kl	900,000 kl
	Thermal utilization of waste	1,490,000 kl	1,860,000 kl
	Biomass thermal utilization	1,420,000 kl	(*1) 3,080,000 kl
	Unused energy	49,000 kl	50,000 kl
	Black liquid, waste material, etc.	4,720,000 kl	4,830,000 kl
Total (rate in total primary energy supply)		11,600,000 kl (2.0%)	19,100,000 kl (about 3%)

*1 Includes biomass-derived fuel (500,000 kl) for transportation.

Figure 13 Target of New and Renewable Energy in Japan

Current pilot projects on bioethanol in Japan are shown in Figure 14 as follows.

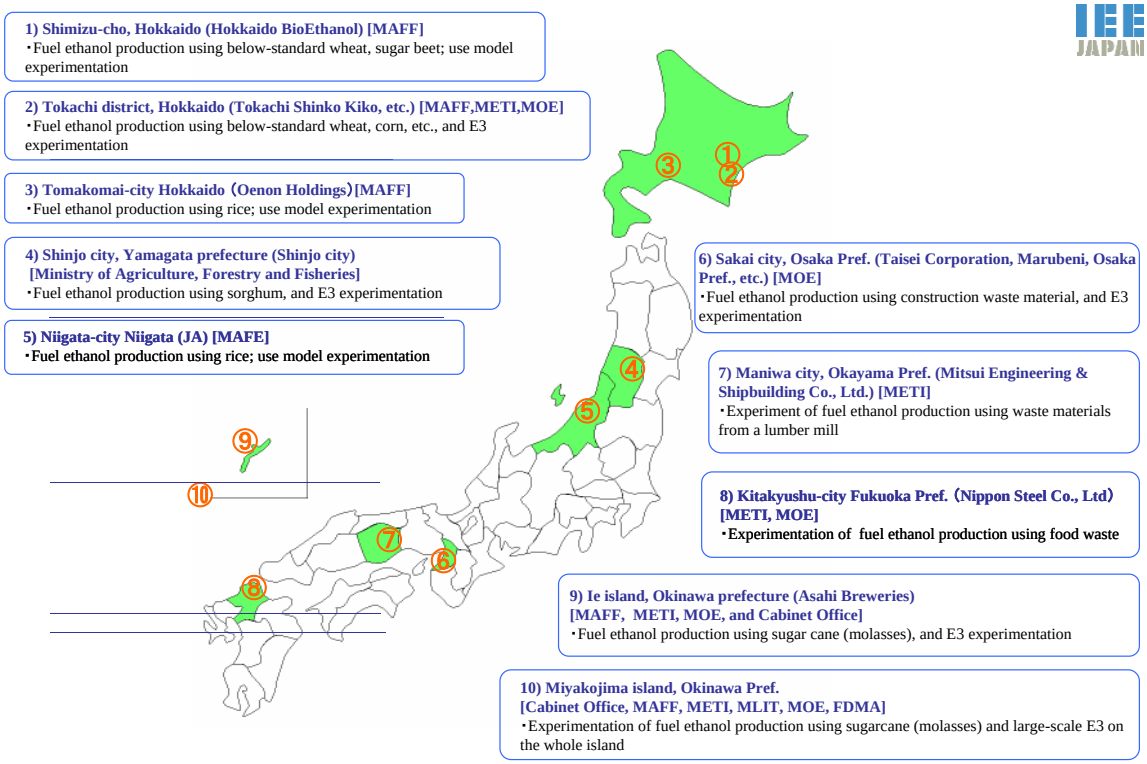


Figure 14 Nationwide pilot projects on bioethanol fuel in Japan

With the potential cultivation land for biofuel feedstock from abandoned arable land, as identified by Ministry of Agriculture, Forestry and Fisheries (MAFF) in Figure 15.

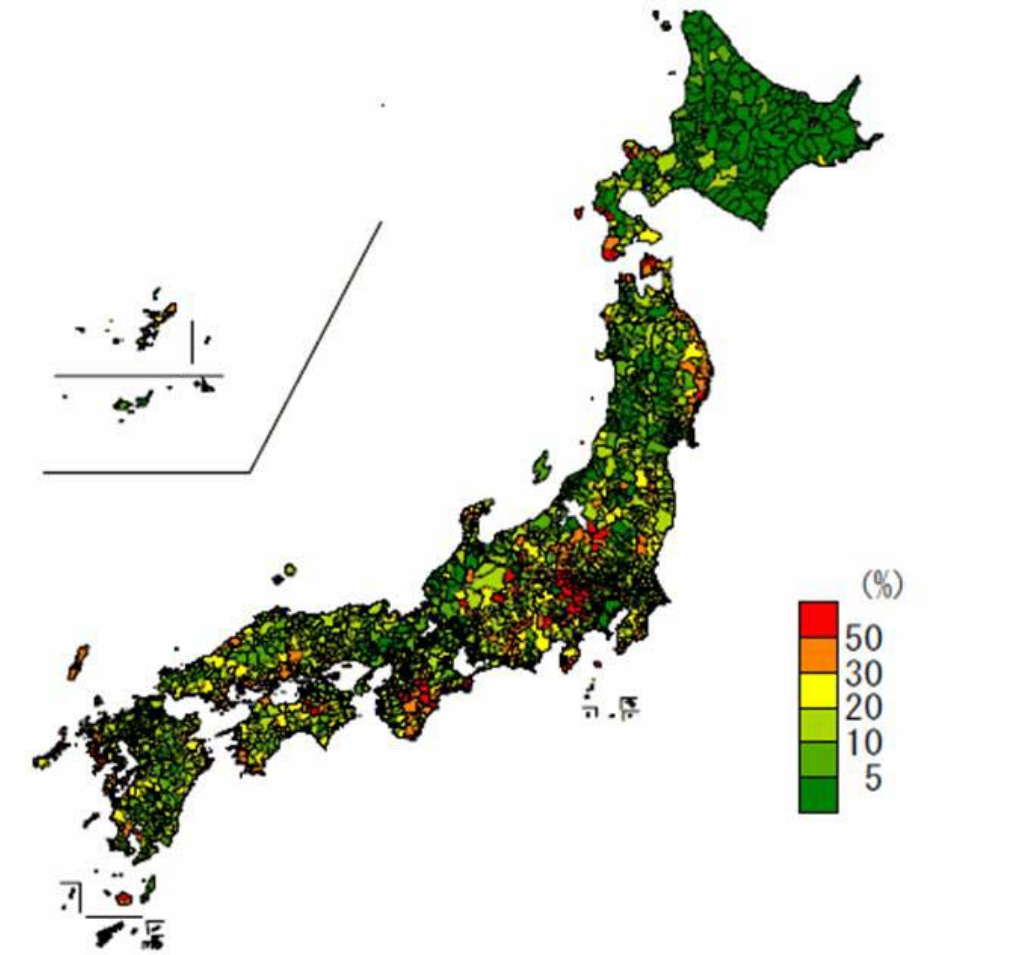


Figure 15 Abandoned arable land

(http://www.maff.go.jp/j/nousin/tikei/houkiti/pdf/zenkoku.pdf)

Another important issue of biofuel is its sustainability criteria. EU is proposing mandatory “environmental sustainability criteria” on biofuel, such as

- GHG emission reduction from the use of biofuels should be at least 35%
- Biofuels should not be made from raw material from
    - high biodiversity value land
    - high carbon stock land

Moreover, various international movements to harmonize this sustainability criteria by ISO and GBEP (Global Bioenergy Partnership), as shown in Figure 16.

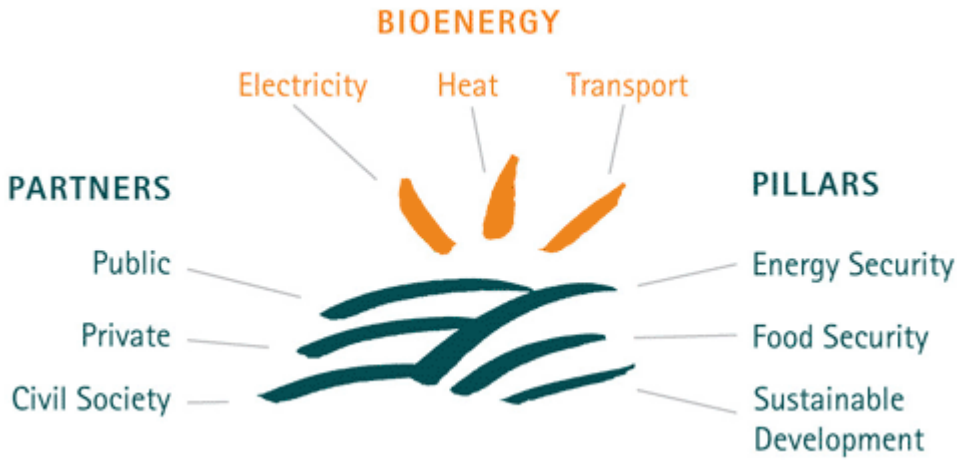


Figure 16 GBEP (Global Bioenergy Partnership) concept

For successful incorporation of biofuel as New and Renewable Energy, related strategies are proposed in Figure 17 as follows.

Figure 17 Five strategies on Innovation of Engines, Innovation of Fuels and Innovation of Infrastructure

With recent food-vs-fuel argument, Ministry of Economy, Trade and Industry (METI) cooperated with the Ministry of Agriculture, Forestry and Fisheries (MAFF) in developing the “Biofuel Technology Innovation Plan” in March 2008 to cut biofuel production cost to 40 yen per liter by 2015 (technology innovation case), to further promote development of cellulosic biofuel. Finally, the roadmap to increase the production of domestic biofuels is presented, as shown in Figure 18.

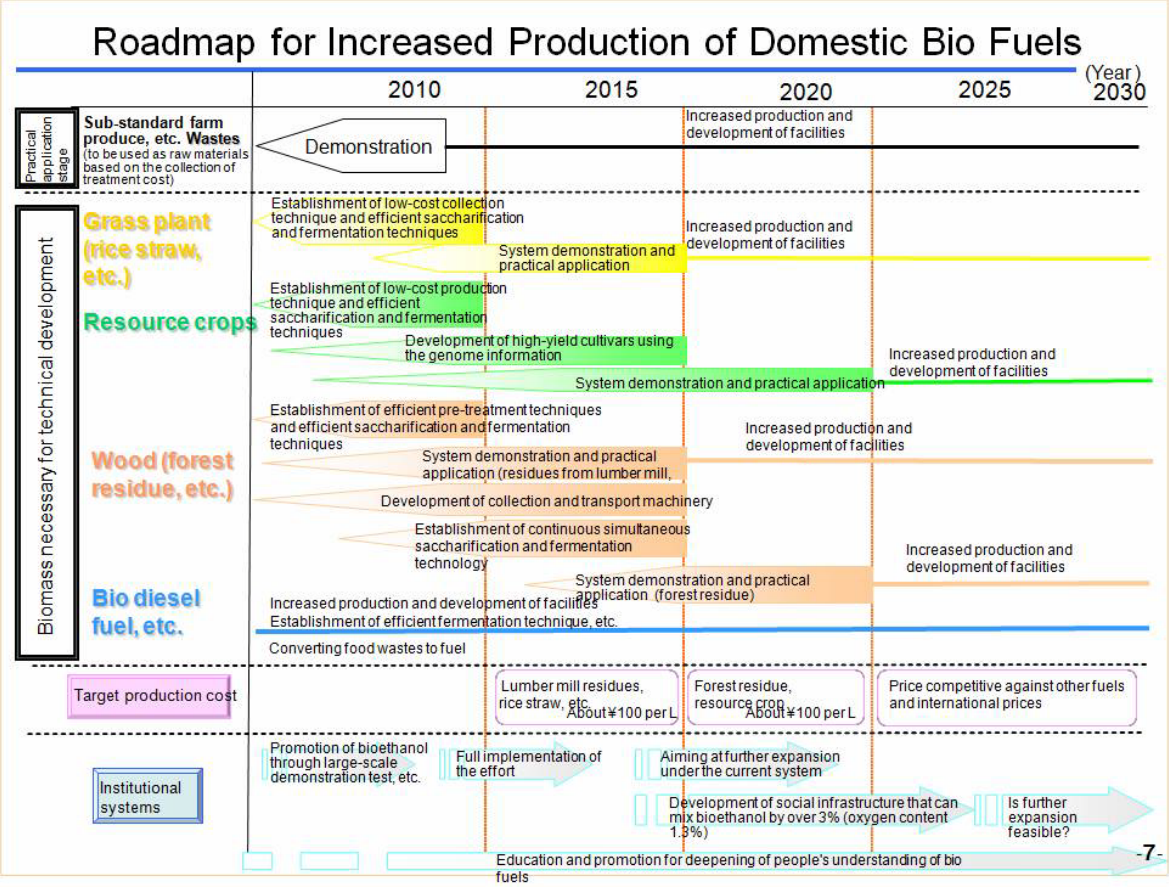


Figure 18 Roadmap to increase production of domestic biofuels in Japan

Comment by Ms. Jenvanitpanjakul: What is the sustainability criteria on unutilized forest as potential cultivation land for biofuel feedstock? Should ERIA-EAS follow EU regulation even for domestic use? Or ERIA-EAS should develop our own with geographically appropriate methodology for assessment. Mr. Ikeda informed that the sustainability issue and criteria are still under consideration in Japan at the moment.

Comment by Ms. Monsada: In case of Philippines, national biofuel board has looked at the definition of arable land with certification authority born by Ministry of Agriculture.

4. Closing Address

Dr. Goto reminded again about ERIA invitation program with a plan for Prof. Tirto for 2 months and Thai delegates from NSTDA and TISTR for Thailand-Japan Annual Workshop on 12-13 February 2009. In June 2009, 1st draft of activity report will be submitted to ERIA. Finally, group photo of the expert participants were taken, as shown in Figure 19.

Schedule of next meeting (2nd meeting) is as follows.
Date: the week of 23-24 February 2009.
Venue: Kota Kinabalu
Technical tour: Yunmar R&D Center (http://www.yanmar.co.jp/en/rd/center.html)

Tentative 3rd meeting is scheduled in May 2009.

Figure 19 ERIA BDF WG1 meeting

6.2 WG2 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 6th Meeting (2nd of FY 2008)

February 22-23, 2009 in Kota Kinabalu, Malaysia

6.2.1 Participating countries

Australia, China, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Thailand and Vietnam
(-without participation from India and New Zealand)

6.2.2 February 23: Working Group Meeting

Figure 20 ERIA BDF WG meeting (opening address by Dr. Goto)

The working group meeting was held at Yanmar Kota Kinabalu R&D center, as shown in Figure 20. Dr. Goto greeted everyone with the opening address, and everyone briefly introduced themselves since there were some observers from Yanmar, Japan, Indonesia and Philippine.

1. Session I – Biodiesel fuel trade handbook -

The first session started with the presentation by Prof. Yamane on the content of the biodiesel handbook, as shown in Figure 21. Various comments and suggestions were discussed among the working group to reach the final agreement as shown below. For examples, the new method to assess oxidation stability called “Petro-Oxi”, which shows promising advantage over Rancimat and TAN increase test, will be explained. The commercial quick-and-portable tool (“i-Spec™ model Q100”) to measure some biodiesel properties will be included. Both countermeasures to oxidation degradation (by antioxidant additives and hydrogenation technique) and low temperature performance (by blending with other fuel and winterization technique) will be reviewed. Other potential feedstock such as Jatropha, rice bran and micro algae will be reviewed. Some market experiences from various countries will be shown as case studies to highlight the importance of quality control for market acceptance. The final biodiesel handbook will be submitted to ERIA in June 2009, in order to report to Energy Ministerial meeting in August 2009.

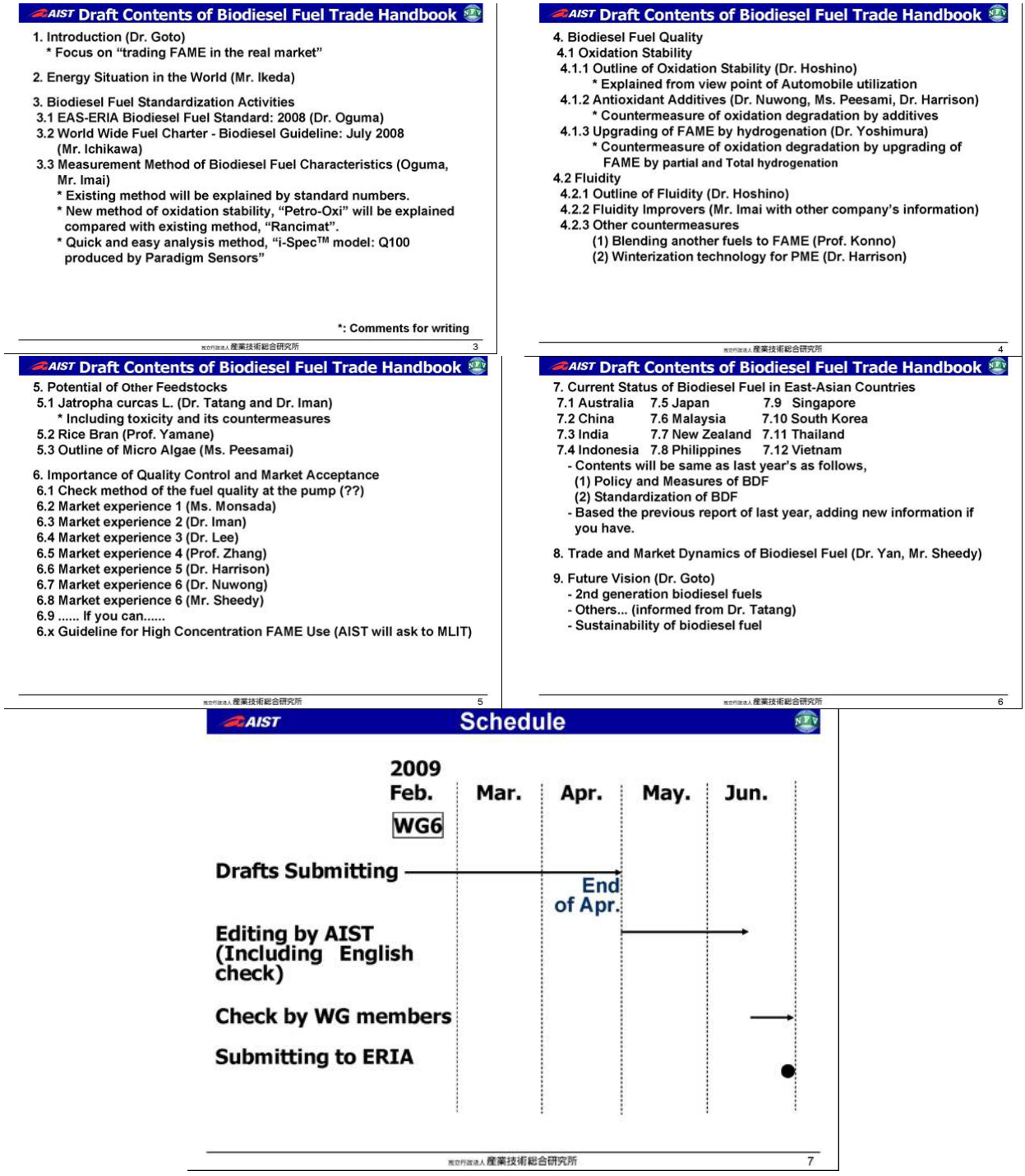


Figure 21 Content of the biodiesel handbook (agreed by the working group) with the timeline

2. Session II – Updates of Current Biodiesel Status and Presentations of New Topics

Updates of Current Biodiesel Status in Malaysia

Second session started with the updates of current biodiesel status from Malaysia by Dr. Lau. For Malaysian update, 17 biodiesel plants have completed construction with total capacity of 1.86 million tons, and another five plants are being constructed, as of January 2009. With plentiful biodiesel production, Malaysian government has implemented the mandatory use of biodiesel as of 1 August 2008, as part of Malaysian Biofuel Industry Act 2006 (passed by Parliament on 26th July 2007). Then, Malaysian PME standard was published in November 2008 with initial B5 usage in government agencies in February 2009, as shown in Figure 22. In June 2009, B5 usage will expand to industrial sectors, and transport sectors in January 2010 before full implementation by 2010. Some of the technical issues foreseen include OEM warranty for vehicle, equipment warranty for IPP (independent power producer), storage stability, microbial growth and compatibility with nano-marker to prevent the misuse of subsidized diesel fuel from transport sector in other sectors.

Figure 22 B5 launching for governmental vehicles on 10 December 2008 by MPIC Minister

Updates of Current Biodiesel Status in Australia

Next, Australian update on biodiesel by Mr. Sheedy was presented with particular emphasis on the amendments of diesel and biodiesel standards, e.g. 5% blend of biodiesel in diesel, changes in standard parameters and test methods, approval for higher blends (B6-B20). As of 1 March 2009, diesel standard has allowed up to 5% (v/v) blending of biodiesel in diesel without the need to explicitly label biodiesel-blending in diesel. With biodiesel blending, the fuel needs to have derived cetane number (DCN) of 51 minimum (ASTM D6890) but allows higher entrained water content of 200 mg/kg (ASTM D6304). For biodiesel standard, the issue of C17 esters, especially for biodiesel from tallow and waste cooking oil, is concerned for %ME content so the method to include C17

detection is suggested based on Schober et al (2006)[3]. Regarding oxidation stability, delta TAN test and PetrOxy test are suggested in addition to conventional Rancimat test. Regarding higher blend than 5%, there are some cases that are appropriate for greater than 5% biodiesel blend but explicit labeling is required. Finally, the B2 mandate from 1 July 2009 onward is pending for legislative approval.

Updates of Current Biodiesel Status in Philippine

Next, Philippine update was briefly added to the discussion among the working group, especially on the B2 mandate since 6 February 2009. Also, Philippine biodiesel standard is modified in order to incorporate shorter coconut methyl ester chain.

Presentation of New Topics: Indonesia

The second half of session II was the presentation of new topics. First, Mr. Wirawan presented the biodiesel development in BPPT, as well as current status of biodiesel in Indonesia. Since February 2006, national biodiesel standard, SNI 04-7182-2006, has been issued by National Standard Agency with recent mandatory use of biofuel set

[3] S. Schober, I. Seidl and M. Mittelbach, 'Ester content evaluation in biodiesel from animal fats and lauric oils', European Journal of Lipid Science and Technology, vol 108, issue 4, 2006, pp 309-314.

on 26 September 2008 via Decree of the Minister of Energy and Mineral Resources. In Indonesia, biodiesel-blend diesel is under trade name BioSolar. With the island nature of Indonesia of more than 17,000 islands, the 1% biodiesel usage mandate is implemented on the company whole sale accounting, regardless of what actual blending in which region, as shown in Figure 23 below. BPPT has helped Indonesian biodiesel industry, particularly on the design and construction of biodiesel reactors, as shown in Figure 24 below.

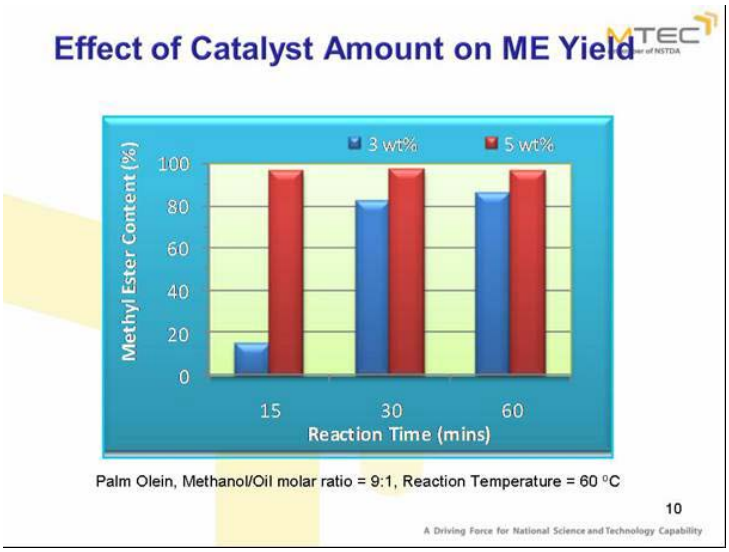
Figure 23 Site specific biodiesel selling in Indonesia

Figure 24 Various biodiesel plants from BPPT

Presentation of New Topics: Thailand

Second, Dr. Chollacoop presented the work of solid catalyst in biodiesel reaction. The work selects SrO loading to MgO because of high basic strength in SrO (but not large enough surface area) and large surface area of MgO (but not high enough basic strength). As shown in Figure 25,

the preliminary investigation show promising results with high %ME achieved within short reaction time at ambient pressure. Various effects from reaction time, amount of catalyst, ratio of methanol to oil were investigated to obtain optimal condition. In addition, CaO/MgO system is explored but larger MeOH:oil ratio and more catalyst are required. Interestingly, it was found that small presence of water (< 500ppm) could help promote methyl ester yield with some proposed mechanism.



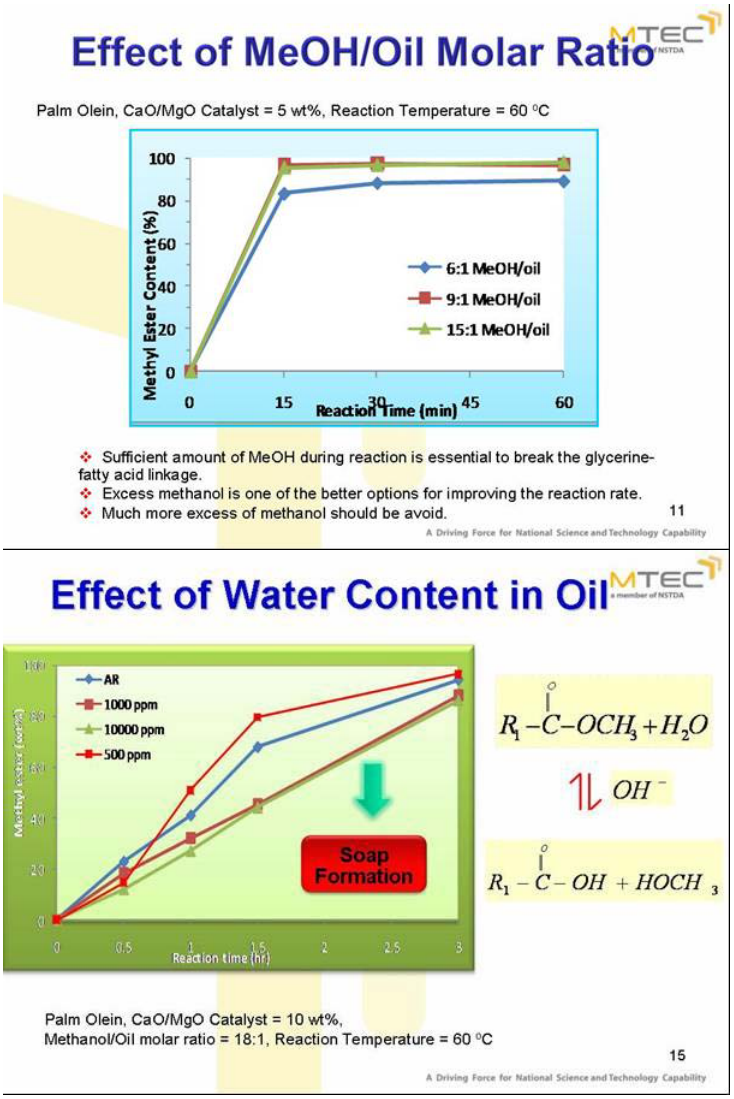
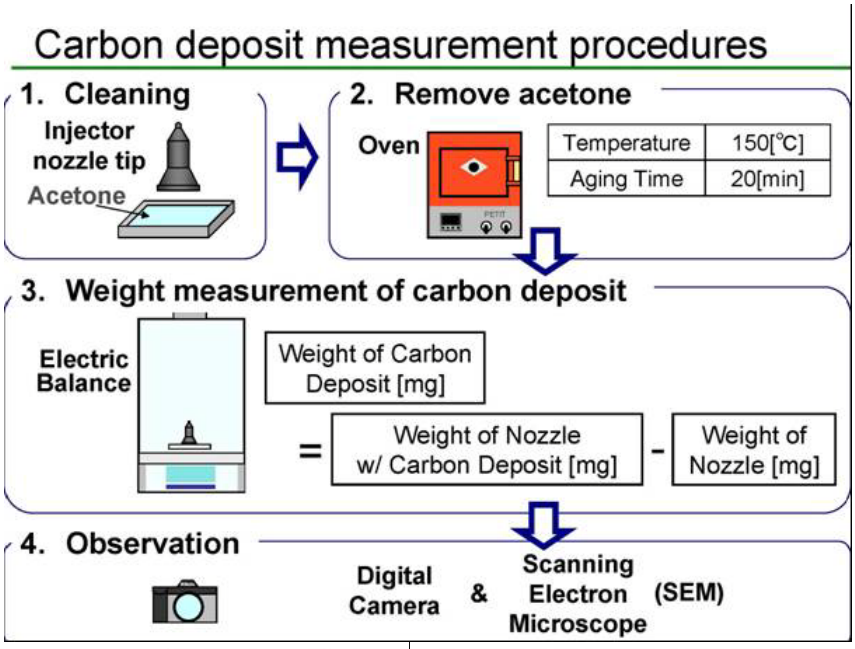


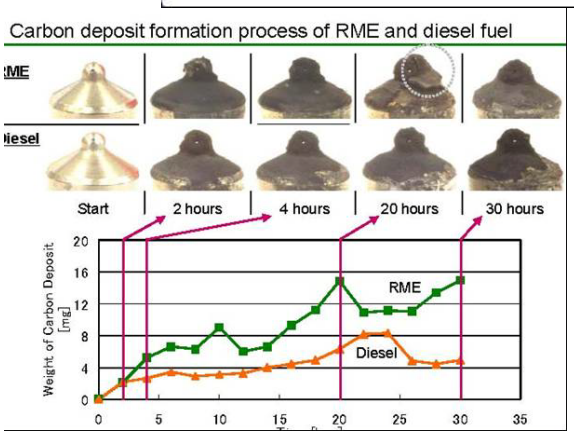
Figure 25 Various effects on heterogeneous catalyst for transesterificaiton

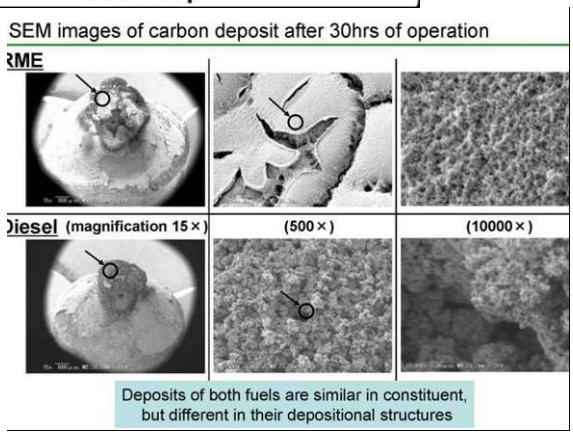
Presentation of New Topics: Japan/Prof. Konno

Third, Prof. Konno presented the work on characteristics of carbon deposit at injector when using biodiesel, as shown in Figure 26. Single cylinder engine was tested with biodiesel (RME at 5% and 100%) and DME by running continuously for 30 hours with 2 hours interval

stop to measure carbon deposit at the injector tip. Results show much faster carbon deposit formation for RME, compared to diesel; whereas, 5% RME blend has no discernible impact on carbon deposit. Distillation property is a dominant factor for deposit formation. Furthermore, mechanism of deposit formation, depending on tested fuel type, was suggested.







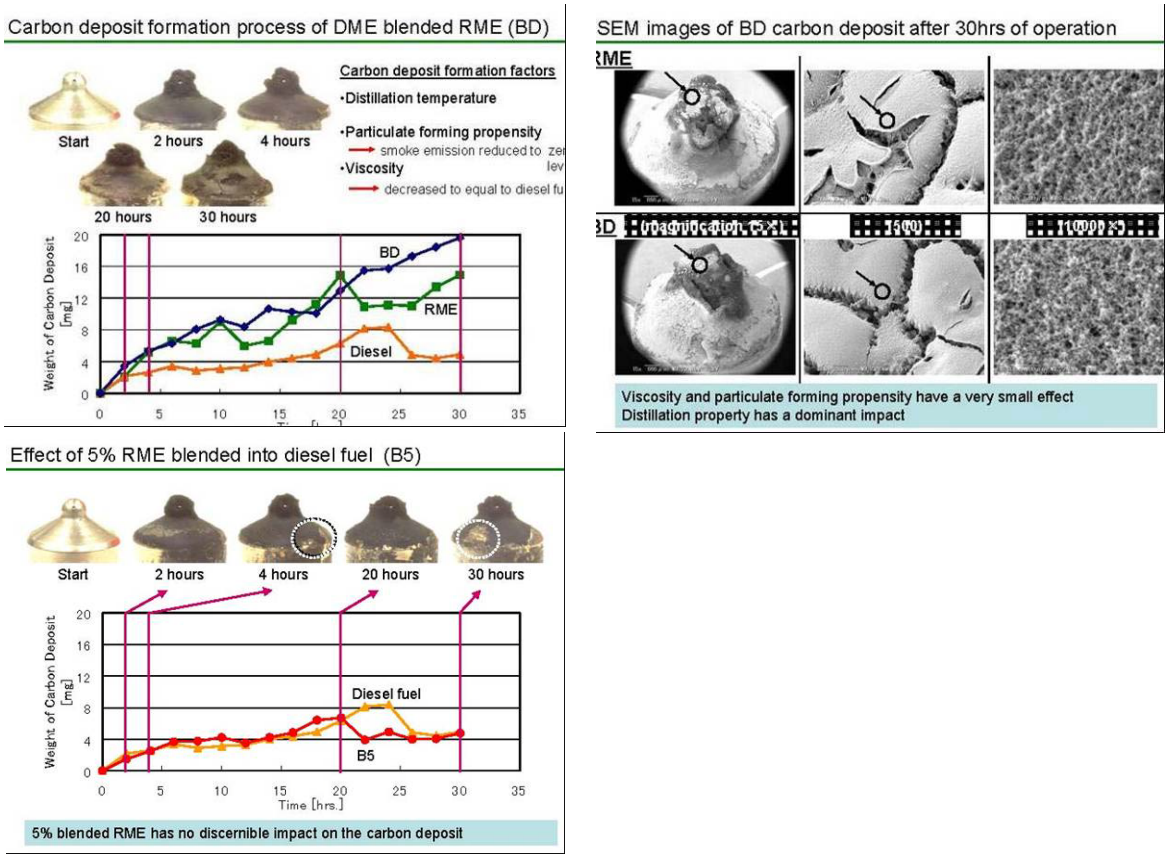


Figure 26 Carbon deposit at injector tip results with various tested fuels

Presentation of New Topics: Japan/Dr. Sakanishi

Fourth, Dr. Sakanishi presented the R&D activities of BTRC (Biomass Technology Research Center), AIST, with emphasis on biomass utilization and BTL. As shown in Figure 27, BTRC has bench-scale BTL plant at AIST/Hiroshima, where BTL is produced from woody biomass. Moreover, catalyst for upgrading BTL quality has been investigated.

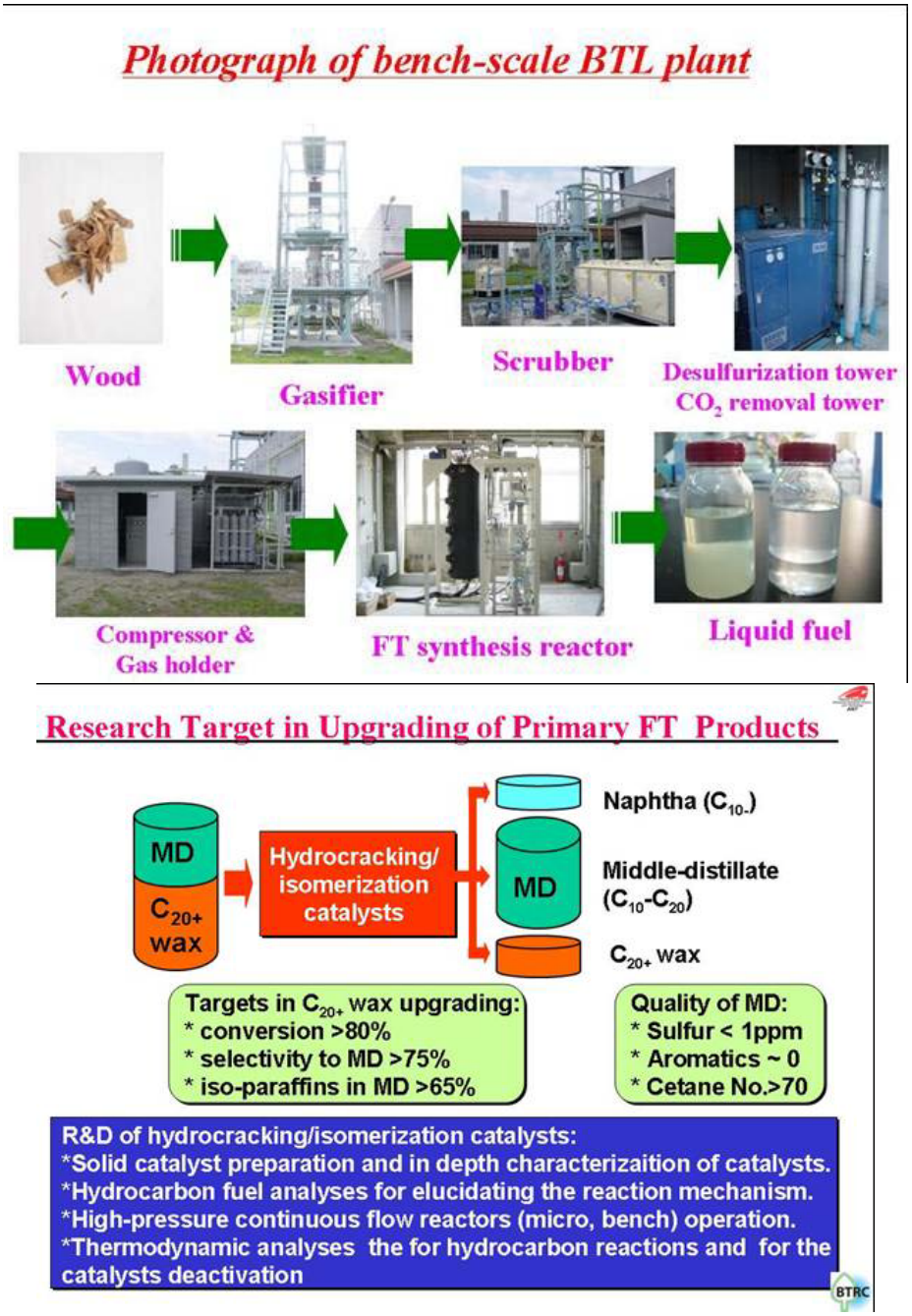


Figure 27 Bench-scale BTL plant and FT research target at BTRC/AIST

3. Closing Address

Lastly, Dr. Goto gave a closing address for this working group meeting with tentative next meeting (WG7th) in July 2009 to review the 1st draft of report. Furthermore, Dr. Goto has summarized the researcher invitation program by NEF with plan for FY2009 to have young researchers come to AIST for a longer term visit (6-10 months), where NEF application will start in April or May 2009. Dr. Goto encouraged working group members to nominate their staffs to apply.

6.2.3 February 23: Presentation and Tour of Yanmar R&D Facility

The meeting was concluded by presentation of Yanmar company and a tour of R&D facilities, as shown in Figure 28.

Figure 28 Tour of Yanmar R&D center

6.3 WG3 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 7th Meeting (3rd of FY 2008)

June 28-29, 2009 in Tsukuba, Japan

6.3.1 Participating countries

China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam

(-without participation from Australia, India, Malaysia and New Zealand)

6.3.2 June 29: Working Group Meeting

Figure 29 ERIA BDF WG meeting (opening address by Dr. Goto)

The working group meeting was held at Meeting Room 2 (1B-2204) of AIST East. As shown in Figure 29, Dr. Goto greeted everyone with the opening address, and everyone briefly introduced themselves since there were some observers from Thailand and AIST. In Figure 30, Prof Kimura then introduced himself and ERIA, which currently has 9 researchers, and was recognized as international

organization for tax exemption purpose. He further emphasized that the ERIA WG report will be posted on the ERIA website so all writers have to be careful of the copyright materials.

Figure 30 Prof. Kimuar introduced himself and ERIA brief information

1. Session I – Report of ECTF meeting

As shown in Figure 31, the first session started with the presentation by Ms. Peesamai and Dr. Nuwong on the 10th ECTF (East Asia Summit Energy Cooperation Task Force) meeting in Bangkok, Thailand during 23-24 June 2009, where the ERIA Working Group for Benchmarking of Biodiesel Fuel Standardization in East Asia was presented. The main purpose of the 10th ECTF meeting was an update from SOE (Senior Official on Energy) from EAS and

prepare for the 3rd EAS EMM (Energy Ministerial Meeting) meeting in Mandalay, Myanmar on 29 July 2009, in which results from ERIA BDF WG will be presented.

Figure 31 Ms. Peesamai presented ECTF meeting

2. Session II – "Biodiesel Fuel Trade Handbook" Making

Next, the content of the BDF Handbook was checked section by section with the deadline of Monday July 6th from each member in order to submit the draft report to 3rd EMM meeting in Myanmar. For those who cannot make the 6th July deadline, their contribution will be postponed to the 2nd edition of BDF Handbook for FY2009. For lunch break, Dr. Oguma from NFV/AIST has demonstrated AIST BDF bus by driving all participants to the AIST cafeteria, as shown in Figure 32.


Figure 32 Dr. Oguma drove biodiesel bus for all participants to lunch at Welfare Center, AIST

3. Session III – Report of Each Country's situation

The afternoon session was mainly for the update by each member country: China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam, as shown in Figure 33.

Prof. Zhang presented country repot for China

Prof. Wirawan presented country report for Indonesia

Ms. Monsada presented country repot for Philippines

Prof. Yang presented country report for Singapore

Prof. Lee presented country report for South Korea

Ms. Tinh presented country report for Vietnam

Figure 33 Various presentations on updates of biodiesel situation in each country

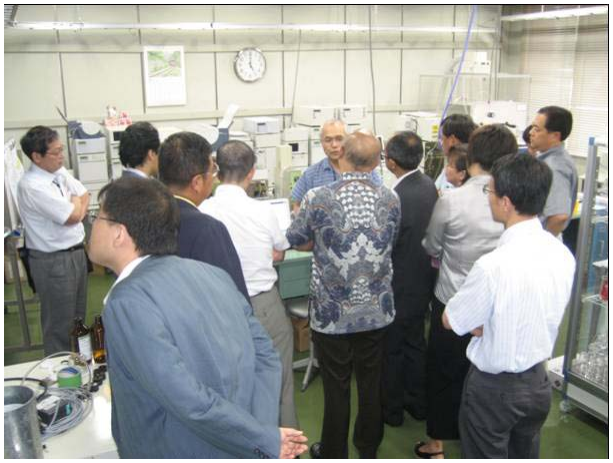
4. Closing Address and Technical Tour of NFV Lab

The meeting was concluded by Dr. Goto with the following schedules for subsequent meeting in FY2009.

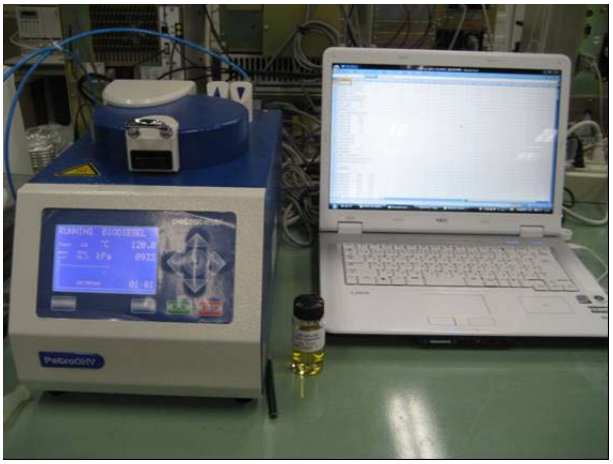
- Joint IEA-ERIA workshop in Tsukuba during Oct 2009

- Meeting in Australia during Dec 2009 – Jan 2010
- Joint 3 ERIA WG workshop in Indonesia during Feb/Mar 2010

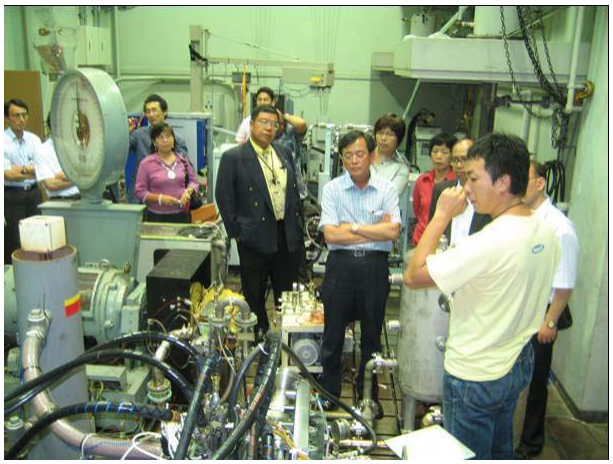
After the ERIA WG meeting, Dr. Goto led the group to the lab tour of Research Center for New Fuels and Vehicle Technology (NFV), as shown in Figure 34.



NFV lab tour by Dr. Hirotsu



PetrOxy test apparatus



NFV lab tour by Dr. Tsujimura

Demonstration of DME truck by Dr. Oguma

Figure 34 NFV/AIST lab tour

6.4 After WG3

The “Biodiesel Fuel Trade Handbook (The First Edition for Comments)” was completed by AIST. The handbook was introduced in the 11th Meeting of the EAS Energy Cooperation Task Force, as well as the Third EAS Energy Ministers Meeting held on 28-29 July 2009 in Mandalay, Myanmar, as shown in Figure 35. Dr. Nuwong reported our results and introduced the handbook in the meeting with WG leader, Dr. Goto, as shown in Figure 36. The summary of two ERIA WG’s activities was presented to 16 Energy Ministers from ASEAN+6 Countries, as part of the ECTF

Biofuels Workstream, as shown in Figure 37. The handbook is attached with this report as an appendix.

Figure 35 ERIA BDF WG participations in 3rd EAS Energy Ministers Meeting and Associated Meetings in Mandalay, Myanmar

3rd EAS Energy Ministers Meeting
29 July 2009, Mandalay, Myanmar

ERIA Working Group on "Benchmarking of Biodiesel Fuel Standardization in East Asia"

Nuwong CHOLLACOOP, Ph.D.
National Metal and Materials Technology Center (MTEC)
Dr. Shinichi Goto (WG leader)
National Institute of Advanced Science and Technology (AIST)

ERIA
Economic Research Institute for ASEAN and East Asia

1

Outline of presentation

1. ~~Objective of ERIA Biodiesel Fuel Working Group~~
2. ~~Membership of Working Group~~
3. ~~Research Plan of 2008/2009~~
4. Making a "ERIA Biodiesel Fuel Trade Handbook"
5. Way forwards (WG plan 2009/2010)


Injector
(source : JAMA)


Fuel tank
(source: Fuel Policy Subcommittee)


Engine
(source: JAMA)

2

4. Making a "ERIA Biodiesel Fuel Trade Handbook"

Contents of ERIA Biodiesel Fuel Trade Handbook

1. Introduction
2. Energy Situation in the World
3. Biodiesel Fuel Standardization Activities
   - 3.1 EAS-ERIA Biodiesel Fuel Standard: 2008
   - 3.2 World Wide Fuel Charter - Biodiesel Guideline: July 2008
   - 3.3 Measurement Method of Biodiesel Fuel Characteristics
     - * Existing method will be explained by standard numbers.
     - * New method of oxidation stability, "Petro-Oxi" vs "Rancimat".
     - * Quick and easy analysis method, "i-Spec™ model: Q100"
4. Biodiesel Fuel Quality
   - 4.1 Oxidation Stability
     - 4.1.1 Outline of Oxidation Stability
     - 4.1.2 Antioxidant Additives
     - 4.1.3 Upgrading of FAME by hydrogenation
   - 4.2 Fluidity
     - 4.2.1 Outline of Fluidity
     - 4.2.2 Fluidity Improvers
     - 4.2.3 Other countermeasures: blending with another fuels & winterization

7

4. Making a "ERIA Biodiesel Fuel Trade Handbook"

Contents of ERIA Biodiesel Fuel Trade Handbook

5. Potential of Other Sustainable Feedstock
   - 5.1 Jatropha Curcas L. including toxicity and its countermeasures
   - 5.2 Rice Bran
   - 5.3 Outline of Micro Algae
6. Importance of Quality Control and Market Acceptance
   - 6.1 Quality Control of BDF-Blended Fuels at the Pump in Philippines
   - 6.2 Field Test of BD5, BD20 and BD100 Vehicles in Korea
   - 6.3 Biodiesel Fuel Experience in China
   - 6.4 Community BDF Standard for Agricultural Machine in Thailand
7. Current Status of Biodiesel Fuel in East-Asian Countries
   - 7.1 Australia, 7.2 China, 7.3 India, 7.4 Indonesia, 7.5 Japan, 7.6 Malaysia, 7.7 New Zealand, 7.8 Philippines, 7.9 Singapore, 7.10 South Korea, 7.11 Thailand, 7.12 Vietnam
8. Trade and Market Dynamics of Biodiesel Fuel
9. Future Vision

8

World Wide Fuel Charter - Biodiesel (B100) Guidelines

EAS-ERIA Biodiesel Fuel Benchmark Standard:2008

WWFC

Items	Units	U.S. ASTM D6751-07b	EU EN14214:2003	Japan JIS K2390:2008	EAS-ERIA BDF Standard (EEBS):2008	WWFC Biofuel Guidelines B100 for up to B5 blend
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900	Report
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.50-5.00	2.00-5.00	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min.	100 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-	-
Carbon residue (100%) or Carbon residue (10%)	mass%	0.05 max. -	- 0.30 max.	- 0.3 max.	0.05 max. 0.3 max.	0.05 max. -
Cetane number		47 min.	51.0 min.	51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.	0.02 max.	0.005 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	500 max.	500 max.	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1	-
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	(*)	10.0 min. (****)	10.0 min.
Iodine value		-	120 max.	120 max.	Reported (***)	130 max.
Methyl Linolenate	mass%	-	12.0 max.	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	N.D.	N.D. (***)	1 max.
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.25 max.	0.25 max.	0.24 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.	4.0 max.

(*)deg.C of flashpoint is available instead of measuring methanol content (***) Need data check and further discussion
(****) Need more data & discussion from 6 to 10 hrs.
leet diesel oil specification

10

5. Way forwards (WG plan 2009/2010)

- Finalizing a Biodiesel Fuel Trade Handbook
- Preparation for establishing Chemical Analysis Laboratory
- R&D for quality control/management method of biodiesel fuel in actual market
- Support engineers' skill-up
- Contribution to other international standardization in other regions based on EAS-ERIA Benchmark Standard

13

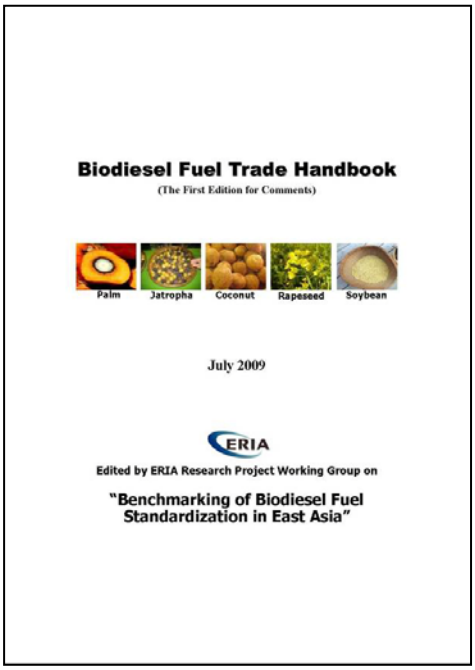
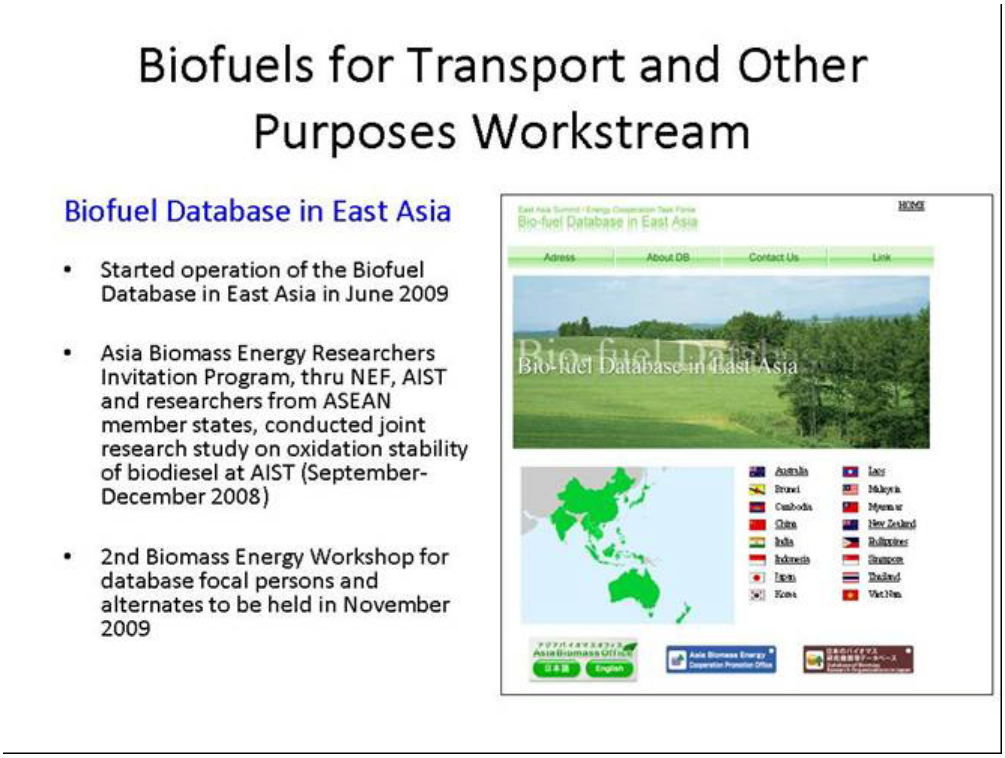


Figure 36 WG outcome and handbook presentation during 11th ECTF Meeting in Mandalay, Myanmar



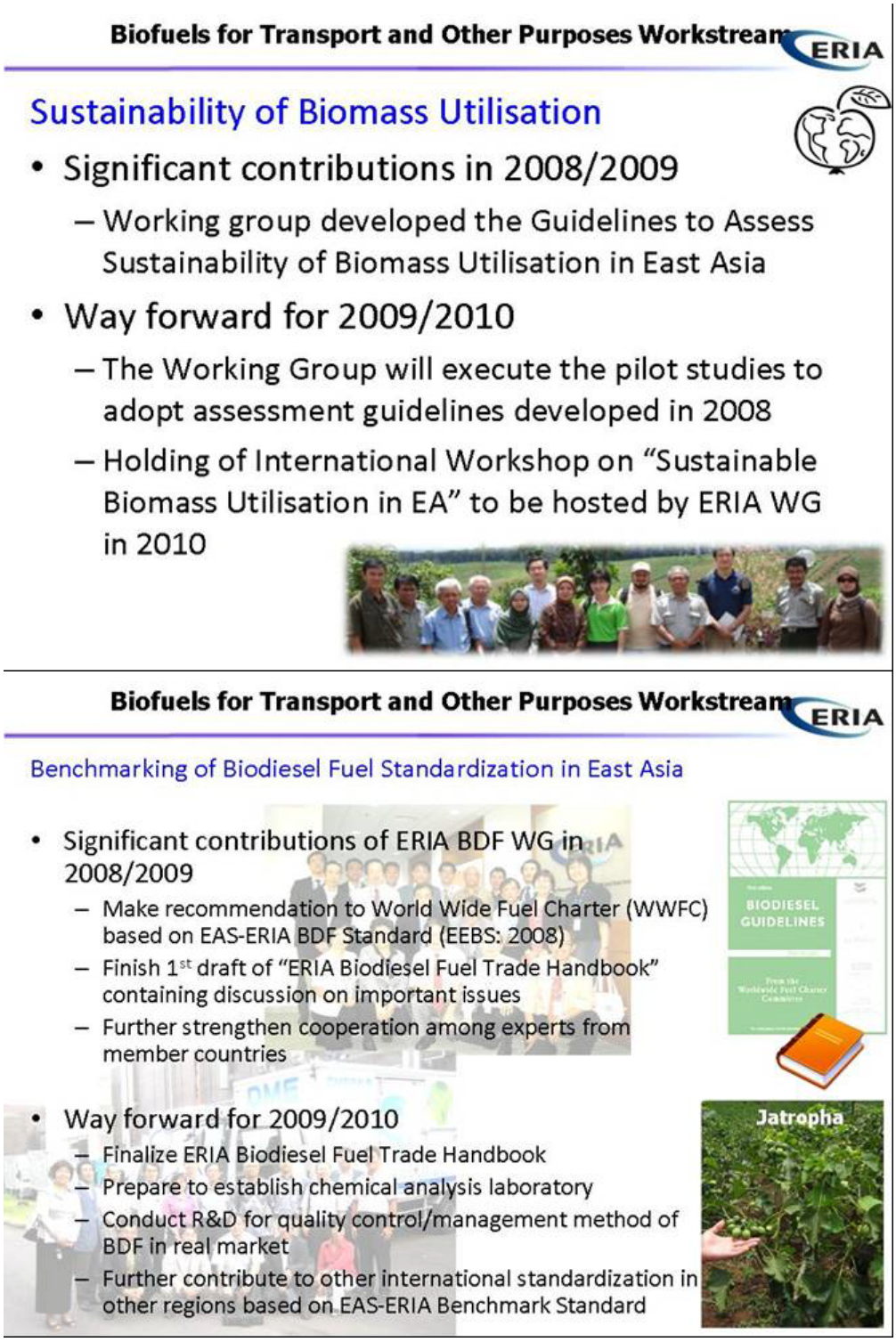


Figure 37 Two ERIA WG presentations during 3rd EAS Energy Ministers Meeting in Mandalay, Myanmar

7. APPENDIX: Biodiesel Fuel Trade Handbook

Biodiesel Fuel Trade Handbook

(The First Edition for Comments)


Palm


Jatropha


Coconut


Rapeseed


Soybean

July 2009

Edited by ERIA Research Project Working Group on

"Benchmarking of Biodiesel Fuel Standardization in East Asia"

Authors

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6. RESULTS

This chapter will describe in details the activities and output of all three regular WG meetings and two special ERIA meetings.

6.1 WG1 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 5th Meeting (1st of FY 2008)

November 11-12, 2008 in Jakarta, Indonesia

6.1.1 Participating countries

China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam

(-without participation from Australia, India, Malaysia and New Zealand)

6.1.2 November 11: Technical tour of Pakuwon Jatropha Plantation, Indonesian Center for Estate Crops Research and Development (ICECRD)

Former Director of ICECRD Dr. Bambang Prastowo (bprastowo@gmail.com) gave a presentation on the overview of Pakuwon Jatropha plantation site, followed by the on-site explanation of various Jatropha breed and its mechanized facility, e.g. de-husking machine, screw-press oil extractor, biodiesel reactor, biogas reactor and customized stoves, as shown in Figure 2. Important findings are as follows.

The front gate

Top view of Jatropha plantation site

Group photo

Group discussion

Jatropha de-husking machine

Jatropha oil extractor (screw-press)

Biogas reactor from Jatropha residue

Biodiesel processing reactor

Special stove with Jatropha derived fuel

Various stoves designed to use biogas

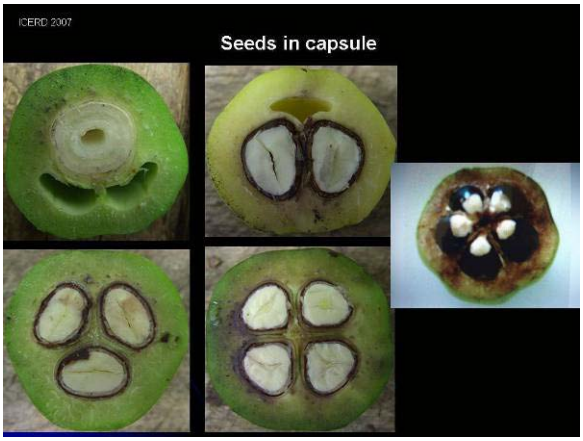
Various Jatropha products on display

Various Jatropha products on display

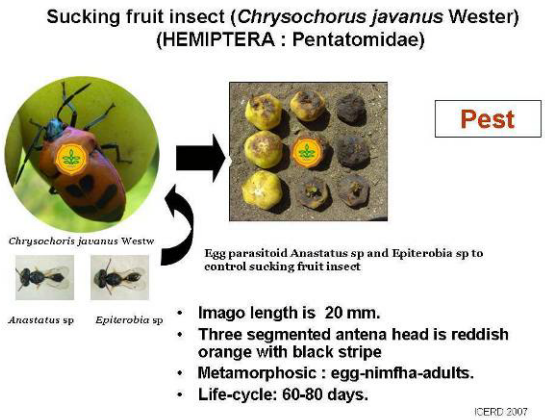
Figure 2 Technical visits of ICECRD

This Jatropha plantation site was established in 2005 by Ministry of Agriculture with the purpose to improve yield of Jatropha seed production. Initially, nine Jatropha breeds were collected from all over Indonesia during the exploratory phase, and planted in a 50 ha area of the

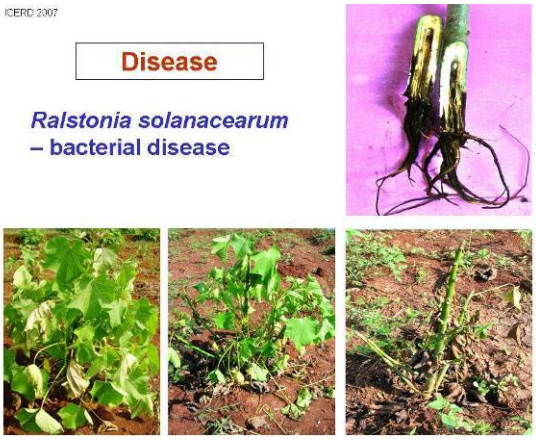
Pakuwon site. This original population yields about 25-30 capsules/shrub or average 1st year yield of 0.3-0.4 ton/ha. The first Improved Progression population (IP-1) was developed in 2006 with more than 200 capsules/shrub or average 1st year yield of 0.9-1.0 ton/ha in a 30 ha plantation area. Then, the second Improved Progression population (IP-2) was further developed in 2007 with more than 400 capsules/shrub or average 1st year yield of 1.9-2.2 ton/ha in a 25 ha plantation area. For each IP population, there are also slight various for dry (IP-1A), medium dry (IP-1M) and wet (IP-1P) area. In addition, other Jatropha research activities include genetic control on number of seeds in Jatropha fruit, pest control, disease control, certification of distributed seed and inter-crop selection, as shown in Figure 3.



Genetic control on number of seeds



Pest control

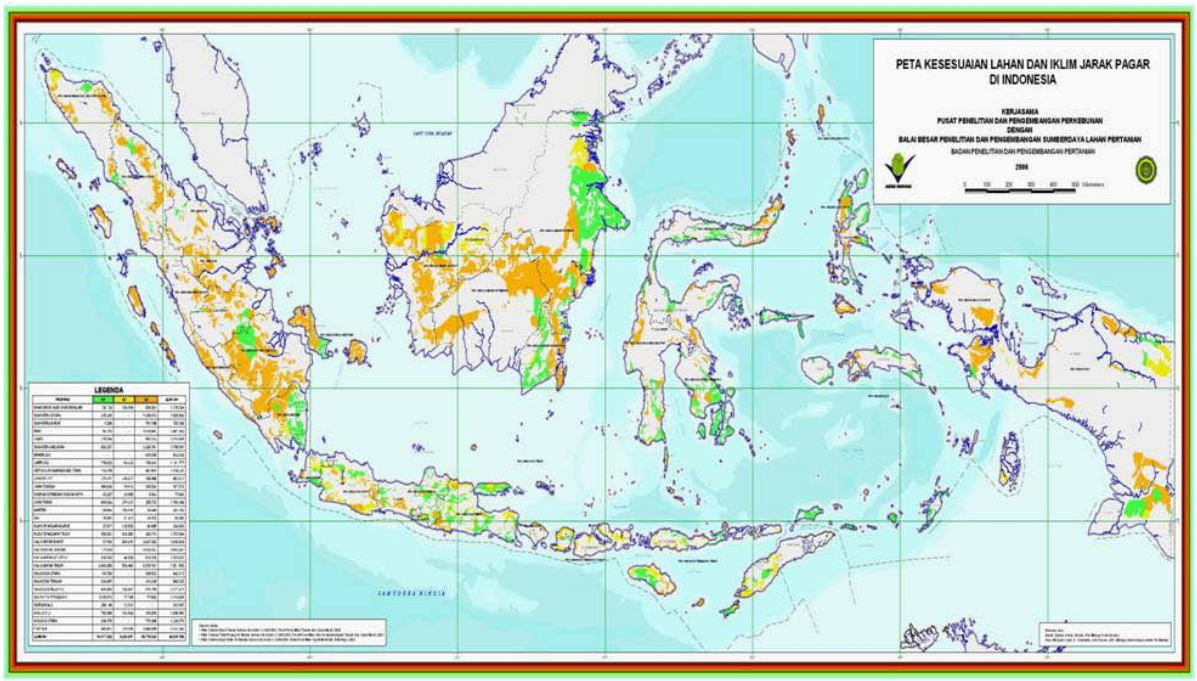


Disease control

Certification of distributed seed

Figure 3 ICECRD information on Jatropha

Currently, there are about 5.5 million ha area that has been identified suitable for Jatropha plantation in Indonesia, as shown in Figure 4, with the target of 1.5 million ha planted with Jatropha by 2010. Thus far, this Pakuwon Jatropha plantation site has identified the best breed, which has fruits at the top for easy mechanized harvesting.



5.5 millon ha suitable area for Jatropha plantation in Indonesia

Dr. Goto with special Jatropha breed yielding fruit at the top for easy mechanized harvesting

Label of this special Jatropha breed

Figure 4 ICECRD Jatropha nursery

6.1.3 November 12: Working Group Meeting

Figure 5 ERIA BDF WG meeting

The working group meeting was held at new spacious ERIA annex office, as shown in Figure 5, started with welcome remark by team leader Dr. Goto on the joint Ministerial statement, which highly recognized the outcome of 1st year ERIA project. Then, Dr. Goto kindly introduced new members of this 2nd year including Dr. Yoshimura from AIST/Japan, Mr. Shoichi Ichikawa from Toyota JAMA/Japan, Mr. Takao Ikeda from IEE/Japan, Mr. Soni Solistia Wirawan from BPPT/Indonesia, Ms. Hoang Thi Tinh from TCVN/Vietnam and Dr. Nuwong Chollacoop from MTEC/Thailand. Dr. Goto also appraised Dr. Oguma for his

administrative help in this ERIA project since the secretary has left AIST. In the future, Dr. Chollacoop will be helping Dr. Oguma for the administrative work, especially on the biodiesel fuel trade book. Finally, Dr. Goto has introduced Prof. Fukunari Kimura to speak about ERIA.

Prof. Kimura was in Faculty of Economic, Keio University but now is a full-time Chief Economist at ERIA. The ERIA has officially started in February 2008 with the first board meeting in June 2008. ERIA has a small office in ASEAN Secretariat building so ERIA has decided to have an much more spacious annex office at Senayan building instead. Currently, ERIA has only 2 full-time researchers, and are now seeking for applicants. The underlying three pillars of ERIA policy research agenda are deepening integration, narrowing the development gap and sustainable development, in which this project is under the 3rd pillar. The ERIA projects from last year will continue this year with the new incoming projects such as “Sustainable automobile society” and “Comprehensive East Asia environmental policy review”. Also, Prof. Kimura has mentioned that Ms. Monsada and Dr. Chollacoop will be presenting and discussing this ERIA biodiesel project in front of many economists at the 11th International Convention of the East Asian Economic Association (EAEA11) in Manila,

Philippines on 15-16 November 2008, in which ERIA has two special sessions to publicize the outcome of six ERIA projects.

Next is the self introduction of all current and new members including the observers Dr. Tirto Prakoso from ITB/Indonesia and Mr. Yohan Soelaiman from Indonesian BDF processing company. Dr. Goto has mentioned about ERIA invitation program, which currently has 5 researchers in his group and 2 researchers in Dr. Yoshimura's group. Dr. Goto further encourage all members to nominate his/her interested researchers for the 2nd call for invitation, including Dr. Tirto Prakoso and Thai researchers from TISTR and MTEC for Thailand-Japan workshop next February.

The meeting has mainly 3 agenda. First, the current status of biodiesel fuel was presented for WWFC (World Wide Fuel Charter) and Vietnam. Second, the content of biodiesel fuel trade book was discussed. Third, the new topics were presented on partial hydrogenation, and the viewpoint from energy economics.

1. Session I –Introduction of current status of BDF from WWFC and Vietnam-

WWFC: Mr. Shoichi Ichikawa

In 1998, the first WWFC was published through co-effort of ACEA, AAM and JAMA with the 4th edition in 2006. The WWFC committee is composed of 15 countries, 9 of which are from East Asian and ASEAN countries as shown in Figure 6 below.

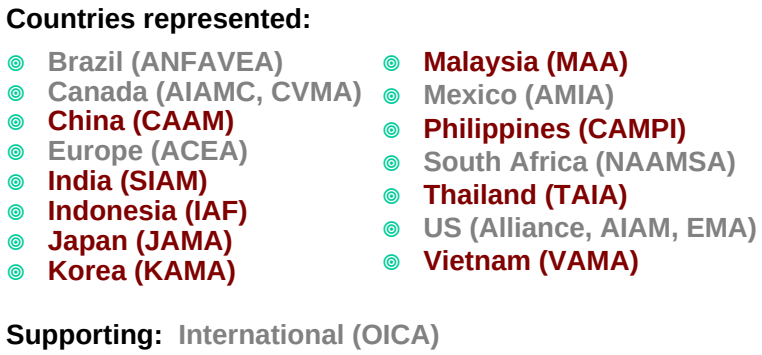
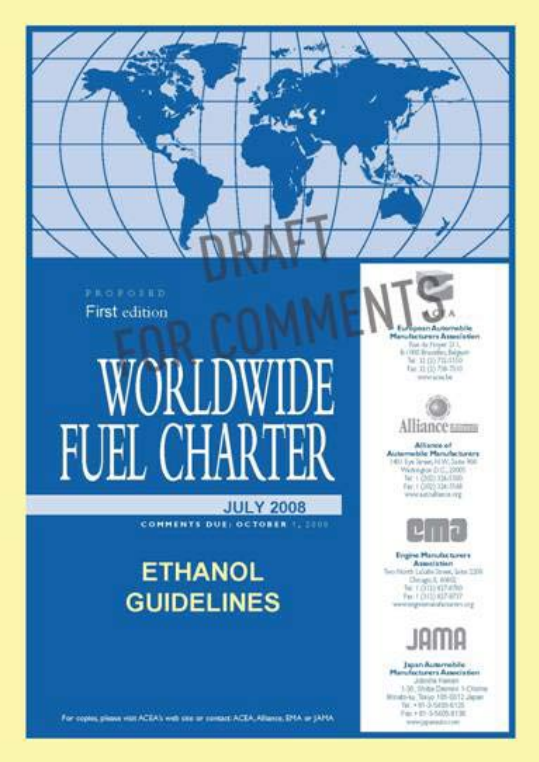
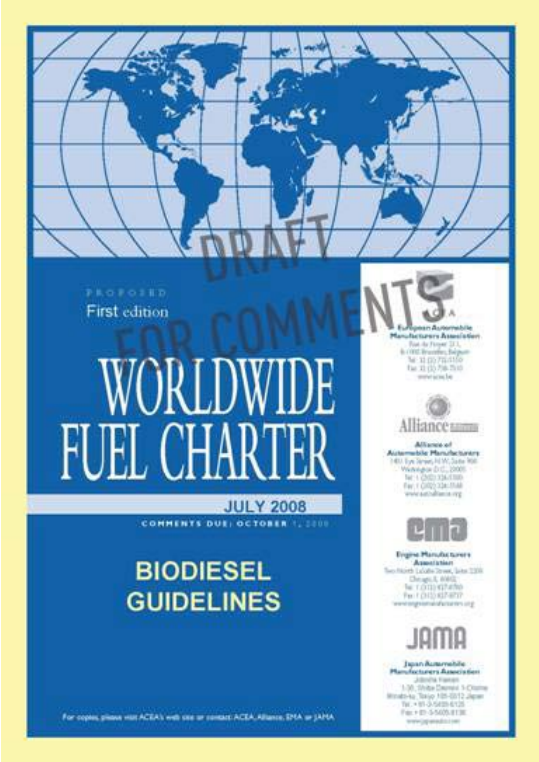


Figure 6 Members of WWFC

The goal of WWFC is clearly to set fuel specification and/or its test method for current and future emission control. Since biofuel is deemed as alternative fuel for fossil, some guidance on fuel with current engine technologies is needed. As shown in Figure 7, bio-ethanol (E100) and biodiesel (B100) guidelines have been drafted for comments among members with goals to benefit consumers, simplify fuel markets, facilitate international trade and help guide governmental public policy. This guideline is for E10 and B5 blends based on engine performance regardless of biofuel feedstock.





E100 guideline B100 guideline

Figure 7 WWFC biofuel guidelines

Focusing on biodiesel, some key comparison between WWFC and ERIA are shown in Table 1 as follows.

Table 1 Comparison of biodiesel fuel specification between WWFC and ERIA

Property	Unit	ERIA	WWFC	Notes
Viscosity	[mm²/s]	2.0 - 5.0	2.0 - 5.0	Feedstock neutral
Flashpoint	[C]	100 min	100 min	Methanol presence
Carbon residue 100% or 10%	[mass %]	0.05 max 0.3 max	0.05 max	Impact on CCD (WWFC only specify 100%)
Sulfated ash Ash	[mass %]	0.02 max (not specify)	0.005 max 0.001 max	Impact on injector deposits Not harmonized
Water &	[vol %]	(not	0.05	Risk of filter

Sediment		specify)	max	plugging Not harmonized
Oxidation stability	[hrs]	10 min	10 min	Risk of tank corrosion (JAMA request)
Iodine number		Report	130 max	Risk of sludge formation Not harmonized
Poly-unsaturated FAME	[mass %]	N.D.	1 max	Risk of sludge formation Not harmonized
Mono-glyceride	[mass %]	0.8 max	0.8 max	Risk of filter plugging Need more discussion
Phosphorous	[ppm]	10 max	4 max	Impact on catalyst Not harmonized
Metals (Na + K) Metals (Ca + Mg)	[ppm]	5 max 5 max	5 max 5 max	Impact on injector deposits Impact on catalyst

With remaining issues on

- Sludge (and also soap) formation tendency: not yet adequate test method for sludge formation (iodine number & poly-unsaturated FAME) and its relation to oxidation stability
- Impact on advanced engine & emission control system: need severe control of metals, ash/sulfated ash and phosphorous
- Filter plugging tendency: consider lower mono-glyceride content limit

At the present, the WWFC draft was issued out in July 2008 for comments. 15 commenters from US, EU and Asia

(including MPOB) has been received and reviewed at WWFC committee meeting on 7 November 2008 in Chicago. Feedback document is now under preparation to meet the final target of January 2009. JAMA has emphasized on the quality of biodiesel and its blend since characteristics of BDF depends on both raw material and refining process. The harmonization of standard is needed with discussion based on technical data.

Comment by Dr. Yan: Organic and inorganic phosphorous may have different effects so need to check which phosphorous should be measured.
Comment by Ms. Jenvanitpanjakul: Should get some technical data for metal contamination. Also, should focus on other properties for discussion like oxidation stability last year.
Comment by Dr. Soerawidjaja: Possible to specify density be measured above CFPP instead of 15 °C to prevent the problem of biodiesel with low CFPP?

Vietnam: Ms. Hoang Thi Tinh

Vietnam is an agriculture based country with over 80 million populations. Two main sectors with high energy

consumption are industry and transport, as shown Figure 8 below.

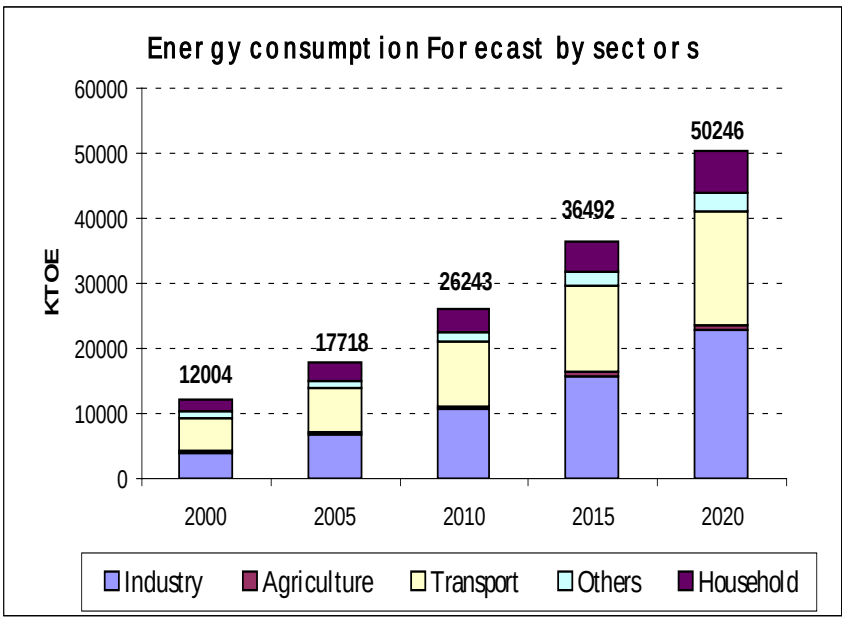


Figure 8 Domestic energy consumption in Vietnam by sectors

Even though Vietnam exports crude oil, it imports all the petro-products so biofuel could potentially help decreasing the import. Most of biofuel projects are still under development with small productions. Biodiesel is produced from catfish fat (Basa fish) while ethanol is produced from cassava and sorgo (sweet sorghum). Difficulties in promoting biofuel are lack of basic research and advanced technology, as well as a big gap between imported fuel and import vehicles. Last year, the government of Vietnam (by

Ministry of Science and Technology) has issued national standard for both ethanol (TCVN7716: 2007, Denatured fuel ethanol for blending with gasoline: E100) and biodiesel (TCVN7717: 2007, Biodiesel fuel blend stock: B100), as shown in Table 2 below.

Table 2 Vietnam standard for biodiesel fuel (TCVN7717: 2007)

Property		limit	Test method
1.Ester, % m/m	min	96.5	TCVN(ASTM)
2.Density,15 ^{o}C, kg/m^3		860-900	TCVN(ASTM)
3.Flash point, ^{o}C	min	130.0	TCVN(ASTM)
4.Water and sediment, %v/v	max	0.05	TCVN(ASTM)
5. Viscosity, 40 ^{o}C, mm^2/s		1.9-6.0	TCVN(ASTM)
6.Sulphated ash, % m/m	max	0.020	TCVN(ASTM)
7.Sulfur, % m/m	max	0,05	TCVN(ASTM)
8.Copper strip corrosion		No. 1	TCVN(ASTM)
9.Cetane number	min	47	TCVN(ASTM)

10.Cloud point, ^{o}C	max	Report	TCVN(ASTM)
11. Carbon residue, % m/m	max	0.050	TCVN(ASTM)
12.Acid number, mgKOH/g	max	0.05	TCVN(ASTM)
13.Iod value, g iod/100g	max	120	TCVN(ASTM)
14.Oxydation stability, h	min	6	TCVN (EN)
15.Free Glycerin, %m/m	max	0.020	TCVN(ASTM)
16.Total Glycerin, % m/m	max	0.240	TCVN(ASTM)
17.Phosphous, % m/m	max	0.001	TCVN(ASTM)
18.Distillation, 90%,^{o}C	max	360	TCVN(ASTM)
19. Na and K, ppm	max	5.0	TCVN(ASTM)

Additional effort from Prime Minister in November 2007 was approving Decision 177/QD-TTg for biofuel development by 2015, with prospect to 2025. By 2010, Vietnam plans to complete 5 biofuel plants with total

production of 100,000 tons/year of ethanol (cassava and sugarcane) in E5 and 50,000 tons/year of biodiesel in B5, in order to meet 0.4% of national demand. The first ethanol plant will be built by Petrovietnam's Oil Group in the northern province of Phu Tho at a cost of $85 million, and will start operation next year with an annual production of 100 million liters. Other plants include 40 million liters/year of ethanol production by Saigon Biofuel Company and the Dung Quat ethanol plant by PV Oil Group. By 2015, ethanol and biodiesel outputs are expected to reach 250,000 tons/year to meet 1% of national demand. Last month, PV Oil Group began selling gasohol E5 to motorcycle and taxi within Hanoi area but it was stopped after 1 week since some engine test and E5 specification are needed.

Comment by Dr. Chollacoop: Would the Dung Quat refinery produce enough ethanol for domestic consumption? Ms. Tinh replied only 30%.

Comment by Ms. Monsada: Any incentive for biofuel for this initial stage of biofuel devlopment? Ms. Tinh replied no, just a standard only.

Comment by Mr. Wirawan: Pricing is a key issue for biofuel promotion

Comment by Dr. Soerawidjaja: There is a worry on ethanol 92.1 % (v/v) for denatured ethanol fuel to be blended with gasoline.

Discussion on oxidation stability and other issues

Comment by Ms. Jenvanitpanjakul: From last meeting on the topic of JAMA recommendation to increase induction period from 6 to 10 hours, Thailand reported that Thailand would not yet conclude on this request, and would conduct further test with JAMA guideline/suggestion. Up till now, there is no report of such test due to high cost, and the testing organization did not have budget. Furthermore, the results from Japan are quite complete. Note the biodiesel feedstock in this region, such as palm oil, coconut oil and Jatropha oil, already possesses higher than 10 hours oxidation stability, except for some processing problems. Nonetheless, if biodiesel has lower oxidation stability than 10 hours, anti-oxidant can be added. Hence, the 10 hours oxidation stability is acceptable in EAS-ERIA standard.

Comment by Dr. Soerawidjaja: Oxidation stability depends on photocatalyzed acid, dissolved acide and acid formation from blending with diesel. Need to look at this issue in details.

Comment by Prof. Yamane: There is a linear correlation between B5 and B100. When the oxidation stability of B5 is to be measured, it can be calculated from B100 oxidation stability, which would take much shorter time.

2. Session II – Biodiesel fuel trade handbook -

Japan: Prof. Koji Yamane

Prof. Yamane presented the research plan of FY2008 categorized as follows.

- Working Group meeting with discussion on
    - Specific properties like oxidation stability, iodine number, polyunsaturated FAME
    - Biodiesel fuel quality control in each country's real market
- Feasibility exploration on new inedible feedstock for biodiesel fuel such as Jatropha, micro-algae
- Publication of "Biodiesel Fuel Trade Handbook" to include all results of discussion and feasibility exploration

The draft content of the biodiesel fuel trade handbook was presented with various comments and suggestions from the WG members as follows. Further comments can be sent to both Prof. Yamane and Dr. Oguma.

Comment by Dr. Goto: Tentative draft of BDF trade handbook will be presented at Ministerial meeting in August 2009. The handbook is planned to be published in English and Japanese, with welcome for other languages of WG member's countries.

Comment by Prof. Zhang: Might be good to add property-engine relationship since BDF properties depend on feedstock.

Comment by Dr. Soerawidjaja: Suggest to include a section on 2nd generation BDF and a comparison of various oils. Also for the micro-algae section, the handbook should focus on optimizing oil from micro-algae rather than conversion technology of micro-algae oil to biodiesel. For section on unused feedstock, a Moringa [1] tree should also be considered.

Comment by Ms. Jenvanitpanjakul: Content in Chapter 5 is suitable for future trend of biodiesel, and further support that section on micro-algae should focus on the oil production instead of BDF conversion.

Comment by Dr. Yan: Agree on the content of Chapter 1-4 but Chapter 5 would be for potential feedstock. Other

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1 http://www.hendrycreekhideaway.com/Moringa%20Miracle%20Tree%20of%20Life.html

important contents are sustainability issue, quick method to check % blend of BDF and cultivation of algae with high oil content and improved extraction method.

After the session, the revised draft content of BDF trade handbook is as follows.

1. Introduction (Dr. Goto)
2. Energy Situation in the World (Mr. Ikeda)
3. Biodiesel Fuel Standardization Activities
    3.1 EAS-ERIA Biodiesel Fuel Standard: 2008 (Dr. Oguma)
    3.2 World Wide Fuel Charter - Biodiesel Guideline: July 2008 (Dr. Hoshino)
4. Upgrading Technologies of Biodiesel Fuel Quality
    4.1 Oxidation Stability (Mr. Imai or Dr. Hoshino)
        4.1.1 Additives (Antioxidant) (Dr. Hirotsu, AIST)
        4.1.2 Upgrading of FAME by Partial Hydrogenation (Dr. Yoshimura)
        4.1.3 Second Generation Biodiesel (BHD, BTL....)
    4.2 Fluidity
        4.2.1 Low Temperature Fluidity
        4.2.2 Normal Temperature Fluidity
5. Utilization Technology of Unused Feedstock

5.1 Jatropha curcas (Dr. Tatang, Dr. Iman)

5.2 Rice Bran (Prof. Yamane)

5.3 Micro Algae 1: Triglyceride to FAME (Dr. Yan)

5.4 Micro Algae 2: Extraction of Hydro Carbone

5.5 Karanja Tree and Neem Tree (India?)

5.6 Calophyllum inophyllum, Moringa oleifera

3. Session III –Presentation of New Topics

Japan (AIST): Dr. Yuji Yoshimura "Upgrading of FAME by Partial Hydrogenation"

Dr. Yoshimura presented the research work on improving oxidation stability of FAME without sacrificing too much on the cold flow property by the technique partial hydrogenation. To improve oxidation stability of biodiesel, antioxidant additive or partial hydrogenation can be used. Possible oxidation mechanism of FAME shown in Figure 9 below is often a result of unsaturated FAME.

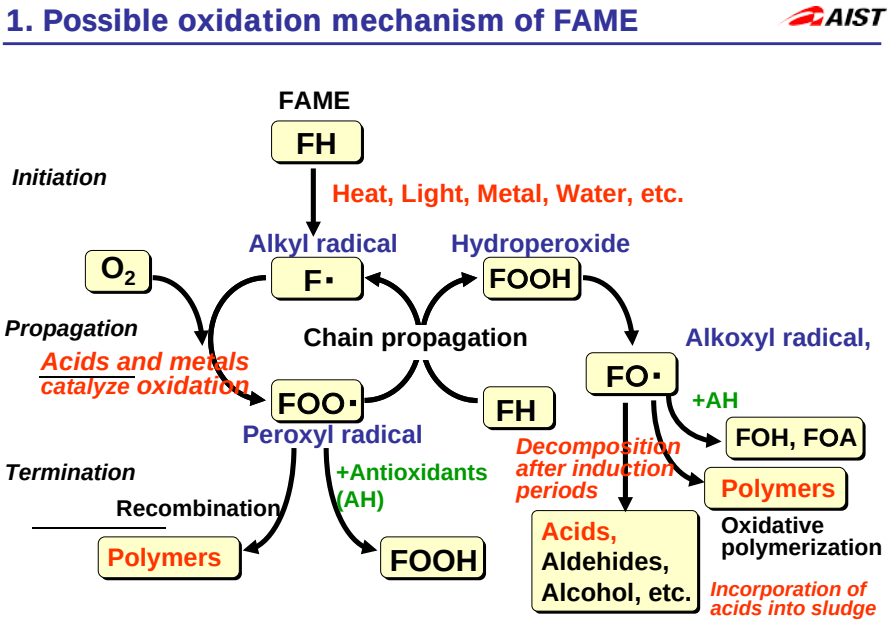


Figure 9 Possible oxidation mechanism of FAME

Considering the relative oxidation rates of unsaturated FAME C18 component, C18:1 : C18:2 : C18:3 = 1: 41: 98. Even though it is best for methyl stearates (C18:0) in term of oxidation stability, methyl oleates (C18:1) is not so bad given that the cold flow property is not much worsen. Interesting finding was that when biodiesel is blended with diesel with high sulfur content (S = 410 ppm), the increment in AV[2] (acid value) of C18:2 and C18:3 is not as bad if compared with the blending with low sulfur diesel (S = 6ppm), as shown in Figure 10 below. The reason is that sulfur compound and aromatic can act as antioxidant.

[2] Acid Value (AV) is an indicator for oxidation stability of biodiesel. Mandatory specification for B5 blending in Japan is $\Delta AV < 0.12$ mgKOH/g

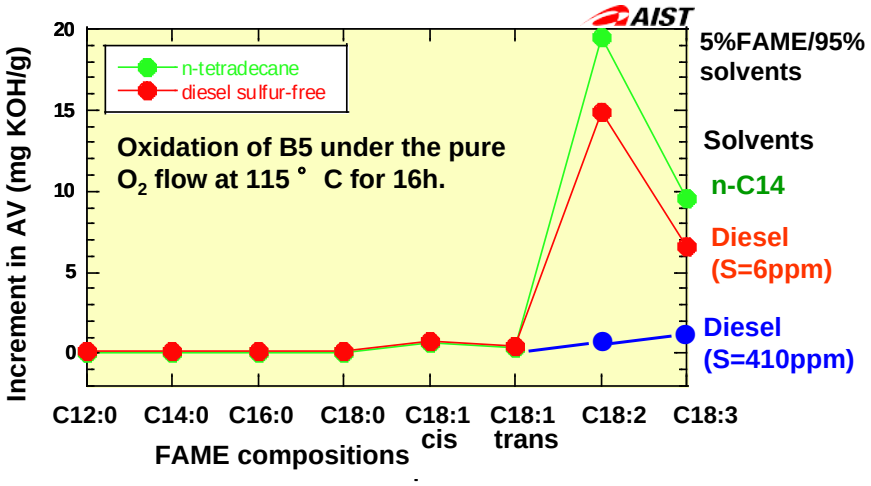
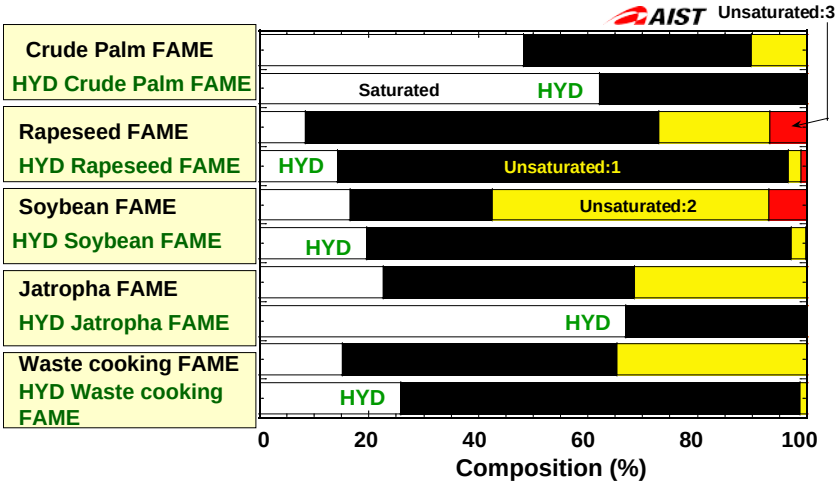


Figure 10 Oxidation stability behavior of various FAME components in B5 blend

Thus, partial hydrogenation to minimize unsaturated FAME component like C18:2 and C18:3, while allowing C18:1 to be present, can compromise both oxidation stability and cold flow property of biodiesel. The catalyst was developed for atmospheric pressure hydrogenation so that

- the hydrogenation reaction does not need high-pressure facility (easy incorporation with existing conventional transesterification process or local communities),
- the hydrogenation reaction only needs low temperature to minimize thermal degradation of FAME
- the biodiesel is intrinsically stable for long-term storage and transportation

Furthermore, hydrogenated BDF can help minimize sludge formation after oxidative polymerization, which can give flexibility in mixing BDF from various oils. Figure 11 below shows that partial hydrogenation of various FAMEs can really decrease the fraction of unsaturated components.



Hydrogenation conditions: H_2 pressure = atmospheric, Temperature= 100 °C, Reaction time = 1h

Figure 11 Effectiveness of partial hydrogenation on % unsaturated FAME component

In addition, hydrogenation is effective enough to allow B20 blend from palm FAME to meet oxidation stability specification, as shown in Figure 12 below.

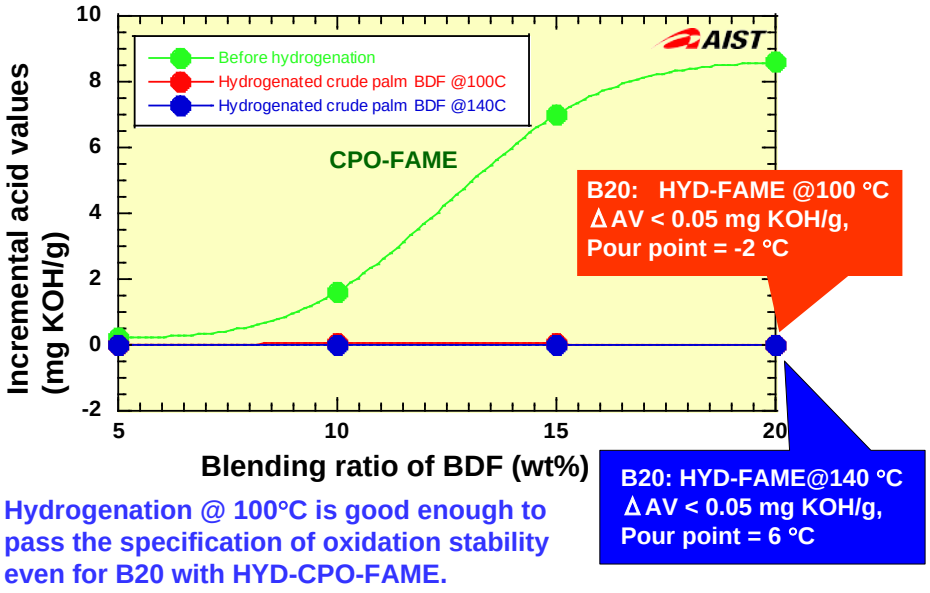


Figure 12 Oxidation stability of B20 with HYD-CPO-FAME/Diesel (S = 6ppm)

Japan (IEE): Mr. Takao Ikeda "Japanese Biofuel Introduction Policy, Resource and Development Plan"

Mr. Ikeda presented the current situation of biofuel in Japan, along with the biofuel introduction policy and development plan in Japan. Up to 3% of ethanol can be blended with gasoline (E3) since August 2003 while up to 5% of biodiesel can be blended with diesel (B5) since March 2007. For E3, oil industries only distribute ethanol-blending gasoline in a form of ETBE at 50 service stations in April 2007 to 100 service stations in 2008. E3 direct blended gasoline is limited for demonstration project since oil industries are insistently worried about ethanol water-

absorbing and water-solubility properties in the water contamination in distribution process. On the other hand, usage of biodiesel in Japan is only limited to some municipalities and local companies ("local production and local consumption").

Other Japanese law and target for biofuel are

- New National Energy Strategy (May 2006) has set a long-term target to introduce 20% of transport fuel (other than gasoline and diesel oils) in 2030.
- Kyoto Protocol Target Achievement Plan has set a target of 500,000 kL COE (crude oil equivalent) of biomass-derived fuel for transportation in 2010.
- Oil industries have set a target of 210,000 kL of bio-ethanol as a form of ETBE in 2010.
- Tax reduction of 1.6 Yen/L for ethanol blended gasoline was set forth in May 2008 for 9 months.
- Biofuel law of Ministry of Agriculture, Forestry and Fisheries started in October 2008 (e.g. 50% reduction of fixed asset tax for biofuel plant)

Figure 13 below shows the target of New and Renewable Energy in Japan

New Energy Introduction Target		FY2005	FY2010 target
Power generation field	Photovoltaic power generation	347,000 kl (1,422,000 kW)	1,180,000 kl (4,820,000 kW)
	Wind power generation	442,000 kl (1,078,000 kW)	1,340,000 kl (3,000,000 kW)
	Waste power generation + Biomass power generation	2,520,000 kl (2,010,000 kW)	5,860,000 kl (4,500,000 kW)
Thermal utilization field	Solar thermal utilization	610,000 kl	900,000 kl
	Thermal utilization of waste	1,490,000 kl	1,860,000 kl
	Biomass thermal utilization	1,420,000 kl	(*1) 3,080,000 kl
	Unused energy	49,000 kl	50,000 kl
	Black liquid, waste material, etc.	4,720,000 kl	4,830,000 kl
Total (rate in total primary energy supply)		11,600,000 kl (2.0%)	19,100,000 kl (about 3%)

*1 Includes biomass-derived fuel (500,000 kl) for transportation.

Figure 13 Target of New and Renewable Energy in Japan

Current pilot projects on bioethanol in Japan are shown in Figure 14 as follows.

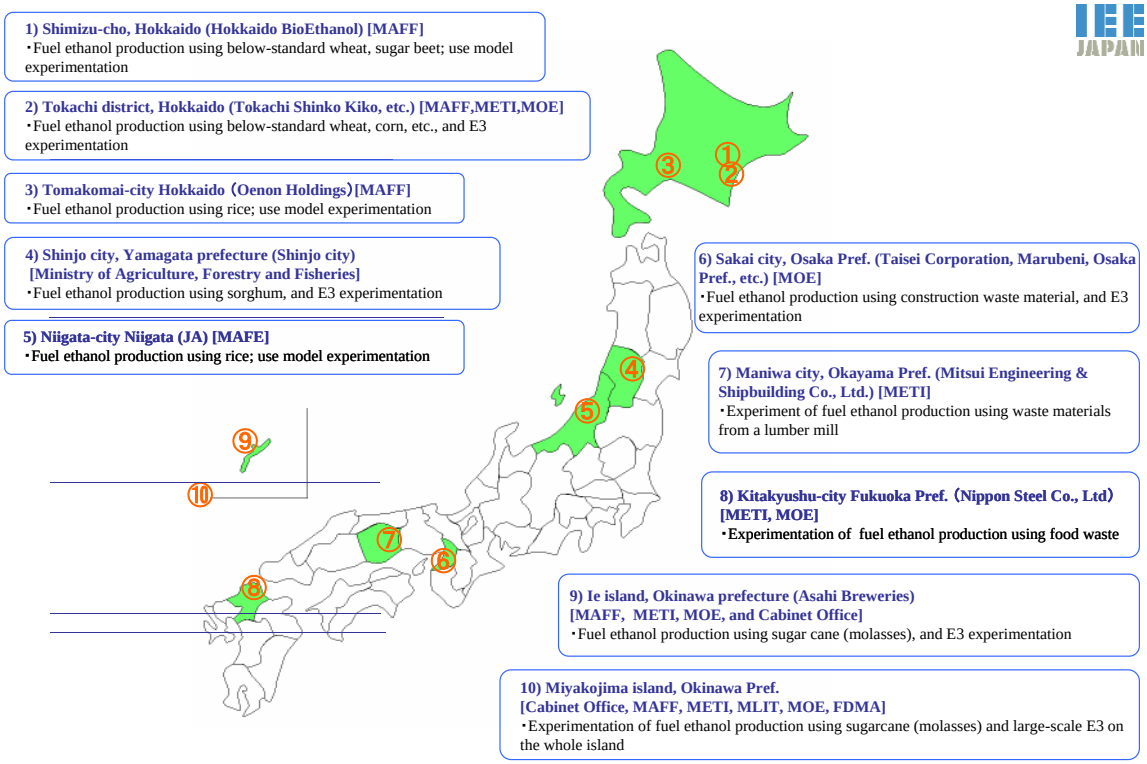


Figure 14 Nationwide pilot projects on bioethanol fuel in Japan

With the potential cultivation land for biofuel feedstock from abandoned arable land, as identified by Ministry of Agriculture, Forestry and Fisheries (MAFF) in Figure 15.

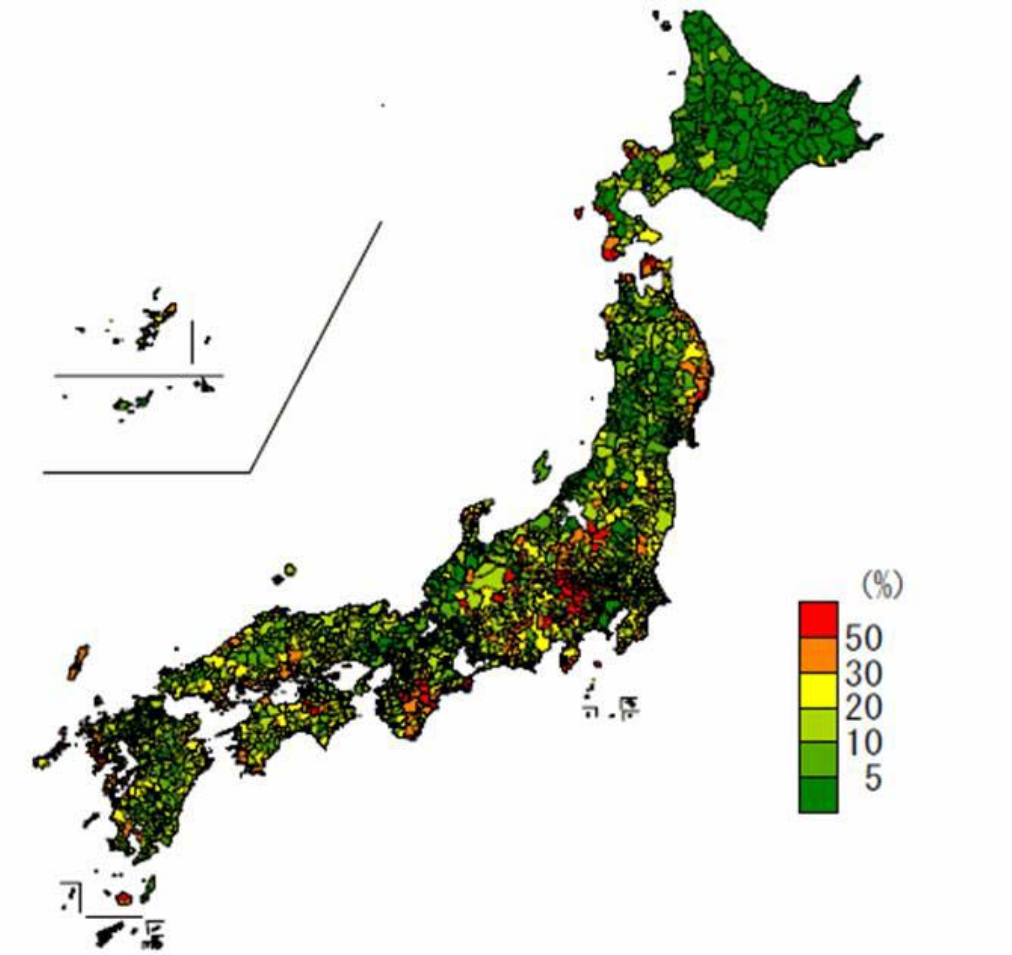


Figure 15 Abandoned arable land

(http://www.maff.go.jp/j/nousin/tikei/houkiti/pdf/zenkoku.pdf)

Another important issue of biofuel is its sustainability criteria. EU is proposing mandatory “environmental sustainability criteria” on biofuel, such as

- GHG emission reduction from the use of biofuels should be at least 35%
- Biofuels should not be made from raw material from
    - high biodiversity value land
    - high carbon stock land

Moreover, various international movements to harmonize this sustainability criteria by ISO and GBEP (Global Bioenergy Partnership), as shown in Figure 16.

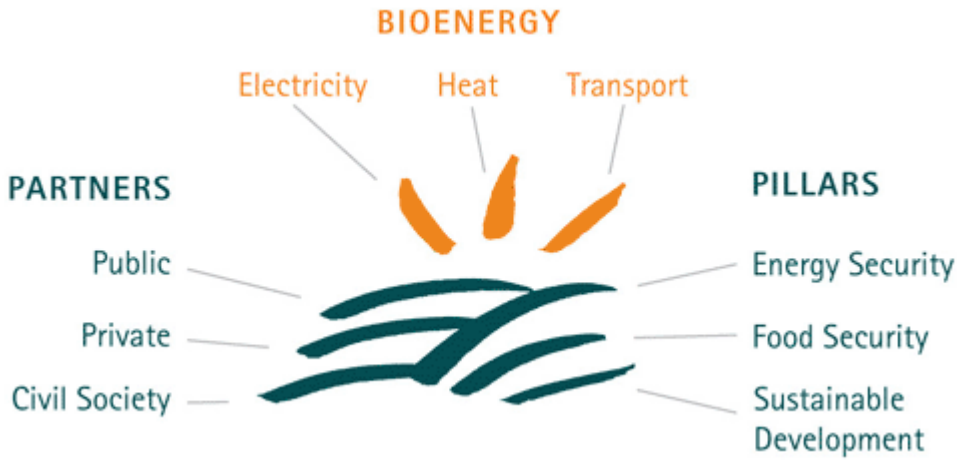


Figure 16 GBEP (Global Bioenergy Partnership) concept

For successful incorporation of biofuel as New and Renewable Energy, related strategies are proposed in Figure 17 as follows.

Figure 17 Five strategies on Innovation of Engines, Innovation of Fuels and Innovation of Infrastructure

With recent food-vs-fuel argument, Ministry of Economy, Trade and Industry (METI) cooperated with the Ministry of Agriculture, Forestry and Fisheries (MAFF) in developing the “Biofuel Technology Innovation Plan” in March 2008 to cut biofuel production cost to 40 yen per liter by 2015 (technology innovation case), to further promote development of cellulosic biofuel. Finally, the roadmap to increase the production of domestic biofuels is presented, as shown in Figure 18.

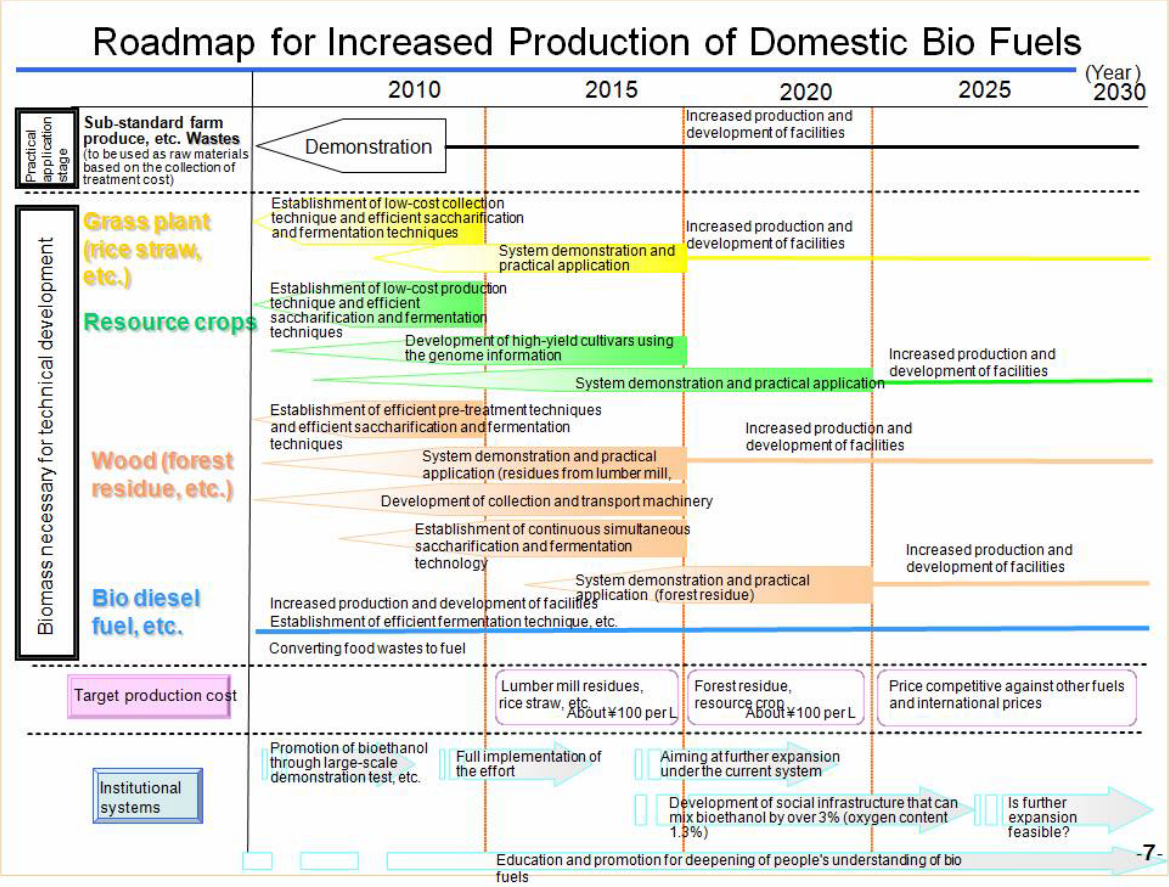


Figure 18 Roadmap to increase production of domestic biofuels in Japan

Comment by Ms. Jenvanitpanjakul: What is the sustainability criteria on unutilized forest as potential cultivation land for biofuel feedstock? Should ERIA-EAS follow EU regulation even for domestic use? Or ERIA-EAS should develop our own with geographically appropriate methodology for assessment. Mr. Ikeda informed that the sustainability issue and criteria are still under consideration in Japan at the moment.

Comment by Ms. Monsada: In case of Philippines, national biofuel board has looked at the definition of arable land with certification authority born by Ministry of Agriculture.

4. Closing Address

Dr. Goto reminded again about ERIA invitation program with a plan for Prof. Tirto for 2 months and Thai delegates from NSTDA and TISTR for Thailand-Japan Annual Workshop on 12-13 February 2009. In June 2009, 1st draft of activity report will be submitted to ERIA. Finally, group photo of the expert participants were taken, as shown in Figure 19.

Schedule of next meeting (2nd meeting) is as follows.
Date: the week of 23-24 February 2009.
Venue: Kota Kinabalu
Technical tour: Yunmar R&D Center (http://www.yanmar.co.jp/en/rd/center.html)

Tentative 3rd meeting is scheduled in May 2009.

Figure 19 ERIA BDF WG1 meeting

6.2 WG2 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 6th Meeting (2nd of FY 2008)

February 22-23, 2009 in Kota Kinabalu, Malaysia

6.2.1 Participating countries

Australia, China, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Thailand and Vietnam
(-without participation from India and New Zealand)

6.2.2 February 23: Working Group Meeting

Figure 20 ERIA BDF WG meeting (opening address by Dr. Goto)

The working group meeting was held at Yanmar Kota Kinabalu R&D center, as shown in Figure 20. Dr. Goto greeted everyone with the opening address, and everyone briefly introduced themselves since there were some observers from Yanmar, Japan, Indonesia and Philippine.

1. Session I – Biodiesel fuel trade handbook -

The first session started with the presentation by Prof. Yamane on the content of the biodiesel handbook, as shown in Figure 21. Various comments and suggestions were discussed among the working group to reach the final agreement as shown below. For examples, the new method to assess oxidation stability called “Petro-Oxi”, which shows promising advantage over Rancimat and TAN increase test, will be explained. The commercial quick-and-portable tool (“i-Spec™ model Q100”) to measure some biodiesel properties will be included. Both countermeasures to oxidation degradation (by antioxidant additives and hydrogenation technique) and low temperature performance (by blending with other fuel and winterization technique) will be reviewed. Other potential feedstock such as Jatropha, rice bran and micro algae will be reviewed. Some market experiences from various countries will be shown as case studies to highlight the importance of quality control for market acceptance. The final biodiesel handbook will be submitted to ERIA in June 2009, in order to report to Energy Ministerial meeting in August 2009.

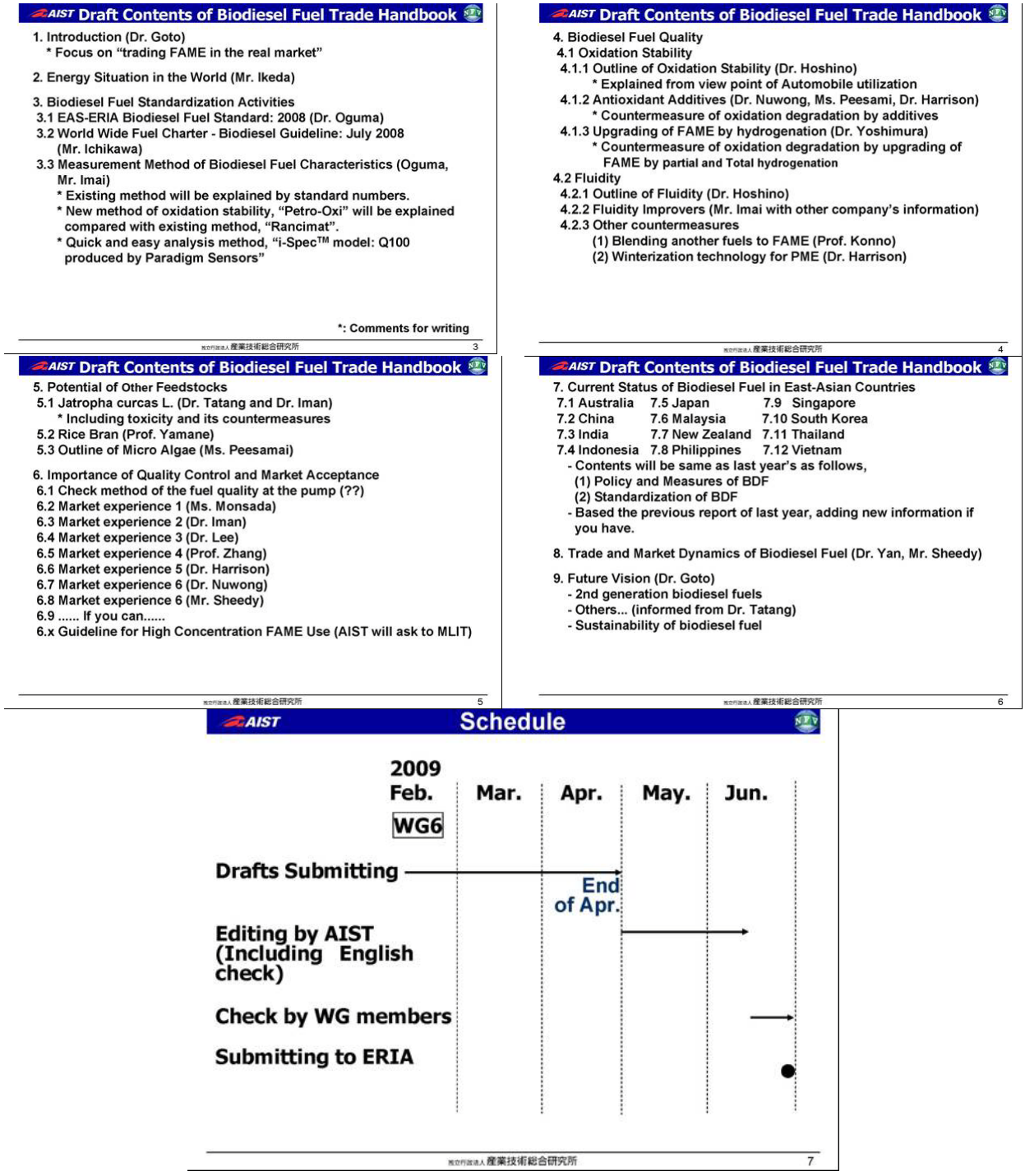


Figure 21 Content of the biodiesel handbook (agreed by the working group) with the timeline

2. Session II – Updates of Current Biodiesel Status and Presentations of New Topics

Updates of Current Biodiesel Status in Malaysia

Second session started with the updates of current biodiesel status from Malaysia by Dr. Lau. For Malaysian update, 17 biodiesel plants have completed construction with total capacity of 1.86 million tons, and another five plants are being constructed, as of January 2009. With plentiful biodiesel production, Malaysian government has implemented the mandatory use of biodiesel as of 1 August 2008, as part of Malaysian Biofuel Industry Act 2006 (passed by Parliament on 26th July 2007). Then, Malaysian PME standard was published in November 2008 with initial B5 usage in government agencies in February 2009, as shown in Figure 22. In June 2009, B5 usage will expand to industrial sectors, and transport sectors in January 2010 before full implementation by 2010. Some of the technical issues foreseen include OEM warranty for vehicle, equipment warranty for IPP (independent power producer), storage stability, microbial growth and compatibility with nano-marker to prevent the misuse of subsidized diesel fuel from transport sector in other sectors.

Figure 22 B5 launching for governmental vehicles on 10 December 2008 by MPIC Minister

Updates of Current Biodiesel Status in Australia

Next, Australian update on biodiesel by Mr. Sheedy was presented with particular emphasis on the amendments of diesel and biodiesel standards, e.g. 5% blend of biodiesel in diesel, changes in standard parameters and test methods, approval for higher blends (B6-B20). As of 1 March 2009, diesel standard has allowed up to 5% (v/v) blending of biodiesel in diesel without the need to explicitly label biodiesel-blending in diesel. With biodiesel blending, the fuel needs to have derived cetane number (DCN) of 51 minimum (ASTM D6890) but allows higher entrained water content of 200 mg/kg (ASTM D6304). For biodiesel standard, the issue of C17 esters, especially for biodiesel from tallow and waste cooking oil, is concerned for %ME content so the method to include C17

detection is suggested based on Schober et al (2006)[3]. Regarding oxidation stability, delta TAN test and PetrOxy test are suggested in addition to conventional Rancimat test. Regarding higher blend than 5%, there are some cases that are appropriate for greater than 5% biodiesel blend but explicit labeling is required. Finally, the B2 mandate from 1 July 2009 onward is pending for legislative approval.

Updates of Current Biodiesel Status in Philippine

Next, Philippine update was briefly added to the discussion among the working group, especially on the B2 mandate since 6 February 2009. Also, Philippine biodiesel standard is modified in order to incorporate shorter coconut methyl ester chain.

Presentation of New Topics: Indonesia

The second half of session II was the presentation of new topics. First, Mr. Wirawan presented the biodiesel development in BPPT, as well as current status of biodiesel in Indonesia. Since February 2006, national biodiesel standard, SNI 04-7182-2006, has been issued by National Standard Agency with recent mandatory use of biofuel set

[3] S. Schober, I. Seidl and M. Mittelbach, 'Ester content evaluation in biodiesel from animal fats and lauric oils', European Journal of Lipid Science and Technology, vol 108, issue 4, 2006, pp 309-314.

on 26 September 2008 via Decree of the Minister of Energy and Mineral Resources. In Indonesia, biodiesel-blend diesel is under trade name BioSolar. With the island nature of Indonesia of more than 17,000 islands, the 1% biodiesel usage mandate is implemented on the company whole sale accounting, regardless of what actual blending in which region, as shown in Figure 23 below. BPPT has helped Indonesian biodiesel industry, particularly on the design and construction of biodiesel reactors, as shown in Figure 24 below.

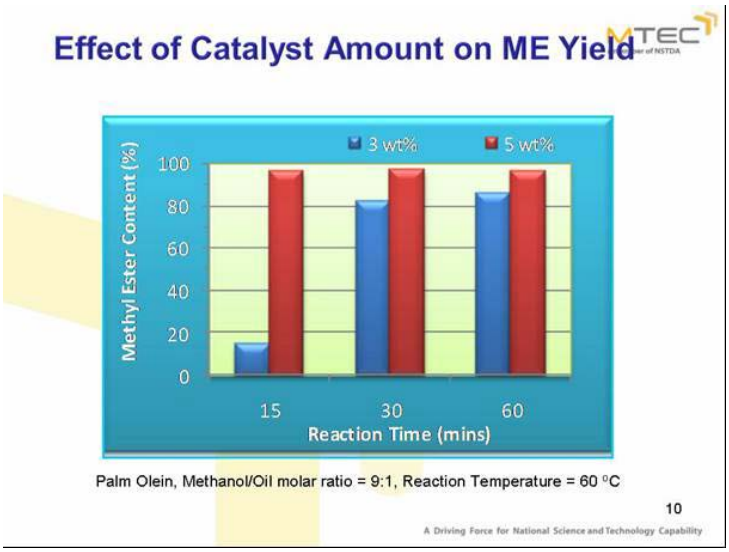
Figure 23 Site specific biodiesel selling in Indonesia

Figure 24 Various biodiesel plants from BPPT

Presentation of New Topics: Thailand

Second, Dr. Chollacoop presented the work of solid catalyst in biodiesel reaction. The work selects SrO loading to MgO because of high basic strength in SrO (but not large enough surface area) and large surface area of MgO (but not high enough basic strength). As shown in Figure 25,

the preliminary investigation show promising results with high %ME achieved within short reaction time at ambient pressure. Various effects from reaction time, amount of catalyst, ratio of methanol to oil were investigated to obtain optimal condition. In addition, CaO/MgO system is explored but larger MeOH:oil ratio and more catalyst are required. Interestingly, it was found that small presence of water (< 500ppm) could help promote methyl ester yield with some proposed mechanism.



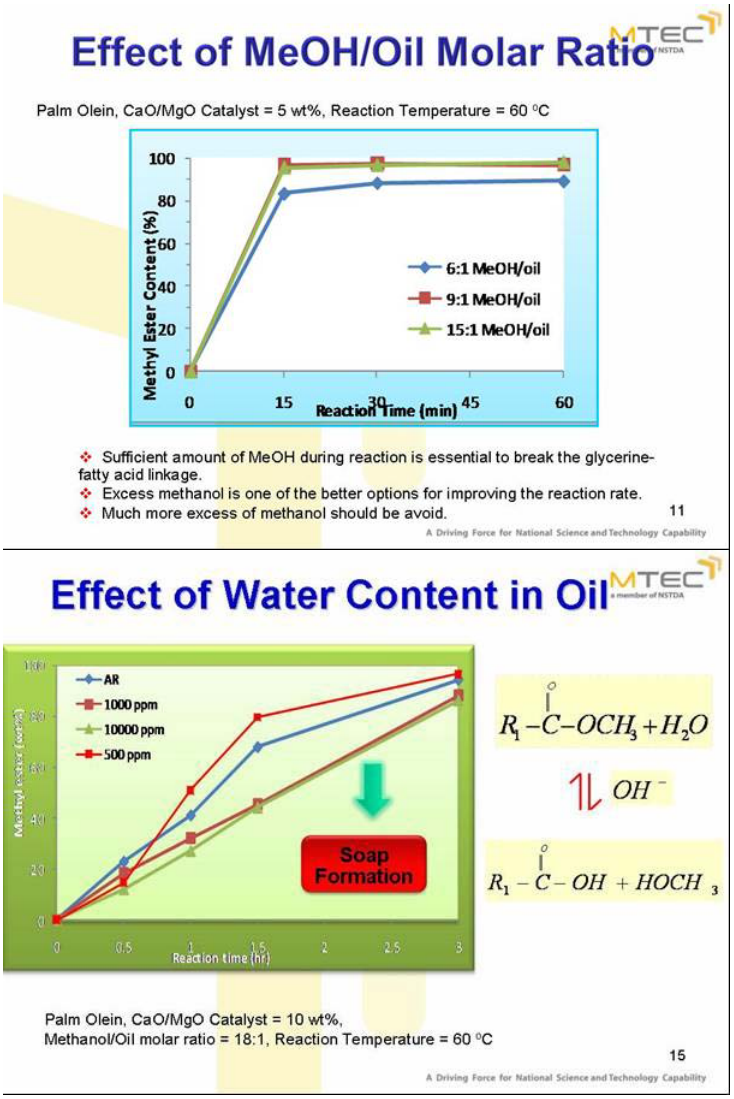
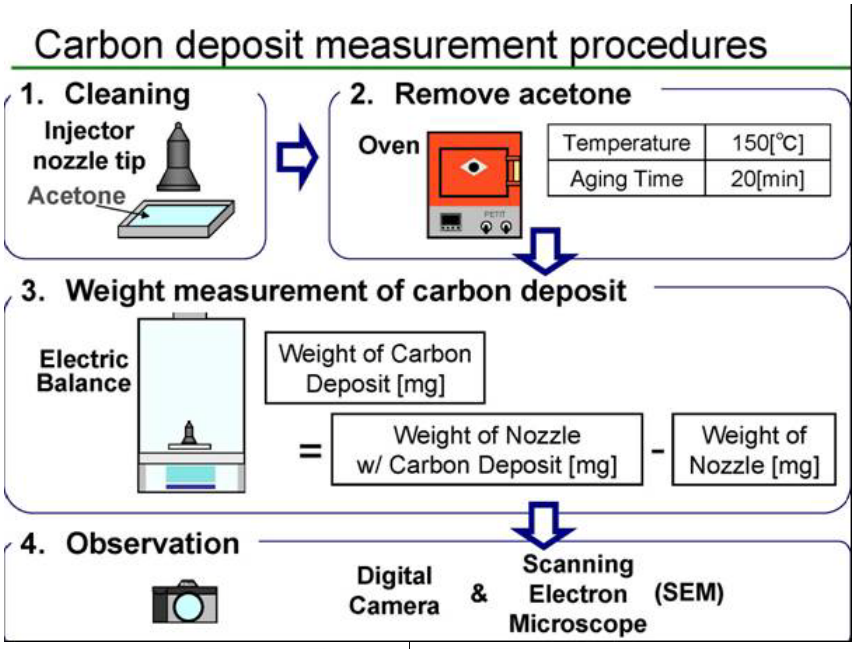


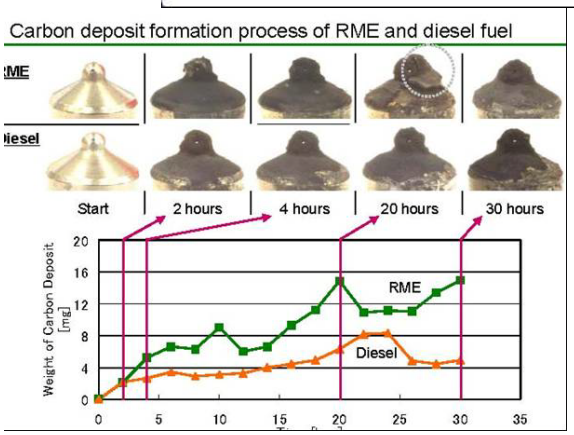
Figure 25 Various effects on heterogeneous catalyst for transesterificaiton

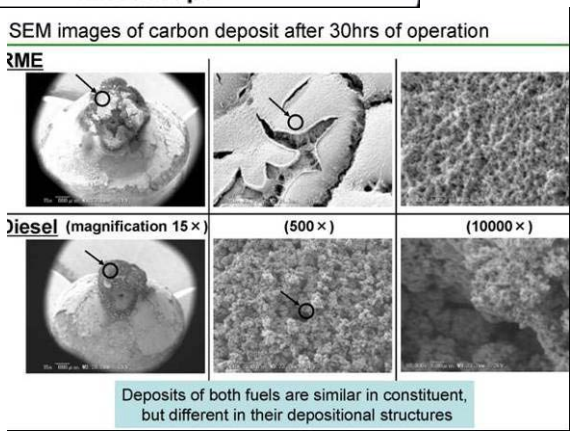
Presentation of New Topics: Japan/Prof. Konno

Third, Prof. Konno presented the work on characteristics of carbon deposit at injector when using biodiesel, as shown in Figure 26. Single cylinder engine was tested with biodiesel (RME at 5% and 100%) and DME by running continuously for 30 hours with 2 hours interval

stop to measure carbon deposit at the injector tip. Results show much faster carbon deposit formation for RME, compared to diesel; whereas, 5% RME blend has no discernible impact on carbon deposit. Distillation property is a dominant factor for deposit formation. Furthermore, mechanism of deposit formation, depending on tested fuel type, was suggested.







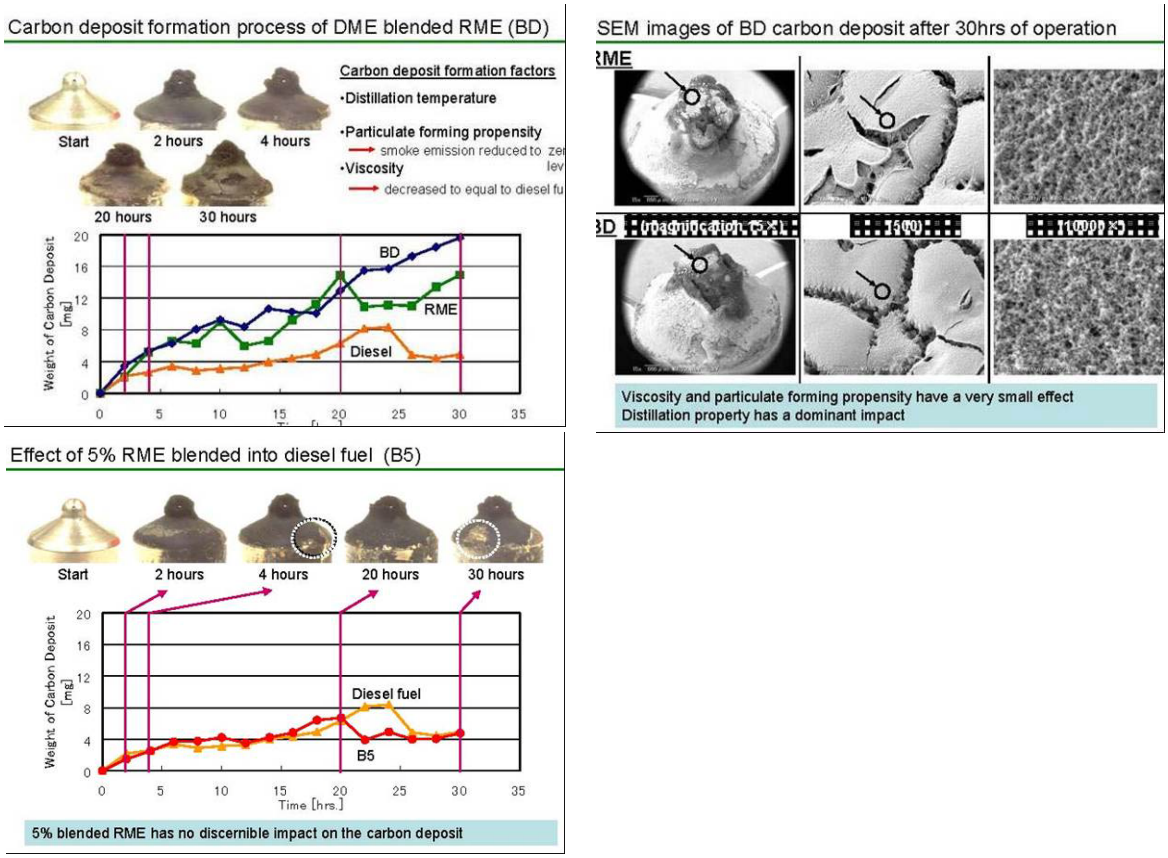


Figure 26 Carbon deposit at injector tip results with various tested fuels

Presentation of New Topics: Japan/Dr. Sakanishi

Fourth, Dr. Sakanishi presented the R&D activities of BTRC (Biomass Technology Research Center), AIST, with emphasis on biomass utilization and BTL. As shown in Figure 27, BTRC has bench-scale BTL plant at AIST/Hiroshima, where BTL is produced from woody biomass. Moreover, catalyst for upgrading BTL quality has been investigated.

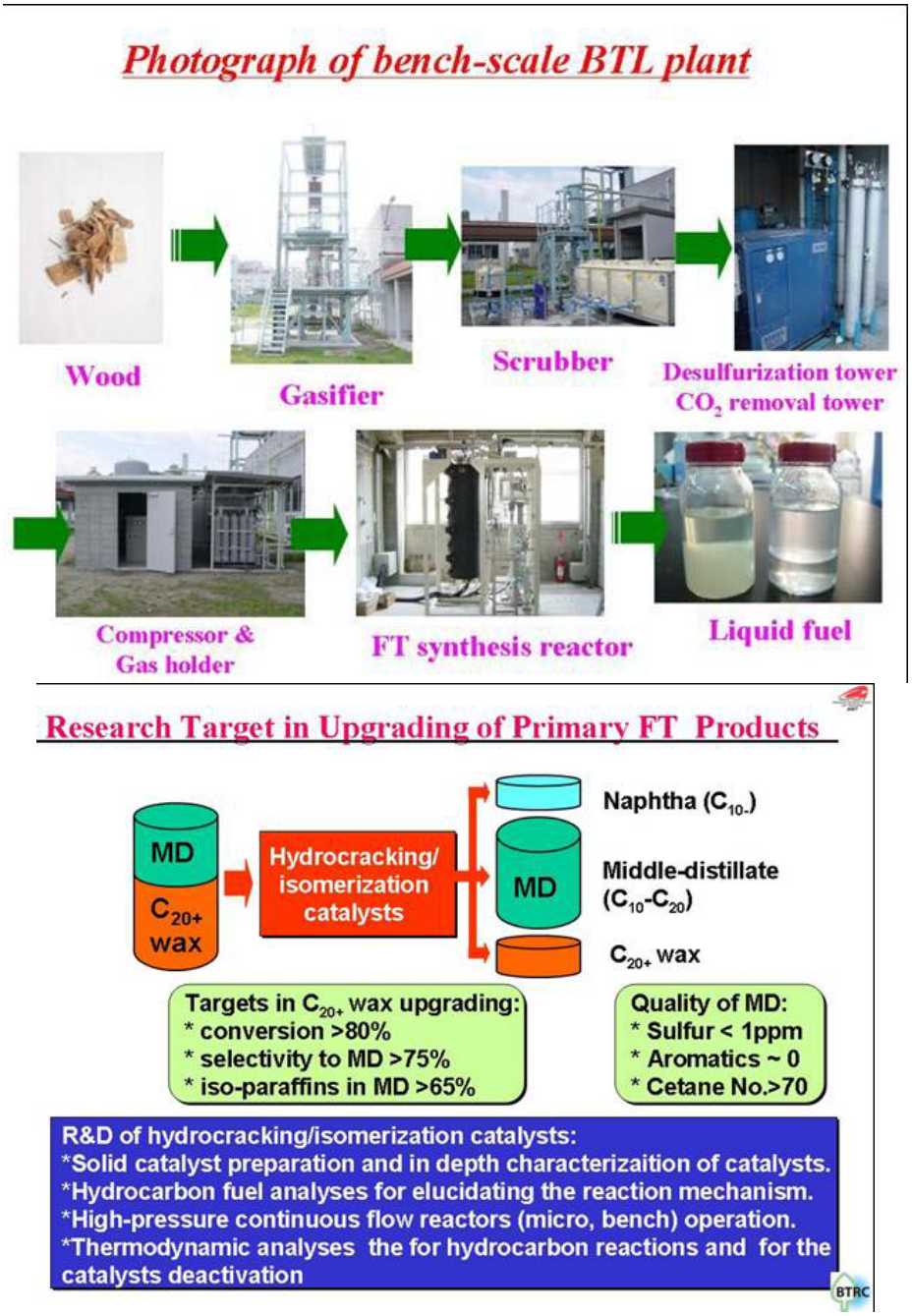


Figure 27 Bench-scale BTL plant and FT research target at BTRC/AIST

3. Closing Address

Lastly, Dr. Goto gave a closing address for this working group meeting with tentative next meeting (WG7th) in July 2009 to review the 1st draft of report. Furthermore, Dr. Goto has summarized the researcher invitation program by NEF with plan for FY2009 to have young researchers come to AIST for a longer term visit (6-10 months), where NEF application will start in April or May 2009. Dr. Goto encouraged working group members to nominate their staffs to apply.

6.2.3 February 23: Presentation and Tour of Yanmar R&D Facility

The meeting was concluded by presentation of Yanmar company and a tour of R&D facilities, as shown in Figure 28.

Figure 28 Tour of Yanmar R&D center

6.3 WG3 meeting

ERIA Working Group

for the Benchmarking of Biodiesel Fuel Standardization in East Asia

Report of the 7th Meeting (3rd of FY 2008)

June 28-29, 2009 in Tsukuba, Japan

6.3.1 Participating countries

China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam

(-without participation from Australia, India, Malaysia and New Zealand)

6.3.2 June 29: Working Group Meeting

Figure 29 ERIA BDF WG meeting (opening address by Dr. Goto)

The working group meeting was held at Meeting Room 2 (1B-2204) of AIST East. As shown in Figure 29, Dr. Goto greeted everyone with the opening address, and everyone briefly introduced themselves since there were some observers from Thailand and AIST. In Figure 30, Prof Kimura then introduced himself and ERIA, which currently has 9 researchers, and was recognized as international

organization for tax exemption purpose. He further emphasized that the ERIA WG report will be posted on the ERIA website so all writers have to be careful of the copyright materials.

Figure 30 Prof. Kimuar introduced himself and ERIA brief information

1. Session I – Report of ECTF meeting

As shown in Figure 31, the first session started with the presentation by Ms. Peesamai and Dr. Nuwong on the 10th ECTF (East Asia Summit Energy Cooperation Task Force) meeting in Bangkok, Thailand during 23-24 June 2009, where the ERIA Working Group for Benchmarking of Biodiesel Fuel Standardization in East Asia was presented. The main purpose of the 10th ECTF meeting was an update from SOE (Senior Official on Energy) from EAS and

prepare for the 3rd EAS EMM (Energy Ministerial Meeting) meeting in Mandalay, Myanmar on 29 July 2009, in which results from ERIA BDF WG will be presented.

Figure 31 Ms. Peesamai presented ECTF meeting

2. Session II – "Biodiesel Fuel Trade Handbook" Making

Next, the content of the BDF Handbook was checked section by section with the deadline of Monday July 6th from each member in order to submit the draft report to 3rd EMM meeting in Myanmar. For those who cannot make the 6th July deadline, their contribution will be postponed to the 2nd edition of BDF Handbook for FY2009. For lunch break, Dr. Oguma from NFV/AIST has demonstrated AIST BDF bus by driving all participants to the AIST cafeteria, as shown in Figure 32.


Figure 32 Dr. Oguma drove biodiesel bus for all participants to lunch at Welfare Center, AIST

3. Session III – Report of Each Country's situation

The afternoon session was mainly for the update by each member country: China, Indonesia, Japan, Philippines, Singapore, South Korea, Thailand and Vietnam, as shown in Figure 33.

Prof. Zhang presented country repot for China

Prof. Wirawan presented country report for Indonesia

Ms. Monsada presented country repot for Philippines

Prof. Yang presented country report for Singapore

Prof. Lee presented country report for South Korea

Ms. Tinh presented country report for Vietnam

Figure 33 Various presentations on updates of biodiesel situation in each country

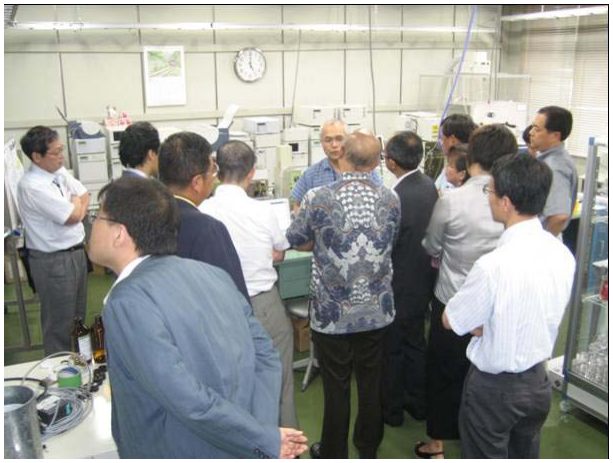
4. Closing Address and Technical Tour of NFV Lab

The meeting was concluded by Dr. Goto with the following schedules for subsequent meeting in FY2009.

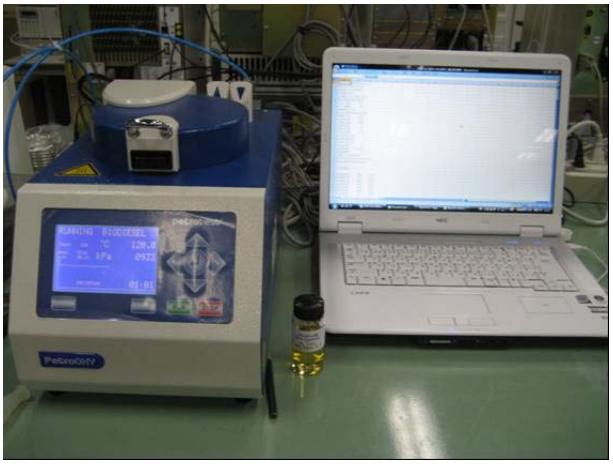
- Joint IEA-ERIA workshop in Tsukuba during Oct 2009

- Meeting in Australia during Dec 2009 – Jan 2010
- Joint 3 ERIA WG workshop in Indonesia during Feb/Mar 2010

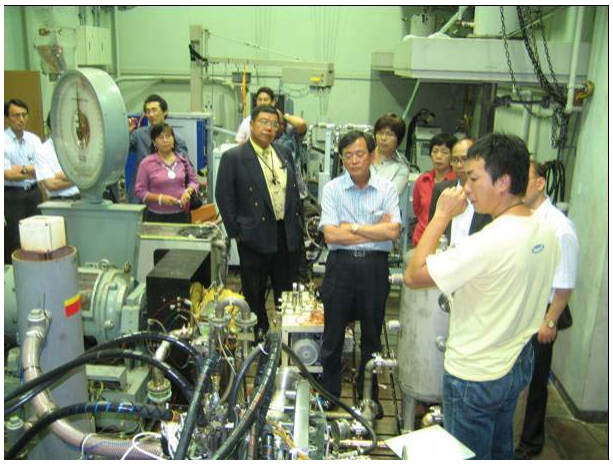
After the ERIA WG meeting, Dr. Goto led the group to the lab tour of Research Center for New Fuels and Vehicle Technology (NFV), as shown in Figure 34.



NFV lab tour by Dr. Hirotsu



PetrOxy test apparatus



NFV lab tour by Dr. Tsujimura

Demonstration of DME truck by Dr. Oguma

Figure 34 NFV/AIST lab tour

6.4 After WG3

The “Biodiesel Fuel Trade Handbook (The First Edition for Comments)” was completed by AIST. The handbook was introduced in the 11th Meeting of the EAS Energy Cooperation Task Force, as well as the Third EAS Energy Ministers Meeting held on 28-29 July 2009 in Mandalay, Myanmar, as shown in Figure 35. Dr. Nuwong reported our results and introduced the handbook in the meeting with WG leader, Dr. Goto, as shown in Figure 36. The summary of two ERIA WG’s activities was presented to 16 Energy Ministers from ASEAN+6 Countries, as part of the ECTF

Biofuels Workstream, as shown in Figure 37. The handbook is attached with this report as an appendix.

Figure 35 ERIA BDF WG participations in 3rd EAS Energy Ministers Meeting and Associated Meetings in Mandalay, Myanmar

3rd EAS Energy Ministers Meeting
29 July 2009, Mandalay, Myanmar

ERIA Working Group on "Benchmarking of Biodiesel Fuel Standardization in East Asia"

Nuwong CHOLLACOOP, Ph.D.
National Metal and Materials Technology Center (MTEC)
Dr. Shinichi Goto (WG leader)
National Institute of Advanced Science and Technology (AIST)

ERIA
Economic Research Institute for ASEAN and East Asia

1

Outline of presentation

1. ~~Objective of ERIA Biodiesel Fuel Working Group~~
2. ~~Membership of Working Group~~
3. ~~Research Plan of 2008/2009~~
4. Making a "ERIA Biodiesel Fuel Trade Handbook"
5. Way forwards (WG plan 2009/2010)


Injector
(source : JAMA)


Fuel tank
(source: Fuel Policy Subcommittee)


Engine
(source: JAMA)

2

4. Making a "ERIA Biodiesel Fuel Trade Handbook"

Contents of ERIA Biodiesel Fuel Trade Handbook

1. Introduction
2. Energy Situation in the World
3. Biodiesel Fuel Standardization Activities
   - 3.1 EAS-ERIA Biodiesel Fuel Standard: 2008
   - 3.2 World Wide Fuel Charter - Biodiesel Guideline: July 2008
   - 3.3 Measurement Method of Biodiesel Fuel Characteristics
     - * Existing method will be explained by standard numbers.
     - * New method of oxidation stability, "Petro-Oxi" vs "Rancimat".
     - * Quick and easy analysis method, "i-Spec™ model: Q100"
4. Biodiesel Fuel Quality
   - 4.1 Oxidation Stability
     - 4.1.1 Outline of Oxidation Stability
     - 4.1.2 Antioxidant Additives
     - 4.1.3 Upgrading of FAME by hydrogenation
   - 4.2 Fluidity
     - 4.2.1 Outline of Fluidity
     - 4.2.2 Fluidity Improvers
     - 4.2.3 Other countermeasures: blending with another fuels & winterization

7

4. Making a "ERIA Biodiesel Fuel Trade Handbook"

Contents of ERIA Biodiesel Fuel Trade Handbook

5. Potential of Other Sustainable Feedstock
   - 5.1 Jatropha Curcas L. including toxicity and its countermeasures
   - 5.2 Rice Bran
   - 5.3 Outline of Micro Algae
6. Importance of Quality Control and Market Acceptance
   - 6.1 Quality Control of BDF-Blended Fuels at the Pump in Philippines
   - 6.2 Field Test of BD5, BD20 and BD100 Vehicles in Korea
   - 6.3 Biodiesel Fuel Experience in China
   - 6.4 Community BDF Standard for Agricultural Machine in Thailand
7. Current Status of Biodiesel Fuel in East-Asian Countries
   - 7.1 Australia, 7.2 China, 7.3 India, 7.4 Indonesia, 7.5 Japan, 7.6 Malaysia, 7.7 New Zealand, 7.8 Philippines, 7.9 Singapore, 7.10 South Korea, 7.11 Thailand, 7.12 Vietnam
8. Trade and Market Dynamics of Biodiesel Fuel
9. Future Vision

8

World Wide Fuel Charter - Biodiesel (B100) Guidelines

EAS-ERIA Biodiesel Fuel Benchmark Standard:2008

WWFC

Items	Units	U.S. ASTM D6751-07b	EU EN14214:2003	Japan JIS K2390:2008	EAS-ERIA BDF Standard (EEBS):2008	WWFC Biofuel Guidelines B100 for up to B5 blend
Ester content	mass%	-	96.5 min.	96.5 min.	96.5 min.	96.5 min.
Density	kg/m3	-	860-900	860-900	860-900	Report
Viscosity	mm2/s	1.9-6.0	3.50-5.00	3.50-5.00	2.00-5.00	2.00-5.00
Flashpoint	deg. C	93 min.	120 min.	120 min.	100 min.	100 min.
Sulfur content	mass%	0.0015 max.	0.0010 max.	0.0010 max.	0.0010 max.	0.0010 max.
Distillation, T90	deg. C	360 max.	-	-	-	-
Carbon residue (100%) or Carbon residue (10%)	mass%	0.05 max. -	- 0.30 max.	- 0.3 max.	0.05 max. 0.3 max.	0.05 max. -
Cetane number		47 min.	51.0 min.	51.0 min.	51.0 min.	51.0 min.
Sulfated ash	mass%	0.02 max.	0.02 max.	0.02 max.	0.02 max.	0.005 max.
Water content	mg/kg	0.05[vol%] max.	500 max.	500 max.	500 max.	500 max.
Total contamination	mg/kg	-	24 max.	24 max.	24 max.	24 max.
Copper corrosion		No.3	Class-1	Class-1	Class-1	-
Acid value	mgKOH/g	0.50 max.	0.50 max.	0.50 max.	0.50 max.	0.50 max.
Oxidation stability	hrs.	3 min.	6.0 min.	(*)	10.0 min. (****)	10.0 min.
Iodine value		-	120 max.	120 max.	Reported (***)	130 max.
Methyl Linolenate	mass%	-	12.0 max.	12.0 max.	12.0 max.	12.0 max.
Polyunsaturated FAME (more than 4 double bonds)	mass%	-	1 max.	N.D.	N.D. (***)	1 max.
Methanol content	mass%	0.2 max. (*)	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Monoglyceride content	mass%	-	0.80 max.	0.80 max.	0.80 max.	0.80 max.
Diglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Triglyceride content	mass%	-	0.20 max.	0.20 max.	0.20 max.	0.20 max.
Free glycerol content	mass%	0.020 max.	0.02 max.	0.02 max.	0.02 max.	0.02 max.
Total glycerol content	mass%	0.240 max.	0.25 max.	0.25 max.	0.25 max.	0.24 max.
Na+K	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.	5.0 max.
Ca+Mg	mg/kg	5 max.	5.0 max.	5.0 max.	5.0 max.	5.0 max.
Phosphorous content	mg/kg	10 max.	10.0 max.	10.0 max.	10.0 max.	4.0 max.

(*)deg.C of flashpoint is available instead of measuring methanol content (***) Need data check and further discussion
(****) Need more data & discussion from 6 to 10 hrs.
leet diesel oil specification

10

5. Way forwards (WG plan 2009/2010)

- Finalizing a Biodiesel Fuel Trade Handbook
- Preparation for establishing Chemical Analysis Laboratory
- R&D for quality control/management method of biodiesel fuel in actual market
- Support engineers' skill-up
- Contribution to other international standardization in other regions based on EAS-ERIA Benchmark Standard

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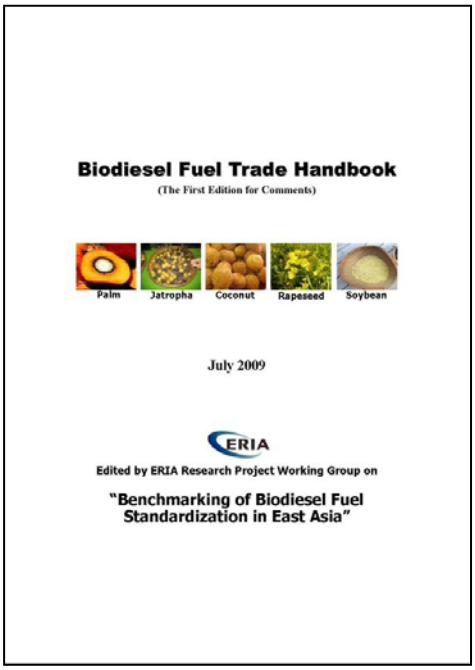
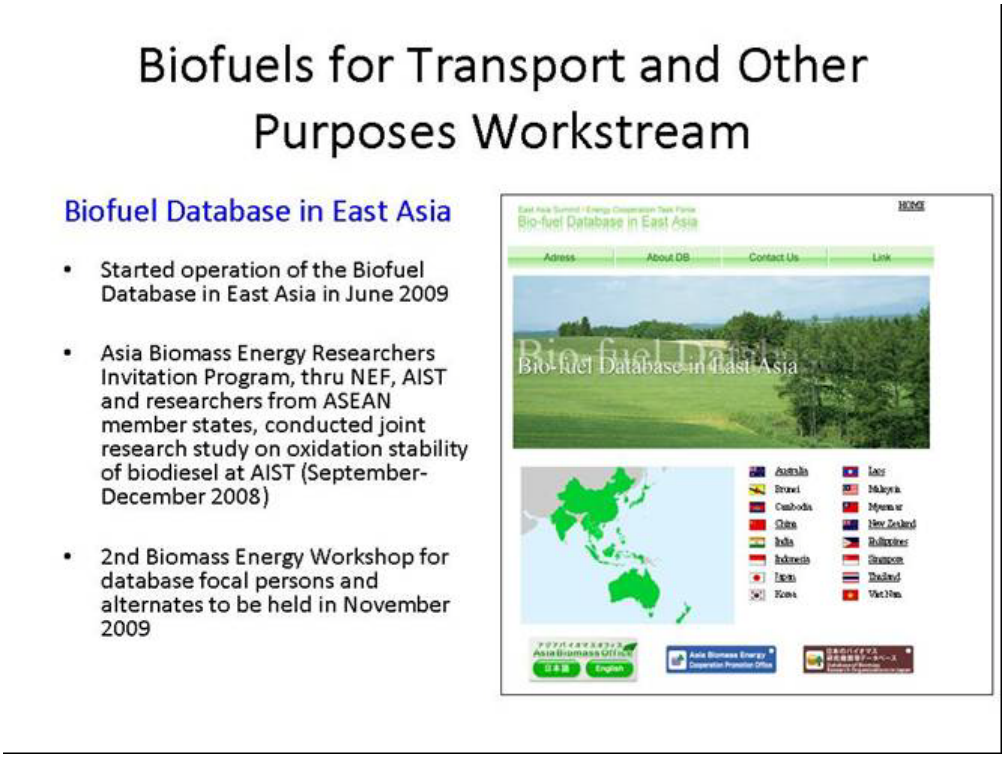


Figure 36 WG outcome and handbook presentation during 11th ECTF Meeting in Mandalay, Myanmar



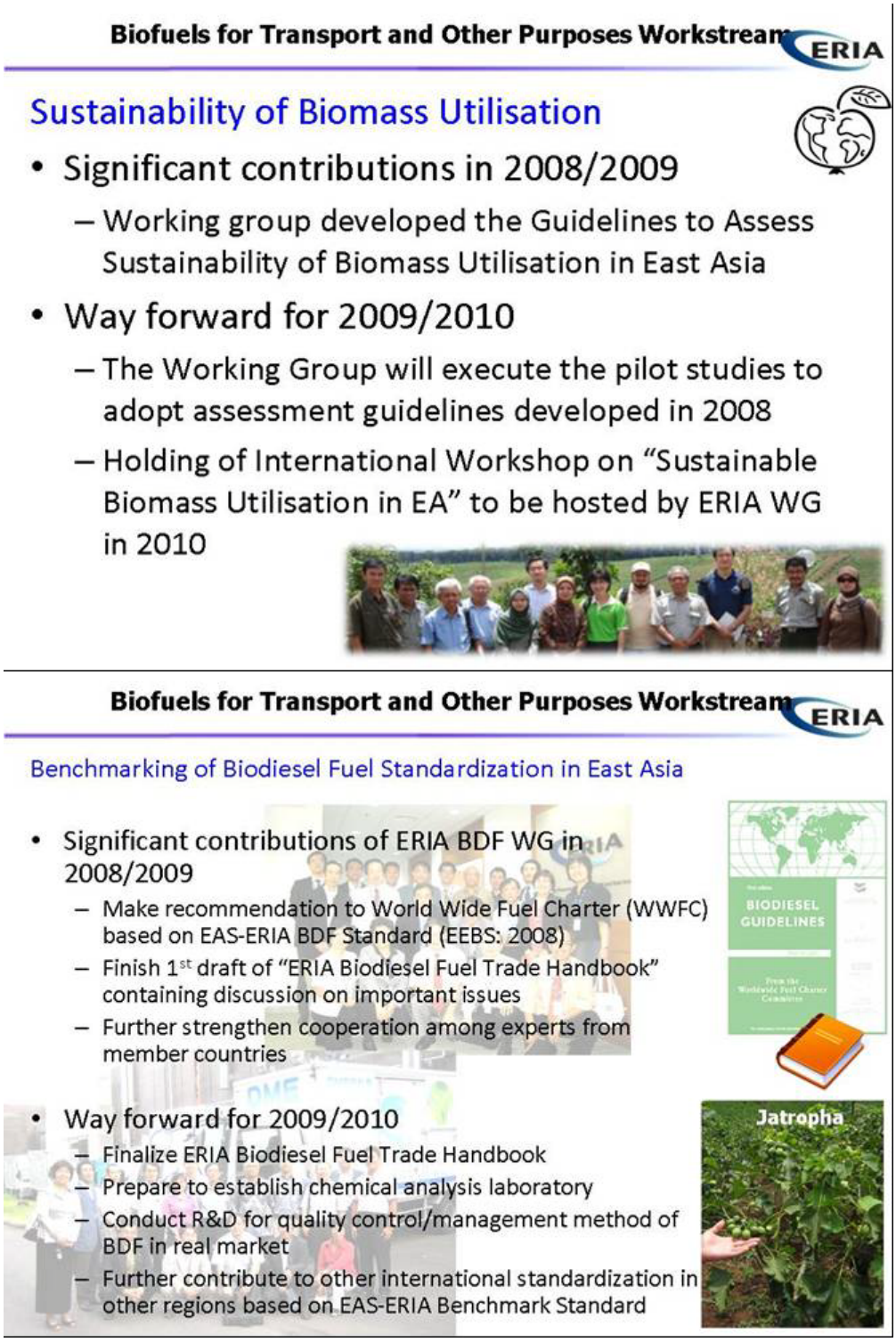


Figure 37 Two ERIA WG presentations during 3rd EAS Energy Ministers Meeting in Mandalay, Myanmar

7. APPENDIX: Biodiesel Fuel Trade Handbook

Biodiesel Fuel Trade Handbook

(The First Edition for Comments)


Palm


Jatropha


Coconut


Rapeseed


Soybean

July 2009

Edited by ERIA Research Project Working Group on

"Benchmarking of Biodiesel Fuel Standardization in East Asia"

Authors

This handbook was edited by ERIA Research Project Working Group on "Benchmarking of Biodiesel Fuel Standardization in East Asia" with result of the studies.
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