Asia-Pacific
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Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

APEC Energy Working Group

April 2018

APEC Project: EWG 20 2016A

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APEC#218-RE-01.6

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Executive Summary

With rising concern on global warming mitigation with various low carbon technologies, sustainable biofuel has been implemented worldwide. In particular, various blends of biodiesel have been introduced and commercially used in the APEC region. Although each economy has its own authority to issue legally complying biodiesel standard, common guidelines toward biodiesel specification would help harmonizing specific properties despite biodiesel feedstock. Since previous APEC EWG 02/2007A investigated on biodiesel standard for low blend (up to 5%), recent trends and initiatives toward high blend of biodiesel (e.g. B20) would need a revisit to discuss upon various issues and concerns on specifications of neat biodiesel and/or biodiesel blend. Two rounds of workshops over a year attended by biodiesel experts from various APEC member economies are set with specific points of discussions to be sent a priori. Those economies with commercial use of biodiesel can share their experiences and scientific evidences as basis for discussion of draft guidelines

Objectives

This project has three key objectives as follows:

1. To develop recommendation for guideline for high biodiesel blend specification.
2. To create a network of biodiesel experts in APEC region for future development of regulatory framework.
3. To ensure workshop participants gain knowledge in recent development of high biodiesel blend being introduced and used in APEC region.

Methodology

This project has four steps to conduct as follows:

1. Set up project team members composed of experts from various institutions selected from APEC member economies, and conduct preliminary analysis on the use of high blend biodiesel among APEC member economies.
2. Hold 1st workshop with APEC experts to discuss and give the additional technical evidences to shape up the draft of guideline.
3. Address concerns and issues from 1st workshop comments in order to modify guideline draft.
4. Hold 2nd workshop with APEC experts to discuss remaining issues and finalize the guideline

Project outcome

This project has expanded the previous APEC project EWG 02 2007A, which investigated on biodiesel standard for low blend (up to 5%), to revisit the guideline issue when biodiesel has been recently used for higher blend, up to 20%. The experts are selected from biodiesel experts from AAF (ASEAN Automotive Federation) and ERIA (Economic Research Institute for ASEAN and East Asia), with their recent attempt to identify regional biodiesel specification. The project held two workshops, the 1st workshop in Pathum Thani, Thailand during 13-14 December 2017 and the 2nd workshop in Honolulu, Hawaii, USA on 19 March 2018. Both workshops were designed to achieve workshop goal via technical background presentation, discussion among experts and active participants, and moderation to address issues/concerns with a focus to draft biodiesel guideline in APEC region. It must be emphasized that this guideline bears no legal binding for participating APEC member economies, but rather serve as technical guideline brainstormed from APEC experts for future reference.

The 1st workshop laid out technical background of those APEC member economies with commercial usage of biodiesel or have concrete plan to do so. Development of biodiesel policy & regulation, biodiesel production industry, biodiesel standard, compliance with auto maker industry and public acceptance were shared among APEC member economies with discussion on lesson learned, best practices and way forward for other APEC member economies of initial stage to implement biodiesel program. Concerns and issues identified from the 1st workshop will be investigated for further fact finding in order to have final discussion at 2nd workshop.

The 2nd workshop was designed to be concise with updates from participating APEC member economies and additional fact finding to address concerns and issues from the 1st workshop. Sufficient discussion was allowed, moderated and steered toward finalizing APEC guidelines for biodiesel and the biodiesel blend diesel at 0-7% and 7-20% levels.

The way forward for this guidelines toward high biodiesel blend diesel (eg B20) specification in the APEC region is served as a reference for not only those APEC member economies that do not yet have standard, but also those with existing standard already but may consider for harmonization in order to promote cross-border trading of biodiesel within APEC region. This guideline, by no mean, carries implication for conforming by each of APEC member economies.

Project Background

Many of APEC member economies have used biodiesel from various feedstock as a blending component at various percentages in diesel fuel and various levels of utilization. For example, commercial diesel sold at retailed stations in Thailand has been mixed with palm biodiesel up to 7 vol% with Thai energy plan to increase blending wall to 10 vol% in the near future. On the other hand, Malaysia has recently announced to introduce B10 in the market in 2016 but has to delay due to high palm oil price; whereas, Indonesia has effectively implemented B20 plan since 2016 after the subsidy scheme was in place. US has also currently used B20 in some area. However, recently available biodiesel standards only specifies pure biodiesel (B100) such as EN 14214 and ASTM D6751 while biodiesel-blended diesel follows standards for fossil diesel except for ASTM D7467, which was issued for diesel with 6-20% (B6-B20) in the US. Consequently, there are very limited support and no warranty acceptance from the Engine manufacturers, Fuel Injection Equipment (FIE) or Original Equipment Manufacturers (OEMs) for the use biodiesel blended in diesel more than 7 vol%. A neat biodiesel specification for the high blend and/or a separate specification for the high blend itself (e.g. B20) are required to promote renewable biodiesel fuel worldwide. Therefore, the guidelines toward those standard is the important step to achieve approved standard among APEC member economies.

As a follow up from APEC EWG 02/2007A that investigate biodiesel standard for low blend (up to 5%), guidelines toward high biodiesel blend diesel (e.g. B20) specification will benefit all the APEC member economies as well as various organizations such as government, private, public, user and academic sectors. Common guideline for high biodiesel blend would help facilitate trading among APEC member economies with different feedstock and also growing up the biodiesel industry and economy.

The project aims to involve several stakeholders related to biodiesel in APEC member economies, ranging from biodiesel production industry, standardization body and automotive industry, who will use biodiesel-blended diesel fuel. Discussion during seminars/workshops on technical aspects of biodiesel specification and its effect on engine usage up to B20 will be conducted with an attempt to reach some common understandings/guidelines with perhaps harmonization of previously existing standards to promote common trade of biodiesel fuel among APEC economies. During such discussion, developing APEC member economies will benefit from capacity building on technical knowledge shared from developed APEC member economies

with constraints and concerns specified by developing APEC member economies. Level of engagement by developing APEC member economies could range from working group member, supporting member and participates to arranged seminars/workshops.

The main goal of this project is to formulate technical guidelines for high biodiesel blend Diesel (up to B20) specification in the APEC region, which should be treated as reference for regulator/authority in APEC member economies without any legal binding implication from participating APEC member economies. Specifically, the project objectives are

1. Set up project team members composed of experts from various institutions selected from APEC member economies, and conduct preliminary analysis on the use of high blend biodiesel among APEC member economies.
2. Hold 1st workshop with APEC experts to discuss and give the additional technical evidences to shape up the draft of guideline.
3. Address concerns and issues from 1st workshop comments in order to modify guideline draft.
4. Hold 2nd workshop with APEC experts to discuss remaining issues and finalize the guideline

Project Methodology

To achieve the main goal previously identified, the project implementation is divided into four steps as follows.

First, the project team members were established from a network of biodiesel experts from related group in APEC member economies, such as AAF (ASEAN Automotive Federation), which has members from various automotive associations in ASEAN, and ERIA (Economic Research Institute for ASEAN and East Asia), which has technical working group on biofuel standardization in East Asia Summit (EAS). With the knowledge and experience in biodiesel matter, the project team members can help speed up the investigation and discussion targeting specific technical issues and concerns in implementing high blend of biodiesel, up to B20. Without political binding of project team members, they can freely discuss based on scientific evidence. Preliminary analysis on the use of high blend biodiesel among APEC member economies was conducted with information sharing and discussion among project team members. Depending on the availability of all project team members, if any member cannot participate in either workshop, they can submit comments to project team leader prior to the event.

Second, the first workshop was held as a platform for project team members, experts and active participants from APEC member economies to share information regarding a development of biodiesel policy & regulation, biodiesel production industry, biodiesel standard, compliance with auto maker industry and public acceptance with discussion on lesson learned, best practices and remaining issues as a way forward for other APEC member economies of initial stage to implement biodiesel program. Discussion will focus on vehicle requirements from Original Equipment Manufacturers (OEMs), including engine and Fuel Injection Equipment (FIE) manufacturers, as well as, biodiesel producers' constraints to meet the standard. Consumer needs, market impacts and the implementation by governments/policy makers will be considered for the development of recommendations and guidelines for high biodiesel blend diesel (neat biodiesel and/or biodiesel blend) specification, which is targeted for feedstock neutrality.

Third, concerns and issues identified from the 1st workshop were consulted among project team members, and other experts if needed, as a follow up for further fact finding in order to have final discussion at 2nd workshop.

Fourth, the second workshop was held to have updates from participating APEC member economies with focus on addressing concerns and issues from the 1st workshop. Interactive discussion was encouraged and moderated in order to get

consensus among participants as APEC guidelines toward high biodiesel blend diesel (up to B20) specification in the APEC region.

Project Team Members

Table 1 shows the list of project team leader, members and coordinators representing 7 economies. Out 10 members, there are well balanced of 4 women & 6 men, 2 government & 2 university & 5 research institute & 1 private sector.

Table 1: Lists of APEC project EWG 20 2016A team members

No	Name	Affiliation	Economy	Gender	Position in project	Email
1	Dr Nuwong Chollacoop	National Metal and Materials Technology Center (MTEC)	Thailand	M	Head	nuwongc@mtec.or.th
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4	Dr Yuji Yoshimura	National Institute of Advanced Industrial Science and Technology (AIST)	Japan	M	Expert	y.yoshimura@aist.go.jp
5	Mr Tomoaki Kakihara	Japan Automobile Manufacturing Association (JAMA)	Japan	M	Expert	Tomoaki_Kakihara@notes.isuzu.co.jp
6	Prof. Ocktaeck Lim	University of Ulsan	Republic of Korea	M	Expert	otlim@ulsan.ac.kr
7	Dr Harrison L.N. Lau	Malaysian Palm Oil Board	Malaysia	M	Expert	harrison@mpob.gov.my
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Summary of 1st workshop

The 1st APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region was held during 13-14 December 2017 in Pathum Thani, Thailand, with the main objective to provide technical background of biodiesel development and utilization in selected APEC member economies, as well as to start discussion on draft guidelines for high biodiesel blend diesel (up to 20%). The agenda is shown in Table 2, where on the 1st day, the workshop was honored to have opening speech by Mr Yongyuth Sawatdisawanee, as shown in Figure 1, Deputy Director General of Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy, who is a key high-ranked government official to push forward biodiesel utilization in Thailand. He was aware of this project and looked forward to the project output so that Thailand, among many other APEC member economies, can join hand to proceed toward the use of high biodiesel blend diesel in the near future.

Table 2: Agenda of the 1st APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

The 1st APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

13-14 December 2017

Convention Center Room CC405

Thailand Science Park, Pathumthani, Thailand (https://goo.gl/maps/e9rEp72J4F12**)**

Day 1: Presentation and discussion

Agenda: Wednesday 13 December	
08.30	Registration
09.00	Opening Session and Workshop/Project Overview Welcoming Remark by Dr Aree Thanaboonsombut, Deputy Executive Director, MTEC Project overview by Ms Munlika Sompranon, DEDE & EGNRET Representative Opening Speech by Mr Yongyuth Sawatdisawanee, Deputy Director General, DEDE Group Photo
09.30	**Keynote – Overview of biodiesel development in Thailand** Dr Apiradee Thammanomai Department of Alternative Energy Development and Efficiency (DEDE)
10.00	Coffee Break

Agenda: Wednesday 13 December	
10.30	**Overview of biodiesel specifications from around the world** **People's Republic of China**: Ms DU Guomin, Division Chief of Development Strategy, PetroChina Planning and Engineering Institute **Indonesia**: Prof. Tatang Hernas Soerawidjaja, Head of Center for Research on Natural Resource Utilization, Institut Teknologi Bandung (ITB) **Malaysia**: Dr Harrison Lau Lik Nang, Leader of Biodiesel Technology Group, Malaysian Palm Oil Board (MPOB)
12.00	**Lunch**
13.00	**Overview of biodiesel specifications from around the world (cont'd)** **Republic of Korea**: Prof. Ocktaeck Lim, University of Ulsan **Philippines**: Mr Ricardo S. Infante, Supervising Science Research Specialist, Department of Energy (DOE) **Thailand**: Dr Manida Tongroon, National Metal and Materials Technology Center (MTEC)
14.30	**Concern from automotive makers for higher blend of biodiesel** Mr Tomoaki Kakihara, Chairman of Diesel Fuel Experts Group, Japan Automobile Manufacturing Association (JAMA), Japan
15.00	Coffee Break
15.30	**Discussion on guidelines toward high biodiesel blend diesel** • Moderator will ask for opinion from participants on each technical specification
16.00	**Way forward for guidelines toward high biodiesel blend diesel** • Based on discussion from biodiesel producers and car makers, a way forward for guideline on high biodiesel blend diesel will be formulated.
16.30	**Wrap up** • The moderator will provide feedback and recommendations on potential guideline. All the feedback will be compiled for further discussion.
18.00	Welcome Dinner

Day 2: Thailand case study for higher blend of biodiesel & Site visit (by invitation)

Agenda: Thursday 14 December	
08.30	Registration
09.00	**Overview of Thailand case study for higher blend of biodiesel** Dr Nuwong Chollacoop, National Metal and Materials Technology Center (MTEC)
09.30	**Introduction of H-FAME Technology for Thai B10 program** Dr Yuji Yoshimura

Agenda: Thursday 14 December	
	Emeritus Researcher, National Institute of Advanced Industrial Science and Technology (AIST)
10.00	Coffee Break
10.30	**Site visit to H-FAME pilot plant at Thailand Institute of Scientific and Technological Research (TISTR)** https://goo.gl/maps/VVqBPFkcjmN2
12.00	**Lunch**
13.00	**Site visit to Thai commercial biodiesel plant: Bangchak Biofuel (**https://goo.gl/maps/xGHbk5wGbsS2**)**

Figure 1: Opening session of the 1st workshop

TOP: (left) Welcoming Remark by Dr Aree Thanaboonsombut, Deputy Executive Director, MTEC, (middle) Project Overview by Ms Munlika Sompranon, DEDE & EGNRET Representative, (right) Opening Speech by Mr Yongyuth Sawatdisawanee, Deputy Director General, DEDE

1st workshop participants

As shown in Figure 2 and

Table 3, the workshop was attended by 58 participants from 8 APEC member economies with a ratio of female ratio of 45% (26 women and 32 men).

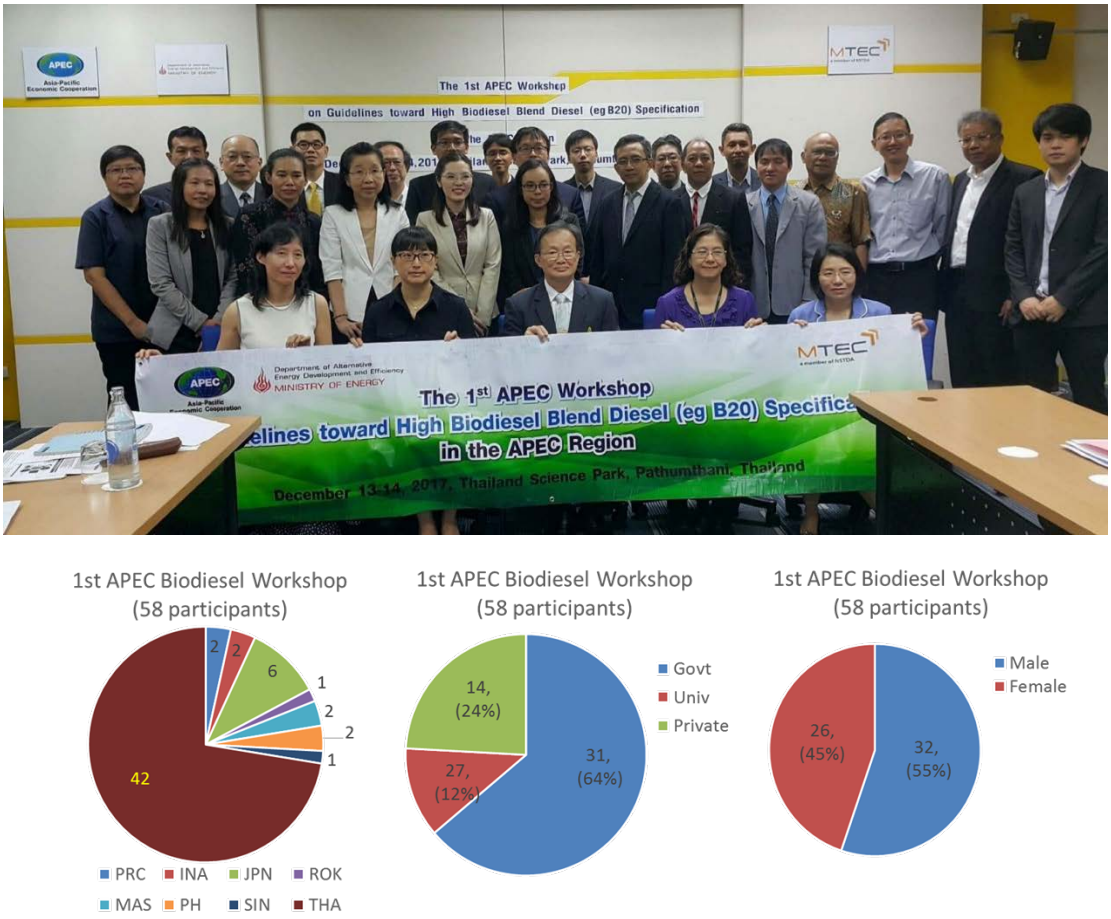

Figure 2: Group photo of the 1st workshop with breakdown statistics

Table 3: List of participants to 1st APEC Workshop

No	Name	Affiliation	Economy	Gender	Email
1	Mr Yongyuth Sawatdisawanee	Deputy Director General, Department of Alternative Energy Development and Efficiency (DEDE)	Thailand	M	yongyuth_s@dede.go.th
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3	Dr Sumittra Charojrochkul	Director Materials for Energy Research Unit (MTEC)	Thailand	F	sumittrc@mtec.or.th
4	Ms Munlika Sompranon	DEDE & EGNRET Representative	Thailand	F	munlika_s@dede.go.th

No	Name	Affiliation	Economy	Gender	Email
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9	Dr Yuji Yoshimura	Emeritus Researcher, National Institute of Advanced Industrial Science and Technology (AIST)	Japan	M	yoshimura.yuji@friends.jica.go.jp
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11	Dr Harrison Lau Lik Nang	Malaysian Palm Oil Board (MPOB)	Malaysia	M	harrison@mpob.gov.my
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1st workshop presentation and discussion

The 1st workshop was structured for 2 days with the first day composed of various technical presentations from participating APEC member economies and concern from auto maker, followed by the discussion on guidelines toward high biodiesel blend diesel. The second day will focus on the case study of Thailand with current initiative to increase blending level from 7% to 10% via upgrading technology called “H-FAME” (partially Hydrogenated Fatty Acid Methyl Ester) to improve the biodiesel quality. Presentation on H-FAME technology was delivered by the inventor, Dr Yuji Yoshimura, who has led the 6-year Japan-Thailand collaborative research project “Innovation on Production and Automotive Utilization of Biofuels from Non-Food Biomass” with the H-FAME technology output. Then, the participants were taken to see the pilot-scale H-FAME reactor at Thailand Institute of Scientific and Technological Research (TISTR), and the demonstration scale at Bangchak Biofuel Co., Ltd. Figure 3 showed various presentations and discussion; whereas, Figure 4 showed technical

visit. Presentation file is shared at http://www.egnret.ewg.apec.org/index.php/en/node/102.

Figure 3: Various presentations and discussion during the 1st workshop

Figure 4: Technical visits during the 1st workshop

The keynote speech on “Biodiesel policy in Thailand” was delivered by Dr Apiradee Thammanomai from Department of Alternative Energy Development and Efficiency (DEDE) focusing on one of the five Thailand Energy Masterplan, namely Alternative Energy Development Plan (AEDP 2015-2036), which focuses on promotion of alternative energy including biofuel. The target of 14 million liters per day (ML/d)

consumption was set in the year 2036 with currently (data of the year 2016) only 3.37 ML/d was used; hence, there exists the gap of almost 11 ML/d to achieve in 10 years. Main feedstock of biodiesel in Thailand is palm oil with 85% plantation area in the southern part. Given the uncontrollable weather, the production of palm oil has been fluctuation so the government by Ministry of Energy has embarked on the use of biodiesel to stabilize palm oil supply. Thailand has started biodiesel program since 2008 with optional B2 commercially available. Over time, the blending level has slowly increased till May 2011, where a blending mandate of 3-5% level was made depending on the palm oil supply. The major step was the B5 mandate in January 2012 and B7 mandate in January 2014. Of course, if there is a shortage in palm oil, the blending level can be adjusted accordingly. The price structure of Thai biodiesel was explained with the higher cost of biodiesel than fossil diesel (due to low oil price) being born by all users of diesel fuel. With the increasing supply of palm oil, the relatively constant domestic consumption by cooking oil, and not so competitive export, biodiesel consumption is the only way to manage increasing palm oil supply. Hence, increasing the blending wall from 7% in B7 to B10 or B20 in the future will be the focus for Ministry of Energy.

Next is presentation by Ms Du Guomin from People's Republic of China, where there are 2 biodiesel specification, B5 (with label 5, 0 & -10 for minimum temperature of 8, 4 and -5 °C, respectively) and B100 (for 10 & 50ppm sulfur content corresponding to Euro V & VI equivalent). Prior to 2017, B5 and B100 standards were separate but got combined after 2017. In 2010, there were more than 150 biodiesel manufacturers with total capacity of 3.5 million tons per year (actual production is more than 1 million ton) but only 40-50 of them are currently running to produce a total of 0.5-0.8 million tons per years (mainly due to high price of raw materials) with the largest producer of 0.2 million tons/year in operation in Hainan in 2014. Main feedstock in China is wasted animal and vegetable oils and fats without competing for food or land. In China, 50% of biodiesel is used in industry, 20% in agricultural machinery and ships, and 30% in transportation. Even though there are no mandatory policies to use biodiesel, it is encouraged to use biodiesel in Beijing, Tianjin, Hebei province, Yangtze River Delta and Pearl River Delta region with priority on government vehicle and public transportation. Since 2010, B5 have been sold at gas station in Yunan provinces and Shanghai. Tax incentives include exemption from consumption tax and return of 70% of value added tax. With the government renewable energy target in 2020, about 2 million tons of biodiesel will be used.

Next is presentation by Prof. Tatang Soerawidjaja from Indonesia. In August 2013, Indonesian government (through Energy and Mineral Resources Ministerial

Decree No. 23/2013) decided that by 2016, the biodiesel blend level in automotive diesel fuel must already reach 20%. To implement this policy, the National Technical Committee on Biofuel Standard then conducted numerous stakeholders' meetings and organized the needed tests to improve the then existing biodiesel specification (SNI 7182 -2012) and thus formulating a new quality standard that would allow the 20% vol blend level of biodiesel, SNI 7182-2015. The improvement from 2012 standard included lower sulfur (100 → 50 ppm), lower phosphorous (10 → 4 ppm), lower acid value (0.6 → 0.5 mgKOH/g), higher oxidation stability (Rancimat 6 → 8 hours or Petro-Oxy 27 → 36 min), and addition of monoglyceride (0.8%) parameter. Through Energy and Mineral Resources Ministerial Decree No. 12/2015, the government has recently decided that the biodiesel blend level in automotive diesel fuel will be increased to 30 % starting in January 2020, where preliminary study conducted by the Agency for Assessment and Application of Technology indicated that the maximum limit of monoglyceride content should be decreased to 0.6%-mass. Further study is ongoing.

Next is presentation by Dr Harrison Lau Lik Nang from Malaysia. Biodiesel in Malaysia has started in R&D scale since 1982 with pilot plant being built and commissioned in 1985 to produce palm biodiesel for engine testing. After extensive trial and testing, palm biodiesel was used as diesel substitute in 1995. Malaysian Palm Oil Board (MPOB) has built 8 biodiesel plants within Malaysia and 4 plants abroad. The National Biofuel Policy launched in March 2006 has put 1 of 5 thrust on biofuel for transport, where biodiesel in-line blending facilities at 35 petroleum depots throughout Malaysia has been invested by the government during 2011-2015 before B7 can be used in all regions of Malaysia. However, 9 plants with total annual capacity of 675,740 tons/year are not in operation (as of June 2017) leaving 22 plants with 2,678,000 tons/year in operation due decrease in export demand (2016 biodiesel production capacity utilization of only 24.2%). Hence, Cabinet decision on implementation of B10 for transportation sector was announced in June 2016 except B7 in highlands region and Euro 5 station. However, due to huge price gap between Brent crude oil and palm oil, the government decided to defer the B10 implementation plan. Since the first palm biodiesel in 2008 (MS 2008), the first revision in 2014 has deleted requirement on carbon residue, increased oxidation stability from 6 to 10 hours, decreased monoglyceride from 0.8% to 0.7% and decreased phosphorous from 10 to 4 ppm. Currently, many B10/B20 trial project in cooperation with JAMA (Japan Automobile Manufacturing Association) has been conducted in order to achieve short term goal of B15 in 2020.

Next is presentation by Prof. Ocktaeck Lim from Republic of Korea. Biodiesel in Korea was used since it was mandated by RFS (renewable fuel standard) with

historical usage dated back since 2007 at 0.5% blending target with government incentive. The blending level has increased to 2% in 2012 under Petroleum Alternative Fuel Act, and 2.5% in 2015 under Renewable Fuel Act with the plan to increase to 3% in 2018. Currently, there are 7 biodiesel plants with total production capacity of 854,068 KL/year with main feedstock from waste cooking oi (palm biodiesel cannot be used in winter). Korean biodiesel specification is similar to EN standard since 2006.

Next is presentation by Mr Ricardo S. Infante from the Philippines. Under Biofuels Act of 2006, biodiesel has been mandated at 1% blending in 2007, and 2% blending in 2009, where Philippine National Standard (PNS) covers B2, B5 and B100 with coconut oil as main feedstock. Currently, there are 11 accredited biodiesel producers with total production capacity of 574.9 million liters/year. According to fuel quality roadmap, B5 was planned to be introduced during 2016-2017 but was postpone due to some issues about flake formation in B5, which cold soak filter test (CSFT) has been used to screen the quality.

Next is presentation by Dr Manida Tongroon from Thailand. Based on EN standard, the 1st B100 specification was issued in 2005 for 0-5% blending (oxidation stability > 6 hours, monglyceride < 0.8 wt% and water < 0.05 wt%), which was revised in 2007 (change in water and total contaminate measurement methods), 2009 (oxidation stability > 10 hours) and 2013 (monglyceride < 0.7 wt%). The current mandate blending level is up to 7% depending on price and supply of palm oil.

Next is presentation on concern from automotive makers for higher blend of biodiesel by Mr Tomoaki Kakihara from Japan Automobile Manufacturing Association (JAMA). With Japanese vehicle domination in ASEAN region, JAMA has often been consulted for requirement on higher blend of biodiesel usage. JAMA has issued global statement to accept 5-7% biodiesel blend (http://www.jama.or.jp/eco/wwfc/pdf/JAMA_FQ_PositionStatement_FAME.pdf) with supplemental (regional) statement to accept up to 20% blend under certain biodiesel quality improvement, vehicle emission standard and surrounding conditions (http://www.jama.or.jp/eco/wwfc/pdf/FAME_JAMA_Supplementary_Position_Statement_December2016.pdf). Worries are for > B7 with Euro4 emission regulation (due to effect of biodiesel on diesel particulate filter, DPF) and > B20 with any Euro emission regulation. Compared to fossil diesel, biodiesel shows different characteristics, such as easier to oxidize and deteriorate (corrosion), easier to produce precipitate (fuel filter clogging), higher boiling point (oil dilution), higher capability in water absorption (corrosion), lower calories (lower exhaust gas temperature) and higher solubility (sludge peeling off). Each of the different characteristics and potential damage to

engine was carefully explained to underline the need for mutual cooperation between biodiesel producer and car maker in pursuing safe use of higher biodiesel blending.

Prior to discussion on guidelines toward high biodiesel blend diesel, Dr Nuwong Chollacoop from Thailand presented an overview of ASTM and EN standards for biodiesel and biodiesel blending in diesel, as well as various attempts to harmonize biodiesel specification, such as APEC, TriPartite (Brazil-EU-US), WWFC (Worldwide Fuel Charter), EAS (East Asian Summit) and AAF (ASEAN Automotive Federation). Lesson learned from various attempts are that it is difficult to enforce mandatory regional specification due to wide ranges of acceptable properties in particular oxidation stability and blending limit. It is best to have reference standard for interested APEC member economies to consider. After the presentation, the discussion was focused on technical specification from each of participating APEC member economies. All participants were strongly encouraged to express his/her opinions, viewpoints, worries in order to constructively align different opinions before arriving at the consensus to use AAF recommendations, as shown in Table 4, as a draft for further discussion in the 2nd workshop.

Table 4: AAF recommendation for biodiesel and diesel specifications

☐ Recommended B100 Spec. for B7 & (B7-B20) JAMA

- Requirements for B100

Property items	Unit	Requirement
FAME content	mass%	96.5 min.
Density, @15℃	g/cm3	Report
Viscosity, @40℃	mm2/s	2.0 - 5.0
Flash point	℃	100 min.
Sulfur content	ppm	10 max.
Carbon residue, 10%	mass%	0.3 max.
Carbon residue, 100%	mass%	0.05 max.
Cetane number	-	51 min.
Sulfated ash content	mass%	0.02 max.
Water content	**ppm**	**500 max.**
Total contamination	ppm	24 max.
Copper corrosion	-	Class 1 max.
Acid number	mgKOH/g	0.50 max.
Oxidation stability		
Rancimat method	hrs	**10 min.**
Iodine number	-	120 max.

Property items	Unit	Requirement
Linolenic acid methyl ester	mass%	12.0 max.
Methanol content	mass%	0.20 max.
Mono-glyceride content	mass%	**a. 0.70 / 0.60*1 max.** **b. Determined by field test *4**
Di-glyceride content	mass%	0.20 max.
Tri-glyceride content	mass%	0.20 max.
Free glycerin	mass%	0.02 max.
Total glycerin	mass%	0.25 max.
Metals (Na + K)	ppm	5.0 max.
Metals (Ca + Mg)	ppm	5.0 max.
Phosphorus content	ppm	4.0 max.
Cloud point	℃	**16 / 13*2 max.**
CFPP	℃	**13 / 10*3 max.**

- ***1, 2 & 3: applicable in the region where out-side temp. bellow 5℃ in Winter (at cool condition).**
- ***4:MG limit must be specified by precipitate test at residential region with lowest temperature in the country.**

☐ AAF Recommendation for Diesel Spec.

- Requirements for Euro4 Diesel Fuel

Property items	Unit	Requirement
Density, @15℃	g/cm3	0.820 - 0.845
Cetane number	-	51 min.
Cetane index	-	51 min.
Viscosity, @40℃	mm2/s	2.0 - 4.5
Sulfur content	ppm	**50 max.**
Flash point	℃	55 min.
Distillation		
T50	℃	Report
T90	℃	Report
T95	℃	360 max.
End point	℃	Report
PAH	mass%	**11 max.**
Oxygenates		
FAME content	vol.%	a. 7 max. b. 7 – 20 (PME)*1
Alcohols content	vol.%	Not detected
Lubricity (HFRR)	μm	460 max.

Property items	Unit	Requirement
Carbon residue, 10%	mass%	0.30 max.
Cloud point	℃ (max.)	Decided by out-side temp. in Winter (at cool condition)
Pour point	℃ (max.)	
CFPP	℃ (max.)	
Water content	ppm	200 max.
Oxidation stability-1		
conventional method	g/m3	25 max.
Oxidation stability-2		
modified Rancimat method*2	hrs	**35 min.**
⊿TAN method*3	mgKOH/g	**0.12 max.**
PetroOXY method*4	minutes	**65 min.**
Copper corrosion	-	1 max.
Total contamination	mg/kg	**24 max.**
Ash content	mass%	0.01 max.

*1: 7-20 % is applicable with PME (Palm Methyl Ester) only.
*2, 3, 4: At least one method out of three is required.

☐ AAF Recommendation for Diesel Spec.

- Requirements for Euro5 Diesel Fuel

Property items	Unit	Requirement
Density, @15℃	g/cm3	0.820 - 0.845
Cetane number	-	51 min.
Cetane index	-	51 min.
Viscosity, @40℃	mm2/s	2.0 - 4.5
Sulfur content	ppm	**10 max.**
Flash point	℃	55 min.
Distillation		
T50	℃	Report
T90	℃	Report
T95	℃	360 max.
End point	℃	Report
PAH	mass%	**8 max.**
Oxygenates		
FAME content	vol.%	7 max.
Alcohols content	vol.%	Not detected
Lubricity (HFRR)	μm	460 max.

Property items	Unit	Requirement
Carbon residue, 10%	mass%	0.30 max.
Cloud point	℃ (max.)	Decided by out-side temp. in Winter (at cool condition)
Pour point	℃ (max.)	
CFPP	℃ (max.)	
Water content	ppm	200 max.
Oxidation stability-1		
conventional method	g/m3	25 max.
Oxidation stability-2		
modified Rancimat method*2	hrs	**35 min.**
⊿TAN method*3	mgKOH/g	**0.12 max.**
PetroOXY method*4	minutes	**65 min.**
Copper corrosion	-	1 max.
Total contamination	mg/kg	**24 max.**
Ash content	mass%	0.01 max.

*2, 3, 4: At least one method out of three is required.

AAF Recommendation for Euro6 Diesel Spec.

Property Items	Unit	Requirement
Density @15 C	g/cm^3	0.82 – 0.845
Cetane Number	-	51 min.
Cetane Index	-	51 min.
Viscosity @40 C	mm^2/s	2.0 – 4.5
Sulfur Content	ppm	10 max
Flash Point	℃	55 min.
Distillation		
T50	℃	Report
T90	℃	Report
T95	℃	360 max.
End Point	℃	Report
PAH	mass%	7 max.
Oxygenates		
FAME Content	vol.%	7 max.
Alcohols Content	Vol.%	Not Detected
Lubricity (HFRR)	μm	460 max.

Property Items	Unit	Requirement
Carbon Residue 10%	mass%	0.30 max.
Cloud Point	℃(max)	Decided by out-side temperature in winter (at cool condition)
Pour Point	℃(max)	
CFPP	℃(max)	
Water Content	ppm	200 max.
Oxidation Stability-1		
Conventional Method	g/m^3	25 max.
Oxidation Stability-2		
Modified Rancimat*1	hr	35 min.
⊿TAN *2	mgKOH/g	0.12 max.
PetroOXY*3	Minutes	65 min.
Copper Corrosion	-	1 max.
Total Contamination	mg/kg	24 max.
Ash Content	mass%	0.01 max.

**1,2,3: At least one method out of three is required.*

On the second day focusing on Thailand case study for higher blend of biodiesel, the first presentation by Dr Nuwong Chollacoop from Thailand covered current initiative put forth by DEDE to technically and economically demonstrate biodiesel upgrading technology (H-FAME) in a larger scale by scaling up H-FME reactor in the participating commercial biodiesel plant and conducting on-road test with many new and old vehicles, as shown in Figure 5.

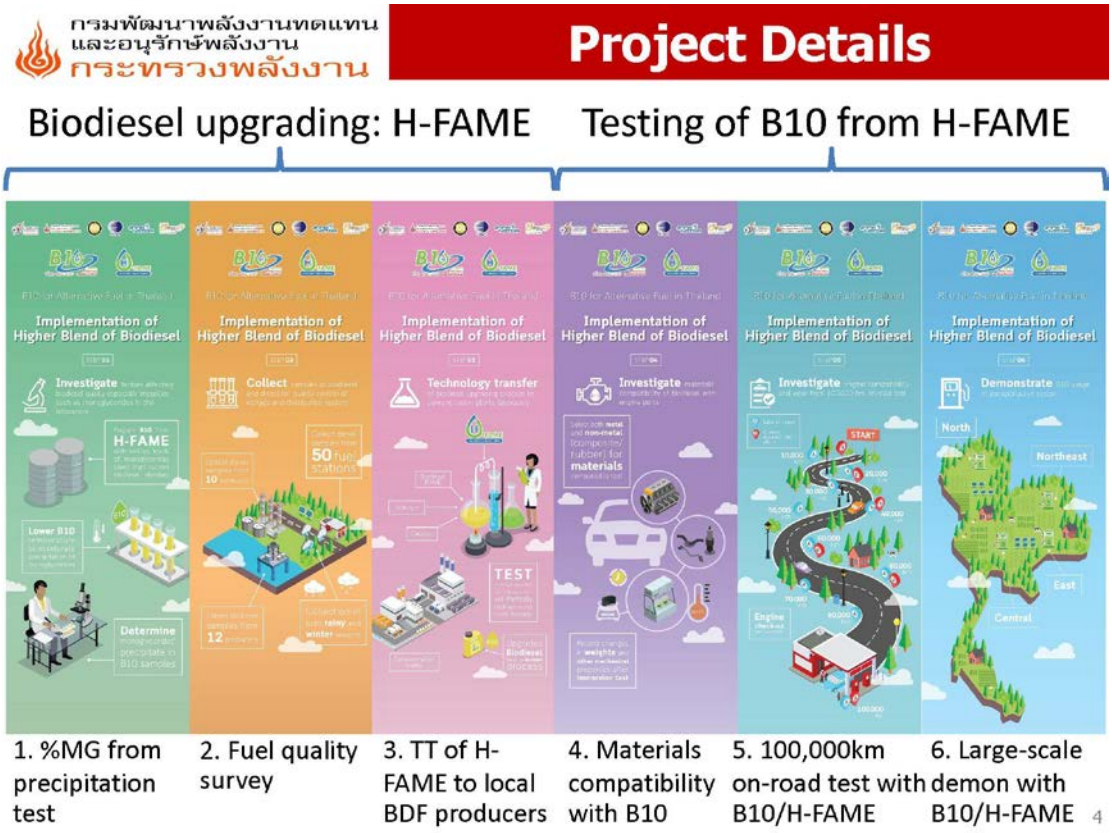

Figure 5: Thailand project on B10

Next is presentation on H-FAME technology by Dr Yuji Yoshimura from Japan, who has been working under Japan-Thailand collaborative research project on biodiesel upgrading technology. This partial hydrogenation technology was developed as a transition choice before 2nd generation bio-hydrotreated diesel (BHD) technology since H-FAME technology consumes less hydrogen at lower temperature. In addition to technical advantage, H-FAME technology offers relatively cheaper solution while retaining biodiesel industry (if BHD, biodiesel producer will be bypassed). Then, technical visits to pilot scale at Thailand Institute of Scientific and Technological Research (TISTR) and demonstration scale at Bangchak Biofuel could really show workshop participants how lab scale technology could be scaled up.

Summary of 2nd workshop

The 2nd APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region was held on 19 March 2018 in Honolulu, Hawaii, USA, with the main objective to follow up discussion from 1st workshop and finalize draft guidelines for high biodiesel blend diesel (up to 20%). The agenda is shown in Table 5, where the director of Hawaii Natural Energy Institute (HNEI) and representative from EGNRET could join the opening session, as shown in Figure 6.

Table 5: Agenda of the 2nd APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

The 2nd APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

19 March 2018

Territorial 1&2, Hilton Waikiki Beach Hotel, Hawaii, USA

Monday 19 March 2018

Agenda	
08.30	Registration
09.00	Opening Session and Workshop/Project Overview Welcoming Remark by Dr Richard Rocheleau, HNEI Director Project overview by Dr Tom, H. T. Lee, EGNRET Representative Opening Speech by Ms Sutharee Kiatman, DEDE, Thailand Group Photo
09.20	**Keynote – Overview of bioenergy development in Hawaii** Dr Scott Q. Turn Researcher, Hawaii Natural Energy Institute (HNEI), University of Hawaii
09.50	**Keynote – Overview of biodiesel development in Hawaii** Mr Robert King Pacific Biodiesel Technologies
10.20	Coffee Break
10.50	**Update of biodiesel specifications for high blend from around the world** **Indonesia**: Prof. Tatang Hernas Soerawidjaja, Head of Center for Research on Natural Resource Utilization, Institut Teknologi Bandung (ITB) **Malaysia**: Dr Harrison Lau Lik Nang, Leader of Biodiesel Technology Group, Malaysian Palm Oil Board (MPOB) **Thailand**: Dr Manida Tongroon, National Metal and Materials Technology Center (MTEC)

	USA: Prof. Scott Q. Turn, Hawaii Natural Energy Institute (HNEI), University of Hawaii
12.30	Lunch
14.00	**Summary from 1st workshop** Dr Nuwong Chollacoop, MTEC
14.20	**Items to be considered in establishing to Guidelines of High-FAME Blends** Mr Tomoaki Kakihara, Chairman of Diesel Fuel Experts Group, Automobile Manufacturing Association (JAMA), Japan
14.40	**Thailand case study on low carbon transportation** Mr Siamnat Panassorn, Tripetch Isuzu Sales, Co., Ltd., Thailand
15.00	**Discussion on guidelines toward high biodiesel blend diesel** • Moderator will ask for opinion from participants on each technical specification
15.30	Coffee Break
16.00	**Drafting guidelines toward high biodiesel blend diesel** • Based on discussion from 1st and 2nd workshop, a draft for guideline on high biodiesel blend diesel will be formulated.
17.00	**Wrap up** • The moderator will provide feedback and recommendations on potential guideline. All the feedback will be compiled for further discussion.

Figure 6: Opening session of the 2nd workshop

TOP: (left) Welcoming Remark by Dr Richard Rocheleau, HNEI Director, (middle) Project Overview by Dr Tom, H. T. Lee, EGNRET Representative, (right) Opening Speech by Ms Sutharee Kiatman, DEDE, Thailand

2nd workshop participants

As shown in Figure 7 and Table 6, the workshop was attended by 25 participants from 9 APEC member economies with a ratio of female ratio of 40% (10 women and 15 men).

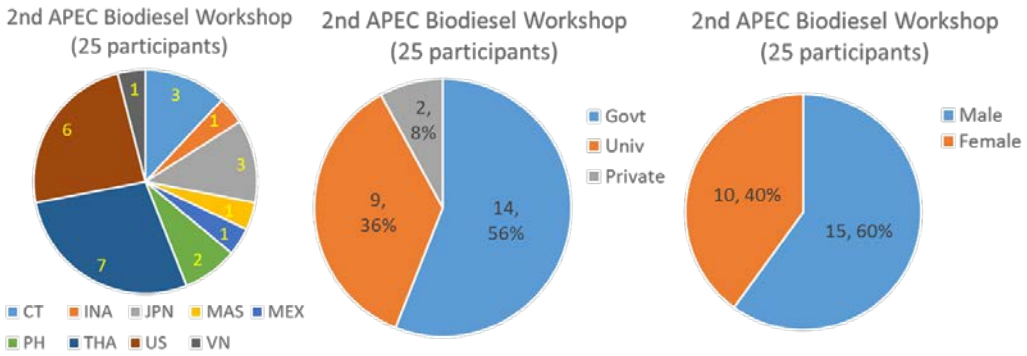

Figure 7: Group photo of the 2nd workshop with breakdown statistics

Table 6: List of participants to 2nd APEC Workshop

No	Name	Affiliation	Economy	Gender	E-mail
1	Dr NGUYEN Linh Dan	Researcher – APERC	Japan	F	dan.nguyen@aperc.ieej.or.jp
2	Mr Takao Ikeda	Senior Economist, New and Renewable Energy Group – The institute of Energy Economics Japan	Japan	M	ikeda@tky.ieej.or.jp
3	Dr Keng-Tung Wu	Research Consultant – Industrial Technology Research	Chinese Taipei	M	ktwu@itri.org.tw
4	Ms Tarcy Sih-Ting Jhou	Secretariat – EGNRET	Chinese Taipei	F	tarcy@itri.org.tw
5	Dr Cary Bloyd	Senior Staff Scientist – Pacific Northwest National Laboratory	United States	M	Cary.bloyd@pnnl.gov
6	Dr Tom, H. T. Lee	Division Director – Industrial Technology Research Institute	Chinese Taipei	M	htlee@itri.org.tw
7	Dr Worajit SETTHAPUN	Dean – Chiang Mai Rajabhat University	Thailand	F	worajit@cmru.ac.th

No	Name	Affiliation	Economy	Gender	E-mail
8	Dr Sumittra CHAROJROCHKUL	Director of Materials for Energy Research Unit – National Metal and Materials Technology Center (MTEC)	Thailand	F	sumittrc@mtec.or.th
9	Ms Ma.Cheliza AMBAS	Science Research Specialist II – Department of Energy	Philippines	F	cheliza.ambas@gmail.com
10	Dr Manida TONGROON	Senior Researcher – National Metal and Materials Technology Center (MTEC)	Thailand	F	manidat@mtec.or.th
11	Dr Jiravan MONGKOLTANATAS	Researcher – National Metal and Materials Technology Center (MTEC)	Thailand	F	jiravan.mon@mtec.or.th
12	Ms Sutharee KIATMAN	Engineer, Practitioner Level – Department of Alternative Energy Development and Efficiency (DEDE)	Thailand	F	sutharee_k@dede.go.th
13	Dr Nuwong CHOLLACOOP	Head of Renewable Energy Laboratory – National Metal and Materials Technology Center (MTEC)	Thailand	M	nuwongc@mtec.or.th
14	Mr Siamnat PANASSORN	Manager – Tri Petch Isuzu Sales Co., Ltd	Thailand	M	p_siamnat@tripetch-isuzu.co.th
15	Ms Marissa Cerezo	DIRECTOR-III – DEPARTMENT OF ENERGY	Philippines	F	maris.cerezo@gmail.com
16	Mr Marc Matsuura	Sr. Smart Grid Program Manager – Hawaii Natural Energy Institute	United States	M	marcmm@hawaii.edu
17	Mr Leon Roose	Specialist – Hawaii Natural Energy Institute	United States	M	lroose@hawaii.edu
18	Dr Scott Turn	Researcher – Hawaii Natural Energy Institute	United States	M	sturn@hawaii.edu
19	Mr Bob King	President – Pacific Biodiesel	United States	M	info@biodiesel.com
20	Dr Richard Rocheleau	Director – Hawaii Natural Energy Institute	United States	M	rochelea@hawaii.edu

No	Name	Affiliation	Economy	Gender	E-mail
21	Dr Tatang Hernas Soerawidjaja	Professor – Institut Teknologi Bandung (ITB)	Indonesia	M	tatanghs@che.itb.ac.id
22	Dr Harrison Lau Lik Nang	Group Leader, Biodiesel Technology Malaysian Palm Oil Board (MPOB)	Malaysia	M	harrison@mpob.gov.my
23	Mr Tomoaki Kakihara	Chairman of Diesel Fuel Experts Group – Japan Automobile Manufacturing Association (JAMA)	Japan	M	Tomoaki_Kakihara@notes.isuzu.co.jp
24	Mr Quang Dong Quach	Officer – Electricity and Renewable Energy Authority, Ministry of Industry and Trade	Vietnam	M	donggq@moit.gov.vn
25	Ms Ana Cecilia PORTEPETIT ANDUAGA	Director for Bioenergetics – Ministry of Energy	Mexico	F	acporte@energia.gob.mx

2nd workshop presentation and discussion

The 2nd workshop was concisely structured for 1 day with various technical updated presentations from participating APEC member economies and additional concern from auto maker, followed by the discussion on finalizing guidelines toward high biodiesel blend diesel. Figure 8 showed various presentations and discussion, where presentation file is shared at http://www.egnret.ewg.apec.org/index.php/en/node/103.

Figure 8: Various presentations and discussion during the 2nd workshop

The keynote speech on “Overview of bioenergy development in Hawaii” was delivered by Dr Scott Turn from Hawaii Natural Energy Institute (HNEI), University of Hawaii focusing on Hawaii energy situation with Hawaii energy strategy to reduce Hawaii’s dependence on oil, protect the environment, reduce the negative impacts related to using imported fuels, enhance renewable energy use and energy efficiency and improve the security, reliability, and resilience of Hawaii’s energy systeMs Various legislations have been enacted to support Hawaii energy strategy, e.g.

- Act 240 (2006): Mandates biodiesel preference of $0.05 per gallon in State procurement laws
- Act 253 (2007): Mandates development of a Hawaii State Bioenergy Master Plan
- Federal Energy Independence and Security Act (2007) requires36 billion gallons of biofuels by 2022 w/ special consideration for advanced biofuels
- Act 202 (2016) Five year, renewable fuels production tax credit (equal to $0.31/gal or 0.08/liter for biodiesel) for five years

Not only in transportation but also some power plants in Hawaii used biodiesel for power generation, such as

- 110 MW combustion turbine power plant at Campbell Industrial Park
- 8MW internal combustion engine for emergency power at Daniel K. Inouye International Airport, Honolulu
- 50 MW dual fueled power plant at Schofield Barracks (in construction)
- Several others in the State use biodiesel for start up/shut down

Another keynote presentation by Mr Robert King, President of Pacific Biodiesel Technologies, which is a pioneer in biodiesel production in US with already 13 biodiesel facilities built. The presentation highlighted the benefit of using various biodiesel blend including car manufacturers that approve the use of B20 and B100, especially the local use of biodiesel in Hawaii, as shown in Figure 9.

Figure 9: Use of biodiesel in Hawaii

Next four presentations were updates from 4 participating APEC member economies, e.g. Indonesia, Malaysia, Thailand and US. The US presentation was delivered by Dr Scott Turn from HNEI to highlight the common use of biodiesel, as shown in Figure 10, partly due to many incentives as follows.

- Federal incentives
    - Fueling equipment for diesel fuel blends containing a minimum of 20% biodiesel installed through December 31, 2017, is eligible for a tax credit of 30% of the cost, not to exceed $30,000.
    - The Biomass Crop Assistance Program (BCAP; Section 9010) provides financial assistance to landowners and operators for a reimbursement of 50% of the cost of establishing a biomass feedstock crop, as well as annual payments for up to five years for herbaceous feedstocks and up to 15 years for woody feedstocks.
    - The Biodiesel Fuel Education Program (Section 9006) provide competitive grants to educate governmental and private entities that operate vehicle fleets, the public, and other interested entities about the benefits of biodiesel use. (Reference Public Laws 113-79 and 112-240, and 7 U.S. Code 8106)
    - A biodiesel blender that is registered with the Internal Revenue Service (IRS) may be eligible for a tax incentive in the amount of $1.00 per gallon of pure biodiesel, agri-biodiesel, or renewable diesel blended with petroleum diesel to produce a mixture containing at least 0.1% diesel fuel.
- State incentives
    - Texas (#1)
        - The biodiesel portion of blended fuel containing taxable diesel is exempt from the diesel fuel tax. (Reference Texas Statutes, Tax Code 162.204)
    - Iowa (#2)
        - Retailers selling biodiesel blends containing a minimum of 5% biodiesel (B5) are eligible for a state income tax credit of $0.035 per gallon. Biodiesel blends containing a minimum of 11% biodiesel (B11) are eligible for a state income tax credit of $0.055 per gallon beginning January 1, 2018. (Reference Iowa Code 422.11P)
        - Biodiesel distributors may apply for cost-share grants for infrastructure upgrades and installations at biodiesel

terminal facilities. Facilities blending or dispensing blends ranging from 2% biodiesel (B2) to 98% biodiesel (B98) are eligible for up to 50% of the total project, up to $50,000. Facilities blending or dispensing B99 or B100 are eligible for up to 50% of the total project, up to $100,000. (Iowa Code 159A.13-159A.15)

- The Iowa Department of Transportation (IDOT) may purchase biodiesel for use in IDOT vehicles through the biodiesel fuel revolving fund created in the state treasury. (Reference Iowa Code 307.20)

o Missouri (#3)

- At least 75% of the Missouri Department of Transportation (MoDOT) vehicles and heavy equipment that use diesel fuel must be fueled with biodiesel blends of at least 20% (B20). (Reference Missouri Revised Statutes 414.365 and 414.407)
- The Missouri Biodiesel Fuel Revolving Fund uses the money generated by the sale of Energy Policy Act of 1992 credits to cover the incremental cost of purchasing fuel containing biodiesel blends of at least 20% (B20) for state fleet vehicle use. (Reference Missouri Revised Statutes 414.407)

o Illinois: (#4)

- Tax exemption to the proceeds from the sale of biodiesel blends containing more than 10% biodiesel up to 99% biodiesel sold between July 1, 2003, and December 31, 2023. (Reference Illinois Compiled Statutes 120/2-10)
- Any diesel-powered vehicle the governmental entities and state educational institutions owns or operates must use a biodiesel blend that contains at least 5% biodiesel (B5) when fueling at a bulk central fueling facility. (Reference 20 Illinois Compiled Statutes 689/10 and 625 Illinois Compiled Statutes5/12-705.1)

o Washington (#5)

- Waste vegetable oil, specifically cooking oil gathered from restaurants or commercial food processors, an individual uses to produce biodiesel for personal use is exempt from state sales and use taxes. (Reference Revised Code of Washington 82.08.0205 and 82.12.0205)

- At least 2% of all diesel fuel sold in Washington must be biodiesel or renewable diesel. (Reference Revised Code of Washington 19.112.010)
- At least 20% of all diesel fuel used to fuel state agency vehicles, vessels, and construction equipment must be biodiesel. (Reference Revised Code of Washington 43.19.642)

o Hawaii: (#27)

- Hawaii Senate Bill 2019 proposes on-road fuel sold in the State to contain no less than ten per cent biofuel by volume.

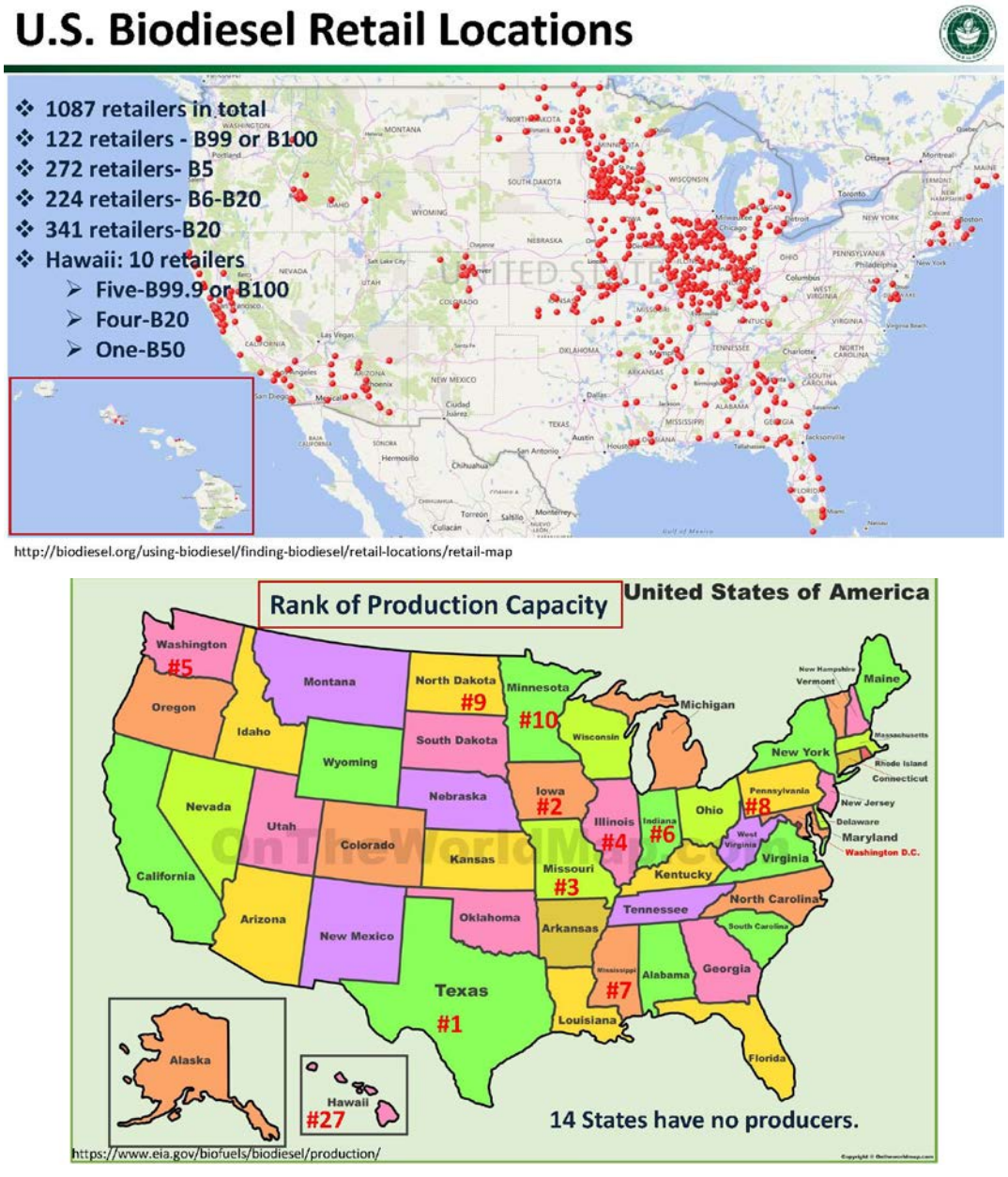

Figure 10: US biodiesel market

Next is presentation on the summary from 1st workshop by Dr Nuwong Chollacoop from Thailand since there were participants who have not attended 1st workshop. Then, presentation on additional concern from automotive makers for establishing guideline of higher blend of biodiesel by Mr Tomoaki Kakihara from Japan Automobile Manufacturing Association (JAMA). As shown in Figure 11, a wide range of vehicle emission regulation, climate temperature, feedstock and base diesel fuel in APEC member economies needs to be considered when drafting APEC guideline on biodiesel, especially on oxidation stability, monoglyceride content, cold properties and metallic content. With constructive discussion, draft APEC guideline on biodiesel is shown in Table 7.

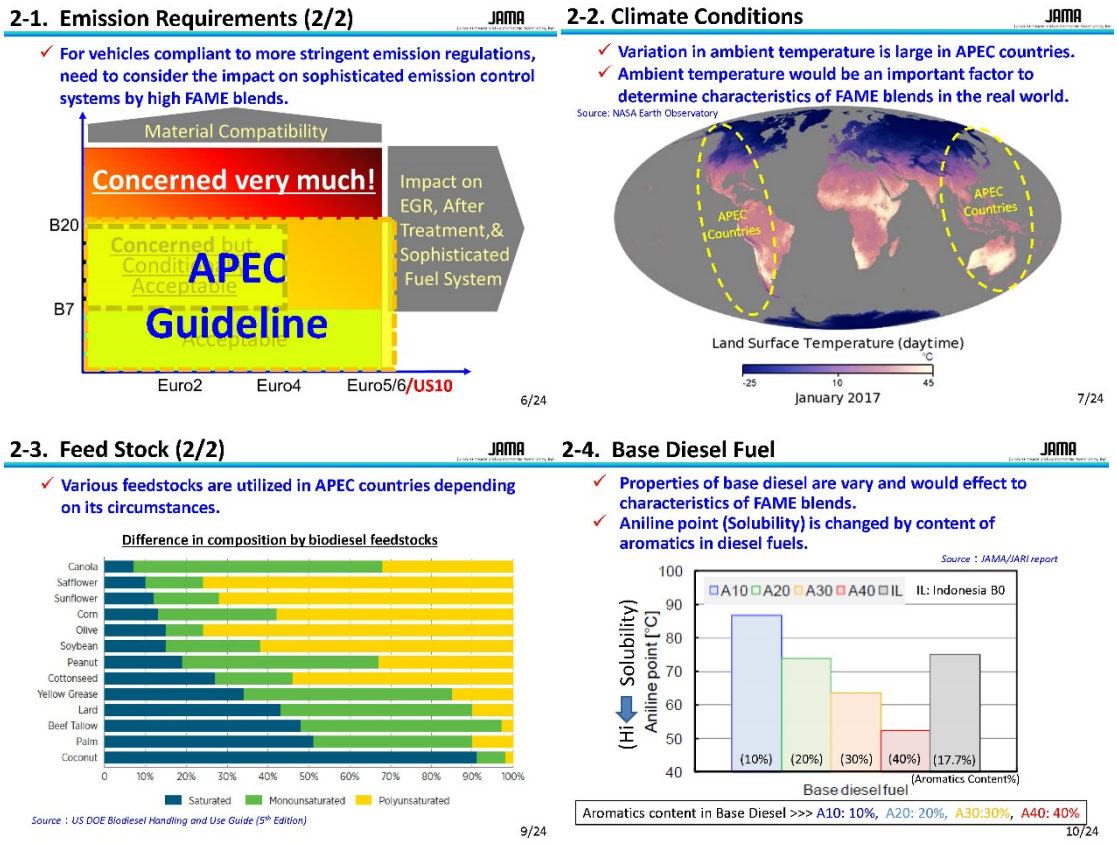

Figure 11: Factors to be considered in establishing APEC guideline on biodiesel

Table 7: Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

Property	Unit	B100		B20	
		B7	B7-B20	Euro4	Euro5/6
Oxygenates					
FAME content	mass%	96.5 min	96.5 min		
	vol%			20 max	20 max
Alcohol content	vol%			Not detected	Not detected
Density, @15°C	g/cm3	Report	Report	0.82 - 0.845	0.82 - 0.845
Viscosity, @40°C	mm2/s	2.0 - 5.0	2.0 - 5.0	2.0 - 4.5	2.0 - 4.5
Flash point	°C	100 min	100 min	55 min	55 min
Sulfur content	ppm	15 max	10 max	50 max	10 max
Carbon residue, 10%	mass%	0.3 max	0.3 max	0.3 max	0.3 max
Carbon residue, 100%	mass%	0.05 max	0.05 max		
Cetane number	-	51 min	51 min	51 min	51 min
Sulfated ash content	mass%	0.02 max	0.02 max		
Ash content	mass%			0.01 max	0.01 max
Water content	ppm	500 max	500 max	200 max	200 max
Total contamination	ppm	24 max	24 max	24 max	24 max
Cooper corrosion	-	Class 1 max	Class 1 max	1 max	1 max
Acid number	mgKOH/g	0.50 max	0.50 max		
Oxidation stability					
Conventional method	g/m3			25 max	25 max
Rancimat method	hrs	10 min	10 min	35 min	35 min
PetroOXY method				65 min	65 min
Iodine number	-	120 max	120 max		
Methanol content	mass%	0.2 max	0.2 max		
Cold soak filterability	sec	360	360		
Mono-glyceride content	mass%	0.70/0.60* max	0.4		
Di-glyceride content	mass%	0.20 max	0.20 max		
Tri-glyceride content	mass%	0.20 max	0.20 max		
Free glycerin	mass%	0.02 max	0.02 max		
Total glycerin	mass%	0.25 max	0.25 max		
Metals (Na + K)	ppm	5.0 max	5.0 max		
Metals (Ca + Mg)	ppm	5.0 max	5.0 max		
Phosphorous content	ppm	4.0 max	4.0 max		
Cloud point	°C	Report	Report	Check requirement by economy	
Pour point	°C	Report	Report		
CFPP	°C	Report	Report		
Distillation					
T50	°C			Report	Report
T90	°C			Report	Report
T95	°C			360 max	360 max
End point	°C			Report	Report
PAH	max%			11 max	8 max
Lubricity (HFRR)	um			460 max	460 max
*where outside temp < 5°C in winter					

Summary of public seminar

The APEC Seminar on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region was held on 30 April 2018 in Pathumthani, Thailand, with the main objective to disseminate finding from the 1st and 2nd workshop focusing on draft guidelines for high biodiesel blend diesel (up to 20%). The agenda is shown in Table 8, where Mr Somchai Stakulcharoen, Director of Biofuel Development Bureau, DEDE could join the opening session, as shown in Figure 12.

Table 8: Agenda of the APEC Seminar on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

The APEC Seminar on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

30 April 2018

Convention Center Room CC405

Thailand Science Park, Pathumthani, Thailand (https://goo.gl/maps/e9rEp72J4F12)

Monday 30 April 2018

Agenda	
09.00	Registration
09.30	Opening Session and Workshop/Project Overview Welcoming Remark by Dr Aree Thanaboonsombut, Deputy Executive Director, MTEC Opening Speech by Mr Somchai Stakulcharoen, Director of Biofuel Development Bureau, DEDE Group Photo
10.00	**Keynote – Overview of biodiesel development in Thailand** Ms Sutharee Kiatman, Engineer, Biofuel Development Bureau Department of Alternative Energy Development and Efficiency (DEDE)
10.30	Coffee Break
11.00	**Summary of APEC project** Dr Nuwong Chollacoop, National Metal and Materials Technology Center (MTEC)
12.00	**Lunch**

Figure 12: Opening session of the seminar

TOP: (left) Welcoming Remark by Dr Aree Thanaboonsombut, Deputy Executive Director, MTEC, (right) Opening Speech by Mr Somchai Stakulcharoen, Director of Biofuel Development Bureau, DEDE

Public seminar participants

As shown in Figure 13 and Table 9, the workshop was attended by 44 participants with a ratio of female ratio of 50% (22 women and 22 men).

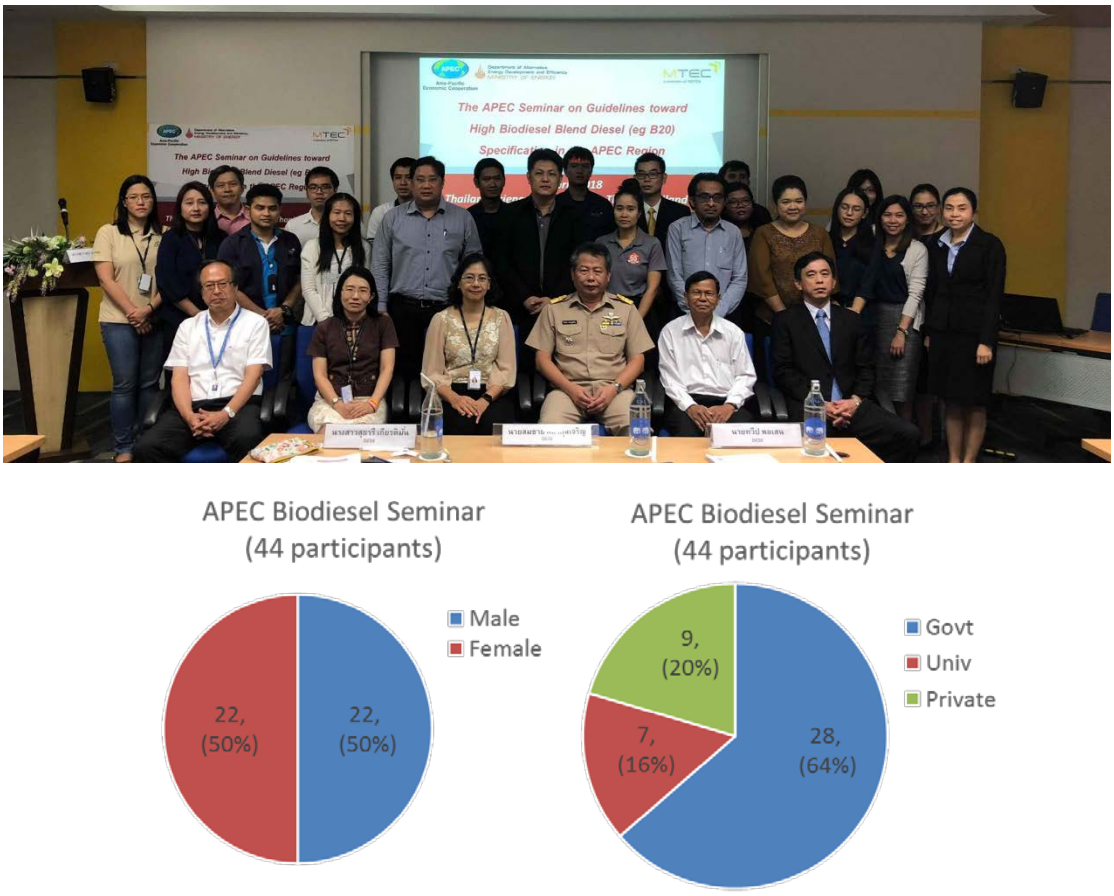

Figure 13: Group photo of the public seminar with breakdown statistics

Table 9: List of participants to APEC public seminar

No	Name	Affiliation	Gender	E-mail
1	Mr Somchai Stakulcharoen	Director of Biofuel Development Bureau, Department of Alternative Energy Development and Efficiency (DEDE)	M	somchai_st@dede.go.th
2	Dr Aree Thanaboonsombut	Deputy Executive Director National Metal and Materials Technology Center (MTEC)	F	areeh@mtec.or.th
3	Dr Sumittra Charojrochkul	Director Materials for Energy Research Unit (MTEC)	F	sumittrc@mtec.or.th
4	Dr Yuji Yoshimura	National Institute of Advanced Industrial Science and Technology (AIST), Japan	M	yoshimura.yuji@friends.jica.go.jp
5	Mr Thaweep Pholasen	Department of Alternative Energy Development and Efficiency (DEDE)	M	thaweep_p@dede.go.th
6	Ms Sutharee Kiatman	Department of Alternative Energy Development and Efficiency (DEDE)	F	sutharee_k@dede.go.th
7	Mr Panupat Tengtrsorn	Department of Alternative Energy Development and Efficiency (DEDE)	M	panupat_t@dede.go.th
8	Ms Touchakarn Boonyaprasit	Department of Alternative Energy Development and Efficiency (DEDE)	F	touchakarn_b@dede.go.th
9	Ms Jariya Patthana	Department of Energy Business (DOEB)	F	jariya@doeb.go.th
10	Ms Patcharin Pinthong	Department of Energy Business (DOEB)	F	patcharin@doeb.go.th
11	Ms Angsuwan Tarmsit	Department of Energy Business (DOEB)	F	angsuwan@doeb.go.th
12	Mr Ong-Arj Pongkijworasin	Thailand Automotive Industry Association (TAIA)	M	p_ong-arj@tripetch-isuzu.co.th
13	Mr Worathon Suksomboon	Thailand Automotive Institute (TAI)	M	worathon@thaiauto.or.th
14	Mr Kamonwat Settachai	Tri Petch Isuzu Sales Co., Ltd.	M	s_kamonwat@tripetch-isuzu.co.th
15	Mr Surat Manorattana	Tri Petch Isuzu Sales Co., Ltd.	M	m_surat@tripetch-isuzu.co.th
16	Ms Patiya Thanthanapat	Tri Petch Isuzu Sales Co., Ltd.	F	t_patiya@tripetch-isuzu.co.th
17	Mr Whicha Thaitavon	Tri Petch Isuzu Sales Co., Ltd.	M	t_whicha@tripetch-isuzu.co.th

No	Name	Affiliation	Gender	E-mail
18	Mr Chawal Taweerojkulsri	Tri Petch Isuzu Sales Co., Ltd.	M	t_chawal@tripetch-isuzu.co.th
19	Mr Siamnat Panassorn	Tri Petch Isuzu Sales Co., Ltd.	M	p_siamnat@tripetch-isuzu.co.th
20	Mr Sanin Triyanond	Biodiesel producer association	M	sanin@patumoil.co.th
21	Ms Suchada Narinsakchai	Global Green Chemical Public Co., Ltd.	F	Suchada.N@ggcplc.com
22	Mr Phumanan Niyomna	Panyapiwat Institute of Management (PIM)	M	ranf47237@gmail.com
23	Mr Kampanart Poorahong	King Mongkut's Institute of Technology Ladkrabang (KMITL)	M	po.kampanart@gmail.com
24	Ms Kamonwan Samanphan	Suranaree University of Technology (SUT)	F	Kamonwan_belle@hotmail.com
25	Ms Patinya Tanakhan .	Suranaree University of Technology (SUT)	F	frame.flame@hotmail.com
26	Mr Tripoom Painrungrot	King Mongkut's Institute of Technology Ladkrabang (KMITL)	M	tripoom.pai@gmail.com
27	Mr Kontorn Thammakul	King Mongkut's Institute of Technology Ladkrabang (KMITL)	M	kz_thammakul@windowslive.com
28	Dr Nuwong Chollacoop	National Metal and Materials Technology Center (MTEC)	M	nuwongc@mtec.or.th
29	Dr Manida Tongroon	National Metal and Materials Technology Center (MTEC)	F	manidat@mtec.or.th
30	Dr Yatika Somrang	National Metal and Materials Technology Center (MTEC)	F	yatikas@mtec.or.th
31	Dr Peerawat Saisirirat	National Metal and Materials Technology Center (MTEC)	M	peerawas@mtec.or.th
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35	Dr Jiravan Mongkoltanatas	National Metal and Materials Technology Center (MTEC)	F	jiravan.mon@mtec.or.th
36	Dr Boonyawan Yoosuk	National Metal and Materials Technology Center (MTEC)	F	boonyawy@mtec.or.th
37	Ms Buppa Shomchoam	National Metal and Materials Technology Center (MTEC)	F	buppap@mtec.or.th
38	Ms Parncheewa Udomsap	National Metal and Materials Technology Center (MTEC)	F	parncheu@mtec.or.th

No	Name	Affiliation	Gender	E-mail
39	Mr Mongkon Kananont	National Metal and Materials Technology Center (MTEC)	M	mongkonk@mtec.or.th
40	Mr Amornpoth Suebwong	National Metal and Materials Technology Center (MTEC)	M	amornpoth.sue@mtec.or.th
41	Mr Jirasak Aunchaisri	National Metal and Materials Technology Center (MTEC)	M	jirasak.aun@mtec.or.th
42	Ms Wanita Powsakul	National Metal and Materials Technology Center (MTEC)	F	wanitap@mtec.or.th
43	Ms Sirorat Boonrattanakul	National Metal and Materials Technology Center (MTEC)	F	siroratb@mtec.or.th
44	Mr Ragkiat Niyomvanicha	National Metal and Materials Technology Center (MTEC)	M	ragkiat.niy@mtec.or.th

Public seminar presentation and discussion

The public seminar was structured for half a day with keynote speech on biodiesel update in Thailand, followed by a summary of the APEC project focusing on how the technical guideline was developed addressing various concerns from biodiesel producers and automakers. Figure 14 showed various presentations and discussion.

Figure 14: Presentations and discussion during the public seminar

The keynote speech on “Overview of biodiesel development in Thailand” was delivered by Ms Sutharee Kiatman, DEDE focusing on Thailand energy situation with Alternative Energy Development Plan (AEDP 2015-2036) with a highlight on the current project to promote B10 by demonstrating H-FAM technology. Then, the summary of APEC project was delivered by Dr Nuwong Chollacoop from MTEC, where project details including objectives, scope and methodology were elaborated. Presentations by various participating APEC member economies and automaker’s

concerns from both 1st and 2nd workshop were summarized with detailed explanation on the technical guideline shown in Table 7.

Conclusion

In order to promote cross border trading of biodiesel to increase the use of renewable fuel as a measure to reduce greenhouse gas emission, technical specification is a necessary parameter to have mutual understanding between producers and users. Of course, users would like to have the best fuel quality but it comes with cost. Hence, discussion among related stakeholders ranging from biodiesel producers, automakers and regulators based on scientific evidence is necessary. Although it is difficult to establish mandatory biodiesel standard for all APEC member economies due to each economy authority decision, it is helpful to develop a less political but more technical guideline as a reference. This is indeed the main goal for the APEC Project (EWG20 2016A): Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region.

The project was structured to have two interactive workshops to provide technical background from selected APEC member economies with initial discussion of the biodiesel guideline in the 1st workshop; whereas, the 2nd workshop encouraged discussion on each property to finalize the technical guidelines toward high biodiesel blend diesel (eg B20) specification in the APEC region. It must be emphasized that this guideline shown in Table 7, by no mean, carries any legal or political implication by the participating APEC member economies but rather serve as a reference technical guideline for any APEC member economies who are interested.

The way forward for the guideline is, of course, subjected to further revision if any new technical and scientific evidence have arisen. The guideline can serve as technical reference or any economy who may begin to consider using biodiesel or those who may want to increase the usage of biodiesel at higher blending level.

APPENDIX: Summary of Evaluation Forms

APEC Project Evaluation Result

The 1st and 2nd APEC Workshop on Guidelines toward High Biodiesel Blend Diesel (eg B20) Specification in the APEC Region

Statement	Strongly Agree	Agree	Disagree	Comment
The objectives of the training were clearly defined.	78.26%	21.74%	0 %	- Needed an update of the previous workshop for clearer context
The project achieved its intended objectives.	95.65%	4.35%	0 %	- Reached agreements of specification for H Blends
The agenda items and topics covered were relevant.	91.30%	8.70%	0 %	- Very interesting approach from different economies
The content was well organized and easy to follow.	86.96%	13.04%	0 %	
Gender issue were sufficiently addressed during implementation.	63.64%	36.36%	0 %	
The trainers/experts or facilitators were well prepared and knowledgeable about the topic.	95.65%	4.35%	0 %	
The materials distributed were useful.	81.82%	18.18%	0 %	- No materials (2nd workshop)
The time allotted for the training was sufficient.	57.14%	42.86%	0 %	- Timing between the presentation and site visit were appropriate.

1. How relevant was this project to you and your economy?

5 Very 80.95 % 4 Mostly 14.29 % 3 Somewhat 4.76 %

- Useful for Malaysia as we are moving forwards high biodiesel blend.
- Because my economy is presently implementing B20 and will step further to utilizing B30 starting in 2020.
- Because my economy (Indonesia) is presently implement B20 and will increase the utilization of biodiesel to B30 in 2020
- Guideline for establishing the policy
- RAD topics
- Useful for developing standard for high biodiesel blend
- Additional information regarding parameters used in other economy
- Very interesting & enriching experience to access new & other economies point of view, experience in the implementation of Biofuels.

2. In your view what were the project's result achievements?

- Mutual understanding between participants (stakeholders) the higher blends of biodiesel (say ≥ 20% vol.) requires better/higher specifications.
- The framework has been laid out in the 1st meeting.
- Check an understanding about the need and limitation of biodiesel standard development in APEC economy.
- Good because determine the direction for meeting.
- To come together to a harmonized table of specifications in the APEC region
- It will provide guideline which is useful for APEC economy
- Agreement of specification guidelines
- Experience sharing, cooperative
- Mutual understanding between participants (various stakeholder) that biodiesel specification is still dynamic and higher blends will require higher specification
- Show case the best practice of real implementation. Emphasize the need for harmonization of biodiesel standard for APEC economies
- Guideline for everyone's agreement
- Update, tendency, demand, specification for biofuels; case study.

3. What new skill and knowledge did you gain from this event?

- Experience and technical solution of other economies (participants) in attempting to implement higher biodiesel blend (≥7 % vol).
- Differences in terms of biofuel policy of each economy.
- Biodiesel policy of each economy
- Approaching methods; policy making; technical aspects.
- Know more about economy's update on biodiesel
- Spec information
- Technical measurement procedure
- Experience and technical solutions of other economies (participants) in attempting to implement higher biodiesel blends (more than 7% vol)
- Biodiesel implementation in various economies
- Biodiesel in the US. esp. Hawaii
- Learned about US biodiesel specification in more details.
- Relevance of parameters & comparison of biodiesel using other feedstock
- Better understanding of common barriers, technical aspects, and policies to strength the whole chain value to ensure high blends biodiesel.

4. Rate your level of knowledge of and skill in the topic prior to participating in the event

Very High 17.39 % High 34.78 % Medium 39.13 % Low 8.70 % Very Low 0 %

5. Rate your level of knowledge of and skill in the topic after participating the event:

Very High 30.43 % High 56.52 % Medium 13.04 % Low 0 % Very Low 0 %

- I am a member of technical committee on biodiesel in my econmy (Indonesia), which already apply high biodiesel blends (b20) and I was a speaker in the workshop.
- As a policy maker it is important to broaden out understanding & knowledge on technical criteria and experiences.
- Method to implement
- I am a member of technical committee on biodiesel in my economy (Indonesia) and I was an invited speaker in the workshop.
- I'm a policy maker and local point for APEC cooperation so that some technical specifications are not easy for me to understand.
- I developed a better understanding of the information needed to establish guideline on higher biodiesel blends.

6. How will you apply the project's content and knowledge gained at your workplace? Please provide examples (e.g. develop new policy initiatives, organise trainings, develop work plans/strategies, draft regulations, develop new procedures/tools etc.)

- Drafting biodiesel specifications suitable for B30 blends.
- Will use it as baseline to develop biodiesel standard.
- Develop new research on the raw materials for biodiesel.
- Revisit biodiesel specification.
- Drafting and incorporating information in new policies and standard into economy instruments.
- Additional information in Biofuel program implementation
- Yes, will apply the knowledge in developing policy and standard
- Develop work strategies
- Guideline of specification
- To draft biodiesel specification suitable for B30 blends, which will be mandatory in Indonesia starting 2020
- Organize training/ Capacity building/ creating awareness/research biodiesel/ bioenergy to grid
- This is very useful in doing my own research
- Develop relevant policy; raise awareness of public community; organize trainings and workshops; technology transfer and capacity enhancement…
- Share the activities with JAMA companies

7. What needs to be done <u>next by APEC</u>? Are there plans to link the project's outcomes to subsequent collective actions by fora or individual actions by economies?

- Producing and distributing "guidelines" of specifications of biodiesel for use in different blend levels.
- Next; The support mechanism of APEC for APEC economies. It should combine both fora and individual action by economies.
- All invited participants should give contribution
- Facilitate biodiesel goals to be inline of each economy
- Producing are distributing "guidelines" of specification of biodiesel for use in various level of blend.
- Confirmation from policy makers for implementation of B10-B20

- Strategies in promotion of biofuels & disseminate information to public (public awareness)
- Following up on policy implementation and share successful cases with other economy members.

8. How could this project have been improved? Please provide comments on how to improve the project, if relevant.

- The above "guidelines" should contain explanation about the advantages/disadvantages properties of biodiesel useful components and to improve the properties.
- This is a very difficult project to develop the guideline with the consensus of each economy
- Direction is clear for now.
- To sharing the work form both workshops and continuing the follow up in high blend biodiesel experiences among economy member.
- More commitments from government of each economy
- The above "guidelines" should give explanation on "ideal/best quality biodiesel" and ways to reach it.
- The Project should be arranged separately for policy makers and technical ones
- Have APEC economies participation is necessary