Appendix 1

Record of ERIA Working Group Meeting:

Study of Renewable Energy Potential and Its Effective Usage in East Asian Countries

First Working Group Meeting (2015–2016), 8–9 February 2016, Jakarta, Indonesia

1. Opening Address and Invited Lecture

The first meeting (2015–2016) of the ERIA Working Group (WG) was held in Indonesia, hosted by the BPPT (Agency for the Assessment and Application of Technology). WG Leader Dr Toba from the National Institute of Advanced Industrial Science and Technology, Japan (AIST) gave the welcome address and expressed great appreciation for all WG members. This was followed by self-introductions of all WG members and observers.

Dr Toba explained the outline of this third ERIA Energy Project and the WG title 'Study of Renewable Energy Potential and Its Effective Usage in East Asian Countries'. The present ERIA project focuses on three subjects:

1. Potential study of diversified transportation energy mix, which will discuss transportation energy including biofuels from the viewpoint of international trade, energy consumption in the transportation sector, and domestic and international strategies for biofuel promotion. It is headed by Mr Ichikawa from Toyota, Japan.
2. Research of next-generation biofuels, which will investigate the production technologies of next-generation biofuels, and discuss the policy to introduce biofuel. It is headed by Dr Toba from AIST, Japan.
3. Biomethanol as an energy carrier, which will investigate biomethanol production and discuss its role as an energy carrier. It is headed by Dr Goto from AIST, Japan.

In combination, these subjects aim to support three strategies under the ASEAN Plan of Action for Energy Cooperation (APAEC: 2016–2025):

1. Energy efficiency and conservation
2. Renewable energy
3. Regional energy policy and planning

The invited lecture on 'Progress in Indonesian Biodiesel' was given by Mr Imam Paryanto from BPPT, Indonesia. Indonesia's policy on development and implementation of bioenergy was

elaborated to show the shape of Indonesian biofuel since 2007 with particular emphasis on the mandatory biodiesel road map according to the Energy and Mineral Resource Ministry Regulation.

2. Session I: Potential Study of Diversified Transportation Energy Mix

The session started with an outline of the subject presented by Mr Ichikawa. The scope covered five countries over the two years: Thailand, Indonesia, and the Philippines are the focus this current year, while Malaysia and Viet Nam are the focus in the following year. Measures for mitigating energy issues (gap between energy supply and demand) and achieving the policy target (energy conservation and alternative energy) will be investigated and proposed. Regional cooperation with ASEAN will be considered if necessary. The Thailand and Indonesia cases were given a preliminarily analysis.

Dr Nuwong from the National Metal and Materials Technology Center (MTEC), Thailand gave the 'Presentation from Thailand', in which he explained the Thailand Integrated Energy Blueprint (TIEB: 2015–2036) with emphasis on the Oil Plan, Energy Efficiency Plan (EEP), and Alternative Energy Development Plan (AEDP). Detailed targets of bioethanol and biodiesel were shown with action plans and consideration of feedstock supply.

Ms Ruby from the Philippine Department of Energy gave the 'Presentation from Philippines', in which she presented the government policy on biofuel, supply ability, and vehicle registration data. The Biofuel Act (Republic Act 9367) was passed in 2006 with targeted biofuel blends during 2013–2030 prescribed in the National Biofuels Program.

Dr Arie from BPPT, Indonesia gave the 'Presentation from Indonesia' with various statistics on national energy resources/production, energy mix, infrastructure power, and fuel for the transportation sector. The National Energy Policy (NEP) was presented in detail with its target and road map. Alternative fuels, such as biodiesel and compressed natural gas (CNG), were discussed with the possibility of electric vehicles (EVs). Finally, some vehicle registration data were presented.

3. Session II: Research of Next-Generation Biofuels

In this session, Dr Toba presented the details on this subject. From previous WG recommendations on common and individual strategies, this subject aimed to (1) clarify technological problems to produce and introduce next-generation biofuels; and (2)

investigate the feedstock availability and energy policy for next-generation biofuels.

The focus of the discussion on next-generation biofuels was the following:

1. Biofuels from non-edible feedstock via both conventional and new technologies resulting in conventional fuel (e.g. first generation).
2. Drop-in fuel via new technology resulting in synthetic hydrocarbon.
3. Sustainable aviation fuel as it is an international issue rather than a domestic issue in the case of automobile fuel.

The definition of 'drop-in' was clarified with discussion among WG and ERIA members.

Dr Nuwong presented the current situation of next-generation biofuels in Thailand based on biohydrotreated diesel (BHD), bio-jet fuel, partially hydrogenated fatty acid methyl ester (H-FAME), and compressed biogas (CBG).

4. Session III: Biomethanol as an Energy Carrier

In this session, Dr Goto presented the details on this subject. With the growing number of vehicles worldwide, low-carbon energy sources are preferred for vehicles to reduce greenhouse gas emissions. Various sources of hydrogen carriers, such as liquid hydrogen, ammonia, methyl cyclohexane, and methanol, were explained with emphasis on methanol availability in linkage with dimethyl ether (DME).

The following presentation was on 'On-road test of DME vehicle' by Mr Seta from Isuzu, Japan. Isuzu has been developing a DME engine and vehicle since 2001. In-depth results of DME from on-road and chassis-dynamometer tests showed better emissions, high efficiency than diesel, and no engine problems.

All members were taken to visit the BPPT research laboratory.

Second WG Meeting (2015–2016), 26–27 April 2016, Chiang Mai, Thailand

1. Opening Address and Invited Lecture

The second WG meeting (2015–2016) was held in Thailand, arranged by MTEC.

Mr Yamamoto from ERIA gave the opening remarks to welcome and acknowledge the help from foreign experts in this WG. He also proposed the direction of the research.

The WG members visited the Energy Research and Development Institute (ERDI), Chiang Mai University (CMU). ERDI Deputy Director, Assistant Professor Dr Sirichai Koonaphapdeelert gave a presentation on the 'Overview of R&D Activities at ERDI, CMU'. ERDI manages the research and innovation on biogas, biomass, and energy management.

The invited lecture was on 'Current Trend of Bio-oil Research in Thailand', which was given by Assistant Professor Dr Adisak Pattiya, Head of Bio-Energy and Renewable Resources Research Unit, Mahasarakham University (MSU). The principle and advantage of the fast pyrolysis process were explained, before going through the bio-oil research activities in selected research organisations, namely MSU, Thailand Institute of Scientific and Technological Research (TISTR), MTEC, Chulalongkorn University (CU), King Mongkut's University of Technology North Bangkok (KMUTNB), and PTT.

2. Session I: Potential Study of Diversified Transportation Energy Mix

This session started with the agreed scope and target of this subject from the first WG meeting, where all three countries (Thailand, Indonesia, and the Philippines) helped collect and supply the necessary data for the model. The biofuel blending ratio among the three countries was shown for comparison to understand each country's setting and policy direction. The results of the analysis of energy issues of the three countries were shown, and possible measures to achieve policy target of each country were proposed.

Thailand, Indonesia, and the Philippines took turns to present an update of their situation with regard to the biofuel (bioethanol and biodiesel) policy/target, as well as main fossil fuel.

3. Session II: Research of Next-Generation Biofuels

The important points and the problems that should be solved in the introduction of next-generation biofuels were clarified based on the survey results reported at the first WG meeting. The availability of raw materials and the cost for producing next-generation biofuels

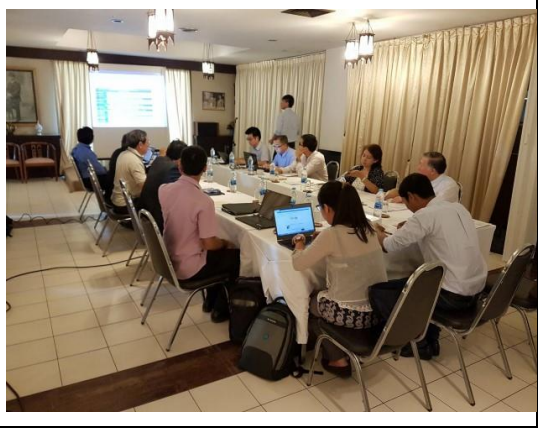
were proposed as next subjects of investigation.

4. Session III: Biomethanol as an Energy Carrier

General characteristics and details of various energy carriers such as liquid hydrogen, ammonia, methyl cyclohexane, and methanol were introduced before focusing on biomethanol production. Methanol itself can be an energy carrier, as well as precursor for DME to substitute diesel fuel.

5. Wrap-up and Closing Address

The WG Leader asked the members to prepare an annual report according to the proposed content.



First WG Meeting (2016–2017), 5–6 December 2016, Hanoi, Viet Nam

1. Opening Address

The first WG meeting (2016–2017) was held in Viet Nam, arranged by the Hanoi University of Science and Technology (HUST). Dr Tuan joined the meeting as a WG new member from Viet Nam. Dr Toba, WG Leader, gave an overview of the progress of the project.

2. Session I: Study of Diversified Transportation Energy Mix

Mr Ichikawa explained the objective, which was to find the best fuel mix based on cost-effectiveness and scope for Indonesia, with various case studies with respect to fuel economy improvement, biofuel, and CNG introduction.

The methodology and required information were presented for the case of Viet Nam with input and discussion by Dr Tuan in order to conduct analysis in the current year.

This was followed by presentations on Viet Nam, Thailand, and the Philippines, delivered by Dr Tuan, Dr Nuwong and Ms Ruby, respectively. For Viet Nam, the presentation focused on HUST and related research outcomes in the field of biomass/bioenergy with some information on Vietnamese transportation statistics. For Thailand, the presentation focused on the Thailand Integrated Energy Blueprint (2015–2036), which is composed of the Power Development Plan (PDP), Energy Efficiency Plan (EPP), Alternative Energy Development Plan (AEDP), Gas Plan, and Oil Plan.

For the Philippines, the presentation focused on the biofuel target, production capacity, supply–demand outlook, and related activities with discussion on the current concerns regarding the B5/E10 mandates. As for Indonesia, Dr Arie was absent, but his presentation was submitted for viewing during the meeting.

3. Session II: Research of Next-Generation Biofuels

This session started with objectives, first-year outcomes, and the second-year focus of theme 2. The main investigation themes in the second year were to clarify promising resources and technological problems for producing next-generation biofuels. Dr Toba elaborated on the three pillars of sustainability, namely social, environmental, and economic aspects for biofuel production with examples of greenhouse gas savings from biofuel production and cost comparison. Then, the status of the biomass potential in ASEAN was presented with technical analysis on raw materials and their implications on fuel properties. Information from research

institutes and researchers to enhance the research and development (R&D) network on renewable energy technology development and utilisation was presented with a case study of the Japan–Thailand collaboration on biofuel through the Japan International Cooperation Agency (JICA) Third Country Training Program (TCTP) as a channel to disseminate research outcomes in ASEAN.

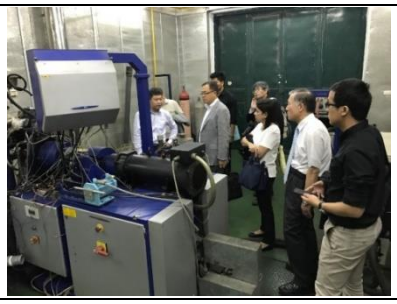
4. Session III: Biomethanol as an Energy Carrier

This session started with a general energy pathway to show that both fossil fuel and biofuel can be interchanged with characteristics and details of various energy carriers such as liquid hydrogen, methyl cyclohexane, ammonia, and methanol. Each carrier was presented with details on production and transportation. Next, methanol production and price were highlighted, as were alternative sources for use with possible biomethanol technology on a large production scale and bio-DME that uses biomethanol as feedstock. Finally, the International Energy Agency Implementing Agreement on Advanced Motor Fuel (IEA AMF) network was highlighted as a way to disseminate research outcomes via their newsletter.

5. Technical Visit

A technical visit was arranged to three laboratories where WG members could learn about the research conducted in HUST:

1. Laboratory of Heat Engineering, School of Heat Engineering and Refrigeration
2. Laboratory of Materials, Advanced Institute of Science and Technology
3. Laboratory of Internal Combustion Engine, School of Transportation Engineering



Second WG Meeting (2016–2017), 16–17 March 2017, Kuala Lumpur , Malaysia

1. Opening Address

The second WG meeting (2016–2017) was held in Malaysia, arranged by the University of Malaya (UM). Dr Ong (UM) joined the meeting as a new WG member from Malaysia. Dr Toba, WG Leader, gave an overview of the progress of the project.

2. Session I: Study of Diversified Transportation Energy Mix

This session started with the scope and target of the activity within theme 1, which covered five ASEAN countries (Thailand, Indonesia, Philippines, Viet Nam, and Malaysia), aiming to propose measures for mitigating energy issues in the transportation sector and achieving the policy target. For this meeting, analysis on Malaysia and Viet Nam were presented in detail. Given the characteristics of each country's fuel consumption, the imbalance between gasoline and diesel can be reduced by cross-border trading of biofuel (ethanol and biodiesel) within the ASEAN region.

Next, country presentations on Malaysia, Viet Nam, Thailand, and Indonesia were delivered by Dr Ong, Dr Tuan, Dr Nuwong, and Dr Arie, respectively. For Malaysia, the energy policy was presented with emphasis on biodiesel development. For Viet Nam, the energy policy was presented with emphasis on the ethanol road map (E5 and E10). For Thailand, an update on the energy policy, Thailand Integrated Energy Blueprint, was presented with the current status of biofuel, both bioethanol and biodiesel, and recent bioeconomy initiative as part of the new S-Curve campaign. For Indonesia, the national energy balance was presented along with the renewable energy policy framework focusing on transport fuel (biodiesel, bioethanol) with the funding mechanism, as well as electricity generation from renewable resources.

3. Session II: Research of Next-Generation biofuels

This session started with objectives, first-year outcomes, and second-year focus of theme 2. Dr Toba presented a feasibility study of alternative diesel production, where fuel production cost can be reduced by use of cheap resources (due to the large influence of the biomass price on biofuel cost) and improvement of technologies (due to the variety of available technologies with various levels of possible cost reduction). The conclusions of the analysis were the following:

1. Utilisation of non-conventional resources contributes to reduction of feedstock cost. In particular, it is effective for producing conventional biofuels.
2. Various cheap raw materials are available for production of next-generation biofuels.
3. The production process of next-generation biofuels has not been established.
4. In producing next-generation biofuels, improving the manufacturing process is more effective than using the raw material price for cost reduction.

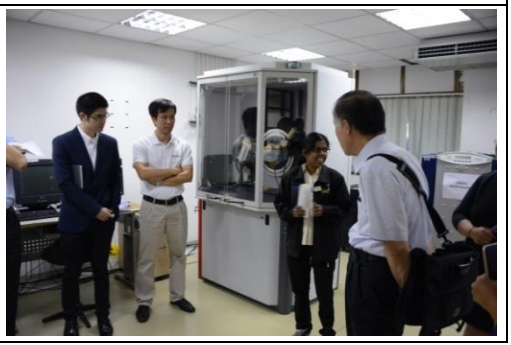
4. Session III: Biomethanol as an Energy Carrier

This session started with the general energy pathway to show that both fossil fuel and biofuel can be interchanged with characteristics and details of various energy carriers such as liquid hydrogen, methyl cyclohexane, ammonia, and methanol. Each carrier was presented with details on the production and transportation, highlighting methanol production and price as alternative sources and where biomethanol technology can be applied on a large production scale.

5. Technical Visit

A technical visit to the Nanotechnology & Catalysis Research Centre (NANOCAT), University of Malaya was arranged. WG members discussed research subjects on biomass conversion technology with NANOCAT researchers.





First WG Meeting (2017–2018), 23–24 November 2017, Manila, Philippines

1. Meeting with Director, Renewable Energy Management Bureau, PDOE

Dr Toba and Dr Goto visited the Renewable Energy Management Bureau, Department of Energy, Philippines (PDOE) on 22 November. Dr Toba explained the contents of the current WG project to Ms Marissa P. Cerezo, Director of the Renewable Energy Management Bureau. The current situation in the transportation sector and the government policy in the Philippines were discussed also.

2. Opening Address

Dr Venkatachalam Anbumozhi gave opening remarks on behalf of ERIA to acknowledge the contribution from this WG with anticipation for outcomes of this WG. Dr Toba gave an overview of the progress of the project, which was divided into three subjects.

3. Session I: Study of Diversified Transportation Energy Mix

This session started with the scope and target of the activity within theme 1, which covered five ASEAN countries (Thailand, Indonesia, Philippines, Viet Nam, and Malaysia), aiming to propose measures for mitigating energy issues in the transportation sector and achieving the policy target. For this meeting, the analysis on all five countries was reviewed in detail in order

to propose a measure for mitigating energy issues in the transportation sector through regional cooperation to achieve appropriate biofuels utilisation. A proposal of alternative oil reduction in all five countries was presented with a summary of biofuel demand and supply in 2030. However, the projection of biofuel demand and supply in some countries needed further revision.

4. Session II: Research of Next-Generation Biofuels

This session started with the objectives and outcomes of the past 2 years, followed by the third-year focus. Linkages between biomass price and biofuel cost, the process selection, and production cost for bio-jet fuel were shown for a few technological processes, with an illustration of the total cost distribution and cost sensitivity to confirm that improving the manufacturing process is more effective than using the raw material price for cost reduction in producing next-generation biofuels.

5. Session III: Biomethanol as an Energy Carrier

This session started with a review of the energy pathways to show how various fuels are connected with hydrogen. Thus, investigating the pros and cons of hydrogen as a carrier via various pathways (liquid hydrogen, methyl cyclohexane, ammonia, and methanol) is important. The global status of methanol was reviewed, followed by introduction of poly dimethyl ether (oxymethylene or OME) as a new candidate.

6. Technical Visit

A technical visit to Chemrez biodiesel plant (Quezon City) was arranged, where coco methyl ester (CME) was produced at a capacity of 300 kilolitres per day (6,000 kilolitres storage tank) using Lurgi technology with investment costs amounting to 650 million pesos.

Second WG Meeting (2017–2018), 30–31 January 2018, Bangkok, Thailand

1. Opening Address

The second WG meeting (2017–2018) was held in Thailand, arranged by MTEC. Dr Toba, WG Leader, gave an overview of the progress of the project. All WG members had submitted preliminary reports to the WG Leader before the meeting for final discussion.

2. Session I: Study of Diversified Transportation Energy Mix

The possibility of multilateral cooperation was discussed based on the simulation results of biofuel supply potential in 2030 in each country. Necessary measures to realise the idea included unified biofuels specification and reduction of barriers to prevent import/export of biofuels.

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3. Session II: Research of Next-Generation Biofuels

The scale merit for producing next-generation biofuels was clarified based on the articles of simulation. The influence of other factors such as energy supply for operating factories was also discussed.

4. Session III: Biomethanol as an Energy Carrier

Biomethanol plants around the world were introduced to understand resource supply, plant scale, and cost.

5. Wrap-up and Closing Address

The WG Leader indicated the crucial items of the final report to all WG members and the deadline for submission was decided.

Appendix 2

Abstracts of Invited Lectures

The WG invited two lecturers to give lectures about production, utilisation, and testing of biofuels.

Progress in Indonesian Biodiesel

Mr Imam Paryanto (BPPT, Indonesia), a submember of this WG, gave a lecture at the first WG meeting in Serpong, Indonesia. He first introduced the energy situation in Indonesia. Currently, Indonesia imports large amounts of crude oil and diversification of the energy source is strongly desired. To achieve this, the Indonesian government promotes its policy on the development and implementation of bioenergy. He himself is engaged in research and evaluation of biodiesel fuel to generate useful information for its safe use. In this lecture, he reported on B20 (20% of biodiesel blended diesel) tests on vehicle engines and roadshows. These results will contribute to the safe use of fuels when high biodiesel-blended diesel is introduced to the market.

Current Trend of Bio-oil Research in Thailand

Assistant Professor Adisak Pattiya (Mahasarakham University, Thailand) gave a lecture at the second WG meeting in Chiang Mai, Thailand. He first explained the production processes of bio-oil (fast pyrolysis) and advantages of the process. Many kinds of solid resources can be used as feedstock for bio-oil production. This is one of the advantages of this technology. Next, he introduced the bio-oil research situation in Thailand. Currently, fast pyrolysis technology development is at the R&D stage. Several organisations such as national institutes, universities, and petroleum refinery companies are working on this technology. Finally, he pointed to future directions for bio-oil R&D in Thailand.