Appendixes

Appendix I: Working Group Members

Country	Institution	Name and Designation
Indonesia	Ministry of Energy and Mineral Resources (MEMR)	Mr Junifer Saut Pangidoan Simanjuntak, S.T., M.T. Senior Electricity Inspector, Directorate General of Electricity
		Mr Tri Suhartanto, S.T., M.Eng Mid-Level Electricity Inspector, Directorate General of Electricity
		Mr Andi Hanif, ST, M.Eng Mid-Level Electricity Inspector, Directorate of Electricity Engineering and Environment, Directorate General of Electricity
Malaysia	Energy Commission (ST)	Mr Mohd Amirulazry Mohd Amin, Assistant Director
Thailand	Ministry of Energy	Mr Tananchai Mahattanachai, Senior Professional Geologist, Department of Mineral Fuels (DMF)
		Dr Yaowateera Achawangkul, Mechanical Engineer, Senior Professional Level of the Energy Research Division, Department of Alternative Energy Development and Efficiency (DEDE)
Vietnam	Ministry of Industry and Trade	Mr Doan Ngoc Duong, Deputy Director General, IE(Institute of Energy)
	Ministry of Industry and Trade	Dr Nguyen Manh Cuong, Deputy Head of Power System Development Department IE(Institute of Energy)

Appendix II: Report of the First Working Group Meeting

ERIA Research Project 2021/2022

First Working Group Meeting for the Study on the Applicability of CCT for Comprehensive and Optimal Carbon-neutral Solution in ASEAN

Virtual meeting held on 8 July 2022

At the outset, Ms Yamada, a study team member, as MC called on JCOAL's Director of International Collaboration Department to deliver his brief remarks to welcome the working group members and the guests on behalf of Dr Phoumin, Senior Energy Economist, ERIA.

Dr Murakami: Firstly, on behalf of Dr Han Phoumin, Senior Energy Economist of ERIA, I would like to welcome and express our appreciation to the working group members from Indonesia, Malaysia, and Thailand, as well as the special guests from ACE, for their participation in this important working group for the ERIA study on the applicability of CCT for comprehensive and optimal carbon-neutral solution in ASEAN. As you know, in the era of the energy transition, action for carbon neutrality is essential. But the pathway would be different from one country to the other because of differences in the respective situations and potentials of the countries. However, some measures and solutions are better to be worked on regionally in close collaboration with other countries. There this study will be of some help. In the study, the essential components are (i) inputs from the working group members, (ii) literature surveys by the JCOAL Study Team, and (iii) discussions in the working group. These three components are essential to complete these studies. I hope we will have a fruitful discussion and everybody will get good takeaways.

The briefing on the schedule was provided while viewing the on-screen meeting agenda, followed by a self-introduction of participants.

Dr Ambiyah: My name is Ambiyah Abdullah. I am working with my colleague, Amira Bilqis, for the joint study group for a joint report on the CCT, together with JCOAL. We aim to publish a policy brief in August 2022 and a strategic report by next year, August 2023.

Ms Amira: My name is Amira Bilqis, and I am the associate for modelling and policy planning. I look forward to gathering more insights, as ACE is now working on a strategic report and policy brief on CCT and CCU.

Mr Tri: My name is Tri Suhartanto from the Directorate General of Electricity. My friend is Mr Andi Hanif from the same directorate general. Unfortunately, the other member, Mr Junifer, cannot join us due to another appointment falling at the same time. So, Mr Andi and I will engage in a discussion with you.

Mr Andi: My name is Andy Hanif, and my specialisation is reliability and electricity safety. I look forward to inputs we can consider while elaborating our future policy and its direction. We will also try to share the latest information on the energy transition in Indonesia. Mr Tri has experience working with ERIA, so we expect fruitful exchanges with you.

Mr Amirulazry: My name is Mohammad Amirulazry. I am the only representative from Malaysia. I serve as Assistant Director for Electricity Market Operation and Economic Regulator Department in Malaysia's Energy Commission. I expect this study to have an optimal carbon-neutral solution, especially in Malaysia and ASEAN. As you might know, Malaysia aims to be a carbon-neutral country by 2050 at the earliest.

Mr Yaowateera: My name is Yaowateera Achawangkul. I work at the Department of Alternative Energy Development and Efficiency, abbreviated as DEDE, under the Ministry of Energy of Thailand. I am very happy to see everybody and am glad to work on this study again. I expect this study to correspond with Thailand's emission reduction targets. Thailand aspires to be carbon neutral by 2050 and to have net-zero carbon emissions by 2065, respectively. Therefore, this study will be conducted to contribute to Thailand's relevant policy towards the committed targets.

Mr Tananchai: My name is Tananchai Mahattanachai. My profession is geophysicist, but I work for the Department of Mineral Fuels, Ministry of Energy Thailand. I have been serving the department for over 20 years.

The study team members also introduced themselves.

Dr Murakami: Hello, I am Kazuyuki Murakami, Director of International Collaboration Department, JCOAL. Under this study, I do energy sector analysis. Also, having worked for JCOAL's roadmap of technology for carbon neutrality, I handle the technology chapter of this study to identify the technology options and their availability for ASEAN and the four target AMSs in cooperation with my colleagues working for country subchapters.

Mr Ozawa: My name is Ozawa. I am the chief engineer of JCOAL. Being a professional boiler engineer, I have worked for decades in basic plant design and engineering parts of a thermal power plant. Since I came to JCOAL, I have been working on new areas like applicable CCT for ASEAN and biomass and ammonia cofiring.

Mr Otaka: Good afternoon. I am Otaka, programme manager of resources, a department of JCOAL. I am a professional in coal characteristics analysis and other chemical analyses of resources. I was a leading member of the two-phase ERIA study on coal-biomass cofiring potential in ASEAN, for which I also conducted the techno-economic analysis. Under this study, I undertake the Indonesia subchapter.

Mr Teuchi: My name is Teuchi, a geologist. I belong to the Technology Strategy Center of JCOAL, where I work on the research and development of carbon-recycling technologies. I undertake the Thailand subchapter.

Mr Yamashita: My name is Yamashita. I serve in the Resources Development Department. I am a mining engineer. Decades back, I worked at a coal mine in Japan under the seabed. And just 4 years ago, I worked on developing an underground coal mine in East Kalimantan, Indonesia. I undertake the Viet Nam subchapter.

Mr Nakano: My name is Tatsuhito Nakano. I serve as Deputy Manager of the International Collaboration Department and Accounting Group in the General Affairs Department. My major is resources science. After joining JCOAL, I experienced international cooperation and business development for CCT and budget control and accounting. I oversee the processes and progress of this study and offer help when required. I look forward to the discussion.

Mr Tri made the first presentation on behalf of all Indonesian members.

Following the presentation, Mr Andi Hanif made supplementary clarification.

Andi Hanif: Since the presentation has provided the required overview, I would like to refer to the information from Mr Tri on Indonesia's energy transition and provide additional clarification.

The grand design of Indonesia's energy transition is net-zero emissions in 2060. This vision consists of three main activities: (i) we will retire the existing coal power plants; (ii) we will also try to stop the construction and contract of new coal power plants; (iii) we will try to increase the installed capacity of new and renewable energy. Any technology that can support our vision of net-zero emission will be welcome. For example, clean coal technology, super grid technology, and all those technologies would possibly support that vision.

【Q&A with Indonesia】

Dr Murakami: I have one question on the availability factor of solar. In your presentation, solar capacity and share of capacity are growing. I talk about dependence in relation to the grid fluctuation issues. I would like to know what you think about solar's availability factor. As the availability factor of solar is around 10% to 15%, its generation dependence is not so high.

Mr Andi: I agree that a solar power plant has a relatively lower availability factor. We understand that. That is why we are trying to support and enhance the battery industry, which we hope will substitute for the insufficient availability factor of solar. If battery production can be done in Indonesia, it will also be cost-competitive. And then the other technologies supporting the situation are super grid and microgrid. In our activity. We prefer that solar power focuses on the decentralized systems of small, remote islands and is to be managed by PLN rather than IPPs. We are trying to articulate the overall power system on many different grids, divided into more than 17,000 islands, for sustainable power supply and optimal grid management.

So, the number we put in the presentation is for the entire Indonesian archipelago, including East Indonesia. As I said, we are open to other technology that can support our people. For now, battery for energy storage is one of the envisaged major solutions. Through local production, prices can be lower, and deploying batteries, with super-grid and small/micro-grid, can support our efforts to address the intermittency of renewable energy.

Ms Yamada: I have a minor comment on the graph on slide 10. Towards 2060, combined cycled power plants will go off before coal-fired power plants go off. That means in your country, both gas and coal are transitional, which is one of the features of Indonesia's energy transition. We understand that one of your key majors will be retiring inefficient coal-fired power plants first, followed by other coal-fired power plants in a phased manner. All these tell us that coal can be transitional and will have roles even in the energy transition.

Malaysia was the second presenter.

【Q&A with Malaysia】

Ms Yamada: I have a few questions. Malaysia will replace the existing 8,054-megawatt (MW) coal-fired plant with only 2,800 MW. So, overall, the coal-fired power plant installed capacity will be less. However, 2,800 megawatts are coming in. In that context, I would like to know for what year Malaysia has set its national target for coal-fired power plant phaseout or phase-down to zero.

Mr Amirulazry: Starting in 2029, we will embark on the phase-down by retiring the first coal power plant. Others will follow as time goes by. We will substitute the reduced installed capacity with gas and RE. That is what I can tell you now. We must see what it will be like because the government's comprehensive national energy policy is currently being discussed. That is why we can say that in 2040, we will have around 2,800 MW of coal in the electricity-installed capacity mix.

Ms Yamada: Thank you for the clear explanation, which I fully understand. I have a personal concern. If you construct a coal-fired power plant now, it will cause concern about its economy since the life of a power plant in Malaysia is generally much longer, thanks to high-level O&M techniques of utilities and engineers.

Mr Amirulazry: I understand, but the government has decided that there will be no more new coal power plants. However, I understand what you said; our power plants are well maintained and operate well. I do not know; maybe they will focus on cofiring after this.

Ms Yamada: Exactly, that can happen in any country. You are right; it depends on the energy security situation and supply requirements.

Mr Amirulazry: For example, Germany has been initiating green energy utilisation. But recently, we have seen Russia stop the gas supply, and Germany had no choice but to resume the operation of their coal power plants.

Thailand had two presentations: Mr Yaowateera, from DEDE, Ministry of Energy, and Mr Tananchai, from the DMF, Ministry of Energy.

Mr Yaowateera made the presentation, followed by Mr Tananchai.

Mr Yaowateera's presentation can be summarised as follows:

- Thailand's renewable energy (RE) status: the share of RE in 2021 was 14.62%, which decreased compared to 2020 due to the COVID-19 pandemic.
- Thailand's long-term GHG emission development strategy: Thailand aims to reduce 40% of GHG in 2030 with international support. In addition, Thailand aims to achieve carbon neutrality and net-zero carbon emissions by 2050 and 2065, respectively.
- The Ministry of Energy of Thailand is preparing the 'National Energy Plan (NEP) 2022', which aims to (i) increase the share of RE in new power installed capacity by 2040, (ii) promote the use of electric vehicles to be more than 30% of total vehicles by 2030, (iii) increase energy efficiency to be more than 30% by applying new technology and innovation, and (iv) energy transition coping with the 4D 1E policy.
- The 4D 1E policy consists of digitalisation, decarbonisation, decentralisation, deregulation, and electrification. The decarbonisation policy aims to reduce carbon emissions by replacing fossil fuels with clean energy, such as solar and bioenergy.
- Thailand also introduces the bio-circular-green (BCG) economic model, which aims to consolidate the concept of bio-material use, recycling, zero waste, and natural problem-solving. The expected outcomes from the BCG economic model are to increase domestic GDP to THB4.3 trillion within 5 years, support the local economy (e.g. agriculture sector), and contribute to the United Nations Sustainable Developments Goals.

【Q&A with Thailand】

Ms Amira: Thank you so much for the two presentations. I was impressed, especially by the presentation on the development of CCUS in Thailand. Considering the carbon market will constitute a crucial part of CCUS development in Thailand, I wonder if the government has implemented domestic policies or something to kickstart the carbon market. Also, have you already brought the matter to REPSSN or maybe to the ASEAN Forum on Coal (AFOC)?

Mr Tananchai: Yes, it is quite new, and we are trying to initiate this topic into AFOC and Asian cooperation. Now we are at the stage of setting up. We formulated a cooperation programme for CCUS, which was already submitted to ACE for the concept note for circulation to the AMSs. Hopefully, we will get good feedback from them. Another important domain of CCUS is the carbon market because it is one of the important mechanisms to drive and incentivise the CCUS project in ASEAN.

Finally, the study team presented on the identified potentials and findings of the study.

【Q&A with the Study Team】

Mr Amirulazry: I have just one question to be addressed. For the recommendations to ASEAN, will it be like a 'one-fit-for-all' recommendation or will recommendations be provided for the four AMSs?

Ms Yamada: We have chosen four countries with high potential: Indonesia, Malaysia, Thailand, and Viet Nam. Dr Ambiyah mentioned the other study that is now ongoing and the framework of the ACE-JCOAL cooperation in close collaboration with AFOC. The study is more in pursuit of ASEAN's readiness to introduce and apply CCT and CCU technology during their energy transition. So, the subjects are the same: energy transition and technology for carbon neutrality, but the approaches are different. In this study, the main focus is on the four AMSs. So, individual recommendations for those AMSs will be furnished in addition to the recommendations to ASEAN. The method is to prepare by-country recommendations from which we make extracts and formulate those for ASEAN. So, the focus is more on by-country recommendations, though we also regard our recommendations to all ASEAN as important.

Mr Tananchai: I have a little observation that the topic of our working group is applicability of CCT for comprehensive and optimal carbon neutrality. But we agreed that CCUS plays an important role in carbon neutrality, so I would like to suggest that CCUS be considered part of the target technology.

Ms Yamada: Thank you, Tananchai-san and Teuchi-san, who are engaged in the Thai study and have been conducting literature surveys for months. However, he could not obtain a full range of information due to language barriers and/or limited availability of information in the public domain. So far, his analytical work has focused more on biomass-dedicated firing and the introduction of relevant technology. However, the study team's report today is to provide initial ideas. And we are expecting your and Mr Yao's cooperation to help Ozawa-san by giving him advice and relevant information, including the advice you have just provided about the inclusion of CCUS as part of the target technology. We appreciate your advice and your forthcoming cooperation with us.

Ms Yamada: Amirul-san, I heard that Malaysia is very positive about deregulation or improving the tariff systems so that the electricity sector will be more competitive. I think the energy commission must be in the central position. If we may know, how much is the progress as of today because that is related to renewable energy development? It is a general observation that the more competitive the electricity sector, the smoother renewable energy development proceeds. And that Malaysia is now trying to go further in that direction is being mentioned in some internet sources.

Mr Amirulazry: It is a very good question, and I would like to check updates on the matter and communicate further by email.

Ms Yamada: Thank you very much, Amirul-san. Let us communicate further by email. We will draft the minutes, which will be shared with you for comments. Before we close this meeting, the team would like to express its wholehearted thankfulness to all working group members and the guests from ACE.

The meeting was closed with the announcement that the Second Working Group Meeting is scheduled in the middle of October 2022. The meeting will be held physically at the ERIA headquarters in Jakarta, Indonesia, if the situation allows.

Attendance: Working Group Members and Observers

Country	Institution		Attendance
Indonesia		Mr Tri Suhartanto, S.T., M.Eng Mid-Level Electricity Inspector, Directorate General of Electricity	@ MS Teams
		Mr Andi Hanif, ST, M.Eng Mid-Level Electricity Inspector, Directorate of Electricity Engineering and Environment, Directorate General of Electricity	@ MS Teams
Malaysia	Energy Commission (ST)	Ir Mohd Helmi bin Mohd Zaihan, Assistant Director	@ MS Teams
		Mr Mohd Amirulazry Mohd Amin, Assistant Director	@ MS Teams
Thailand	Ministry of Energy	Mr Tananchai Mahattanachai, Senior Professional Geologist, Department of Mineral Fuels (DMF)	@ MS Teams
		Dr Yaowateera Achawangkul, Mechanical Engineer, Senior Professional Level of the Energy Research Division, Department of Alternative Energy Development and Efficiency (DEDE)	@ MS Teams
Vietnam	Ministry of Industry and Trade	Mr Doan Ngoc Duong, Deputy Director General, IE(Institute of Energy)	@ MS Teams
	Ministry of Industry and Trade	Dr Nguyen Manh Cuong, Deputy Head of Power System Development Department IE(Institute of Energy)	@ MS Teams
ASEAN Centre for Energy (ACE)		Dr Ambiyah Abdullah - Senior Officer, Energy Modelling and Policy Planning (MPP)	@ MS Teams
		Ms Amira Bilqis - Associate Officer, Energy Modelling and Policy Planning (MPP)	@ MS Teams

Attendance: ERIA and JCOAL

Organization	Participants
Economic Research Institute for ASEAN and East Asia (ERIA)	Dr Han Phoumin, Energy Economist
Japan Coal Frontier Organization (JCOAL)	Dr MURAKAMI Kazuyuki, Director, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Mr OTAKA Yasuo, Senior Program Manager, Resources Development
Japan Coal Frontier Organization (JCOAL)	Mr YAMASHITA Eiji, Senior Program Manager, Resources Development
Japan Coal Frontier Organization (JCOAL)	Mr OZAWA Masahiro, Chief Engineer, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Ms YAMADA Fumiko, Assistant Director, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Mr TEUCHI Shinjiro, Deputy Manager, R&D Development Department

Appendix III: Report of the Second Working Group Meeting

ERIA Research Project 2021/2022

Second Working Group Meeting for the Study on the Applicability of CCT for Comprehensive and Optimal Carbon-neutral Solution in ASEAN

Hybrid Meeting held in Jakarta, Indonesia, and on MS Teams on 18 October 2022

At the outset, Ms Yamada of JCOAL, serving as MC, expressed the team's gratitude to working group members who came all the way and made themselves available at the busiest period of the year. Appreciation was expressed also to the directors of ERIA attending the meeting.

Then Mr Toru Furuichi, Director General of Research and Policy Design Department, ERIA, welcomed the delegates.

Mr Furuichi: Today, I am very pleased to welcome you all to the second working group meeting on the 'Applicability of the CCT for Comprehensive and Optimal Carbon-neutral Solution in ASEAN'. This study is one of the important studies in line with ERIA's recent published document on the technology list and the perspectives for the transition of finance in ASEAN TLPTFA, which aims to support the smooth energy transition in developing Asia with realistic approaches that can facilitate many countries in Asia to embark on pathways to carbon neutrality with consideration of energy security, affordability, accessibility, and environmental protection simultaneously. It is very important to note that among the transition technologies, cofiring at coal-fired power generation with ammonia and hydrogen fuel is highly recommended in the ASEAN Energy Transition Study.

ASEAN countries have announced their respective carbon neutrality targets before or at the COP-26, which impressed us that ASEAN made one big leap forward in the initial part of their energy pathways. However, we are aware that pathways to carbon neutrality will be diverse among countries. There will be numerous opportunities to reduce emissions in the ASEAN region, and such opportunities will be fully utilised only if optimal solutions with applicable technologies were in place. Some countries would have limited abilities to straightaway jump to massive renewable energy and new energy development and introduction due to economic constraints.

In the meantime, CCT, combined with CCUS, will remain important for ASEAN.

Many ASEAN countries adopt CCTs, which are vital for energy security as coal contributes sustainable power supply at affordable cost. In addition, coal supply is steadily available within the region. Now the question is what are the CCTs that are for decarbonisation and energy transition? Given that high dependence on fossil fuels could continue in the region, improving emission reductions is necessary through the introduction of a highly efficient coal power plant with CCT technologies, such as coal and ammonia cofiring, and coal and biomass cofiring in power generation. At the same time, the possibility of CCUS is vital and relevant for the energy transition towards carbon neutrality. Gradually, all transition technologies will need to be identified and financed across multiple sectors.

Ladies and gentlemen, I wish to take this opportunity to thank all the working group members for their contribution to this study, which is very important for ASEAN energy security and support to the AMSs' energy transition.

Then Dr Kazuyuki Murakami, Director of International Collaboration Department, JCOAL, made remarks on behalf of JCOAL and its study team.

Dr Murakami: Firstly, I would like to express my sincere appreciation to all of you for participating in this working group meeting for the study on the applicability of CCT for comprehensive and optimal carbon-neutral solution in ASEAN. We are very happy to present our draft report for technology introduction and the reports of these four countries regarding the trend for carbon neutrality with the energy shift from fossil to non-fossil fuels. It is an irreversible trend, and many countries have announced their carbon-neutral target and related policies. Since most measures for carbon neutrality are basically at the R&D or demonstration stage, it is still difficult to clearly show the practical solution option. In this regard, this study has an important meaning, and all of you can be requested to join the discussion today actively.

After the discussion of today's meetings, the JCOAL Study Team will try its best to identify suitable and applicable technology options for furnishing recommendations to all four target AMSs and to overall ASEAN at the end of November 2022.

ERIA officers, working group members, guest working group members, and JCOAL Study Team members introduced themselves.

The JCOAL Study Team presented on decarbonisation technology solutions.

Q & A session on decarbonisation technology solutions

Mr Doan: Can you change to slide 12, question about Japan's policy on carbon neutrality by 2050? I have questions about the carbon neutrality goal of Japan. Here, I see a huge number of carbon dioxide emissions in electricity, but it decreased very much – about half in 10 years. I was wondering how CO_2 emissions from electricity generation decreased.

Dr Murakami: Thank you very much; you make a good point. So far, our government has declared about 46% reduction towards 2030, with 2013 being the base year. That is 9 years back from today. That was when the most emissions were observed in our country. So, the main measure for decreasing is phasing out all coal-fired plants and cofiring. So, by combining these measures in addition to energy mix optimisation, mainly introducing RE, we can achieve 46% reduction by 2030.

Mr Doan: To my understanding, will the power demand decrease in Japan in the next decade?

Dr Murakami: No, the demand is mostly the same so far.

Mr Doan: That is stable. Maybe it is not changing much in the next 10 years. Actually, we have about a 10% increase per year.

Dr Murakami: I understand that the required measure depends on the country's situation. Yes, I understand that Viet Nam's situation is very challenging.

Mr Amirulazry: Okay, just one more question from me: slide number 19, concerning the NOx emission. So, you are saying that stable combustion and reduced NOx emissions with 20% of ammonia cofiring have been achieved. I understand that when you try a higher cofiring of ammonia, you create more or additional NOx emissions. So, how do you reduce NOx emissions? Maybe you need more equipment or something to reduce NOx?

Dr Murakami: Okay. So far, in our previous study, according to IHI on the technology supplier, by 20%, NOx generation does not increase because the main factor or origin of NOx is air. I mean, nitrogen is the main factor. If we increase ammonia by 20%, chemical NOx may increase, but we expect it to decrease by controlling combustion temperature. Also, NOx can be reduced after the boiler. They think they do not need to modify more but in the case of a higher-mixing ratio, they must consider the SCR units' performance improvement.

Mr Amirulazry: Okay. Yes, thank you. I understand.

Mr Doan: So, may we relate to the question? I think the emission reduction comes from ammonia cofiring because ammonia is a clean fuel.

Murakami: Yes.

Ir. Mohd Helmi bin Mohd Zaihan, Malaysia: I am unfamiliar with the map of Japan. Are these in separate locations? Or are these plants located near each other?

Murakami: No, the top one is located in West Japan, and the Soma energy plant is in the northern part of Japan.

Mr Helmi: So, you're planning to fire the biomass. Where do you get the biomass resources?

Dr Murakami: Good question. So, most biomass resources are imported by the trading agent and the utilities. In these cases, they own a coal yard, a storing site of biomass close to the thermal power plant.

Dr Yao: In Thailand, biomass is collected and sent to Japan. Some companies must modify their plant for cofiring.

Murakami: In Japan, most USC plants conduct 1%–4% biomass cofiring without modification.

Mr Andi: Dr Murakami-san, in my understanding, carbon cannot be recycled. So, how does carbon-recycling work?

Dr Murakami: Please move to number 24. Yes, this is the roadmap by the government. Now, we are in phase 1, looking for any possibility of carbon recycling and recycling other materials. Also, in parallel, we are conducting reality check about CO_2 recovery. If CO_2 is recovered, it costs more. So, the commercialisation of CO_2 recycling becomes difficult. Interaction with any person over R&D, which we are also conducting through the supplier, universities, and all centres concerned. Government supports and funds R&D for carbon recycling. Now, our government has decided to support 14 sectors of the future industry, one of which is carbon recycling. That is the current situation in Japan.

Dr Phoumin: Normally, the carbon is related to CCUS. If you can recycle, as Dr Murakami said, it is a mini product. If hydrogen is combined with CO_2, you produce a specific fuel. If you have industrial waste available, you can produce many kinds of construction materials using carbon. You see many other materials. So, carbon can be recycled. But Dr Murakami said that the net hydrogen, this becomes commercialised, then the cost becomes available. Carbon must be recycled as much as possible.and The rest of the carbon is to be permanently stored underground.

Dr Cuong: May I have one more question. It is about CCUS. Some people say CCUS is the licence for emissions; so it could violate the environment. What is the reason the Japanese chose CCUS as one of the solutions for a net-zero goal?

Dr Murakami: It is difficult, but we do not have many options. I mean, we do not have enough resources. You have to consider all the technology to achieve carbon neutrality. So that is why CCUS is rather important to other countries.

Dr Phoumin: ERIA is working on CCUS. You can become a member of the Asia CCUS Network Forum. I think some of my colleagues can take the attendance and reach out to you. Actually, CCUS is quite important because the region still yields fossil fuels. In the East Asia Region, the share of fossil fuel is almost 80% in the primary energy supply mix. . So, if we continue using fossil fuels because of energy security or because of coal stability or supply security, the clean use of fossil fuel is very critical in which the carbon recycling technology is vital in the whole process. Generally, we cannot recycle 100% of the emission. The NOx can be reduced with the environmental facility to a much lower acceptable standard. But CO_2 cannot be captured basically, so you need to recycle the CO2 emission. Then the remaining CO2 must be injected to be stored underground.

In that case, if you still use fossil fuel, you need to use CCUS. Otherwise, you must offset with reforestation, afforestation that is still okay. But as long as you continue using fossil fuel, you must combine with CCUS. ERIA conducted the study, and we found that the capture cost of CO2 is very high representing about 70% of the whole value chain of CCUS. Basically, the capturing cost varies depending on types of industries ranging from petrochemical to power generation.. Power generation represents almost $60 per tonne CO_2 currently, transport represents around 5%, and injection around 25%. So, we want to bring down the capture cost in the future. So, I think this working group is relevant to our members. I hope to pass your name on to my team. Thank you.

The Indonesian member made an updated presentation, followed by JCOAL Study Team's by-country observation and perspectives presentation on Indonesia.

Q & A session on the presentation on Malaysia:

Mr Helmi: I have questions for Indonesia. In one of your earlier slides, you mentioned that Indonesia will have its first nuclear power plant by 2049, if I'm not mistaken. This means the construction for the same will start soon. So, how do you convince your public that nuclear is the way forward? Because, for example, in Malaysia, nuclear is taboo. We do not want nuclear, so we would like to learn from Indonesia.

Mr Andi: That is a very good question. So it is okay that our discussion has reached another point. We already have three reactors in Indonesia, but only a kind of research reactor. We tried to install a nuclear power plant in the 1960s during the term of our first president. Then the decision maker in our ministry already found a keyword that will convince people, commitment from the top management, I mean, the president or the prime minister. If the president says to do it, it will be a little bit easier. So, if the president or the prime minister is still not sure, the people will not be sure. So, that is why we propose to the president this net-zero emissions scenario to assure him. We are happy that our current president is not objecting to a nuclear power plant. That is why the president and the national energy council agreed to put the nuclear power plant in the scenario. Yes, that is our answer. Thank you.

Dr Phoumin: We were very impressed with your presentation. Looking at your national installed power capacity, for coal, it goes to zero, in 2059, 2057, and nuclear, new energy and renewable energy will be generation sources from there onwards. Do you have hydrogen or ammonia, a 100% coal power plant? I just want to check because you have hydrogen. Will you import ammonia and hydrogen for power generation, or do you not have any power generation from ammonia or hydrogen?

Mr Andi: We do not have any for now, but this is the programme. This is the direction from the Energy Council and the president as head of the Energy Council. We will build nuclear; we will build hydro, gas, etc. And how we do it, you find the way. That is how we work. So, for now, we do not have hydrogen. Maybe our member from Indonesia, the Indonesian from ACE, and ERIA already know that our president said, "You must build the highway from Jakarta to Surabaya. That is my direction. How you build it is your duty; find a way. Say, now we have a long highway on the island of Jafa, and then after this long highway into Sumatra, the same thing will happen. We will do the same in the energy sector. Yes, and all sectors, because the focus of our president – and maybe the next president – is infrastructure and how to build it. So, my answer is no. We still do not have, but we will find a way to do that – whether we will build ourselves or we will import nuclear energy. We still have no idea who will support us – Russia, the United States, China, or all. We still do not have an idea, but we will find ways.

Dr Phoumin: I am very excited about that roadmap. ERIA is interested in being involved in Indonesia as you want to develop further. We support the ministry in that net-zero emission roadmap. I am unsure how because I see solar and wind coming, so they are intermittent. Then the capacity of green hydrogen production is quite small compared to the scale of renewables, right? So, I want to know whether you will completely use curtailed electricity or wind or solar

farms. I also think importing ammonia and hydrogen will be critical for Indonesia to meet that objective.

Mr Andi: Maybe this is the key information like nuclear, where will we buy the uranium. We do not have uranium; just the same problem. But we will put it as a concern. Thank you.

Dr Ambiyah: I would like to ask you to elaborate on the projection of power generation emissions. I am concerned about the kind of scenario you envisage and whether factors, such as energy efficiency reduction in power generation, are considered. Or are you only focusing on the expansion of renewables in Indonesia's power sector?

Mr Andi: There is no doubt we will create the efficiency of the coal power plant. We already do cofiring in several coal-fired power plants. Then we have a kind of safety competition for the power plant. We call it the safety competition of power plants, the cofiring biomass, and how the power plant reduces emissions and increases efficiency. It is one of the points of that competition. So, we will not stop because we are the more significant coal exporter.

Yes, we are the larger exporter, so when we will not stop. We still focus on the condition of our economy. Coal is one of the high-income sources in our country. So, we are not going to like stop producing and utilising coal. We will do other things like increase efficiency and use cofiring; we already do that now. Okay, so in the year 2057, yes, we hope to stop the coal power plants. But we also hope that the coal power plants in that year can be 100% very efficient or very clean. We do not know what technology will arise. But this is the direction, and as I explained before; we will find a way to find the technology, and we must be optimistic. Thank you.

By-country observation and perspectives presentation: Malaysia

Q & A session on Malaysia's presentation

Mr Helmi: As one recommendation we found for Malaysia, our minister was at one of the programmes on green energy tariffs last year. You can buy an electricity tariff for customer needs in the peninsula region, which we call the great electricity tariff. By that, you enjoy the electricity supply from renewable energy only. But we have a premium charge of around 3.7% per kWh, so this is new and underway in ASEAN countries. This is one of the programmes that may encourage the reduction of the carbon footprint in electricity consumption. Then maybe the way forward is to increase the quota for this year, and because it is enrolled to receive the internationally recognized renewable energy safety kit (IREK) after the end of the 20-day year to prove that the energy we are using is from renewable energy. So, voluntarily, it is similar, unlike in Europe where renewable portfolio standards are mandatory. Also, the renewable certificates will be traded in Malaysia only and are recognised by the government.

Dr Phoumin: But what does the one who produces green renewable electricity get in return? Does he get any carbon credit or not?

Dr Yao: The company can buy this renewable certificate.

Mr Helmi: In Malaysia, we have one organization called mGATS (Malaysia Green Attribute Tracking System) that is a national marketplace for renewable certificates called mREC. Renewable certificates will be pooled and sold to companies that need the certificates.

Mr Amirulazry: The other good thing is that buyers are given opportunities several times. We will announce in November and December 2022; we opened the following quarter later – supposedly around March 2023.

Dr Phoumin: Thank you so much. Thank you for your plan. We go back to Yamada-san. I think your report on Malaysia is very detailed, but I just want to see the hydrogen economy that Malaysia committed. Sometime back in 2005, they had a hydrogen roadmap that was stopped. It has started again and seems to be good. Now is the right time because hydrogen is a potential game changer. So, I think Malaysia should be engaging in the supply chain. If we are promoting the hydrogen economy in ASEAN and East Asia, then the supply chain should be established. It has been proven recently that the segment of hydrogen carrier, SIP carrier, from Australia is successful. Brunei asked for Tokyo's support for the Olympic Games recently.

Dr Murakami: I think this will be very, very good for Malaysia. ASEAN countries have already taken a dip in exploring hydrogen technology.

Dr Phoumin: Yes, but the fuel stock can come from anywhere. But green hydrogen comes from renewables.. But more hydrogen is produced from natural gas, currently 95%. So, Malaysia has the potential for clean hydrogen, which can be tapped from the hydro potential in Sarawak. Hydrogen is a very big game changer for Malaysia. That is why maybe you can highlight in the master plan, the roadmap of hydrogen. Perhaps this will encourage ASEAN to follow the Malaysian model. But now I am happy to see Thailand also taking the hydrogen issue seriously. I want to follow that closely.

Dr Yao: Yes, you can. We have the report.

Mr Amirulazry: We now have the hydrogen roadmap; it is not a policy but a proposal.

Mr Helmi: Akademi Sains's roadmap has yet to become a policy. It is just one of the government's research projects and is still being reviewed. So, it is not yet a final government policy.

Ms Yamada: Can it be a part of the national team for considering the policy. Is Akademi Sains a government institution?

Mr Amirulazry: Yes, to both. It is a government agency.

Ms Yamada: While it is yet to be finalised as a policy, it is something, especially considering that multiple sectors and organisations are involved. Group studies and projects are proposed and are sorted chronologically by 5-year plans towards 2050. It would benefit your government to incorporate its vision and proposals when Malaysia's national hydrogen policy is ready for implementation.

Mr Helmi: Let us see and hope a confirmed hydrogen policy is in place soon.

The member from Thailand made an updated presentation, followed by JCOAL Study Team by-country observation and perspectives presentation: Thailand

Q & A session on presentation on Thailand

Ms Yamada: I have a question about slide no. 4. What is the difference between carbon neutrality and necessary emissions? We usually use those with the same meaning, but they may have different meanings on this slide.

Dr Yao: For carbon neutrality, we can use carbon sinks, such as afforestation, etc., while net-zero emissions mean we have no emissions.

Mr Tananchai: The carbon neutrality measures comprise natural carbon sinks like afforestation. While net-zero emissions mean what we are producing, we take it back, including the CCUS, to ensure technology can abide by the mission to net zero.

Ms Yamada: In slide no. 5, you say at the bottom 'to minimise overall costs'. Thailand has developed a portfolio of complementary renewable energy sources and intelligent control systems to manage variable sources. I am particularly interested in intelligent control systems. To what extent are these intelligent? Are they a kind of artificial intelligence or AI? Do you already have particular systems in mind that are already commercially established?

Dr Yao: Yes, Yamada-san. To better forecast power generation while balancing between VRE and other power, we use the Internet of Things or IoT and the application and platform to forecast by using meteorological data, such as wind direction, solar deviation, etc., to evaluate it with the domestic energy demand. It is the tough headstart that ECA demonstrated because ECA now has launched a forecasting centre. We recognise that, in the future, we will have an effect on power generation, which may be higher. Therefore, we must decide and utilise the same innovations to decide what can be used. What can we do to use as flexible sources – the natural gas or hydropower plant.

Yamada: So, that is an additional problem.

Dr Yao: Yes, for a different study.

Ms Yamada: My last question concerns the second to the last slide. Here you mention biojet and hydrogen. Do you say that this is sustainable aviation fuel? What kind of fuel is biojet?

Dr Yao: J-set is a sustainable aviation fuel that we will try to adopt in the future. So, demand will be high for J-set in the future. Naturally, there will be a considerable decrease in the use of the bioenergy and bio off field.

Ms Yamada: Thank you very much. May I ask Mr Tananchai to make some supplementary updates or comment on Ozawa-san's presentation?

Mr Tananchai: Thank you, Ms Yamada, I do not have any presentation right now. I would like to update you a bit about the CCUS plan in Thailand. Tomorrow we will have our first meeting of the national CCUS subcommittees. We will have our prime minister. After tomorrow, we will eventually have a more solid plan for the pilot project and the study. It is now updated, and it is more than what we currently have to do in June. The pilot project now becomes 10 pilot projects, and the study on device use in the United States and Thailand is has increased to 11 studies.

Anyway, we will update you after tomorrow's meeting with the department of internal affairs. We are going to press ahead and get approval from the subcommittee tomorrow. We will update you soon. Thank you very much.

Ms Yamada: Thank you very much, Mr Tananchai. We are expecting updates maybe by email; we can communicate later.

Dr Phoumin: I have a quick question for Mr Tananchai. You said that Thailand would hold an important meeting tomorrow about its CCUS plan. After that meeting, Thailand will have a roadmap for the CCUS. Is my understanding correct?

Mr Tananchai: It is just a plan. The roadmap is coming. We plan to finish our CCUS roadmap next year.

Dr Cuong: Thank you so much. I still have questions regarding your second to the last slide. What is the point of conducting capacity building and information dissemination? That is the first question. Is there any problem regarding the public about renewable energy? Is there any problem? Do you still have problems making the public understand renewable energy and digital technology like biomass and biogas? I do not think the public believes that burning biomass will generate power and release heat into the atmosphere. My second question concerns the consequences. Capacity rating is an important issue in the new renewable energy policy. The next question is about adequate environmental policy. We are considering a scheme under which we can charge fees according to the degree of carbon intensity released into the atmosphere.

Dr Yao: Is that large-scale or small hydropower? The cost of small-scale hydropower cannot compete with conventional ones. The cost would be slightly higher than the large-scale hydropower. Is it possible to revise this summary again? One thing on the third recommendation on biomass, the classification of biomass is not popular for transport. We can discuss classification later.

By-country observation and perspectives presentation: Viet Nam

Q & A session on the presentation on Viet Nam

Mr Duong: About the carbon capture in storage as a solution, we would have a problem with CCS. For example, under the ATP policies, we cannot get knowledge to maintain the existing coal fired power plants. They just provide the loan to retire a coal-fired power plant, not for CCS or carbon capture to maintain the operation of the coal-fired power plant. That is the problem for us.

Mr Yamashita: It is all very valuable. I know that for countries, it is difficult to reduce finance, so CCS or CCUS is right. Money is very important. Many coal-fired power plants are currently in operation. Those power plants have been in operation for less than 10 years. As coal-fired power plants usually have an operating life of 30 to 40 years, CCUS must be installed to reduce the CO_2 emissions from coal-fired power plants to keep them operating longer in the future. CCUS is quite an effective choice of technology, however, as of today finance scheme availability is rather slim, though many institutions are considering to establish or enhance finance schemes for CCUS. The issue is how to get finance to implement CCUS.

Dr Murakami: I put that ad, so your point is very good. It is one of the recommendations for this report in preparing CCS. So, strong government support is recommended. That might be one of the recommendations of this study. Thank you.

Mr Helmi: I have a question. In one of your recommendations regarding solar power, you mentioned that solar power is encouraged only for self-consumption. And if self-consumption for rooftops, there is no limit; it is not connected to the grid. What if the customers want to connect their facilities to the grid? Is there any special charge or limit on the installed capacity?

Mr Duong: I cannot answer that question. You may know that as the presentation of the report clearly indicated. In the last few years, we have installed a huge solar power capacity, about 20 GW, both land-based and on rooftops. Those have a very big capacity. So, the government decided that was enough for rooftops, at least for the next 10 years because of the issues with the power system operation. So, the government will not encourage rooftop solar installation, try to sell the power to the grid, and encourage self-consumption for rooftop solar. So, generating that scale of solar capacity will not affect the overall power grid operation. That is the direction of the government.

Mr Helmi: Just another quick question. Is the electricity tariff in Viet Nam cost-effective? Or is it heavily subsidized?

Mr Duong: That is a very tough question. In Viet Nam, there are state-owned corporations not responsible for the operation of the power system. Even with EVN as a single buyer of all generated power, the tariff of all and any power producers with any power resources reflects all required costs for generation. We will determine the tariff of the power system based on the summary of all power generation sources, including feed-in tariffs. But because the feed-in tariff is quite high, that may be creating solar wood rust. So, in short, we are experiencing some loss in this operation since we cannot compensate for such a high feeding tariff of solar or wind power. But in the mid to long term, it is necessary as we proceed with the energy transition

pathway. Currently, the government wants to stabilise the economy by not pressuring the enterprises and increasing the power tariff. Increasing the power tariff later will enable the economy to gain.

Mr Duong: I agree with the presentation on Viet Nam. However, looking at nos. 87 and 88 on the eastern power system in PDP8, some would ask why, after reviewing, the capacity will tremendously increase.

I see some differences between what you present as the tentative power plan of Viet Nam and the latest draft PDP 8 that is under discussion in the government. I just guessed because I do not remember all the details. But you may need to mention that the two columns on the left are not based on the base scenario for power demand. Up to April this year, the data on the right is based on a high scenario. The process is a little complicated. In any case, it should be the most technical consideration–based scenario.

Mr Yamashita: We will look into it and later confirm how we shall express the situation in this part of the report.

Dr Phoumin: It is good that you say hydrogen or ammonia cofiring may be suitable for Viet Nam or other countries. However, more information may be required regarding the commercialisation, the maturity of the technology, and the cost because green hydrogen and green ammonia will still be expensive. As for Viet Nam, as long as we understand the PDP8 and other resources, hydrogen remains costly for a country like Viet Nam.

Mr Yamashita: In my view, solar and wind are clean, but they can make intermittent power supply of VRE. Then coal power can complement those shortcomings and support the grid through flexible operations. That way, we can also sustain the economy of the overall power supply. That is what we do in Japan, and it may also apply to Viet Nam.

Dr Phoumin: Just one more minute. As for hydrogen utilisation, we all know that Japan is the leading country in studying and researching ammonia in existing coal-fired power plants. We expect a continuously updated information about your technological advances so that we can eventually keep our plant as close to reality as possible.

Finally, at the wrap-up session, the study schedule towards the end of November 2022 was confirmed. The closing remarks by ERIA and the JCOAL Study Team followed.

Dr Phoumin: I thank and congratulate all working group members of these important studies. In particular, I thank Furuichi-san for his time. He is very busy with many projects. I greatly appreciate his giving high importance to this study. I am also very thankful to the JCOAL Study Team, headed by Dr Murakami, for putting their best efforts into this study, which is important for the ASEAN region. I think there is no single pathway towards the carbon neutrality solution.

We are seeking multiple pathways suitable for the respective countries. That is why we see a kind of variation among target countries – how countries seek different ways to work on carbon neutrality and CO_2 emissions. This is great because we cannot meet all these countries' needs. Each country has different requirements and economic and social circumstances, which must be tailored to find an appropriate way to meet carbon neutrality with affordability, balancing with security and environmental concerns.

I would like to express my appreciation for the great contributions of the countries. The report could not meet the very high standard without your contribution through this very, informative discussion and contribution. I am confident that countries can use the report. It could give food for policy formulation, support direction and thinking towards the roadmap to carbon neutrality, or whatever use this report is for.

Mr Otaka: The discussion was long and very fruitful, so my remarks would be very short. Thank you very much for all your cooperation – your insights and comments during the discussion. We will prepare a study report based on the members' inputs, comments, and discussions. The final draft report will be compiled and sent to the Working Group members next month for their consideration.

We look forward to your comments on the draft to improve the final report.

Attendance of Working Group Members (Regular and Guest members)

Country	Institution		Attendance
Indonesia	Ministry of Energy and Mineral Resources (MEMR)	Mr Junifer Saut Pangidoan Simanjuntak, S.T., M.T. Senior Electricity Inspector, Directorate General of Electricity	@ MS Teams
		Mr Tri Suhartanto, S.T., M.Eng Mid-Level Electricity Inspector, Directorate General of Electricity	@ MS Teams
		Mr Andi Hanif, ST, M.Eng Mid-Level Electricity Inspector, Directorate of Electricity Engineering and Environment, Directorate General of Electricity	@ ERIA Headquarters
Malaysia	Energy Commission (ST)	Ir Mohd Helmi bin Mohd Zaihan, Assistant Director	@ ERIA Headquarters
		Mr Mohd Amirulazry Mohd Amin, Assistant Director	@ ERIA Headquarters
Thailand	Ministry of Energy	Mr Tananchai Mahattanachai, Senior Professional Geologist, Department of Mineral Fuels (DMF)	@ MS Teams
		Dr Yaowateera Achawangkul, Mechanical Engineer, Senior Professional Level of the Energy Research Division, Department of Alternative Energy Development and Efficiency (DEDE)	@ ERIA Headquarters
Vietnam	Ministry of Industry and Trade	Mr Doan Ngoc Duong, Deputy Director General, IE(Institute of Energy)	@ ERIA Headquarters
	Ministry of Industry and Trade	Dr Nguyen Manh Cuong, Deputy Head of Power System Development Department IE(Institute of Energy)	@ ERIA Headquarters
ASEAN Centre for Energy (ACE)		Dr Andy Tirta - Manager, Energy Modelling and Policy Planning (MPP)	@ ERIA Headquarters
		Dr Ambiyah Abdullah - Senior Officer, Energy Modelling and Policy Planning (MPP)	@ ERIA Headquarters
		Ms Amira Bilqis - Associate Officer, Energy Modelling and Policy Planning (MPP)	@ ERIA Headquarters

Attendance of ERIA and JCOAL

Organization	Participants
Economic Research Institute for ASEAN and East Asia (ERIA)	Dr Han Phoumin, Energy Economist
Japan Coal Frontier Organization (JCOAL)	Dr MURAKAMI Kazuyuki, Director, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Mr OTAKA Yasuo, Senior Program Manager, Resources Development
Japan Coal Frontier Organization (JCOAL)	Mr YAMASHITA Eiji, Senior Program Manager, Resources Development
Japan Coal Frontier Organization (JCOAL)	Mr OZAWA Masahiro, Chief Engineer, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Ms YAMADA Fumiko, Assistant Director, International Collaboration Department
Japan Coal Frontier Organization (JCOAL)	Mr TEUCHI Shinjiro, Deputy Manager, R&D Development Department