

SUMMARY REPORT

e-ASIA Workshop on Alternative Energy
17 January 2024 | via Zoom videoconferencing

Attendees (PH)

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| 1. Dr. Enrico C. Paringit | - Executive Director |
| 2. Ms. Grace F. Estillore | - Chief Science Research Specialist |
| 3. Ms. Carlota P. Sancho | - Senior Science Research Specialist |
| 4. Ms. Clarinda Reyes | - Supervising Science Research Specialist |
| 5. Ms. Desiree Vera | - Senior Science Research Specialist |
| 6. Ms. Jenica Rozette Uy | - Project Technical Specialist I |
| 7. Ms. Kristene Mendoza | - Project Technical Specialist I |
| 8. Mr. Aren Renz Centeno | - Project Technical Assistant IV |
| 9. Engr. Agerico Bautista | - Senior Science Research Specialist |
| 10. Ms. Gracelene Balverde | - Project Technical Assistant IV |
| 11. Mr. Julius Mayorga | - Project Technical Specialist I |
| 12. Mr. Jerome Monforte | - Project Technical Assistant IV |
| 13. Mr. Mark Anthony C. Bathan | - Project Technical Specialist I |
| 14. Ms. Hannah Marie T. Mejia | - Project Technical Specialist I |

Highlights of the Meeting

Opening Session

The meeting started at 9:00AM (TH-time)/ 10:00AM (PH-time) with opening remarks from Ms. Emi Kaneko, JST Director of Singapore Office/e-SIA Secretariat.

Dr. Yukio Kemmochi of the e-ASIA Secretariat provided an introduction of the 13th e-ASIA Call for Proposals highlighting the fields of cooperation such as Food and Nutrition, Agriculture, Health, and Alternative Energy. He also emphasized the funding modality wherein each member organization (MO) will support its own country's researchers through a joint funding scheme, whether monetary or in-kind.

Some member organizations (MOs), i.e, Ms. Jane Frawley and Ms. Hannah Mejia of NHMRC and DOST-PCIEERD, respectively, presented their country's specific requirements for the Call.

Technical Session: Alternative Energy

The Alternative Energy session was moderated by Ms. Grace F. Estillore of DOST-PCIEERD and Dr. Worajit Setthapun of PMU-B. The nominated speakers and pitch presenters were from Indonesia, Japan, Thailand, and The Philippines.

The technical session started with a poll asking the participants whether they had submitted a proposal in the previous e-ASIA Call for proposals. Results showed that the majority of the respondents (93%) had not yet submitted any proposals in the previous calls.

Dr. Enrico Paringit, DOST-PCIEERD Executive Director, shared an overview of the Alternative Energy (AE) topics field along with its sub-topics such as Renewable Energy, Energy Storage, and Energy Management Systems. He highlighted the list of participating MOs of AE and the specific subtopics they will join in.

Another poll was launched to gauge the participants' interest in the three subtopics. Results revealed that 67% of the respondents are leaning towards Renewable Energy, 21% for Energy Storage, and 12% on Energy Management Systems.

Details of the presentations are as follows:

DR. IZUMI KUMAKIRI, JP

Presentation Title: Membrane separation processes in bioethanol production: Developments and applications of inorganic microporous membranes

Position/Designation: Professor
Institute: Yamaguchi University

Presentation Highlights:

Dr. Kumakiri gave an overview of the membrane separation process in bioethanol production. He shared the differentiation of using conventional distillation process vs the combined membrane and fermentation processes in energy consumption. Results showed that the latter process shall produce less energy consumption and lower CAPEX and OPEX.

Dr. Kumakiri also provided some of the technologies available in Japan such as those related to high-temperature fermentation and inorganic members specifically for dehydration and ethanol separation. Current interests is related on on-site biorefinery (fermentation + membrane separation) and membrane reactors.

DR. ALVIN CULABA, PH

Presentation Title: Multi-functional bioenergy research

Position/Designation: Professor
Institute: De La Salle University (DLSU)

Presentation Highlights:

Dr. Culaba underscored the importance of Energy to national economic development and global competitiveness. He also shared the significance of Lignocellulosic biomass (LCB) as an energy source through energy-dense feedstock found in natural forests, agricultural fields, and agricultural wastes (*Nunes et al., 2020*). LCB comprises polysaccharides and lignin which can be converted into value-added products such as biochemicals and bioenergy (*Hassan et al., 2019*). However, there are issues raised on the utilization of LCB such as Achieving optimal product conversion efficiency, along with ensuring economic and environmental sustainability, which continues to be a significant challenge in biorefinery systems.

Dr. Culaba also presented some of the research works being undertaken by his team in terms of the drying (converting algal biomass to biofuels) technology, Molecular dynamics, Optimization research, and Bio-energy product research. In addition, he also mentioned a United States Agency for International Development Energy Secure Philippines (USAID ESP) funded program granted to DLSU titled CALABARZON Regional Energy Advancement Think-Tank Ecosystem (CREATE) which aims to host information and knowledge management framework to ensure appropriate, reliable, and high-quality information is available and accessible within CALABARZON and beyond. The program's priority research areas are: Smart grid technologies, Demand forecasting, Biofuel research, Resource and site assessment, Energy system optimization, and Energy storage technologies.

DR. FELICIDAD CHRISTINA R. PEÑAFIEL, PH

Presentation Title: Electroactive textile supercapacitor electrodes for renewable energy storage

Position/Designation: Associate Professor
Institute: University of Sto. Tomas (UST)

Presentation Highlights:

Dr. Peñafiel started her presentation by sharing a background of the state of Philippine Energy Industry. Based on the 2019 Department of Energy statistics, 51.4% of the country's total primary energy supply comes from indigenous energy sources, with 32.4%, from renewable. Based on the graph presented, wind and solar energy only contributed to 0.3% energy supply, wherein wind and solar resources are capable of providing 20% of the total energy needs. These low numbers are caused by the variable availability of wind and solar energy since both are not available during high demand which tends to provide uneven power depending on weather conditions, and that current energy storage devices, such as batteries charge slowly and have a short life span. To address this difficulty, developing better energy storage systems such as batteries and supercapacitors is vital to efficiently store variable renewable energy. Supercapacitors store energy through charge separation on the surface of their electrodes. Moreover, supercapacitors can store energy quickly, better cope with current variations produced by wind and solar energy sources and have a long cycle life. However, it can only store a small amount of energy compared to batteries. Likewise, its performance is dependent on its electrode properties, therefore, new electrode materials are necessary to improve energy storage. Dr. Peñafiel also provided some of UST's research initiatives on supercapacitors specifically on pineapple and water hyacinth polyester composite fabrics as supercapacitor electrode materials, Abaca Fibers' highly porous carbon and Polypyrrole/ Rice Straw Biochar/ Natural Fiber – Cotton Fabrics for supercapacitor applications.

DR. KAZUTO HATAKEYAMA, JP

Presentation Title: Solid electrolytes for fuel cells using nanosheets
Position/Designation: Assistant Professor
Institute: Kumamoto University

Presentation Highlights:

Dr. Hatakeyama highlighted the use of electrolytes for fuel cells through nanosheets. Nanosheets are flexible, with good mechanical strength, and have molecular barrier property. Nanosheet laminated films can be fabricated using different methods such as the LB method, spin coat method, and vacuum filtration method. These laminated films have highly oriented layered structures which resulted in a unique permeation properties appearance.

Compared to conventional solid electrolytes polymer and Solid oxides, Electrolytes using nanosheet laminated film is promising with its High proton conductivity; High mechanical strength and flexibility; High H₂ barrier property; and High thermal, physical and chemical stability. The low fuel cell performance can be improved by reducing the film thickness, optimizing the catalyst, etc.

DR. DUANGMANEE WONGRATANAPHISAN, TH

Presentation Title: Sustainable Energy Future: Navigating Challenges through Perovskite

Position/Designation: Associate Professor/ Director of Thailand Center of Excellence in Physics
Institute: Chiang Mai University

Presentation Highlights:

Dr. Wongratanaphisan started by sharing the energy trilemma, which is Sustainable, Reliable, and affordable. Based on the presentation, perovskite solar cells pave the way for eco-commercialization in countries such as UK, Singapore, and Thailand. She also mentioned the advantages of choosing perovskite, for instance, perovskite solar cells (PSC) have lower carbon footprints than silicon solar cells (SSC); PSC have shorter energy payback periods than SSC. Moreover, PSC market is expected to expand for about \$6.29 billion in 2029. She ended her presentation by sharing a framework in advancing eco-commercialization of perovskite for sustainable energy.



DR. DRANREB JUANICO, PH

Presentation Title: Electro-Acoustic Charging and Integrated Waste-to-Energy Approach for Enhancing Lead-Acid Batteries in Renewable Energy Storage

Position/Designation: Principal Researcher
Institute: Technological Institute of the Philippines

Presentation Highlights:

In the presentation of Dr. Juanico, he pointed out that one of the problems in the field of energy is the intermittent renewable sources which shorten the battery life. One way to mitigate this is to have an enhanced electron sulfate interaction through pore pressure reconfiguration. A series of experiments were conducted using x-ray nanotomography and scanning electron microscopy. Results revealed the following:

- enhanced electron sulfate interactions reduce the electrode resistance while charging
- temperature and pressure measurements corroborate the pore pressure reconfiguration hypothesis
- diagnostics reveal fewer lead sulfates after four deep cycles when exposed to sound

Thus, it is recommended to require engineering in sound injection for scale-up and field tests in battery energy storage including integration of waste to energy approach.

DR. JULIE ANN PARAGGUA, PH

Presentation Title: Vertically-Integrated Research Approach in the Laboratory of Electrochemical Engineering (V.I.R.A.L. in LEE)

Position/Designation: Department Chair, Department of Chemical Engineering
Institute: University of the Philippines (UP)

Presentation Highlights:

Dr. Paraggua shared some of the UP Laboratory of Electrochemical Engineering's research topics. In terms of *molecular-level research*, it aims to perform computational screening of novel catalysts for energy storage technologies and understand how reactions occur at catalytic surfaces. These computational methods shall allow the prediction of materials on mechanical, structural, catalytic, magnetic, and electronic properties; On the other hand, *Multiphysics modeling research* aims to perform multi-physics modeling to understand the operation of electrochemical cells, such as batteries, fuel cells, and electrolyzers and draw insights to improve the performance. This covers the different behaviors of chemistry-specific reduced order vs the ideal battery model as well as the interaction of Multiphysics modeling with disciplines in other length scales; For the *Cell level research*, this aims to develop novel electrodes (and polymer membranes) for batteries, hydrogen fuel cells, liquid fuel cells, microbial fuel cells, water electrolyzers, sensors, and electrocoagulation systems. This includes studies

on combined catalyst application techniques of metal surface charging and conventional electrodeposition, Porous transition metal phosphide (TMP) catalysts for OER/HER using the Dynamic Hydrogen Bubbling Template method, and Ligand-substituted hexacyanoferrate (Prussian Blue) Frameworks as Cathode Materials for Rechargeable Batteries; on the device level research, this intends to develop novel and efficient energy storage devices for relevant use cases such as aerzinc, jolt, and leadium; lastly, on the systems level research, this intends to provide science-based policy recommendations to off-grid electrification stakeholders through techno-economic analysis and optimization and multi-criteria decision-making methodology.

Moreover, she also highlighted some of her team's on-going projects such as:

- CIPHER Project being funded by Commission on Higher Education (CHED)
- Advanced Batteries Center being funded by Department of Science and Technology (DOST)
 - Advanced Cathode Materials for Next Generation Batteries (NextGen Project)
 - Rechargeable Edison Battery with Advanced Cell Architecture for High Energy Density Applications (REBCell Project)
- Systematic, Multi-disciplinary, and Data-driven Electrification Planning in Off-Grid Islands in the Philippines (ElectriPHI Program) being funded by UP
- Advanced Utilization and Research On Renewable Ammonia (Project AURORA) being supported by research partnership grant of China, Japan, South Korea, and ASEAN Region

DR. RICHARD ESPIRITU, PH

Presentation Title: Fabrication of cellulose acetate-based anion exchange membranes for fuel cell application

Position/Designation: Associate Professor
Institute: University of the Philippines

Presentation Highlights:

Dr. Espiritu gave an overview about fuel cell, its operating temperatures, types, electrolytes, and power generation efficiency. He mentioned that PH is embarking on renewable and sustainable energy technologies to address the increasing energy demand. Therefore, the use of locally available cellulose resources will translate to cheaper membrane electrode assemblies. Cellulose-based membranes specifically polymer membranes undergo several processes such as synthesis, characterization, and degradation studies. In conclusion, Novel CA-based Anion Exchange Membranes (AEMs) were successfully fabricated via radiation grafting technique, electrospinning process and wet-chemistry crosslinking approach with highest degree of grafting obtained at ca. 45% with corresponding ionic exchange capacity (IEC) of 2.1 mmol/g. In addition, AEM fabrication should focus on optimizing the balance between the IEC and the hydrophysical properties. Finally, the DFT study confirmed the experimental results of the loss of the vinylbenzyl-TMA group through multi-step process.

DR. RAPEE UTKE, TH

Presentation Title: Hydrogen-based energy storages

Position/Designation: Associate Professor/ University lecturer
Institute: Suranaree University of Technology

Presentation Highlights:

Dr. Utke provided an overview of hydrogen being an energy storage as hydrogen provides large energy capacities and a broad power range with respect to other energy storages. The global green hydrogen market size is expected to grow up to 39.5% from 2022 to 2023 (E. Wolf. Electrochemical Energy Storage for Renewable Sources and Grid Balancing, 2015). She also shared the components of hydrogen economy from upstream, midstream, to downstream. Moreover, Dr. Utke also mentioned some of the facilities available in Thailand such as hydrogen and thermal storage test stations for

hydrogen release and uptake contents and heating and cooling supplies based on temperatures and energy densities. Lastly, some of the current/future research to be undertaken related to: RT hydrogen storage systems; Integration of hydrogen storage systems with hydrogen productions; Integration of thermal storage with other heat sources at $T \geq 100$ C (e.g., waste heat); and Integration H₂-FC with other energy storages (batteries, supercapacitors)

DR. BENJAMIN CRAIG MCLELLAN, JP

Presentation Title: Drivers and Barriers for a Hydrogen Economy: from Resources to Social Acceptance

Position/Designation: Professor
Institute: Kyoto University

Presentation Highlights:

Dr. Mclellan shared the importance of hydrogen economy for energy management technologies. Hydrogen is considered as an option for clean energy storage and utilization since 1875 (*Jules Verne – The Mysterious Island*). Despite its good idea, minimal progress has been seen through the years due to barriers in terms of social, technical, and resources. Some of the reasons are: techno-economic: the cost of hydrogen technologies is still not low enough to be competitive; Social acceptance: there is a need for a better understanding of hydrogen in society; resources: some critical minerals may be limited in supply for a transition to a hydrogen economy.

DR. LORAFE LOZANO, PH

Presentation Title: Sustainability of Renewable Energy Implementations in Off-grids Communities

Position/Designation: Professor and Department Chair, Department of Industrial Engineering
Institute: University of San Carlos

Presentation Highlights:

Dr. Lozano provided background about the Center for Research in Energy Systems and Technologies (CREST) established in 2015 which is actively engaged in R&D works related to energy, environment, and green systems. She also shared their notable research initiatives from 2015 to the present. In conclusion, there is a need to improve private sector participation to ensure accessibility of electricity in off-grid communities. Financial viability of projects necessary for private investments **BUT** socio-economic impacts must also be considered; improve operations and services in missionary areas by understanding where communities are weak in terms of electricity access to strategize new projects effectively and efficiently or improve current ones as no single electrification plan fits all; lastly, rationalize electricity subsidy – universal charge for missionary electrification (UCME). A more holistic strategy to justify UCME distribution for both on-grid and off-grid areas should not be compromised.

She also mentioned some of the CREST's future works related to:

- SwarmGrids (interconnected microgrid clusters for off-grid island communities) – a DOST-PCIEERD funded project which covers power sharing device and algorithm.
- Business models for renewable electrification of basic services of rural island communities in the Philippines - Collaborative research with the University of Applied Sciences and Arts Northwestern Switzerland funded by ETH Zurich
- Implementation of interconnected microgrids - Proposal submitted with the Einstein Project of Yonsei University

DR. IR. SONI SOLISTIA WIRAWAN, M.ENG.,

Presentation Title: Biofuel (Biodiesel) Implementation: Opportunity & Challenges

Position/Designation: Researchers

Institute: National Research and Innovation Agency

Presentation Highlights:

Dr. Wirawan introduced the research group for the development and utilization of biofuels. The biodiesel plant design engineering was started in 2000 with the goal of increasing the country's industrial competitiveness. Road Test dan Static Engine Test was initiated in 2002 to prove its feasibility and technology demonstration steps. As of 2011, there are 15 small to medium-scale biodiesel plants construction established in the country.

Some research topics needed for the sustainable use of fuels with higher levels of biodiesel mixture are as follows: low-cost production, alternative raw materials, design engine euro 4-5, proper handling & storage, water removal, Compatible Elastomer and metal, Adsorbent and Additive, Glycerol Utilization, and Filtration.

Subsequently, Poll Question 3 was released asking the participants of which country they are looking for collaborators/partners. Results revealed that 67% wanted to collaborate with researchers from Japan, 60% from Thailand researchers, 47% from The Philippines researchers, 40% from New Zealand researchers, and 33% from Indonesia researchers.

Pitching Session

There were three (3) pitch presenters present during the session.

Pitch Presenter 1 is Dr. Sirikorn Chasvised with the presentation title, BLOCK COPOLYMER SELF-ASSEMBLY AND APPLICATION FOR POLYMER ELECTRODES. The European School on Artificial Leaf Project is divided into two parts. The first part refers to water oxidation from printed electrodes, research strategy while the second part is on P3HT System for H₂ Evolution. This collaboration with Europe and Thailand envisions to:

- Develop nano porous honeycomb printed electrode of P3HT-based block copolymer films to create organic solar cell for portable device
- Increase the conductivity of electrode by using carbon nanotube or silver particle
- Upscale printing to make numerous electrodes
- Develop conducting electrode by using P3HT block copolymer as binder and P3HT-Co as catalyst
- Create a real device consisting of MBM/Ru anode and P3HT-*b*- PMMA/Co cathode

Pitch Presenter 2 is Assoc. Prof. Andante Hadi Pandyaswargo with her presentation title Sustainable Smart Biowaste-to-Energy System for Regional Revitalization. She highlighted that securing enough feedstock to meet the plant capacity and stability of power generation are key problems in waste to energy technologies. Thus, she is proposing to have an integrated monitoring on the overall energy lifecycle.

Pitch Presenter 3 is Mr. Thiti Jittayasotorn, PhD Student with presentation title, A Techno-Economic Assessment of Photovoltaic and Electric Vehicle Integration for CO₂ Emission Reduction in Cities. Techno-economic assessment evaluates the feasibility and economic viability of integrating specific technologies that guides strategic decision making and identifies cost-effective solutions. With the pressing challenges on in urban CO₂ emissions, urgent solutions are needed. Thus, integration of PV and EV is necessary through: Utilizing Vehicle-to-Home (V2H) systems for EVs to charge using PV-generated electricity at households; Providing a dual solution for sustainable urban living; and Focus on both technologies for a holistic solution to combat CO₂ emissions in cities.

Dr. Worajit thanked the presenters and asked questions with regard to their interests, what are they looking for in the collaboration, and the needed support to make their proposed solutions possible.

Moreover, the secretariat prepared an excel spreadsheet where participants can place their information voluntarily for them to easily communicate with one another.

The fourth poll question inquired on the participants' reasons for seeking collaboration under the e-ASIA JRP. Seventy-four percent (74%) of the respondents showed that it was because of expertise and knowledge they could gain in the partnership, followed by 58% due to shared challenges, and 37% because of available equipment and facilities. Furthermore, the final poll question was released asking the participants about their constraints in doing collaborations. More than half of the respondents (56%) answered data sharing and security, 50% is communication barriers, 38% is Intellectual Property (IP), and 25% cultural differences.

To conclude the workshop, Dr. Paringit gave his closing remarks and emphasized the importance of team effort to successful joint research. Communication is also vital as most of the research work will be done remotely by the research team. He wished that this workshop allowed researchers to forge new partnerships and develop proposals for the 13th e-ASIA Call for proposals.

Prepared by:



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DR. ENRICO C. PARINGIT
Executive Director

Annex 1.

List of Speakers for Alternative Energy Workshop

Name	Position/ Designation	Institute	Title of the Presentation	Nominated by	Email Address
Izumi KUMAKIRI	Professor	Yamaguchi University	Membrane separation processes in bioethanol production: Developments and applications of inorganic microporous membranes	JST	izumi.k@yamaguchi-u.ac.jp
Kazuto HATAKEYAMA	Assistant professor	Kumamoto University	Solid electrolytes for fuel cells using nanosheets	JST	hatakeyama-k@kumamoto-u.ac.jp
Benjamin Craig MCLELLAN	Professor	Kyoto University	Drivers and Barriers for a Hydrogen Economy: from Resources to Social Acceptance	JST	b-mclellan@energy.kyoto-u.ac.jp
Dr. Alvin Culaba	Professor	De La Salle University	Energy Governance in the Philippines: Transitioning to a Low-Carbon Economy	DOST-PCIEERD	alvin.culaba@dlsu.edu.ph
Dr. Felicidad Christina R. Peñafiel	Associate Professor	University of Santo Tomas	Electroactive textile supercapacitor electrodes for renewable energy storage	DOST-PCIEERD	fframirez@ust.edu.ph
Dr. Dranreb Juanico	Principal Researcher	Technological Institute of the Philippines	Electro-Acoustic Charging and Integrated Waste-to-Energy Approach for Enhancing Lead-Acid Batteries in Renewable Energy Storage	DOST-PCIEERD	reb.juanico@tip.edu.ph
Dr. Julie Ann Paraggua	Department Chair	University of the Philippines Diliman	Vertically-Integrated Research Approach in the Laboratory of Electrochemical Engineering (V.I.R.A.L. in LEE)	DOST-PCIEERD	jdelrosario2@up.edu.ph
Dr. Richard Espiritu	Professor	University of the Philippines Diliman		DOST-PCIEERD	richard.espiritu@coe.upd.edu.ph
Dr. Lorafe F. Lozano	Professor and Department Chair	University of San Carlos	Sustainability of Renewable Energy Implementations in Off-grids Communities	DOST-PCIEERD	lflozano@usc.edu.ph
Associate Professor Duangmanee Wongratanaphisan, Ph.D.	Director of Thailand Center of Excellence in Physics	Chiang Mai University	Sustainable Energy Future: Navigating Challenges through Perovskite	PMU-B	duangmanee.wongratanaphisan@cmu.ac.th
Associate Professor Rapee Utke	University lecturer	Suranaree University of Technology	Hydrogen-based energy storages	PMU-B	rapee.g@sut.ac.th
Dr. Ir. Soni Solistia Wirawan, M.Eng.	Researcher	National Research and Innovation Agency	Biofuel (Biodiesel) Implementation: Opportunity & Challenges	BRIN	no email address