

INTERNATIONAL CONFERENCE  
**ENERGY**  
**ENVIRONMENT**  
and **CLIMATE CHANGE**

**ICUE**  
**2020**



20 - 22 OCTOBER 2020

Robert B. Banks Auditorium, AITCC  
Asian Institute of Technology, THAILAND



**PROGRAMS & ABSTRACTS**

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## **RATIONALE OF THE CONFERENCE**

Sustainable development is based on three interlinked criteria: economic development, social progress, and environmental protection. It is the state of development that seeks to produce sustainable economic growth while ensuring future generations' ability to do the same by not exceeding the regenerative capacity of nature. This conference focuses on three main topics that relate to sustainable development namely energy, environment, and climate change. In the energy area, the technical, economic, and social dimensions of energy utilization, its effect to the environment and to climate change will be covered. Considering the environment side, the current major concerns include the status and remediation measures through technology and policy of air, water, and soil pollution, and issues related to waste and plastic management. Lastly, climate change is focused on as it is one of the major threats to human survival due to increasing green house gas emissions. The conference will broadly discuss topics related to climate science, green house gas mitigation and climate change impacts and adaptation in terms of technology aspects, policies, case studies, and measures to address the challenges.

This ICUE 2020 conference will be a venue to exchange research ideas, experiences, technical, social, financial, economic and policy issues covering greening energy utilization. Here, academicians, members of the private sector and industry sector, businesspersons, energy professionals, policy makers, non government organizations, engineers, international and regional institutions, consulting agencies, and research scholars/students, will have a platform to showcase research findings, technological innovations, transformative emerging technologies, and even to discuss burning global, regional and national issues in energy utilization for development and environment policies and programmes.

## ORGANIZERS

Regional Energy Resources and Information Center (ERIC)  
Sustainable Energy Transition Program  
Department of Energy, Environment and Climate Change  
Asian Institute of Technology (AIT)

## ORGANIZING COMMITTEE

### *Advisory Committee:*

**Dr. Eden Y. Woon**

President  
Asian Institute of Technology,  
Thailand

**Prof. Deepak Sharma**

Vice President, Academic Affairs  
Asian Institute of Technology,  
Thailand

**Prof. Rajendra Shrestha**

Dean  
School of Environmental Resources  
Development, AIT

**Prof. Sivanappan Kumar**

Conference Chair  
Sustainable Energy Transition  
Program, SERD, AIT

### *Scientific Organizing Committee:*

#### *Conference Chair:*

**Prof. Sivanappan Kumar**

Sustainable Energy Transition Program, SERD, AIT

#### *Technical Program Co-Organizers:*

**Dr. Avishek Datta**

Agricultural Systems and  
Engineering Program, SERD, AIT

**Prof. Shobhakar Dhakal**

Sustainable Energy Transition  
Program, SERD, AIT

**Prof. Thammarat Koottatep**

Environmental Engineering and  
Management Program, SERD, AIT

**Dr. Brahmanand Mohanty**

Sustainable Energy Transition  
Program, SERD, AIT

**Prof. Nguyen Thi Kim Oanh**

Environmental Engineering and  
Management Program, SERD, AIT

**Prof. Weerakorn Ongsakul**

Sustainable Energy Transition  
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**Dr. P. Abdul Salam**

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Management Program, SERD, AIT

**Dr. Sangam Shrestha**

Water Engineering and  
Management Program, SET, AIT

**Dr. Jai Govind Singh**

Sustainable Energy Transition  
Program, SERD, AIT

**Dr. Sylvia Szabo**

Development and Sustainability  
Program, SERD, AIT

**Prof. Chettiyappan Visvanathan**

Environmental Engineering and  
Management Program, SERD, AIT

**Dr. Indrajit Pal**

Disaster Preparedness, Mitigation  
and Management Program, SERD,  
AIT

**Prof. Joyashree Roy**

Sustainable Energy Transition  
Program, SERD, AIT

*Secretariat:*

**Ms. Maria Kathrina B. Gratuito**

Co-Coordinator, AIT

**Ms. Phornsinee Thanara**

Member, AIT

*AIT Student Assistants:*

**Ms. Maria Marinela M. Gutierrez**

**Ms. Isrrah C. Malabanan**

**Mr. Shubham Tiwari**

**Dr. Ekbordin Winijkul**

Environmental Engineering and  
Management Program, SERD, AIT

**Dr. Wenchao Xue**

Environmental Engineering and  
Management Program, SERD, AIT

**Mrs. Sheree Ann Soriano -  
Gonzales**

Member, AIT

**Mr. Firuz Ahamed Nahid**

**Mr. Hasan Mahmud**

## THE ASIAN INSTITUTE OF TECHNOLOGY (AIT)

The Asian Institute of Technology (AIT) is an international English-speaking postgraduate institution, focusing on engineering, environment, and management studies. AIT's rigorous academic, research, and experiential outreach programs prepare graduates for professional success and leadership roles in Asia and beyond.

Founded in 1959, AIT offers the opportunity to study at an institution in Asia which possesses a global reputation. Going forward, AIT will be stressing its global connections, injection of innovation into research and teaching, its relevance to industry, and its nurturing of entrepreneurship, while continuing to fulfill its social impact and capacity building role. Sitting on a beautiful green campus located just north of Bangkok, Thailand, AIT operates as a multicultural community where a cosmopolitan approach to living and learning is the rule. You will meet and study with people from all around the world.

Today, AIT's internationally recognized engineering, environment, and management graduates are highly sought after by employers in their home country and elsewhere. Across many walks of life in Asia, AIT alumni have distinguished themselves as CEO's of private and state enterprises, as business owners, as well-respected researchers and faculty, and as senior university and government officials.

### **Vision**

AIT will strive to become a leading and a unique regional multicultural institution of higher learning, offering state-of-the-art education, research and training in technology, management and societal development.

### **Mission**

The mission of AIT in the context of the emerging environment is "to develop highly qualified and committed professionals who will play a leading role in the sustainable development of the region and its integration into the global economy".

Guided by the above clear, timeless vision and mission, the dedicated students, faculty and staff of AIT are set to steer the Institute along its path of becoming:

- A trailblazer in advanced education in the region, with leadership in IT and new types of multidisciplinary programs
- An exemplary institution, with an emphasis on academic quality in terms of courses and other aspects of operation
- A leader in professional development programs
- A hub for the implementation of regional and transnational research projects, and a research facility for academic professionals. A nexus for networking with other academic and research institutions in the region and the world
- A model international citizen
- A collaborator and partner of national postgraduate institutions
- A financially viable, self-sustaining institution, able to draw support from donors the private sector and individuals, with good governance and strong leadership

- A strong partner to its alumni, who are principal stakeholders through the AIT Alumni Association (AITAA)

### **Awards and Recognitions**

- **1987 Science and Technology for Development Award** presented to AIT by the United States Agency for International Development and the National Research Council for effectively transferring industrial technology and skills to the developing world, by training scientists and engineers from Asian countries.
- **1989 Ramon Magsaysay Award for International Understanding** presented to AIT for shaping a new generation of engineers and managers committed to Asia, in an atmosphere of academic excellence.
- **1994 Development Management Award** presented to AIT by the Asian Management Awards for fostering manpower development, technological change and sustainable growth in the region, through advanced education and research.
- **1996 DAAM International Vienna Awards** presented by the Danube Adria Association and Manufacturing (DAAM) International Vienna, Austria, to express appreciation to AIT and its high-technology experts from the Industrial Systems Engineering Program of the School of Advanced Technologies for their significant contribution in the field of technical sciences and international scientific cooperation within the framework of DDAM, on the occasion of the 7th DAAM international symposium to celebrate the 1000th anniversary of Austria.
- **2006 Friendship Order** was awarded to AIT in the area of international relations that have contributed to human resource training for Vietnam and to the development of friendly relations between Vietnam and other countries.
- **2016 Gold medal in Thai Research Fund (TRF) Ratings** was awarded to AIT for bagging the most perfect scores (seven scores of '5' each) among all universities in Thailand.

### **Key Facts and Figures**

- 1607 Students from 40+ countries
- 23,932 Alumni from 100+ countries/territories
- 125 Faculty members from 20+ countries
- 34 Board of trustee members from 16 countries
- 30+ Fields of study
- 1078 Graduate courses
- 38000+ Short-course trainees from 100+ countries
- 300+ ongoing research project
- 200+ Partners Worldwide
- 3 Schools
- 551 Research and Support Staff

**AIT Offers**

- Masters degrees: MBA, MEng, MSc
- Executive Master Degree Programs
- Doctoral Degrees: DEng, DTechSc, PhD
- Diploma and Certificate Programs
- An intensive English language and academic Bridging Program
- Non-degree continuing education courses for practicing professionals



## ABOUT RERIC

The Regional Energy Resources Information Center (RERIC) was established in 1978 as a result of recommendations made at various meetings held in Asia, and particularly those made at a meeting of experts in solar and wind energy utilization held in 1976 under the energy program of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP).

RERIC is the publications arm of the Sustainable Energy Transition Program. It occasionally publishes workshop, project reports, books of some members of the Energy faculty and the long-established **International Energy Journal**.

The current RERIC staff are as follows:

Director:	Dr. Jai Govind Singh
Research/Information Professional:	Maria Kathrina B. Gratuito
Assistants:	Ms. Phornsinee Thanara Ms. Sheree Ann-Soriano Gonzales

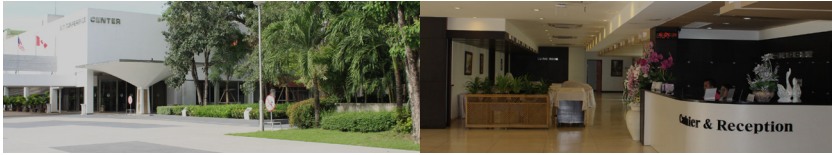
RERIC regularly publishes the **International Energy Journal (IEJ)** since 1979. It is a journal dedicated to the advancement of knowledge in energy by the vigorous examination and analysis of theories and good practices, and by encouraging innovations needed to establish a successful approach to solve identified problems. IEJ is a quarterly journal that publishes peer-reviewed papers on technical, socio-economic and environmental aspects of energy planning, energy conservation, renewable sources of energy, and electric power transmission, generation and management. The papers are reviewed by world renowned referees. IEJ also maintains an online journal system wherein not only current volumes are available but also archives containing past volumes and past special issues. IEJ is a quarterly publication published in *March, June, September* and *December* of each year. IEJ also occasionally publishes Special Issues on current relevant topics. The IEJ is proud to be:

- Included in the Emerging Sources Citation Index of **Clarivate Analytics** (*Web of Science™ Core Collection*).
- It is also indexed and abstracted in the **Scopus** title list
- Listed and ranked in the **SJR** (*SCImago Journal and Country Rank*).
- It is also listed in the **EI Compendex Journal Source List** (Compendex Database of Engineering Information, Inc.).

The IEJ is also the only Energy-category focused international journal published in **Thailand**. All articles since **1979** are archived in its online database at [www.ericjournal.ait.ac.th](http://www.ericjournal.ait.ac.th)

RERIC's occasional publications include conference/seminar/workshop proceedings, research reports, directories, environment systems review, and do-it-yourself manuals. RERIC also occasionally publishes some books, workshop reports of some of the faculty members of the Sustainable Energy Transition Program. RERIC also occasionally organizes training workshops and short online international masterclass.

## VENUE



### Asian Institute of Technology Conference Center (AITCC)

The **AIT Conference Center (AITCC)** is a fully equipped conference center nestled inside the green campus of **Asian Institute of Technology**. It is surrounded by a beautiful greenery and wildlife, and away from the noise, traffic and pollution of the city.

AITCC's role is to provide modern, efficient and fully-equipped on-campus conference facilities for use by trustees, faculties, students, alumni, staff, visiting lecturers, course participants, other visitors to the Institute and the campus community in general. It has facilities to cater to a wide range of conference and seminar needs from 10-500 people. The 500-seat tier auditorium is fully equipped and state-of-the art perfect for holding big conferences and other social gatherings. It is also now **fully equipped to hold hybrid types of gatherings to accommodate virtual seminars, webinars and conferences.**

The AITCC **also offers accommodation.** There are more than 100 guest rooms varying from suites, superior and standard rooms, together with a selection of dining and other eating or drinking venues.





*International Conference*  
**ICUE 2020 on Energy, Environment and Climate Change**

20-22 October 2020  
Robert B. Banks Auditorium, AIT Conference Center  
Asian Institute of Technology, Thailand



**DAY 1 PROGRAM**  
**20 October 2020, Tuesday**

- 09:00 - 09:05 Welcome remarks and introduction of the AIT President
- 09:05 - 09:15 OPENING REMARKS by **Dr. Eden Y. Woon**, AIT President
- 09:15 - 09:20 Presentation of Plaques of Appreciation to ICUE 2020 Sponsors by the AIT President
- Platinum Sponsor* - Electricity Generating Public Company, Ltd.  
(EGCO)
- Gold Sponsor* - Electricity Generating Authority of Thailand (EGAT)
- Technical Collaborator* - Provincial Electricity Authority of Thailand  
(PEA)
- 09:20 - 10:00 Keynote Address I  
**Dr. Edward Vine**  
Lawrence Berkeley National Laboratory, USA
- “Evaluation of Energy Programs and Policies in Asia Pacific Region: Current Status, Challenges and Opportunities Ahead”*
- 10:00 - 10:15 Coffee/Tea Break
- 10:15 - 12:15 Session A: Energy Resources and Technology
- 12:15 - 13:15 Lunch Break
- 13:15 - 15:15 Session B: MESfIA’s Special Session on “Energy Access”
- Opening note by the Session Chair
  - Special Remarks by Prof. Antonios Tsikalakis
  - Paper presentations
  - Wrap-up
- 15:15 - 15:30 Coffee/Tea Break

15:30 - 17:00	Session C: Climate Change I
17:00 - onwards	Welcome Dinner at AIT CC Dining Hall

**DAY 2 PROGRAM**  
**21 October 2020, Wednesday**

09:00 - 12:00	Session D: Energy and Environment
12:00 - 13:00	Lunch Break
13:00 - 13:40	Keynote Address II

**Dr. Joydeep Dutta**

Professor and Head of Functional Materials Group Department of Applied Physics, SCI School, KTH Royal Institute of Technology, Sweden

*“Energy-efficient Brackish Water Desalination with Membrane-free Capacitive Deionization”*

13:40 - 14:00	Coffee/Tea Break
14:00 - 16:00	Session E: Beijing Normal University’s Special Session on “Water Ecology and River Restoration” <ul style="list-style-type: none"><li>– Opening Address</li><li>– Paper Presentations</li><li>– Closing Statement</li></ul>
16:00 - 16:15	Coffee/Tea Break
16:15 - 17:45	Session F: Energy Price and Policy

**DAY 3 PROGRAM**  
**22 October 2020, Thursday**

09:00 - 09:40 Keynote Address III

**Dr. Venkataramana Sridhar**

Diplomate, American Academy of Water Resources Engineers Biological  
Systems Engineering Department, Virginia Tech Blacksburg, Virginia  
24061

*“Progress Towards Integrated Modeling of Food-Energy-Water  
Systems: Success and Challenges”*

09:40 - 10:00 Coffee/Tea Break

10:00 - 12:00 Session G: Smart Grid and Smart Cities

12:00 - 13:00 Lunch Break

13:00 - 15:00 Session H: Climate Change II (Emissions)

15:00 - 15:15 Coffee/Tea Break

15:15 - 16:30 Session I: Energy

16:45 – 17:00 CLOSING CEREMONIES

Closing Remarks by **Prof. Deepak Sharma**  
AIT Vice President for Academic Affairs

## KEYNOTE SPEAKER 1



### **Evaluation of Energy Programs and Policies in the Asia Pacific Region: Current Status, Challenges and Opportunities Ahead**

**Dr. Edward Vine**

Lawrence Berkeley National Laboratory (LBNL)

**Dr. Edward Vine** is an Affiliate at the Lawrence Berkeley National Laboratory (LBNL), where he had been involved in the evaluation of energy efficiency programs, policies and technology performance measurement for over 40 years.

Dr. Vine contributed to the development of the California Public Utilities Commission's Energy Efficiency Evaluation Protocols, the US Department of Energy's Impact Evaluation Framework for Technology Deployment Programs, and the National Action Plan on Energy Efficiency's Evaluation, Measurement and Verification Guidelines. He was also on the Board and the Planning Committee of the International Energy Program Evaluation Conference (IEPEC), and was on the Planning Committee of the International Energy Policy and Program Evaluation Conference (IEPEEC).

He has received the following awards related to his work on evaluation: the Lifetime Achievement Award from the IEPEC, Outstanding Achievement in Marketing Research and Evaluation Award from the Association of Energy Service Professionals and Certificates of Appreciation from the IEPEC and from the International Performance Measurement and Verification Protocol (IPMVP) organization. In 2007, as a member of the Intergovernmental Panel on Climate Change (IPCC), he received the Nobel Peace Prize.

He has consulted on evaluation projects around the world. For the last five years, he has been working with colleagues in creating a community of evaluators in Asia. He has led several evaluation workshops in Asia, was instrumental in establishing the first conference in Asia on the evaluation of energy efficiency programs and policies, and, working with others, created an organization, Energy Evaluation Asia Pacific ([energy-evaluation.org](http://energy-evaluation.org)) to support the evaluation of energy policy and programs.

Dr. Vine has a BS in Environmental Studies from Middlebury College, and a MS and Ph.D. in Ecology from the University of California at Davis.

## KEYNOTE SPEAKER 2



### **Energy-efficient Brackish Water Desalination with Membrane-free Capacitive Deionization**

**Prof. Dr. Joydeep Dutta**

Professor and Head of Functional Materials Group  
Department of Applied Physics, SCI School  
KTH Royal Institute of Technology, Sweden

**Dr. Joydeep Dutta** is a Professor at KTH Royal Institute of Technology since 2015 and is the head of the Functional Materials Group in the Department of Applied Physics. After completing his PhD in 1990, he did Post-Doctoral work at the Electrotechnical Laboratory (ETL, Japan) and at Ecole Polytechnique (France) before moving to Switzerland in 1993 where he was associated with the Swiss Federal Institute of Technology (EPFL) until 2003 following which he joined Asian Institute of Technology (AIT), Thailand. He served as the Vice President (Academic Affairs), Director of the Center of Excellence in Nanotechnology and Professor in Nanotechnology at AIT. Finally, before coming to KTH, he was Chair Professor in Nanotechnology for Water Desalination and other applications in Sultan Qaboos University, Oman from 2011-2015. His broad research interests encompass development of sustainable nanomaterials for planetcare including, photocatalysis and electrocatalysis and saline or impaired water treatments as well as energy production by water splitting and blue energy generation. Prof. Dutta is an award winning author (Choice award for Outstanding Academic title of 2010 from American Library Association) of the book “Fundamentals of Nanotechnology”. He has over 200 original research publications, 11 chapters in Science & Technology reference books, edited several books receiving 11,000+ citations (h-index 52; google scholar), 5 patents and has delivered over 100 invited and keynote lectures. He is in the editorial board of a few journals and regularly referees articles in international journals. He is the chairman of the board of Stockholm Water Technology AB producing spirally wound capacitive deionization modules integrated into solutions ranging from water desalination to urban mining.

## KEYNOTE SPEAKER 3



### **Progress Towards Integrated Modeling of Food-Energy-Water Systems: Success and Challenges**

**Dr. Venkataramana Sridhar**

Diplomate, American Academy of Water  
Resources Engineers

Biological Systems Engineering Department  
Virginia Tech, Blacksburg, Virginia

**Dr. Venkataramana Sridhar** is an Associate Professor in the Department of Biological Systems Engineering at Virginia Tech. Dr. Sridhar was working as an Associate Professor in Civil Engineering at Boise State University. Prior to joining Boise State, he was a research faculty at University of Nebraska-Lincoln and Postdoc at University of Washington. Dr. Sridhar earned his Ph.D. in Biosystems Engineering at Oklahoma State University in 2001. Dr. Sridhar is a hydrologist and conducts modeling research to understand the impact of climate change on hydrology and water resources, water management, drought and flood modeling. Dr. Sridhar's research group designed, developed, and refined a suite of computational hydrological models to generate datasets that were translated into an operational decision support system for many river basins in the conterminous U.S. This helps to avoid the conflicts between water managers and water users thus benefitting the agriculture sector. It is noteworthy that these decision support tools were used by the local stakeholders to examine alternative water resource management scenarios, considering various environmental and socio-economic conditions.

Ongoing projects in his lab on the assessment of future precipitation, temperature, snowmelt, streamflow, soil moisture, droughts and floods in several regions including the Mid-Atlantic US, Caucasus and Central Asia, South and Southeast Asia are expected to provide insights into planning and managing both land and water resources in many river basins. These projects inform improved solutions to avoid water demand conflicts and improve potential yields from agriculture, ensuring a vibrant agricultural industry and enhancing food security.

Dr. Sridhar also co-leads the NASA-funded Mekong Basin project to study the coupling of land, water, and livelihoods under a changing Climate and water-energy-food nexus in the Lower Mekong River basin. This international partnership covering Thailand, Laos, Cambodia and Vietnam provides opportunities to build Dr. Sridhar's research program and contribute to capacity building in host countries and facilitating knowledge sharing in an interdisciplinary framework. Through an NSF-Partnerships for International Research and Education (PIRE)-funded project, Dr. Sridhar is currently working to estimate pollutant loads to rivers and streams in urban watersheds in six countries, which includes Sweden, Switzerland, China, India, Philippines, and Portugal. He closely works with National Institute of Technology Warangal funded by the SPARC program in India and



serves as an Adjunct Faculty in the Department of Water Resources Development and Management, IIT Roorkee.

Dr. Sridhar has served as the principal investigator or co-investigator on 15 research projects with grants over \$2.5 Million to perform research related to various topics in water resources. He has published more than 160 research articles, including 75 peer-reviewed journal articles and 85 technical papers at conferences and several invited talks nationally and internationally. He is a Registered Professional Engineer in Idaho and Nebraska and a member of American Society of Civil Engineers, American Society of Agricultural and Biological Engineers, American Meteorological Society, American Water Resources Association, American Geophysical Union and the American Association for the Advancement of Science.

Dr. Sridhar is a Diplomate of American Academy of Water Resources Engineers. He was a Review Panel Member, Horton Award Committee, American Geophysical Union, 2009-12. He has trained six postdoctoral researchers, over 20 graduate and undergraduate students, and overseas research scholars.

## PRESENTATION SCHEDULES

### Day 1: 20 October 2020 (Tuesday)

<b>Session A: Energy Resources and Technology</b>			
Time: 10:15 – 12:15 noon			
Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)			
<b>Ref. No.</b>	<b>Title, Authors, Affiliation</b>	<b>Country of Origin</b>	
S. A.1 <b>Student Award Entry</b> (Virtual)	<b>A Year Around System Simulation for An Experimental Set-Up of A Thermosyphon Solar Water Heater in Thailand</b> <i>Uthpala Ekanayake<sup>1</sup> and Bundit Limmeechokchai<sup>2</sup></i> <sup>1</sup> University of Peradeniya, Sri Lanka <sup>2</sup> Sirindhorn International Institute of Technology, Thammasat University, Pathum Thani, Thailand	Sri Lanka	
S. A.2 (Virtual)	<b>Simultaneous upgrading utilizing Iron Sponge and Zeolite 13X fixed bed columns for Gaseous Fuel Production</b> <i>Antonio-Abdu Sami M. Magomnang and Dianne Mae M. Asifñero</i> University of Science and Technology of Southern Philippines – Cagayan de Oro Campus, Philippines	Philippines	
S. A.3 <b>Student Award Entry</b> (Virtual)	<b>Econo– Environmental Dispatch Solutions for Power Systems Integrated with Renewable Energy Resources</b> <i>Femin Varghese<sup>1</sup>, Petra I.<sup>1</sup>, and Mathew S.<sup>2</sup></i> <sup>1</sup> Universiti Brunei Darussalam, Brunei Darussalam <sup>2</sup> University of Agder, Grimstad, Norway	Brunei	
S. A.4 <b>Student Award Entry</b> (Virtual)	<b>Effect of Process Parameters on Slow Pyrolysis of Rice Straw: Product Yield and Energy Analysis</b> <i>Anil Kumar Sakhiya, Paramjeet Baghel, Shivangi Pathak, Virendra Kumar Vijay, and Priyanka Kaushal</i> Centre for Rural Development and Technology, Indian Institute of Technology, New Delhi, India	India	

<p>S. A.5  <b>Student Award Entry</b></p>	<p><b>Characterization of Phase Separation and Upgrading of Hardwood derived Bio-oil using Alcoholic Solvents</b></p>	<p>Australia</p>
<p>(Virtual)</p>	<p><i>Manjula Siriwardhana</i>                  The Australian National University, Australia and National Engineering Research and Development Centre, Sri Lanka</p>	
<p>S. A.6                  (Virtual)</p>	<p><b>Study on Application of SOFC on Biogas in Standalone Agriculture Enterprise Power Supply Systems</b></p>	<p>Russia</p>
	<p><i>Elena N. Sosnina, Andrey V. Shalukho, and Leonid E. Veselov</i>                  Nizhny Novgorod State Technical University n.a. R.E. Alekseev, Russia</p>	
<p>S. A.7                  (AITCC)</p>	<p><b>Investigation of the Thermal Hazard of Faulty Li-ion Battery under External Heating</b></p>	<p>Thailand</p>
	<p><i>Pius Victor Chombo and Yossapong Laonual</i>                  King Mongkut's University of Technology Thonburi</p>	
<p>S. A.8                  (Virtual)</p>	<p><b>Electrochemical Study on Activated Carbon Electrode from Kenaf Biowaste for Supercapacitor Application</b></p>	<p>Malaysia</p>
	<p><i>S. Thilageshwaran<sup>1</sup>, M.N.M. Ansari<sup>1,2</sup>, Noor Afeefah Nordin<sup>2</sup>, Alaseel Bassam<sup>1</sup>, Zainudin Yahya<sup>1</sup>, P. Elumalai<sup>3</sup>, and A. Prasath<sup>3</sup></i>  <sup>1</sup>Mechanical Engineering Department, Universiti Tenaga National (UNITEN), Kajang, Malaysia  <sup>2</sup>Institute of Power Engineering, Universiti Tenaga National (UNITEN), Kajang, Malaysia  <sup>3</sup>Madanjeet School of Green Energy Technologies, Pondicherry University, Puducherry, India</p>	

**Session B: MESfIA's Special Session on Energy Access**

Time: 13:15 – 15:15 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

<b>Ref. No.</b>	<b>Title, Authors, Affiliation</b>	<b>Country of Origin</b>
S. B.1 (Virtual)	<b>Challenges in Using Renewable Energy for Islands in Indonesia: A Case Study of Karimunjawa</b> <i>Dwi Novitasari, Rachmawan Budiarto, Fiki Rahmatika Salis, and Sarjiya</i> Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia	Indonesia
S. B.2 <b>Student Award Entry</b> (Virtual)	<b>Potential of Renewable Energy in selected Greater Mekong Subregion (GMS) Countries to achieve NDCs in 2030</b> <i>Degeorge Dul and Bundit Limmeechokchai</i> Sirindhorn International Institute of Technology, Thammasat University, Pathum Thani, Thailand	Thailand
S. B.3 (Virtual)	<b>Training Needs regarding Gensets for Isolated Areas</b> <i>Antonis Tsikalakis, K. Fiorentzis, Y. Syllignakis, N. Mavrikakis, D. Giaourakis, and I. Katsigiannis</i> Hellenic Mediterranean University, Crete, Greece	Greece
S. B.4 <b>Student Award Entry</b> (Virtual)	<b>Sustainable Fuelwood Production In Kenya: Potential Role of Community Forest Associations</b> <i>Kasaon Stephanie Jeping'etich</i> Graduate School of Global Environmental Studies, Sophia University, Tokyo, Japan	Japan
S. B.5 (Virtual)	<b>Pongamia as a Potential Biofuel Crop: Oil Content of Pongamia pinnata from the Best Provenance in Java, Indonesia</b> <i>Trimaria Hasnah<sup>1</sup>, Budi Leksono<sup>1</sup>, Nur Sumedi<sup>1</sup>, Eritrina Windyarini<sup>1</sup>, Hamdan Adma Adinugraha<sup>1</sup>, Himlal Baral<sup>2</sup>, and Yustina Artati<sup>2</sup></i> <sup>1</sup> Center for Forest Biotechnology and Tree Improvement Research and Development, Yogyakarta, Indonesia <sup>2</sup> Center for International Forestry Research, Bogor, Indonesia	Indonesia

S. B.6 (AITCC)	<p><b>Isolated Energy Management Learning Platform through Smart and Green Building Design: A Case Study of USIS Building, Naresuan University</b></p> <p><i>Phisut Apichayakul, Piyadanai Pachanapan, Akaraphunt Vongkumhae, and Sarintip Tantane</i></p> <p>Naresuan University, Phitsanulok, Thailand</p>	Thailand
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Session C: Climate Change I		
Time: 15:30 – 17:00 PM		
Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)		
Ref. No.	Title, Authors, Affiliation	Country of Origin
S. C.1 <b>Student Award Entry</b> (Virtual)	<p><b>An Improved Statistical Method for Rainfall Forecasting in Sri Lanka using the WRF Model</b></p> <p><i>Pavan Perera and K.G.H.S. Peiris</i></p> <p>University of Sri Jayewardenepura, Nugegoda, Sri Lanka</p>	Sri Lanka
S. C.2 (Virtual)	<p><b>Assessing the “Value” of Nature-based Solutions at the Belgian Coast for Sustainable Tourism, using a Ecosystem-based Management Approach</b></p> <p><i>Patrick D. De Klerck and Brendan P. De Baets</i></p> <p>Territorial Development Program for the Flemish Coastal Region, Flemish Government / Department of Environment and Spatial Development, Bruges, Belgium</p>	Belgium
S. C.3 (Virtual)	<p><b>Addressing Climate Change in Brazil: Is Rio De Janeiro City Acting on Adaptation Strategies?</b></p> <p><i>Andrea Souza Santos, Suzana Kahn Ribeiro, and Victor Hugo Souza de Abreu</i></p> <p>Graduate School and Research in Engineering, Federal University of Rio de Janeiro, Rio de Janeiro, Brazil</p>	Brazil
S. C.4 (AITCC)	<p><b>Carbon Footprint and Carbon Stock Volume for Para Rubber Production in Southern Part of Thailand</b></p> <p><i>Tanate Chaichana, Saowalak Thongdee, and Worawan Pechurai</i></p> <p>Maejo University, Chiangmai, Thailand</p>	Thailand

S. C.5 (Virtual)	<b>Are Renewable Energy Technologies Competitive?</b> <i>Govinda Timilsina<sup>1</sup> and Kalim Shah<sup>2</sup></i> <sup>1</sup> World Bank <sup>2</sup> University of Delaware, Delaware, USA	USA
S. C.6 (AITCC)	<b>Assessment of food, water and energy status in the Mekong and Red deltas: implications for achievement of Sustainable Development Goals</b> <i>Malay Pramanik, Sylvia Szabo, Indrajit Pal, and Parmeshwar Udmale</i> Asian Institute of Technology, Pathum Thani, Thailand	Thailand

## Day 2: 21 October 2020 (Wednesday)

<b>Session D: Energy and Environment</b> Time: 09:00 – 12:00 PM Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)		
Ref. No.	Title, Authors, Affiliation	Country of Origin
S. D.1 (AITCC)	<b>Optimization of Microwave Hydrothermal Carbonization Conditions of Hydrochar for Ammonium Adsorption Capacity</b> <i>Anh Kim Phan<sup>1</sup> and Duangkamol Phihu Sutra<sup>2</sup></i> <sup>1</sup> Center of Excellence for Environmental and Hazardous Waste Management, Chulalongkorn University, Bangkok, Thailand <sup>2</sup> Environmental Research Institute, Chulalongkorn University, Bangkok, Thailand	Thailand
S. D.2 (Virtual)	<b>Guidelines for Managing Environmental Impacts on Eco-Rafting Activities of the Lam Dom Noi rafting group, Ban Non Hin Kong, Lamdom Noi Nikhom Sang Ton-eng Subdistrict, Sirinthon District, Ubon Ratchathani Province</b> <i>Pariwat Somnuek</i> Ubon Ratchathani University, Ubon Ratchathani, Thailand	Thailand

<p>S. D.3  <b>Student Award Entry</b>                      (AITCC)</p>	<p><b>Enhanced Enzymatic Conversion of Durian Peel by Sulfuric Pretreatment for Biofuel Production</b>  <i>Jakaphan Ratanapoompinyo<sup>1</sup>, Patchanee Yasurin<sup>1</sup>, Prapakorn Tantayotai<sup>2</sup>, Theerawut Phusantisampan<sup>3</sup>, Elizabeth Jayex Panakka<sup>4</sup>, and Malinee Sriariyanun<sup>4</sup></i>  <sup>1</sup>Assumption University, Bangkok, Thailand  <sup>2</sup>Srinakharinwirot University, Bangkok, Thailand  <sup>3</sup>Faculty of Applied Science KMUTNB, Bangkok, Thailand  <sup>4</sup>Chemical and Process Engineering, TGGS, KMUTNB, Bangkok, Thailand</p>	<p>Thailand</p>
<p>S. D.4                      (Virtual)</p>	<p><b>Assessment of Biochar from Chicken Litter and Sawdust for Soil Amendment</b>  <i>Shooha Tabil, Atique Ahmed Khan, Kawnish Kirtania, Shaumik Sharif, and Md. Saiful Islam</i>                      Bangladesh University of Engineering and Technology (BUET), Dhaka, Bangladesh</p>	<p>Bangladesh</p>
<p>S. D.5  <b>Student Award Entry</b>                      (Virtual)</p>	<p><b>Inhibitory Effect of Inorganic Salts Residuals on Cellulase Kinetics in Biofuel Production from Lignocellulose Biomass</b>  <i>Parita Mutrakulcharoen<sup>1</sup>, Peerapong Pornwongthong<sup>1</sup>, Prapakorn Tantayotai<sup>2</sup>, Kraipat Cheenkachorn<sup>1</sup>, Supacheree Roddech<sup>3</sup>, and Malinee Sriariyanun<sup>1</sup></i>  <sup>1</sup>King Mongkut's University of Technology North Bangkok, Thailand  <sup>2</sup>Srinakharinwirot University, Bangkok, Thailand  <sup>3</sup>Kasetsart University, Bangkok, Thailand</p>	<p>Thailand</p>
<p>S. D.6  <b>Student Award Entry</b>                      (AITCC)</p>	<p><b>Determination of Appropriate Conditions for Volatile Fatty Acids from Rubber Industrial Wastewater by GC-FID: Headspace Technique</b>  <i>Chatchawan Khotsena<sup>1</sup> and Siraporn Potivichayanon<sup>2</sup></i>  <sup>1</sup>Environmental pollution and Safety Program, Suranaree University of Technology, Nakhon Ratchasima, Thailand  <sup>1,2</sup>School of Environmental Health, Institute of Public Health, Suranaree University of Technology, Nakhon Ratchasima, Thailand</p>	<p>Thailand</p>

S. D.7 (AITCC)	<b>Health Risk Assessment of Passive Air Sampler-derived Polychlorinated biphenyl and Polycyclic Aromatic Hydrocarbons in Bangkok and Chiang Mai, Thailand</b> <i>Nareerat Punvitayakul and Wanida Jinsart</i> Chulalongkorn University, Bangkok, Thailand	Thailand
S. D.8 (Virtual)	<b>Farmers' Knowledge, Attitude and Practice on Integrated Pest Management in Kalaw Region, Myanmar</b> <i>Zin Mie Mie Aung<sup>1</sup>, Noppol Arunrat<sup>1</sup>, Sukanya Sereenonchai<sup>1</sup>, Monthira Yuttitham<sup>1</sup>, Thomas Neal Stewart<sup>1</sup>, and Winai Chaowiwat<sup>2</sup></i> <sup>1</sup> Mahidol University, Nakhon Pathom, Thailand <sup>2</sup> Hydro Informatics Institute, Bangkok, Thailand	Thailand
S. D.9 <b>Student Award Entry</b> (Virtual)	<b>Treatment Performance of Nitrate Contaminated without/with Reactive Black 5 dye using Hydrogenotrophic Denitrification</b> <i>Tippawan Singhoona, Kenta Shinodaa, Suphatchai Rujakoma and Futaba Kazamab</i> University of Yamanashi, Yamanashi, Japan	Japan
S. D.10 (Virtual)	<b>Comparison of Rural Livelihoods between Government-led and Local-led Initiatives under Community-based Forest Management: A Case Study in Chin State, Myanmar</b> <i>Ngun Kam</i> Mahidol University, Bangkok, Thailand	Thailand
S. D.11 <b>Student Award Entry</b> (AITCC)	<b>Analyzing Discharge Characteristics of Redox Flow Battery using Hydrochloric Acid as a Reactant</b> <i>Adisorn Thomya and Yottana Khunatorn</i> Chiang Mai University, Chiang Mai, Thailand	Thailand



**Session E: Beijing Normal University's Special Session on "Water Ecology and River Restoration"**

Time: 14:00 – 16:00 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

Ref. No.	Title, Authors, Affiliation	Country of Origin
S. E.1 (AITCC)	<b>Meteorological Drought Hazard Assessment under Future Climate Change Projection for Agriculture Area in Songkhram River Basin, Thailand</b> <i>Thanasit Promping<sup>1</sup> and Tawatchai Tingsanchai<sup>2</sup></i> <sup>1</sup> Kasetsart University Sriracha Campus, Chonburi, Thailand <sup>2</sup> Asian Institute of Technology, Pathum Thani, Thailand	Thailand
S. E.2 <b>Student Award Entry</b> (AITCC)	<b>Seasonal Estimates of Methane Emissions from Natural Wetlands in Nakhon Ratchasima</b> <i>Preecha Panmoon and Nares Chuersuwan</i> Suranaree University of Technology, Thailand	Thailand
S. E. 3 (Virtual)	<b>Multi-dimensional Exploration of the Ecological Restoration of the Yongding River Basin</b> Yijuan Bai Beijing Normal University	China
S. E. 4 (Virtual)	<b>Response of Groundwater in Yongding River Aquifer to River Channel Water Replenishment Project</b> Ruihui Chen Beijing Normal University	China
S. E. 5 (Virtual)	<b>Formation and Succession of Microbial Community Structure in Different Ecological Niches under Reclaimed Water Replenishment</b> Jie Li Beijing Normal University	China
S. E. 6 (Virtual)	<b>Sediment Trapping Processes and Capacity of Vegetative Filter Strips</b> Chengzhong Pan Beijing Normal University	China

S. E. 7 (Virtual)	<b>A New Remote Sensing Way to Get the River Discharge in the Ungauged Areas</b> Hezhen Lou Beijing Normal University	China
S. E. 8 (Virtual)	<b>Treatment of Organic Pollutants in Reclaimed Water using Oxygen-doped Carbon Nitride</b> Yajing Yang Beijing Normal University	China
S. E. 9 (Virtual)	<b>Distribution of Phthalate Acid Esters in Different Water Bodies and its Influential Factors</b> Botao Zhang Beijing Normal University	China

<b>Session F: Energy Price and Policy</b>		
Time: 16:15 – 17:45 PM		
Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)		
<b>Ref. No.</b>	<b>Title, Authors, Affiliation</b>	<b>Country of Origin</b>
S. F.1 <b>Student Award Entry</b> (Virtual)	<b>An Enabling Dissemination Framework Mechanism to Accelerate the Uptake of Energy-efficient Household Appliances and Lighting Products in the Off-grid Energy Product Market of Bangladesh</b> <i>Utpal Bhattacharjee</i> University of Colorado, Denver, USA	Bangladesh
S. F.2 (Virtual)	<b>The Co-benefits of Renewable Energy Policies in Japan: Barriers and Ways Forward</b> <i>Etsujiro Takai</i> Sustainable Governance Center, Institute for Global Environmental Strategies, Hayama, Japan	Japan
S. F.3 <b>Student Award Entry</b> (Virtual)	<b>Comparison of Various Machine Learning Algorithms for Predicting Energy Price in Open Electricity Market</b> <i>Puja Chaudhury, Abhishek Tyagi, and Prabhakar Karthikeyan Shanmugam</i> Vellore Institute of Technology, Vellore, India	India

S. F.4 <b>Student Award Entry</b> (Virtual)	<b>The Potential Role of Carbon Tax in Achieving the Paris Agreement Targets for a Developing Country: A Casestudy of Sri Lanka</b> <i>Gayashika L. Fernando and Migara H. Liyanage</i> Sri Lanka Institute of Information Technology, Malabe, Sri Lanka	Sri Lanka
S. F.5 (AITCC)	<b>A Prospective Feed-in Tariff of Rice Husk Power Plants in Thailand under the Power Development Plan 2018</b> <i>Prachuab Peerapong and Bundit Limmeechokchai</i> Sirindhorn International Institute of Technology, Thammasat University, Pathum Thani, Thailand	Thailand
S. F.6 (Virtual)	<b>Simulation of Blockchain based Power Trading with Solar Power Prediction in Prosumer Consortium Model</b> <i>Kaung Si Thu, Weerakorn Ongsakul</i> Asian Institute of Technology, Bangkok, Thailand	Thailand

### Day 3: 22 October 2020 (Thursday)

<b>Session G: Smart Grid and Smart Cities</b>		
Time: 10:00 – 12:00 noon		
Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)		
<b>Ref. No.</b>	<b>Title, Authors, Affiliation</b>	<b>Country of Origin</b>
S. G.1 <b>Student Award Entry</b> (Virtual)	<b>Chiangmai Smart City Initiative: A Scenario-based Assessment</b> <i>Achiraya Chaichaloempreecha, Puttipong Chunark, and Bundit Limmeechokchai</i> Sirindhorn International Institute of Technology (SIIT), Thammasat University, Pathum Thani, Thailand	Thailand
S. G.2 <b>Student Award Entry</b> (Virtual)	<b>Energy Conservation – Residential Building</b> <i>Atharav Joshi, Niyati Khandelwal, Yash Suryavanshi, and Maya Kurulekar</i> Vishwakarma University, Pune, India	India

S. G.3 Student Award Entry (AITCC)	<b>Scenario-based Analysis of Electric Vehicle Penetration in Road Transportation in Laos</b> <i>BounEua Khamphilavanh<sup>1</sup> and Toshihiko Masui<sup>2</sup></i> <sup>1</sup> Tokyo Institute of Technology, Tokyo, Japan <sup>2</sup> National Institute for Environmental Studies, Ibaraki, Japan	Japan
S. G.4 Student Award Entry (AITCC)	<b>Driving Factors of Smart City Development in Thailand</b> <i>Jirawan Klaylee, Phethai Kesorn, and Pawinee lamtrakul</i> Center for Excellence in Urban Mobility Research and Innovation, Thammasat University, Pathum Thani, Thailand	Thailand
S. G.5 (Virtual)	<b>Potential for Integrating Solar Rooftop Photovoltaic System with Rain Water Harvesting Facility and Electric Vehicle Charging Facility: Designing a Multicriteria Framework</b> <i>Debalina Saha<sup>1</sup> and Rabindra N. Bhattacharya<sup>2</sup></i> <sup>1</sup> Centre for Excellence in Public Management, Administrative Training Institute, India <sup>2</sup> Jadavpur University, Kolkata, India	India
S. G.6 (AITCC)	<b>Measuring Elevated Indoor Carbon Dioxide Concentration from Unsuitable Condition of Indoor Plant</b> <i>Kanittha Pamonpol<sup>1</sup>, Natsima Tokhun<sup>1</sup>, and Atcharaporn Somporn<sup>2</sup></i> <sup>1</sup> Valaya Alongkorn Rajabhat University under the Royal Patronage, Pathum Thani, Thailand <sup>2</sup> Udon Thani Rajabhat University, Udon Thani, Thailand	Thailand
S. G.7 Student Award Entry (Virtual)	<b>The Study on Association between Urban Green Space and Temperature Changes in Mega City</b> <i>Apinya Padon, Pawinee lamtrakul, Benjamin Punson, and Jirawan Klaylee</i> Thammasat University, Pathum Thani, Thailand	Thailand
S. G.8 (AITCC)	<b>Energy Management in Data Centers from Design to Operations and Maintenance</b> <i>Montri Wiboonrat</i> King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand	Thailand

<b>Session H: Climate Change II (Emissions)</b>		
Time: 13:00 – 15:00 PM		
Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)		
<b>Ref. No.</b>	<b>Title, Authors, Affiliation</b>	<b>Country of Origin</b>
S. H.1 <b>Student Award Entry</b> (Virtual)	<b>Reducing Carbon Dioxide Emission Generated by Thermal Power Plants with Solar Power on the Uganda's Electricity Grid</b> <i>Chrish Kavuma<sup>1</sup>, Diego Sandoval, and Hakizimana Khan Jean de Dieu<sup>1</sup></i> <sup>1</sup> African Centre of Excellence in Energy for Sustainable Development (ACEESD), University of Rwanda	Uganda
S. H.2 <b>Student Award Entry</b> (Virtual)	<b>A Study on Green House Gas Mitigation from Solar Parks in India</b> <i>Hirwe Rahul Rajaram<sup>1</sup> and Guru Balamurugan<sup>2</sup></i> <sup>1</sup> Tata Institute of Social Sciences, Mumbai, India <sup>2</sup> Central University of Tamil Nadu Thiruvavur, India	India
S. H.3 <b>Student Award Entry</b> (Virtual)	<b>Sustainable Utilization of Paddy Straw in Punjab for Biochar Production: Estimating the Energy and Emission Potential</b> <i>Imlisongla Aier, Anil Kumar Sakhiya, Abhijeet Anand, Shivangi, Priyanka Kaushal, and Virendra Kumar Vijay</i> Centre for Rural Development and Technology, Indian Institute of Technology Delhi, India	India
S. H.4 (AITCC)	<b>The Assessment of Energy Consumption and Carbon Emission from Maize Production Process in Northern Thailand</b> <i>Tanate Chaichana<sup>1</sup>, Natthawud Dussadee<sup>1</sup>, Nigran Homdoung<sup>1</sup>, Yinnittra Khamnuengphon<sup>1</sup>, Kunyaporn Chaiwoung<sup>2</sup>, Salidpron Withayaphadoung<sup>3</sup>, and Ukrit Samaksaman<sup>4</sup></i> <sup>1</sup> Maejo University, Chiang Mai, Thailand <sup>2</sup> Rajamangala University of Technology Lanna Nan, Nan, Thailand <sup>3</sup> Chiang Rai Rajabhat University, Chiang Rai, Thailand <sup>4</sup> Naresuan University, Phitsanulok, Thailand	Thailand

S. H.5 (AITCC)	<b>Performance of the Outdoor Evaporative Cooling: A Case Study of Thammasat University Rangsit Campus</b> <i>Moaz Altaf, Wisuwat Klabwisas, Kaung Si Thu, and Weerakorn Ongsakul</i> Asian Institute of Technology, Bangkok, Thailand	Thailand
S. H.6 (AITCC)	<b>Design and Simulation of an Islanded Hybrid Microgrid for Remote Off-Grid Communities</b> <i>Shubham Tiwari, Weerakorn Ongsakul, and Jai Govind Singh</i> Asian Institute of Technology, Pathum Thani, Thailand	Thailand
S. H.7 (AITCC)	<b>Very Short Term Wind Speed Forecasting Using Convolutional Long Short Term Memory Recurrent Neural Network</b> <i>Firuz Ahamed Nahid, Weerakorn Ongsakul, Nimal Madhu Manjiparambil</i> Asian Institute of Technology, Thailand	Thailand
S. H.8 (AITCC)	<b>Barriers to Renewable Energy Penetration in Bangladesh: An Analysis Based on Interpretive Structural Modeling Methodology</b> <i>Hasan Mahmud</i> Asian Institute of Technology, Pathum Thani, Thailand	Thailand

**Session I: Energy**

Time: 15:15 – 16:30 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

Ref. No.	Title, Authors, Affiliation	Country of Origin
S. I.1 <b>Student Award Entry</b> (Virtual)	<b>Comprehensive Analysis of Convolutional Neural Network Models for Non-Instructive Load Monitoring</b> <i>G.M. Herath<sup>1</sup>, T.D. Thilakanayake<sup>1</sup>, M.H. Liyanage<sup>1</sup>, and C.J. Angamma<sup>2</sup></i> <sup>1</sup> Sri Lanka Institute of Information Technology, Malabe, Sri Lanka <sup>2</sup> University of Waterloo, Ontario, Canada	Sri Lanka

S. I.2 (Virtual)	<p><b>Exploring the Dependency between Energy Access and other Sustainable Development Goals: Global Evidence</b></p> <p><i>Anver C. Sadath<sup>1</sup> and Rajesh H. Acharya<sup>2</sup></i></p> <p><sup>1</sup>Central University of Kerala, Kasaragod, India</p> <p><sup>2</sup>National Institute of Technology Karnataka, Surathkal, India</p>	India
S. I.3 (Virtual)	<p><b>Economic Viability of Solar PV for Domestic Applications in a Middle-Income Country: A Case Study of Sri Lanka</b></p> <p><i>Janith K. Wijesinghe, Mohamed Y. M. Najim, Gayashika L. Fernando, and Migara H. Liyanage</i></p> <p>Sri Lanka Institute of Information Technology (SLIIT), Malabe, Sri Lanka</p>	Sri Lanka
S. I.4 (Virtual)	<p><b>Low Electricity Access Rate as a Barrier to Achieving the Global Goal of Providing Affordable and Cleaner Energy for All in Burundi</b></p> <p><i>Gatoto Placide<sup>1</sup>, Michel Roddy Lollchund<sup>2</sup>, and Gace Athanase Dalsou<sup>3</sup></i></p> <p><sup>1</sup>African Center of Excellence in Energy for Sustainable Development, University of Rwanda, Kigali, Rwanda</p> <p><sup>2</sup>University of Mauritius, Réduit, Mauritius</p> <p><sup>3</sup>Department of Physics, University of Rwanda, Kigali, Rwanda</p>	Rwanda
S. I.5 (Virtual)	<p><b>Dielectric Strength of Kenaf/Glass Fiber Reinforced Unsaturated Polyester Hybrid Composites Used as Insulator</b></p> <p><i>Alaseel Bassam, M.N.M. Ansari, Fairuz Abdullah, A.R.M. Nazim, K.S. Vinoth, Noor Afeefah Nordin, and S. Thilageshwaran</i></p> <p>Universiti Tenaga Nasional, Kajang, Malaysia</p>	Malaysia

## DETAILED ABSTRACTS

### Session A: Energy Resources and Technology

Time: 10:15 – 12:15 noon

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. A.1 **A Year Around System Simulation for An Experimental Set-Up of A Thermosyphon Solar Water Heater in Thailand**  
Student Award Entry

*Uthpala Ekanayake<sup>1</sup> and Bundit Limmeechokchai<sup>2</sup>*

(Virtual)

<sup>1</sup>University of Peradeniya, Sri Lanka

<sup>2</sup>Sirindhorn International Institute of Technology, Thammasat University,  
Pathum Thani, Thailand

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Due to the high cost and environmental impacts fossil fuel, solar energy remains the most efficient alternative source of energy for water heating. A Solar Water Heater is a widely used apparatus in Thailand as an application of solar thermal energy. In this project a prevailing experimental set up of a thermosyphon solar water heater was used to experiment, model and simulate the yearly performance. The results of the simulations were based on a solar water with a collector surface of 2.16 m<sup>2</sup>, facing south with a tilt angle of 14° and a storage tank of 150 litres, operated at SIIT, Thammasat University in Pathum Thani. After the experimental data modelling a yearly simulation was carried using solar radiation levels and ambient temperatures as inputs to the simulation. After the yearly simulation, the average collector efficiency is 49 %, average collector temperature is 48 °C and average Storage temperature is 47°C.

S. A.2 **Simultaneous upgrading utilizing Iron Sponge and Zeolite 13X fixed bed columns for Gaseous Fuel Production**  
(Virtual)

*Antonio-Abdu Sami M. Magomnang and Dianne Mae M. Asiñero*

University of Science and Technology of Southern Philippines – Cagayan de Oro Campus, Philippines

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Biogas technology is continuously being studied to enhance its quality and expand its power generation application. To increase its heating value and eliminate its corrosive effect on machine components, a biogas upgrading system was designed and developed. This study evaluates the developed upgrading system by its capability to increase the methane content through hydrogen sulfide and carbon dioxide reduction using the iron sponge and Zeolite 13x, respectively as adsorbent columns. The results show that by



varying the volume flow rate of the biogas into the system could lengthen the contact time between the biogas and adsorbent and eventually increase the CH<sub>4</sub> content from the biogas. Furthermore, the highest methane content achieved at 63.1 % from a raw biogas concentration of 32% CH<sub>4</sub>. Meanwhile, with the breakthrough adsorption capacity of zeolite 13x was 224 mg CO<sub>2</sub> /g. This had reduced the CO<sub>2</sub> by 41.76% from its raw biogas composition. The maximum superior and inferior calorific values produced were 22.53 MJ/m<sup>3</sup> and 20.29 MJ/m<sup>3</sup> respectively. The simplified design of a simultaneous upgrading system intends to increase the methane content of the biogas and further extend its application as an alternative fuel for power generation applications.

S. A.3                    **Econo– Environmental Dispatch Solutions for Power  
Student                Systems Integrated with Renewable Energy Resources**  
**Award**  
**Entry**  
(Virtual)

*Femin Varghese<sup>1</sup>, Petra I.<sup>1</sup>, and Mathew S.<sup>2</sup>*  
<sup>1</sup>Universiti Brunei Darussalam, Brunei Darussalam  
<sup>2</sup>University of Agder, Grimstad, Norway  
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With the global concern of clean energy supply, the power dispatch strategies are modified from, the conventional economic dispatch to a timelier approach considering both economic and environmental aspects of generation. In this paper such, an Econo- Environmental dispatch (EED) system that integrated with renewable sources such as solar PV and wind energy systems are developed. The EED problem is formulated with two objective functions which would minimize the unit cost of generation as well as the atmospheric emissions caused during the power production. For attaining these objectives, cost and emission functions for renewable and nonrenewable sources integrated with the power grid has to be developed. The Cost functions of the renewables are developed based on the real performance data and for emission function the Life Cycle Assessment of the renewables are considered. For optimizing the dispatch solution the ramping behaviour models of renewables sources are taken as one of the constraints in this study. The proposed system is tested on the standard IEEE 30 bus system and solved with Mixed Integer Quadratic Programming (MIQP). The results showed that the optimal solutions for the EED is highly dependent on the unit cost of generation from renewables and the weightage factors. Different scenarios with varying costs and weightages were developed and the resulting optimal dispatch solution are further analysed and presented in this paper.

**S. A.4      Effect of Process Parameters on Slow Pyrolysis of Rice  
Straw: Product Yield and Energy Analysis**  
**Student      Anil Kumar Sakhiya, Paramjeet Baghel, Shivangi Pathak, Virendra  
Award      Kumar Vijay, and Priyanka Kaushal**  
**Entry      Centre for Rural Development and Technology, Indian Institute of Technology,  
(Virtual)      New Delhi, India**  
[anilkumar.sakhiya@gmail.com](mailto:anilkumar.sakhiya@gmail.com)

Slow pyrolysis of rice straw was carried out in a bench-scale fixed bed pyrolysis reactor. The effect of pyrolysis temperatures (300, 400, 500, and 600 °C) and residence time (1, 2, and 3 h) on product yield distribution and energy yield was studied. The biochar yield decreased from 57.87-31.25 wt.% with a rise in pyrolysis temperature and residence time. The percentage of carbon increased from 65.92-86.01%, while the percentage of hydrogen and oxygen decreased from 5.14-1.62% and 25.16-9.77%, respectively, with an increase in temperature and residence time. A similar trend observed in bio-oil characterization. The biochar yield initially increased from 300-500 °C and then reduced. The gas yield gradually increased from 11.91-28.16 %, with a rise in pyrolysis temperature and residence time. The concentration of CO and CO<sub>2</sub> decreased gradually from 41.81-29.66% and 54.02-38.46%, while H<sub>2</sub> and CH<sub>4</sub> increased from 1.9-19.22% and 2.3-10.54%, respectively. The energy yield of biochar decreased from 63.76-39.94%, while bio-oil and gas yield increased from 25.02-40.73 % and 4.96-19.23%, respectively, with an increase in pyrolysis temperature and residence time.

**S. A.5      Characterization of Phase Separation and Upgrading of  
Hardwood derived Bio-oil using Alcoholic Solvents**  
**Student      Manjula Siriwardhana**  
**Award      The Australian National University, Australia and National Engineering  
Entry      Research and Development Centre, Sri Lanka**  
**(Virtual)      [Manju\\_taranga@yahoo.co.uk](mailto:Manju_taranga@yahoo.co.uk)**

Bio-oil produced by fast pyrolysis of hardwood was studied. It was observed that bio-oil was phase separated after 15 hours during accelerated aging at 80 °C and the proportion of the viscous bottom phase continued to gradually increase with prolong aging. The chemical compositions of each phases proved that phase separation of bio-oil is not an effective tool to segregate undesired components into a single phase. GC-MS analysis shows that, during accelerated aging, some phenolic, sugar, ketone, ester, acid, furans and aldehyde components are disappearing from the bio-oil and these components might undergo polymerization or condensation reactions with the heavy pyrolytic fraction of bio-oil.

The addition of solvents greatly retards phase separation. Amongst the various alcohols tested (isopropanol, ethanol, propanol and butanol), isopropanol is the most effective in retarding phase separation. These polar solvents change the chemical composition by reactions such as esterification. Addition of 10 % of isopropanol prevents the phase separation for 13 days at 80 °C.

S. A.6 (Virtual) **Study on Application of SOFC on Biogas in Standalone Agriculture Enterprise Power Supply Systems**

*Elena N. Sosnina, Andrey V. Shalukho, and Leonid E. Veselov*  
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The article is devoted to the use of solid oxide fuel cells (SOFC) on biogas in standalone power supply systems of agricultural enterprises. The task of optimal composition and parameters selection for SOFC-based generation systems is solved. The object of research is a standalone power supply system for a livestock enterprise. Three options for the combining SOFC with additional energy sources has been considered. The methodology of SOFC-based generation system parameters selection was developed depending on daily biogas production volume. For the three options of the SOFC-based generation system, there were obtained dependences of Levelized Cost of Energy on the SOFC capacity. It was found out that the most effective option is the SOFC combination with accumulator batteries and a biogas backup power generator. An algorithm for controlling its operation modes was developed for this option. The algorithm was tested on a Simulink-model of the explored power supply system.

S. A.7 (AITCC) **Investigation of the Thermal Hazard of Faulty Li-ion Battery under External Heating**

*Pius Victor Chombo and Yossapong Laonual*  
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Lithium-ion battery tends to explode whenever abused beyond its critical tolerance. However, it is rare for the faulty battery (non-working) to be examined against abuses to investigate its related thermal consequences. In this study, a series of experiments is established to investigate the thermal hazards of faulty Li-ion battery during external heating by studying their combustion behavior and associated thermal consequences; and later results are compared with those of working batteries. The working batteries were charged to 75% and 100% SOC before testing. A group of a faulty battery and working battery were externally heated by an electric heater and the battery surface temperature and flame temperature were recorded throughout a test series. The thermal behavior of the battery was characterized by the battery surface temperature capture by a thermocouple attached on it whereas the flame temperature was captured by five thermocouples located on top of the positive cap. Results showed that, incidents such as gassing, safety vent crack, onset to thermal runaway, ignition, explosion, and extinguishing were similar in both faulty and working battery, but they were increasingly energetic failures. It is found that a faulty battery

triggered to thermal runaway at about 314 °C and reached a maximum surface and flame temperatures of 422 °C and 512.6 °C, respectively. The 100% SOC battery exhibited lower temperature to gassing, safety vent crack and ignition compared to others, whereas 75% SOC battery depicted the highest flame temperature due to energetic and stable combustion. Of great interest is that, all samples, faulty and working batteries, attained their maximum flame temperatures between explosion and extinguishing incidents. Moreover, the hottest region in all samples was within 40 mm from the positive cap. Post-test observations showed that after energetic explosion, the internal pressure in the battery reduces drastically so that ejecta are not expelled farther. At the same time, another flame emerges which burns for some time in the region of 40 mm from the positive cap. Another reason that contributed to the localization of the flame at the region of 40 mm from the positive cap is the safety vent clogging and melting of the Aluminum sheet which blocked or hindered the clear passage of the combustible gases. Thus, it can be concluded that, to enhance the safety, care should still be taken while handling the faulty battery.

S. A.8 **Electrochemical Study on Activated Carbon Electrode from Kenaf Biowaste for Supercapacitor Application**  
(Virtual)

*S. Thilageshwaran<sup>1</sup>, M.N.M. Ansari<sup>1,2</sup>, Noor Afeefah Nordin<sup>2</sup>, Alaseel Bassam<sup>1</sup>, Zainudin Yahya<sup>1</sup>, P. Elumalai<sup>3</sup>, and A. Prasath<sup>3</sup>*

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This paper discusses the fabrication of supercapacitor electrode using activated carbon derived from biowaste, Kenaf natural fibers as a precursor. Kenaf fiber was used as the natural fiber that acted as a precursor for the synthesis of activated carbon to become the active material of supercapacitor. The utilization of kenaf fiber biomass as a sustainable source offers to produce a low cost, light weight, high efficacy, reliable and stable supercapacitor. The carbon was synthesized from kenaf fibers by means of carbonization using potassium hydroxide (KOH). Three temperatures namely 700, 800 and 900 °C were chosen for activation. It turned out that 800 °C was the optimal temperature for efficient activation of the carbonized sample. The sample AC-800 produced the highest specific capacitance compared to AC-900 and AC-700. The electrochemical testing was performed in 6M KOH revealed the specific capacitance values of 91, 100 and 76 F/g for AC-700, AC-800 and AC-900 electrode respectively. The charge retention of AC-800 3 electrode at 5 A/g, was as high as 85% even at 2000<sup>th</sup> cycles.

## Session B: MESFIA's Special Session on Energy Access

Time: 13:15 – 15:15 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. B.1  
(Virtual)

### **Challenges in Using Renewable Energy for Islands in Indonesia: A Case Study of Karimunjawa** *Dwi Novitasari<sup>1</sup>, Rachmawan Budiarto<sup>1,2</sup>, Fiki Rahmatika Salis<sup>1</sup>, and Sarjija<sup>1,3</sup>*

<sup>1</sup>Center for Energy Studies, Universitas Gadjah Mada (UGM), Yogyakarta, Indonesia

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Karimunjawa subdistrict which is located in Central Java Province received electricity supply in 2006 by using diesel powerplant. The Government of Indonesia also installed solar powerplants in 3 of 5 islands in Karimunjawa subdistrict. The management of the solar powerplants in the islands provides challenges not only in technical, but also in economic and social aspects caused by technology which is still new for community. This paper discussed about the challenges in implementing renewable energy technology in islands. The data was collected by (1) daily energy demand survey in 45 households in Karimunjawa (2) observation and (3) stakeholders' interview. The results showed the importance of (1) developing productive used of energy, (2) the collaboration among many parties (3) technical, social and economic assistance in all project phase and (4) community engagement.

### **S. B.2 Potential of Renewable Energy in selected Greater Mekong Subregion (GMS) Countries to achieve NDCs in 2030**

**Student Award Entry**

(Virtual)

*Degeorge Dul and Bundit Limmeechokchai*  
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The selected Greater Mekong Subregion (GMS) countries namely, Cambodia, Lao PDR, Thailand, and Vietnam submitted their respective Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015 and subsequently ratified the Paris Agreement. The INDCs of the selected GMS countries set the total GHG emissions reduction target in the range of 117 to 339 Mt-CO<sub>2</sub>eq by 2030 when compared to the business-as-usual case. The GHG emissions in the INDCs are expected to be reduced through many measures in the energy sector such as efficiency improvement and renewable energy and other measures in the non-energy sector. However, among the four countries only Thailand has certain



make them renewable sources. This can be done through community-based forest management. The Plantation Establishment and Livelihood Improvement Scheme (PELIS) in Kenya is practiced through Participatory Forest Management (PFM) where forest adjacent communities are allocated forest land for three years where they grow trees and food crops. This scheme can be utilized for sustainable charcoal production by setting aside a piece of the land for growing trees suitable for charcoal production. This would provide the communities with viable sources of energy as well as income through the sale of wood fuel. There is potential in utilizing existing community-based management institutions to implement sustainable wood fuel production strategies. This will contribute to bridging the gap between wood fuel demand and supply, as well as complement livelihoods.

S. B.5  
(Virtual) **Pongamia as a Potential Biofuel Crop: Oil Content of Pongamia pinnata from the Best Provenance in Java, Indonesia**

*Trimaria Hasnah<sup>1</sup>, Budi Leksono<sup>1</sup>, Nur Sumedi<sup>1</sup>, Eritrina Windyarini<sup>1</sup>, Hamdan Adma Adinugraha<sup>1</sup>, Himlal Baral<sup>2</sup>, and Yustina Artati<sup>2</sup>*

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*Pongamia pinnata* (L.) Pierre is a fast-growing, leguminous and multipurpose tree species. It grows on degraded and marginal land in South and Southeast Asia. It produces non-edible seeds the oil of which is a potential biofuel. In Indonesia, *Pongamia* is widely found on all islands but mostly to the west of the Wallace line, such as Banten, East Java, South Sumatra, and West Java provinces. The economic feasibility of *Pongamia* depends on the number of seed per tree and the oil content of the seed. Studies on *Pongamia* oil in Indonesia revealed that trees grown in Ujung Kulon National Park, Banten Province, produce seed with a higher oil content (i.e., 15.59%) than those in the provinces of East and West Java using simple mechanical expeller press. In this study the oil content of 48 individual trees, from Ujung Kulon National Park, were analyzed using a solvent extraction method. As a control, bulk seed was extracted using two different methods: 1) fabricant mechanical screw expeller press and 2) solvent extraction. The results show highly significant or great variation in the oil content of the trees. Oil production of individual trees processed using the solvent extraction method reached 44% (varies from 26.61% to 44.68%) than those by mechanical pressing method with bulk seed was only 15 to 19%. The findings show that genetic factors, extraction machines and the method of extraction could all influence the production of *Pongamia* oil. The quality and genetic diversity of seed source is also very important on industrial plantation forest program for bioenergy and land restoration in Indonesia.

S. B.6  
(AITCC) **Isolated Energy Management Learning Platform through Smart and Green Building Design: A Case Study of USIS Building, Naresuan University**  
*Phisut Apichayakul, Piyadanai Pachanapan, Akaraphunt Vongkumhae, and Sarintip Tantanee*  
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Learning process has been shifted from lecture-based to active learning. Active learning can be defined in three main categories: (1) an instructional approach, (2) not an instructional approach, and (3) active learning not defined but viewed as a learning approach. Among these definitions, there is a common issue on strongly focusing student centered activities. Nowadays, electrical engineering curriculum has to cover not only the basic knowledge of electrical power systems but also modern technologies to cope with the disruptive issues. One of the important technologies in electrical engineering is a smart grid of which the smallest management unit can be viewed as an isolated unit. The objective of this paper is to develop isolated energy management platform through smart and green building design in order to support active learning in higher education of Electrical Engineering program. The developed system has been installed in a building which can be used as a demonstration of a small isolated energy management system as well as active laboratory for research.

**Session C: Climate Change I**

Time: 15:30 – 17:00 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. C.1  
**Student Award Entry**  
(Virtual) **An Improved Statistical Method for Rainfall Forecasting in Sri Lanka using the WRF Model**

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Weather Research and Forecasting (WRF) model is one of the forecast models which is used in Sri Lanka for weather forecasting specifically considering rainfall forecasting. This model offers multiple parameters which can be combined in many ways and to be used for simulating the model according to the regional aspects. According to the parameters of the WRF model which is applicable to the region including Sri Lanka, there are twelve model simulations of the WRF model in order to generate twelve rainfall forecasts for a given location at a specific time. The common practice is to select a random forecast value from these generated twelve forecasts. In this research, the daily rainfall patterns over Sri Lanka during the year 2019 were statistically analyzed with the consideration of the main climatic zones as Wet, Intermediate, and Dry. Best regressions were fitted, based on principal component analysis for the climate zones using the data from the first six months of 2019. Moreover, fitted regressions were tested using the data from the next three months of 2019. According to the calculated Mean Square Error (MSE) of the fitted



regressions, the results demonstrated a better accuracy compared to the individual model simulations of the WRF model for all three zones. For the Wet zone, MSE of the fitted regression was decreased by 20.5% compared to the minimum MSE value of the twelve model simulations, for the Intermediate zone, the MSE decrease was by 41.3% and for the Dry zone, the MSE decrease was by 5.5%. Thus, the proposed method can be considered as an improved method based on principal component analysis, for rainfall forecasting in Sri Lanka using the WRF model.

S. C.2  
(Virtual) **Assessing the “Value” of Nature-based Solutions at the Belgian Coast for Sustainable Tourism, using a Ecosystem-based Management Approach**

*Patrick D. De Klerck and Brendan P. De Baets*  
Territorial Development Program for the Flemish Coastal Region  
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Due to mass industrialization of leisure, social costs and ecosystem impacts, the traditional measurement of tourism value in economic terms has come under pressure. Natural coastal landscapes and biodiversity are becoming increasingly appreciated. By using the quintuple helix approach, the objective must be to embed the broad notion of value, elaborating on participatory, social, cultural, environmental issues into the decision-making process. The quintuple helix methodology combines knowledge, know-how, and the natural-environment-system within an ‘interdisciplinary’ and ‘transdisciplinary’ ecosystem-based management framework. The use of nature-based solutions (NbS) in coastal zones results in improved biodiversity, regenerated natural landscape, mitigated climate change and sea-level impacts and minimalized adverse effects of tourism. By implementing ‘building with nature’ coastal living labs in different countries (the Netherlands, the United Kingdom, France and Belgium), momentum is gained to prove the diverse values of this approach, in active collaboration with the public and decision makers.

S. C.3  
(Virtual) **Addressing Climate Change in Brazil: Is Rio De Janeiro City Acting on Adaptation Strategies?**

*Andrea Souza Santos, Suzana Kahn Ribeiro, and Victor Hugo Souza de Abreu*  
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The international scientific community has indicated that anthropogenic greenhouse gas emissions are likely the main cause of rising temperatures since the mid-twentieth century. Cities have not only been a major contributor to these emissions but are also in locations that will experience the impacts most intensely. Accounting for more than half of the world's population, most built assets and economic activity is concentrated in cities - factors that make these environments highly vulnerable to climate change. The impacts caused by

climate change are already being felt in urban centers and have been increasing in recent years. The main problems involving climate change for cities are rising temperatures, rising sea levels, heat islands, floods, and extreme events. Most Brazilian cities already have environmental problems associated with development patterns and transformation of geographical areas. Exacerbated changes in the hydrological cycle by reason of global warming tend to accentuate the existing risks such as floods, landslides, heat waves, and limitations on the supply of potable water. This article presents a case study of Rio de Janeiro city on how the city is acting to confront climate change through adaptation strategies.

S. C.4                    **Carbon Footprint and Carbon Stock Volume for Para  
(AITCC)                    Rubber Production in Southern Part of Thailand**

*Tanate Chaichana, Saowalak Thongdee, and Worawan Pechurai*  
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Para rubber product as it is one of the main exported products from Thailand. There are mostly planted areas in the southern and northeastern part of the country. This research emphasized on the assessment of carbon footprint and carbon stock from rubber trees. The comparison will be made between the production of latex and rubber cup lumps. The assessment was conducted from transportation, soil preparation, plantation, cultivations, rubber tappers and cut down the process. The study area in southern covered 13 provinces (excluding Songkhla province) was conducted on 740 farms with 9,126 Rai (1 Rai = 1,600 m<sup>2</sup>). The results showed that the average carbon footprint of latex and rubber cup lump produced in southern area was 0.77 and 0.81 kg CO<sub>2</sub>-eq /kg, respectively. For latex and rubber cup lumps, the major share of the GHGs emission was contributed by the cultivations and harvest processing follow by cut down. The total CO<sub>2</sub>-eq stock are 5, 10, 15, 20 and 25 years old rubber trees were 11,638.26, 17,288.94, 24,967.15, 29,805.35 and 32,292.98 kg CO<sub>2</sub>-eq /Rai, respectively. Therefore, rubber tree can reduce CO<sub>2</sub> emissions 4,592.09 – 19,480.97 kg CO<sub>2</sub> /Rai it depends on the product.

S. C.5                    **Are Renewable Energy Technologies Competitive?**  
(Virtual)

*Govinda Timilsina<sup>1</sup> and Kalim Shah<sup>2</sup>*

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The electricity generation cost of a technology is often measured in terms of levelized cost of electricity or LCOE despite fundamental flaw is that it treats the intermittent and no-dispatchable renewable technologies equally with the fully dispatchable electricity generation technologies. The LCOE of renewable energy, particularly solar and wind, has been rapidly falling over time as the capital costs that include not only the cost of equipment but also the entire installation of the plant is falling including balance of system (BoS) and soft

costs. One would wonder why have the costs of renewable energy, particularly solar, falling down? A comparison of LCOE reported by various sources or studies is often misleading, and therefore such a comparison should be avoided. technologies. The objective of this article is to illustrate the levelized costs of electricity generation with the values of LCOE estimated from various sources. We also present the declining trends of renewable energy costs and try to explain the potential drivers of the decline. We also explain the factors that affect the LCOE and present renewable energy cost trends with the discussion of the potential drivers of the declining trend and how

S. C.6  
(Virtual) **Assessment of Food, Water and Energy Status in the Mekong and Red Deltas: Implications for Achievement of Sustainable Development Goals**

*Malay Pramanik<sup>1</sup>, Sylvia Szabo<sup>1</sup>, Indrajit Pal<sup>2</sup>, and Parmeshwar Udmale<sup>1</sup>*

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Most South Asian countries have challenges in ensuring food, water, energy (FWE) security, caused by significant economic diversification, high population growth, imbalanced ecosystems, and climate change. FWE nexus is also a conceptual framework to understand the interlinked resources and managing natural resources for achieving sustainable development goals (1, 2, 6, and 7). However, some frameworks built for the implementation of FWE nexus not always account for the availability and accessibility of resources in terms of security. Albeit FAO providing national-level data, it fails to capture the subnational level variations within a country. To understand the linkages among these important natural resources (food, water, and energy) and development instruments, this study adopts a method to estimate FWE security focusing on provincial levels of Vietnam with special emphasis on the Mekong and Red River deltas. The study used Global Standardized, Quantitative, and Transparent Resource Assessment (known as RAND Pardee) approach to enhance the accuracy, transferability, and reproducibility of previous work on an integrated FWE security index. The index represents an unweighted geometric mean of three indices and sub-indices of food, water, and energy. The interaction analysis was also employed to assess the influence of the indicators and sub-indicators in the FWE security nexus. The results show that a larger share of food sectors among the FWE nexus in Vietnam. Food security indicator through agricultural productivity and subsequent impacts on the availability and productivity found to be playing a major role among the FWE sectors. However, these observations vary across the provinces in Vietnam. Our analysis

highlights that strategies on promoting agriculture production for food security, and balancing energy and water with food indicators could have overall positive effects on the FWE security nexus in the provinces. The result is an integrated method to estimate security processes that can be applied at different institutional levels and spatial scales. The obtained results show that three sectors need more attention to balance approach for future development in the provinces in Vietnam. The results can investigate resource security of all three sectors under plausible future conditions, and respective stakeholders might utilize it for the optimized utilization of resources as a decision support tool. This strategy not only provides insights into FWE security in Vietnam and its provinces, but it also can be replicated as an important tool to assess various development goals related to FEW across other regions.

### Session D: Energy and Environment

Time: 09:00 – 12:00 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. D.1  
(AITCC)

### Optimization of Microwave Hydrothermal Carbonization Conditions of Hydrochar for Ammonium Adsorption Capacity

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This study aimed to optimize microwave hydrothermal carbonization (MHTC) conditions of rice husk hydrochar for maximum ammonium adsorption capacity. Processing parameters including hydrothermal temperature (150 - 200°C), residence time (20 – 60 min), and water to biomass ratio (5 - 15 mL g<sup>-1</sup>) were optimized based on the Box- Behnken design. The ANOVA results indicated that only hydrothermal temperature showed a significant effect on the ammonium adsorption capacity of hydrochar. The optimum MHTC conditions were the water to biomass ratio of 10 mL g<sup>-1</sup> under 200°C for 60 min. Hydrochar produced under the optimum condition had the ammonium adsorption capacity of 0.89 mg NH<sub>4</sub><sup>+</sup>-N g<sup>-1</sup>. Findings from this study suggested that hydrochar derived from rice husk through MHTC has the potential to be an alternative adsorbent for preventing ammonium run off from the agricultural area.

S. D.2  
(Virtual) **Guidelines for Managing Environmental Impacts on Eco Rafting Activities of the Lam Dom Noi rafting group, Ban Non Hin Kong, Lamdom Noi Nikhom Sang Ton-eng Subdistrict, Sirinthon District, Ubon Ratchathani Province**

*Pariwat Somnuek*  
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The objectives of the research study were to (1) analyze the potential of the eco - rafting activities of the Lam Dom Noi rafting group, (2) study the environmental impacts on the rafting activities of the Lam Dom Noi rafting group, and (3) study the guidelines for managing environmental impacts on eco- rafting activities of the Lam Dom Noi rafting group. The sampling was chosen by the purposive sampling technique. The sampling was the amount of 20 people, including the community rafting entrepreneurs, the villager representatives, and the representatives of relevant government agencies. The instrument used in the study was a semi-structured interview form. Small group meetings were provided as the data collection technique used for collecting the data. Then, the data were analyzed through content synthesis according to details of environmental impact management on tourism. The findings were as follows.

(1) Eco- rafting activities of Lam Dom Noi rafting group consisted of 4 activities, nature tour rafting activity, paying a respect to the Thep Nimit goddess during rafting activity, rope swinging and swimming during rafting activity, and cooking activity on the raft. Based on the analysis of the potential of the activities indicated that it was an environmental ecotourism activity, encouraging participation in the community and tourists to benefit from tourism activities. (2) Environmental impacts on eco- rafting activities of the Lam Dom Noi rafting group consisted of positive and negative impacts. The examples of positive impacts were includes, 1) tourism led to the development and improvement of the environment of the community and the Lam Dom Noi river, 2) it caused the reduction of illegal logging, 3) tourists behave more in conserving natural resources, and 4) the rafting groups had good waste management. However, there were some negative impacts, including 1) illegal logging of large community forests nearby the Lam Dome Noi river, 2) noise pollution of the tugboat with floating raft engine, 3) causing the water activities that caused aquatic animals in the Lam Dome Noi to change behaviors, and 4) it caused the problem of landscape destruction of Ban Non Hin Kong community.

(3) Guidelines for the management of environmental impacts on eco- rafting activities of Lam Dom Noi rafting group were as follows, 1) determining measures to control tourists' behavior on natural resource conservation, 2) providing a good waste management system, 3) developing and improving environments, including community landscapes, 4) determining measures to reduce public deforestation of the large community forest areas, 5) determining measures to reduce the destruction of environmental conditions

and community landscapes, 6) determining measures to reduce the noise pollution the tugboat with floating raft engines, and 7) determining measures to limit the number of the rafts that were suitable for the Lam Dome Noi river.

S. D.3  
**Student Award Entry**  
(AITCC)

**Enhanced Enzymatic Conversion of Durian Peel by Sulfuric Pretreatment for Biofuel Production**  
*Jakaphan Ratanapoompinyo<sup>1</sup>, Patchanee Yasurin<sup>1</sup>, Prapakorn Tantaiyotai<sup>2</sup>, Theerawut Phusantisampan<sup>3</sup>, Elizabeth Jayex Panakka<sup>4</sup>, and Malinee Sriariyanun<sup>4</sup>*  
<sup>1</sup>Assumption University, Bangkok, Thailand  
<sup>2</sup>Srinakharinwirot University, Bangkok, Thailand  
<sup>3</sup>Faculty of Applied Science KMUTNB, Bangkok, Thailand  
<sup>4</sup>Chemical and Process Engineering, TGGS, KMUTNB, Bangkok, Thailand  
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Burning of agricultural waste after harvesting seasons leads to persistent environmental pollution, especially PM2.5 and PM10. Utilization of agricultural waste by conversion to value-added product or biofuel is a solution for this problem, however, breaking down of lignocellulosic biomass in agricultural waste has a limiting factor due to its inappropriate physical and chemical properties. In this work, durian peel, as lignocellulosic biomass, was pretreated with diluted sulfuric acid to disintegrate the lignocellulosic fibrils and to promote enzymatic saccharification. To optimize this acid pretreatment, three pretreatment parameters, including temperature (60–140°C), time (20–100 minutes), and acid concentration (0.5–3.5%) were designed and varied based on Response Surface Methodology (RSM) using Box-Behnken design. After pretreatment, pretreated biomass was enzymatic hydrolyzed, and pretreatment efficiency was determined based on amounts of reducing sugars. The mathematical model representing the correlation of each pretreatment factor and reducing sugars was generated to calculate the optimized pretreatment condition. At predicted optimal pretreatment condition, 127.14°C, 74.13 minutes, 2.75%, the result showed that the reducing sugar was obtained at 553.1 mg/g-durian peel, which was 1.88 folds higher compared to unpretreated durian peel. This work suggested the necessity of pretreatment in bio-conversion of agricultural waste to produce biofuels and value-added products.

S. D.4 **Assessment of Biochar from Chicken Litter and Sawdust  
for Soil Amendment**

(Virtual)

*Shooha Tabil, Atique Ahmed Khan, Kawnish Kirtania, Shaumik Sharif, and Md. Saiful Islam*

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The study aims at evaluating the produced biochars from biomasses (chicken litter and sawdust) through pyrolysis process. Proximate analyses of both biomass and biochar samples, TGA, SEM-EDS analysis for point detection of heavy metals, and spectrophotometric analysis through acid-leaching method for heavy metal detection in a bulk were studied, respectively. Significant changes were observed for biomasses converted into biochars regarding moisture, ash, volatile content, fixed carbon, and calorific value. The time-vs-temperature graph in TGA indicated the transition zones and volatile eruption sections where both the biochars showed similar characteristics, while the time-vs-mass percentage graph indicated different results for two different biochars showing that chicken litter has less volatile content than sawdust. SEM-EDS images indicated fibrous structure of the biochars and showed the characteristic x-rays of different elements on some specific points. For heavy metal analysis of chicken litter sample, Cd was detected in a higher amount than the sawdust biochar.

S. D.5 **Inhibitory Effect of Inorganic Salts Residuals on  
Student Cellulase Kinetics in Biofuel Production from  
Award Lignocellulose Biomass**

Entry

(Virtual)

*Parita Mutrakulcharoen<sup>1</sup>, Peerapong Pornwongthong<sup>1</sup>, Prapakorn Tantayota<sup>2</sup>, Kraipat Cheenkachorn<sup>1</sup>, Supacheree Roddecha<sup>3</sup>, and Malinee Sriariyanun<sup>1</sup>*

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Biorefining process has the goal to convert lignocellulose biomass to biofuels and value-added products and to reduce burning activities of agricultural wastes after harvesting seasons. Pretreatment of lignocellulose biomass by using inorganic salt has been demonstrated to be an efficient method to improve process productivity, yet its efficiency is inhibited by salt residues in hydrolysis. In this study, the mechanisms of inhibitory effects caused by inorganic salts, NaCl and KCl, on kinetic activities of commercial cellulase were revealed using Michaelis-Menten model. Three different types of cellulose and lignocellulose substrates, CMC, Avicel, and sugarcanes bagasse, were enzymatic hydrolyzed. Using Lineweaver-Burk plot, the results showed that the inhibitory effect of KCl and NaCl residues were non-

competitive and mixed inhibition, respectively. Due to their inhibitory effect, inorganic salt residues reduced reducing sugar yields released from CMC and Avicel, however, the yield obtained from sugarcane bagasse increased for 1.51 fold when adding 1.0 M NaCl. The finding in this research suggested the alternative method to use sugarcane bagasse for biofuel conversion and reduction of agricultural combustion.

S. D.6  
**Student Award Entry**  
**Determination of Appropriate Conditions for Volatile Fatty Acids from Rubber Industrial Wastewater by GC-FID: Headspace Technique**

*Chatchawan Khotsena<sup>1</sup> and Siraporn Potivichayanon<sup>2</sup>*  
<sup>1</sup>Environmental pollution and Safety Program  
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The appropriate conditions of gas chromatography were developed and applied to the volatile fatty acids (VFAs) in from of acetic acid, propionic acid, and isobutyric acid analysis of wastewater from the rubber industry. The headspace technique was used for sample preparation. The purpose of this study is to find the appropriate preliminary conditions, and to identify an appropriate internal standard. The results showed that the linearity, instrumental precision and accuracy are preferable when using the commercially available mixed VFA standard solution to those obtained using the manually mixed standard solution. The chromatograph of VFA mixtures showed good separation by the HP-INNOVAX column. Quantification of VFAs in wastewater from the rubber industry was determined using an internal standard curve with crotonic acid as an internal standard. Crotonic acid performed better than butyric acid as an internal standard. Thus, these results provided evidence that this analytical method could be useful for routine monitoring of VFAs.

S. D.7  
**Health Risk Assessment of Passive Air Sampler-derived Polychlorinated biphenyl and Polycyclic Aromatic Hydrocarbons in Bangkok and Chiang Mai, Thailand**

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Atmospheric pollutants have become a severe problem in creating health issues in Thailand. Due to the increase in fine particles in the air environment, the city population is facing acute respiratory problems. For understanding the concentration of polycyclic aromatic hydrocarbon (PAHs) and Polychlorinated



biphenyls (PCBs), sampling was done in Chiangmai and Bangkok of Thailand using Polyurethane (PUF) disk passive samplers. There were five sampling sites in Bangkok, and three in Chiang Mai. Data were collected in the dry season, i.e. from December 2018- June 2019. A total of 24 samples were extracted and further quantitatively analyzed by the standard method using GC-MS. Both PAHs and PCBs concentrations increased during the dry season. At Chiang Mai, max. PAHs were found to be 848 ng/m<sup>3</sup>, which was higher than that of Bangkok, max. PAHs concentration was found to be 455 ng/m<sup>3</sup>. On the other hand, the max PCBs found in Bangkok were 15 pg/m<sup>3</sup> were higher than that in Chiang Mai (max. value 2.63 pg/m<sup>3</sup>). Chiang Mai sites had more dominant species PAHs than in Bangkok, particularly during forest fire episodes from February to April 2019. The potential sources of PAHs were found as the combined emission of diesel and gasoline vehicles and biomass combustion. The carcinogenic risk associated with inhalation exposure to PAHs and PCBs was estimated to be <10<sup>-6</sup> at all the sampling points. The analyzed PAHs and PCBs species indicated their potential sources that related to both biomass burning and traffic in Bangkok and Chiangmai. Pollutants' level also had seasonal variations. Therefore, air quality management is an essential issue that needs to be monitored in these provinces (cities) of Thailand.

S. D.8 **Farmers' Knowledge, Attitude and Practice on Integrated Pest Management in Kalaw Region, Myanmar**  
(Virtual)

*Zin Mie Mie Aung<sup>1</sup>, Noppol Arunrat<sup>1</sup>, Sukanya Sereenonchai<sup>1</sup>,  
Monthira Yuttitham<sup>1</sup>, Thomas Neal Stewart<sup>1</sup>, and Winai Chaowiwat<sup>2</sup>*

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Integrated Pest Management is an effective method in agriculture, which can reduce chemical usage, lessen environmental impacts and protect human health. However, the perception and opinions of farmers on the practice of IPM methods are limited. Therefore, this study aims to evaluate the farmers' practices of IPM methods in Kalaw Township, Myanmar. A survey of 150 vegetable farmers who mainly grow Cabbage, Cauliflower and Chinese cabbage was conducted. Binary logistic regression was used to identify factors influencing decisions on practicing IPM methods. The results showed male farmers were more invested in IPM methods than female. Farmers who had high greater experience in farming would be more open to IPM methods. Small households were more likely than large households to adopt IPM methods. Farmers who had encountered high crop loss because of pest outbreaks in the past were more likely to adopt IPM methods. Most farmers are familiar with cultural, physical and mechanical control in IPM methods, whereas practicing pheromone traps, natural pesticide, and traditional usages are relatively rare.

S. D.9  
**Student Award Entry**  
(Virtual)

**Treatment Performance of Nitrate Contaminated without/with Reactive Black 5 dye using Hydrogenotrophic Denitrification**

*Tippawan Singhopona, Kenta Shinodaa, Suphatchai Rujakoma and Futaba Kazamab*

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Nitrate and synthetic dye from the textile industry are one of important environment problems in Thailand due to large volumes and toxic contamination that usually discharged into natural sources and still not met wastewater standards. This study aims to observe the nitrogen removal rate (NRR) via hydrogenotrophic denitrification (HD) that is a type of treatment processing to reduce nitrate and nitrite using H<sub>2</sub> as electron donor; comparing with bioreactors treatment when it is contaminated without/with reactive black 5 dye (RB-5) color, and also attempts to evaluate the system that can simultaneously reduce nitrate, nitrite and dye color in a single reactor. Five reactors under different operations and gas supply were set-up with nitrate feeding in range between 40-80 mg-N/L under HRT 24 h in a continuous feeding mode, including an aerobic reactor using air, two anaerobic reactors using argon and H<sub>2</sub>, and a combined process using intermittent air/argon and air/H<sub>2</sub>. The results indicated NRR without RB-5 ranged from 45 - 95 %, and reached 100 % when RB-5 was added. H<sub>2</sub> and air/H<sub>2</sub> reactors experienced partial decolorization of approximately 20–30%; however, the average effluent concentrations were found in high range 50- 60 and 15-18 mg/L at a feeding of 80 and 20 mg/L of RB-5 dye, respectively, whereas the other reactors remained stable. Bacterial communities were found different in the reactors receiving either without or with added dye. The main dominant in high NRR and dye removal were found genus *Phyllobacterium*, family *Rhodobacteraceae* and *Thauera* sp when without dye whereas family *Peptococcaceae* and family *Peptostreptococcaceae* were main dominants when dye was added. Furthermore, family *Xanthomonadaceae* that is an autotrophic denitrifiers for reducing nitrate to nitrogen was also main dominants when without and with RB-5 contaminated depend on gas supply conditions. In conclusion, HD and intermitted air/H<sub>2</sub> processing can completely remove nitrate and nitrite when contaminated with RB-5 color which did not affect the NRR. Also, some dye color particles can be reduced in these processes. Hence, this study can be used for the development of advanced technologies, improving wastewater quality before being discharged, as well as reducing freshwater consumption in developing countries.

S. D.10  
(Virtual)

**Comparison of Rural Livelihoods between Government-led and Local-led Initiatives under Community-based Forest Management: A Case Study in Chin State, Myanmar**

*Ngun Kam*

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Promoting forest conservation as well as the well-being of forest adjacent people requires an appropriate balance of regulation, enforcement, and incentives. The implementation of community-based forest (CBF) in Myanmar continues facing many challenges especially in a local area like Chin State. This study investigates the contribution of community-based forest management to livelihoods, conservation and governance by comparing different cases under the government-led and local-led initiatives. It aims at identifying the constraint factors and what factors should be considered to be promoted by involving interviews with key informants, focus group discussions, the 101 randomly selected households survey using structured questionnaires, field observation, and literature reviews. This research identifies that the community-based forest provides a range of benefits to a local community for their livelihood's matter, in spite of no direct cash income gained from the CBF, such as easily accessible to local construction materials; accessibility to edible forest products during hardship time; protection of ecosystem services; social cohesion; and community awareness. The most notable benefit in the government-led initiative is household building materials, while protection and recreation service is regarded as the highest in the local-led initiative. Despite such benefits, there are still several constraints to meet a genuine participatory forest development complementing the dual objectives of livelihood's improvement and forest regeneration. Thus, strategic steps to take include providing technical skills and economic incentives for conservation, promoting social recognition and empowerment, exploring and integrating indigenous knowledge, and protecting community rights.

S. D.11  
**Student Award Entry**  
(AITCC)

**Analyzing Discharge Characteristics of Redox Flow Battery using Hydrochloric Acid as a Reactant**

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This research focused on two-phase flow performance of a reactant in a cathode that used affordable, locally sold hydrochloric acid to provide low-pressure. The experimental characteristics including current density and cathode flow rate were set to 100 – 400 ml/min while concentration rate was set to 1 – 3 molarity and reaction area was set between 25 and 49 cm<sup>2</sup>. Electrode synthesis and cell performance were obtained in operation to

validate the numerical results with comparison between the two substances, Pt/C and RuO<sub>2</sub>. The best performance was achieved at concentration of 2 M and a flow rate of 400 ml/min with a current density and power density exceeding 179 mA/cm<sup>2</sup> and 3mW/cm<sup>2</sup>, respectively. The limiting current density and power density for reaction area 49 cm<sup>2</sup> was about 123 mA/cm<sup>2</sup> and 98.1 mW/cm<sup>2</sup>, respectively, at 57.9% voltage efficiency. An increased average voltage efficiency for reaction area 25 cm<sup>2</sup> was about 64.5%. The Pt / C side Colleen to RuO<sub>2</sub> catalyst loading resulted in decreasing average voltage efficiency (6.6%). Hence, the investigation will be beneficial to determine the suitable performance of two-phase flow configuration for the redox flow battery with low-cost material and to gain in-depth understanding of operation characteristics of redox flow battery using hydrochloric acid as a reactant for the new model of two-phase flow in cathode.

**Session E: Beijing Normal University's Special Session on "Water Ecology and River Restoration"**

Time: 14:00 – 16:00 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. E.1 **Meteorological Drought Hazard Assessment under  
(AITCC) Future Climate Change Projection for Agriculture Area in  
Songkhram River Basin, Thailand**

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The Songkhram River Basin (SRB) has recently experiencing related drought disaster and water scarcity because of reduction in rainfall and increasing high temperature. This paper presents an assessment of meteorological drought hazard of agriculture area in the river basin under future climate change projection. The study analyzed meteorological drought hazard using the Standardized Precipitation Index or SPI considering the observed daily rainfall data (1970–2010) from 6 meteorological stations and the average trend of the projected future climate change scenarios (2011–2100) from three Regional Climate Models (RCMs) under two Representative Concentration Pathways RCP4.5 and RCP8.5. The results showed that the future annual rainfall in the 21st century at Sakon Nakhon weather station in SRB was reduced by -1.5% and -3.7% per decade for RCP4.5 and RCP8.5, respectively. The drought hazard assessment was quantitatively evaluated for rice and field crops based on the values of drought hazard parameters namely: standardized precipitation index SPI, distance from surface water resources and ground water yields. The weights of each drought parameter were determined by

using Analytical Hierarchy Process (AHP). The result showed a change in potential drought hazard in the future in the study area of 12,880 km<sup>2</sup>, for SPI1 under RCP4.5; the low hazard area was 33%, medium of 22%, high of 45% in 2020s. They did not change much in 2050s but significantly changed from low to medium, medium to high and high to very high hazard respectively in 2080s. While under RCP8.5; the low, medium, high and very high hazard areas in 2020s significantly changed to medium, high and very high hazard respectively in 2050 and 2080s. A bit more significant droughts was expected to occur for SPI3 which is for field crop for both RCPs. Overall, under both RCP4.5 and RCP8.5, we can say that the droughts become more significant in the study area as the time goes on from 2020s to 2050s and to 2080s for both rice and filed crops. However, the predicted drought conditions were only based on standardized precipitation index SPI1 and SPI3 under predicted climate change conditions. In actual situations, other factors such as evapotranspiration, soil moisture conditions, change in runoff and irrigation as well as adaptation measures may change the results of this study. The temporal pattern of future drought hazard levels can be used by researchers and policy makers as a guideline for drought management and mitigation strategies in the study area.

**S. E.2      Seasonal Estimates of Methane Emissions from Natural  
Student      Wetlands in Nakhon Ratchasima  
Award                      Preecha Panmoon and Nares Chuersuwan  
Entry                      School of Environmental Health  
(AITCC)      Suranaree University of Technology, Nakhon Ratchasima, Thailand  
   [nares@sut.ac.th](mailto:nares@sut.ac.th)**

Seasonal methane emissions from natural wetlands in Nakhon Ratchasima province were estimated based on 12-month field works obtained from the actual methane flux measurements at a natural wetland. Methane gas was measured monthly with a static closed chamber technique and later analyzed by a gas chromatography equipped with a flame ionization detector (GC-FID). Results showed that methane fluxes varied widely in the range of 1.9-22.7 mg m<sup>-2</sup>day<sup>-1</sup> with the median ± SD of 10.1 ± 5.4 mg m<sup>-2</sup>day<sup>-1</sup>. Seasonally, the methane fluxes during wet season ranged from 5.2 to 22.7 mg m<sup>-2</sup>day<sup>-1</sup> with the median ± SD of 14.1 ± 5.0 mg m<sup>-2</sup>day<sup>-1</sup> while the methane fluxes during dry season was between 1.9 and 21.9 mg m<sup>-2</sup>day<sup>-1</sup> with the median ± SD of 8.8 ± 5.2 mg m<sup>-2</sup>day<sup>-1</sup>. The estimate methane fluxes of the wetland in wet and dry seasons were 1.5-3.1 kg m<sup>-2</sup> and 0.7-2.9 kg m<sup>-2</sup>, respectively. The estimated methane emission factor from the natural wetland in the province was 1.7 to 5.7 kg m<sup>-2</sup> year<sup>-1</sup> compared to the default methane emission factor from IPCC, 0.0136 kg m<sup>-2</sup>year<sup>-1</sup>. When considering global warming potential (GWP) of methane based 100-year time horizon, the natural wetlands in the province would emitted about 15.48 to 52.16 million ton CO<sub>2</sub> equivalent a year based on the emission factor derived locally. With the IPCC default emission factor, the methane emission was as low as 0.03 to 0.22 million ton CO<sub>2</sub> equivalent a year.

## Session F: Energy Price and Policy

Time: 16:15 – 17:45 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. F.1      **An Enabling Dissemination Framework Mechanism to Accelerate the Uptake of Energy-efficient Household Appliances and Lighting Products in the Off-grid Energy Product Market of Bangladesh**

(Virtual)

*Utpal Bhattacharjee*

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Bangladesh is experiencing a major economic transition to achieve the goal of becoming a middle income country by 2021. Bangladesh Government adopted a vision to provide energy access to all. The country also committed to an un-conditional Green House Gas (GHG) reduction target of 5% by the year 2030 in its Nationally Determined Contribution (NDC, 2015) to the United Nations Framework Convention on Climate Change (UNFCCC). Although Bangladesh Government has adopted an “Energy Efficiency and conservation Master Plan up to 2030 ” with sufficient focus to address the issues like household appliances efficiency and phase-out energy in-efficient incandescent lights by the efficient LED lights, the country still lags in many ways in addressing pertinent issues like setting an appropriate and country reflective household appliances standards and labeling scheme to make sure people even in the remotest part of the country, will be able to purchase quality appliances in an affordable manner. Infrastructure Development Company (IDCOL’s) grant based re-financing scheme inspired many of its partner organizations (POs) to install more than 4 million solar lighting systems in the grant supported Solar Home System (SHS) program. But access to sustainable clean energy without quality household appliances, an issue, yet to receive necessary attention of the program stakeholders and policy makers. As a result, dissemination of efficient household appliances in the SHS program as well as in the rural areas, yet to achieve a desired level of uptake by the off-grid households. Without necessary diversification of existing form of SHS, the IDCOL SHS program will not be able to address the growing demand of energy of their off-grid customers. Also, a suitable energy efficient and quality appliances dissemination framework mechanism is yet to be adopted by the Government to achieve that goal. This paper analyzed different options and programs already took place in country and also in other regions into the consideration for developing a suitable dissemination framework mechanism that might help Bangladesh and other regional countries facing energy access challenges to provide clean and efficient energy to its off-grid populations. Roles of supporting donors and developing partners along with national nodal agencies are being discussed at length with

an expectation that it will be able to bring right synergies in the proposed framework mechanism in terms of right capacities and a suitable arrangement with a provision of monitoring framework to promote quality and low energy consuming appliances in the off-grid energy appliances market.

S. F.2 **The Co-benefits of Renewable Energy Policies in Japan:  
Barriers and Ways Forward**

(Virtual)

*Etsujiro Takai*

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In recent years, many countries have intensified efforts to address the climate emergency. In Japan, these efforts have often built upon policies and plans to promote renewable energy that followed the 2011 Great East Japan Earthquake. Further many of these policies and plans deliver important benefits beyond mitigating climate change such as reductions in air pollution. Achieving these benefits will require both a clear understanding of the magnitude of co-benefits and strategies for overcoming barriers to achieving them. The main purpose of this paper is to describe the policies that can deliver co-benefits from renewable energy in Japan; analyze the technical, social and political barriers to implementing those policies; present a simple method for quantifying co-benefits from those policies; and underline how a concept called Regional Circulating and Ecological Sphere (CES) can provide a useful framework for moving past key barriers.

S. F.3 **Comparison of Various Machine Learning Algorithms for  
Predicting Energy Price in Open Electricity Market**

**Student  
Award  
Entry**

(Virtual)

*Puja Chaudhury, Abhishek Tyagi, and Prabhakar Karthikeyan*

*Shanmugam*

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This paper focus on exploring the possibilities for prediction of energy prices using various machine learning (ML) algorithms. Earlier, this problem has been tackled using various numerical methods like quadratic and cubic spline interpolation, etc. However, the accuracy of prediction has always been sub-par due to the limited capacity of such models. In this work, the focus is on exploring the possibilities of predicting the energy price in the open electricity market using four different algorithms namely: Simple Linear Regression, Support Vector Machines (SVM), K nearest neighbor, and Long Short-Term Memory. The main contribution of this work is to develop an ML system that can predict future prices. Real-time data are obtained from the Indian Energy Exchange (IEX) which handles around 30% of energy transactions through online within India under open access. The results are validated from the

same which ensures the proper validation of the proposed model. The four models on the Indian Energy Exchange dataset are trained and the results are compared to find the best algorithm with the highest accuracy.

S. F.4      **The Potential Role of Carbon Tax in Achieving the Paris Agreement Targets for a Developing Country: A Casestudy of Sri Lanka**  
**Student Award Entry**  
(Virtual)      *Gayashika L. Fernando and Migara H. Liyanage*  
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This study assess the effect of carbon taxes on energy and emissions of the Sri Lankan energy sector during 2015-2050. Along with a Business As Usual (BAU) scenario, three alternative carbon price trajectories were considered. These scenarios have been proposed based on fifth Shared Socioeconomic Pathway (SSP5) to achieve the 2°C Paris target for Asia. The Carbon Price trajectories proposed by AIM/CGA, REMIND-MAGPIE and GCAM were considered. The energy-economic-environmental system was modelled using the AIM/Enduse model. It considered both energy supply and demand sectors. The results show that in the BAU scenario the GHG emissions are expected to increase from 19.8MtCO<sub>2e</sub> in 2015 to 106.2MtCO<sub>2e</sub> in 2050. Out of three carbon tax scenarios the prices proposed by AIM/CGA has been the most efficient for reduction of GHG emissions as it could reduce final energy consumption by 26% and GHG emissions by 24% in 2050 as compared to BAU scenario.

S. F.5      **A Prospective Feed-in Tariff of Rice Husk Power Plants in Thailand under the Power Development Plan 2018**  
(AITCC)      *Prachuab Peerapong and Bundit Limmeechokchai*  
Sirindhorn International Institute of Technology, Thammasat University,  
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Thailand is one of the top producers of agriculture products including rice, sugarcane, oil palm, and coconut. The agriculture residues of these products can be important sources of fuel used for electricity generation. Thailand has great potential to develop the biomass residues for power generation. It also has carried out the objective of promoting the renewable energy investment for power generation. The objective of this research is to propose the prospective feed-in tariffs of electricity generation from biomass. Under the Power Development Plan 2018, the Thai government has initiated the competitive bidding type of feed-in tariffs in all renewables types at a single rate. This type of feed-in tariff uses a rate of power purchasing of all renewable energies at the rate is no more than an electricity price that generated mostly from fossil fuel sources. The biomass power plants with a capacity of 3,496 MW that will be installed between 2018 and 2037, must use



this type of feed-in tariff. The proposed prospective feed-in tariffs rate in this research is proposed at \$0.08/kWh. This rate is lower than the rate from the feed-in tariffs scheme regulated by the government in 2015 at \$0.121/kWh. The research compares the lower prospective feed-in tariffs rate that can reduce the subsidization of electricity generated from renewable energy. The key parameters used for prospective feed-in tariffs rates such as the net present value, interest rate return of investment, IRR, and the payback period of investment. Many sensitivities that affecting the investment are also proposed in this research. This research uses the rice husk power plant as a model for VSPP biomass investment with an installed capacity of less than 10 MW. Three rice husk power plants from different locations in three provinces in Thailand have been used for this research.

S. F.6  
(Virtual) **Simulation of Blockchain based Power Trading with  
Solar Power Prediction in Prosumer Consortium Model**

*Kaung Si Thu, Weerakorn Ongsakul*

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Prosumer consortium energy transactive models can be one of the solutions for energy costs, increasing performance and for providing reliable electricity utilizing distributed power generation, to a local group or community, like a university. This research study demonstrates the simulation of blockchain based power trading, supplemented by the solar power prediction using MLFF neural network training in two prosumer nodes. This study can be the initial step in the implementation of a power trading market model based on a decentralized blockchain system, with distributed generations in a university grid system. This system can balance the electricity demand and supply within the institute, enable secure and rapid transactions, and the local market system can be reinforced by forecasting solar generation. The performance of the MLFF training can predict almost 90% accuracy of the model as short term ahead forecasting. Because of it, the prosumer bodies can complete the decision making before trading to their benefit.



**S. G.3 Student Award Entry (AITCC)**      **Scenario-based Analysis of Electric Vehicle Penetration in Road Transportation in Laos**  
*BounEua Khamphilavanh<sup>1</sup> and Toshihiko Masui<sup>2</sup>*  
<sup>1</sup>Tokyo Institute of Technology, Tokyo, Japan  
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The penetration of EV (electric vehicle) technology in Lao road transportation, in this study, was analyzed by using the AIM/CGE [Laos] model. In line with the increase of number of road vehicles, the energy demand in transport sector has gradually increased, which resulted in a large amount of budget spent for fossil fuels import in last decade and high emission from transport sector. Lao government, in order to mitigate these issues, is promoting EV technology. The aim of this research is to analyze the impact of EVs' penetration on economy and CO<sub>2</sub> emission in short-term, middle-term, and long-term. The cumulative CO<sub>2</sub> emission from transport sector during 2020 to 2050 in BAU case will be 12,000 GgCO<sub>2</sub> and those in the EV mitigation case will be 9,300 GgCO<sub>2</sub> which likely accounts for 77% of cumulative CO<sub>2</sub> emission reduction in road transport sector by introducing the EV technology. On the other hand, the GDP value will be gradually lost by up to one percent in 2050 due to the increase of cost of introducing the EV technology in Laos.

**S. G.4 Student Award Entry (AITCC)**      **Driving Factors of Smart City Development in Thailand**  
*Jirawan Klaylee, Phethai Kesorn, and Pawinee lamtrakul*  
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Smart City is an emerging concept that meets the needs of today's urban development. However, when implementing the above concepts, it is necessary to determine the factors that contribute to the success of urban development goal. This study conducted a policy formulation in term of strategy and development mechanism for Pathum Thani to exploring driving factors of smart city development. By gathering data of 1,000 sets from questionnaire survey from the residents in the study area which was input into the statistical analysis process to identify the factors that have an impact on driving Pathum

Thani smart city development. Including the consideration of an understanding about pattern of urban development, it is the signification finding ways to drive smart city development by integrating knowledge based to create a realsmart city.

S. G.5  
(Virtual) **Potential for Integrating Solar Rooftop Photovoltaic System with Rain Water Harvesting Facility and Electric Vehicle Charging Facility: Designing a Multicriteria Framework**

*Debalina Saha<sup>1</sup> and Rabindra N. Bhattacharya<sup>2</sup>*

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In this paper we attempt to capture technical, socio-economic and environmental effects with a conceptual model that combines three environmental interventions, rooftop solar photovoltaic system (RTPV), rain-water harvesting system (RWH) and solar powered electric vehicles (EV). We develop a framework for multicriteria analysis considering technical, socio-economic and environmental criteria. This framework can be applied to case studies to obtain the numerical values of the scores using data specific to a particular region. We conceive four scenarios based on how the three systems, RTPV, RWH and EV are combined. For each scenario we consider a multicriteria score as well as the scores for each criterion to analyze the performance of each scenario in terms of the three criteria in consideration. The multicriteria score gives us the overall score of each scenario taking all three criteria into consideration. Comparing the multicriteria score we can determine which scenario performs better in terms of the three criteria providing a direction for framing policy models. We can also compare the four scenarios in terms of each criterion separately and take policy decisions accordingly.

S. G.6  
(AITCC) **Measuring Elevated Indoor Carbon Dioxide Concentration from Unsuitable Condition of Indoor Plant**

*Kanittha Pamonpol<sup>1</sup>, Natsima Tokhun<sup>1</sup>, and Atcharaporn Somparn<sup>2</sup>*

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People spend most of their life indoor so indoor air quality is very important. They try to improve air quality by plants to reduce CO<sub>2</sub> that is varied based on human activities. *Sansevieria trifasciata* is a suggested plant to grow in the bedroom. This study aims at investigating CO<sub>2</sub> concentration from planting *Sansevieria trifasciata* in indoor environment. The experiment was carried out by varying number of plants (1-10pots) in a 0.5 m<sup>3</sup> enclosed transparent acrylic chamber. The chamber was placed on the floor in an air conditioned office. The CO<sub>2</sub> concentration measuring device was placed in the chamber to measure CO<sub>2</sub> once in every minute for 24 hours. Two cases of the experiment

were conducted: clean and polluted by CO<sub>2</sub> to investigate CO<sub>2</sub> concentration. The results presented that the CO<sub>2</sub> concentration continued increasing because of unsuitable condition at low intensity of light in the room.

S. G.7      **The Study on Association between Urban Green Space  
Student      and Temperature Changes in Mega City**  
**Award      *Apinya Padon, Pawinee lamtrakul, Benjamin Punson, and Jirawan***  
**Entry      *Klaylee***  
(Virtual)      Thammasat University, Pathum Thani, Thailand  
   [Apinya.padon@gmail.com](mailto:Apinya.padon@gmail.com)

This research is aimed to study the factors affecting the changing of green space in Bangkok, consisting of surface temperature, air temperature, and carbon monoxide (CO) in 2007, 2012, and 2019. By applying the satellite's images and Geographic Information System (GIS), the analysis of the association between urban green area and temperature changes can be evaluated from statistical data. The analysis results showed that surface temperature, air temperature, carbon monoxide (CO) have been increased for 10 years, especially central business district of Bangkok. This problem would be affected by an increasing in the number and density of buildings, in contrary with nowadays, the green area has been limited. Therefore, this research realizes the green area that affects the green spaces crisis by proposing a suitable measurement to mitigate temperature changes in the mega city.

S. G.8      **Energy Management in Data Centers from Design to  
(AITCC)      Operations and Maintenance**  
   *Montri Wiboonrat*  
   King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand  
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Data centers are the information factories of the digital evolution. Creating, storing, processing, distributing, and analyzing data all need energy. Therefore, data center industry consumes energy more than 2 percent of the global electricity consumption. Energy efficiency need to discuss at the outset of data center design. The root cause of oversizing data center design is the research question because this will affect investment or CAPEX and long-term operating costs or OPEX of data center as long as data center life cycle (DCLC). Data center measurement in power usage effectiveness (PUE) unit helps data center owners and consultants realized on relationship between oversizing data center design and total cost of ownership (TCO). The research results propose modular data center as a solution to handle uncertainty demand of IT equipment, scalability for growth as your need, flexibility in any size of infrastructure, fast deployment because of prefabricated design, and more efficiency by applying energy management platform called data center infrastructure management (DCIM).

## Session H: Climate Change II (Emissions)

Time: 13:00 – 15:00 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

S. H.1  
**Student Award Entry**      **Reducing Carbon Dioxide Emission Generated by Thermal Power Plants with Solar Power on the Uganda's Electricity Grid** *Chrish Kavuma<sup>1</sup>, Diego Sandoval, and Hakizimana Khan Jean de Dieu<sup>1</sup>*

(Virtual)      <sup>1</sup>African Centre of Excellence in Energy for Sustainable Development (ACEESD), University of Rwanda  
[kavumachris@gmail.com](mailto:kavumachris@gmail.com)

Electricity generation emits half of carbon dioxide emissions globally. This has contributed to increasing global warming. The aim of this paper is to determine the quantity of carbon dioxide generated by grid connected thermal power plants in Uganda and estimate the solar power required to lower the emission to recommended levels. The installed and effective generation capacities of the thermal and solar power plants were obtained from Uganda electricity regulatory authority. The Carbon dioxide emission from electricity generation was estimated using emission factor. The net present worth method was used to evaluate economics of replacing thermal power with solar. Thermal power plants emitted an average of 60021 tonnes of Carbon dioxide per year. Replacing the 100 MW produced from thermal power plants will require investing in solar to achieve the same capacity while reducing carbon dioxide. The economic analysis indicated a positive net present worth USD24.7 million after 25 years and a breakeven point of 8 years.

S. H.2  
**Student Award Entry**      **A Study on Green House Gas Mitigation from Solar Parks in India** *Hirwe Rahul Rajaram<sup>1</sup> and Guru Balamurugan<sup>2</sup>*

(Virtual)      <sup>1</sup>Tata Institute of Social Sciences, Mumbai, India  
<sup>2</sup>Central University of Tamil Nadu Thiruvavur, India  
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Renewables are playing pivotal role in promoting sustainable development. India through its Intended Nationally Determined Contributions to United Nations Framework Convention on Climate Change has shown its commitment on mitigating Green House Gases. In February 2015, India stated its federal mission is to achieve 175 GW of Renewable Energy based capacity by the year 2022. This paper analyses the solar capacity installed through solar parks in India, corresponding power produced with prevailing solar insulations and potential Greenhouse gas abated. The current identified 20 GW solar park project with varying solar insolation of 4 - 5 kWh/m<sup>2</sup>/day has potential to produce 37155982 MWh of solar power and mitigate 34672792

tonnes of CO<sub>2</sub>/annually. Similarly, additional 40 GW Solar park capacity being considered would generate 74311963 MWh mitigating 69345584 tonnes of CO<sub>2</sub> annually. Better solar suitability areas would help in enhanced solar generation by 15% more as compared to moderate and low solar areas. Capacity planned through Solar Parks would help in mitigating 1.40% and 2.81% of Greenhouse gases of the total India's emissions respectively.

S. H.3  
**Student Award Entry**  
**Sustainable Utilization of Paddy Straw in Punjab for Biochar Production: Estimating the Energy and Emission Potential**

*Imlisongla Aier, Anil Kumar Sakhiya, Abhijeet Anand, Shivangi, Priyanka Kaushal, and Virendra Kumar Vijay*  
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Indian Institute of Technology Delhi, New Delhi, India  
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The burning of tonnes of paddy straw in the open field by the farmers in Punjab has resulted in air pollutant emissions causing serious environmental and health consequences. The paper presents a study on the utilization of the surplus paddy straw in Punjab for biochar production by pyrolysis. From the study, 7.60 MT of paddy straw are available in Punjab as surplus. The pyrolysis study was set at four different operating temperature conditions 300, 400, 500 and 600°C with biochar conversion efficiency of 57.87, 42.90, 37.19 and 35.63 % respectively. The corresponding energy yield potential obtained from converted biochar were 77.51, 60.46, 56.25 and 55.59 PJ respectively. The analysis of air pollutant emission from burning of paddy straw was further quantified in terms of CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, TPM, NMHC CO, NO<sub>x</sub>, SO<sub>2</sub> and PM 2.5 emissions and the net GHG CO<sub>2</sub> emission was recorded as 8264.64 Gg/year.

S. H.4  
**(AITCC)**  
**The Assessment of Energy Consumption and Carbon Emission from Maize Production Process in Northern Thailand**

*Tanate Chaichana<sup>1</sup>, Natthawud Dussadee<sup>1</sup>, Nigran Homdoun<sup>1</sup>, Yinnittra Khamnuengphon<sup>1</sup>, Kunyaporn Chaiwoung<sup>2</sup>, Salidpron Withayaphadoung<sup>3</sup>, and Ukrit Samaksaman<sup>4</sup>*

<sup>1</sup>Maejo University, Chiang Mai, Thailand

<sup>2</sup>Rajamangala University of Technology Lanna Nan, Nan, Thailand

<sup>3</sup>Chiang Rai Rajabhat University, Chiang Rai, Thailand

<sup>4</sup>Naresuan University, Phitsanulok, Thailand

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The objective of this research is to evaluate the factors of production. Energy consumption greenhouse gas emission from maize production process in the area of 12 provinces, northern part of northern Thailand. Moreover, the studies

of guideline for reduction factor data were directly collected from farm owners with the total number of 1,205 fields or in the area of 13,884.7 Rai (1Rai = 1,600m<sup>2</sup>). The maize production of northern Thai's farmer was related with traditional way by following the preparation of planting area, cultivation, fertilizer and chemical used, harvesting and transportation of product to the maize mill plant. EC and GHGs were evaluated in terms of carbon footprints (CF). Energy potential (EP) from biomass and energy intensity (EI) were also analyzed based on the collected data. Moreover, the assess guidelines for reducing energy used in the maize farms and reducing energy used in the maize farms and reducing greenhouse gases emission were recommended. The survey result showed that production factors and EC reported in the average working time of 4.45 hours/person/Rai. The using od diesel and gasoline oil were 6.96 and 1.50 litter/Rai, respectively. The average weight of seed per Rai was equal to 3.98 kg. The using of fertilizer and chemical (herbicides and pesticides) per Rai were equal to 3.98 kg and 1.74 kg, respectively. Furthermore, the yield of corn product has resulted in an average of 924.07 kg/Rai. The conversion of production factor to value of EC was in the range of 1,917.97 to 2,705.62 MJ/Rai that represented in and average of 2,305.77 MJ/Rai. For EC of corn yield was equal to 2.50 MJ/Rai. The highest value of EC was significant in process of fertilizer and chemical used. The result of CF occurrence from the overall maize production was 134.83 kgCO<sub>2</sub>eq/Rai or 0.1459 kgCO<sub>2</sub>eq/kg. Total biomass was 974.24 kg/Rai that can be converted to the values of EP and EI equal to 16,703.73 MJ/Rai and 7.80, respectively. From this study can be guiled farmers for reducing EC and GHGs in several techniques such as the using of fit agricultural machinery, replacement of fertilizer by using organic substances fertilizer, is suggested to produce a fermented organic substances fertilizer by using maize biomass as a raw material and use for cultivation. These can reduce fertilizer by 45.54 kg/Rai, EC by 1,377.13 MJ/Rai and GHGs by 57.70 kgCO<sub>2</sub>eq/Rai, respectively.

S. H.5  
(AITCC)

### **Performance of the Outdoor Evaporative Cooling: A Case Study of Thammasat University Rangsit Campus**

*Moaz Altaf, Wisuwat Klabwisas, Kaung Si Thu, and Weerakorn Ongsakul*

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It is very important to maintain the thermal comfort for the residents at outdoor arena, to develop sustainable cities and promote outdoor activities for the residents. Although, there are many passive ways to maintain that thermal comfort at outdoor spaces without using much energy like the design and



orientation of the building envelope. Also, adopting passive measures like using shades, and shading of trees, reflectors, shutters, louvers and so forth, help in mitigating the heat in a building. Similarly, humans can adapt to the environment by making changes in their physiological behavior to help combat extreme weathers too, like maintaining healthy habits, diet, posture, use of light clothing and so on, and adapting to the environment. However, in humid and hot areas like Thailand where the weather challenges the residents to extreme, there are ways to maintain the thermal comfort using little energy for the outdoor spaces. Evaporative cooling is one of these options. This study was conducted to analyse the effectiveness of direct evaporative in an open area at Thammasat university, Rangsit campus. We collected the data by installing sensors at the evaporative coolers to analyse how much energy it requires to operate, and its performance and effectiveness by measuring the outdoor temperature and humidity with and without the use of evaporative coolers. The data was recorded from October 31 to November 1, 2019 on hourly basis. This data was tallied with the environmental meteorological data which was measured at Don Mueang international airport station. The type of the evaporative cooling systems installed at the Thammasat university is the jet fan type direct evaporative cooling system (DES) system. It is important to check the effectiveness of evaporative coolers by calculating air enthalpy at different times of the day. This way, we tried to see at what time of the day, at what temperature and at what enthalpy the evaporative coolers are most effective. Moreover, we found out what should be the effective daily duration of evaporative coolers operation. We also calculated the energy offset, that is, the total energy saved using evaporative coolers which could not have been saved, if air conditioners had been used instead.

S. H.6  
(AITCC)

### **Design and Simulation of an Islanded Hybrid Microgrid for Remote Off-Grid Communities**

*Shubham Tiwari, Weerakorn Ongsakul, and Jai Govind Sing*

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To fulfill the Sustainable Development Goal of energy access (SDG 7), renewable energy sources are the main contributing force. This paper focuses on the electrification of remote islanded community with renewable energy sources. This paper proposes two electrification schemes. In first scheme, the whole village is centrally electrified with the use of biodiesel generator, solar PV and with battery banks as storage. With the addition of renewable energy resources in the grid due to its intermittent nature causes fluctuations in frequency. The paper shows the design of frequency controller incorporated with battery to reduce frequency fluctuations. To investigate, a microgrid comprises of diesel generator, solar P.V as generating units with an external battery energy storage system as an ancillary service source to provide primary frequency response is modeled in MATLAB Simulink. In second scheme, a single phase

decentralized design is proposed to electrify individual houses with solar and battery arrangement. To assess the effectiveness of the intended system, actual solar irradiance data and load profile of Pahadi village, Morena in Madhya Pradesh, India is taken into consideration.

S. H.7  
(AITCC) **Very Short Term Wind Speed Forecasting Using  
Convolutional Long Short Term Memory Recurrent Neural  
Network**

*Firuz Ahamed Nahid, Weerakorn Ongsakul, Nimal Madhu  
Manjiparambil*

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To control, manage and optimize the generation of electricity form wind resource, an accurate forecasting of wind speed is imperative. This paper illustrates the implementation of a Convolutional Long Short Term Memory (CLSTM) neural network to forecast the wind speed on a half hourly basis for up to six steps ahead. To harvest maximum privilege form the uncertain wind energy, both point wise and probabilistic forecasting approach are combined together in this research. Two and a half years of historic dataset of wind speed and related variables (temperature and relative humidity) are used to train the model by dividing them into three cases. The performance of the proposed model is evaluated in terms of Root Mean Squared Error (RMSE), Mean Absolute Percentage Error (MAPE), Mean Absolute Error (MAE) and Correlation between actual and predicted values. Besides, the performances of the proposed model is also compared with deep learning based Convolutional Neural Network (CNN) and Long Short Term Memory (LSTM) Neural Network models. Results from the experiments shows that the proposed model has forecasted the wind speed with a better accuracy.

S. H.8  
(AITCC) **Barriers to Renewable Energy Penetration in Bangladesh:  
An Analysis Based on Interpretive Structural Modeling  
Methodology**

*Hasan Mahmud*

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Accelerated penetration of renewable energy is assuming increased relevance for fast growing economies like Bangladesh. Country specific literature show a number of individual barriers hindering the penetration of renewable energy in Bangladesh. This study considers all these barriers comprehensively and categorized them in seven dimensions of human capacity, institutional,

technical, resource & environment, economic & financial, policy & governance and informational. Interpretive Structural Modeling (ISM) have been then applied to identify strength and interactions of the barriers. For validation, Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) analysis has been carried out. The findings identify prevailing non-inclusive governance and policy formulation as the most influential barrier. In a chain reaction this is inhibiting - business model development, proper subsidy allocation and tariff structure, technical infrastructure development and local innovation, exploitation of resources, availability of information, human capacity development, proper institutional function and in arising public consciousness for renewable energy penetration in Bangladesh.

### Session I: Energy

Time: 15:15 – 16:30 PM

Room Assignment: Robert B. Banks Auditorium, AIT Conference Center (AITCC)

#### S. I.1 **Comprehensive Analysis of Convolutional Neural Network Models for Non-Instructive Load Monitoring**

**Student Award Entry**

(Virtual)

*G.M. Herath<sup>1</sup>, T.D. Thilakanayake<sup>1</sup>, M.H. Liyanage<sup>1</sup>, and C.J. Angamma<sup>2</sup>*

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Non-Instructive Load Monitoring (NILM) schemes have become more popular in recent years with the availability of smart meters. It provides energy use data to utilities and per-appliance energy consumption details to end users. This study carries out a comprehensive analysis of existing Convolutional Neural Network (CNN) architectures that have been used for NILM. Nevertheless, it provides an unbiased comparison of the existing architectures thereby helping to select the best performing model for NILM applications. The commonly used CNN disaggregation models were categorized into distinctive groups based on their architectures which considered structure of the Neural Network (NN) and outputs. It considers regression-based sequence to sequence and sequence to point mapping, classification-based sequence to point hard association and soft association-based mapping. The CNN models are improved and modified to bring them onto a common platform for comparison. Thereafter, a rigorous comparison was performed using indices which included accuracy, precision, F-measure and recall. The results reveal interesting relationships between architectures, appliances and measures.

S. I.2 **Exploring the Dependency between Energy Access and other Sustainable Development Goals: Global Evidence**  
(Virtual)

*Anver C. Sadath<sup>1</sup> and Rajesh H. Acharya<sup>2</sup>*

<sup>1</sup>Central University of Kerala, Kasaragod, India

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This paper examines the interlinkage between energy access and other Sustainable Development Goals (SDGs) in the global context. For this purpose, we have calculated the indices for all 17 SDGs and use correlation and path analysis under structural equation modelling framework. Empirical results confirm that SDG 7 has positive and significant correlation with goal 4 and goal 12 indicating that ensuring access to modern energy resources enables women and girls to spend more time on education and gainful employment than gathering fuel. Further, energy access fosters sustainable production and consumption pattern and also promotes food security and promoting sustainable agriculture.

S. I.3 **Economic Viability of Solar PV for Domestic Applications in a Middle-Income Country: A Case Study of Sri Lanka**  
(Virtual)

*Janith K. Wijesinghe, Mohamed Y. M. Najim, Gayashika L.*

*Fernando, and Migara H. Liyanage*

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Department of [janith.w@slit.lk](mailto:janith.w@slit.lk)

This study focuses on the economics of using solar PV for residential in a middle-income country like Sri Lanka. It considers solar irradiance in the Colombo district to estimate the power generation potential by a solar PV system throughout the year. It used solar irradiance data by NASA Surface Meteorology and Solar Energy (SSE), satellite solar insolation values for Sri Lanka and used the Liu and Jordan (LJ) method. Furthermore, it considered economics of four different scenarios depending on appliance usage with and without Net Accounting. Moreover, the annualized cost of a unit LCOE in Colombo was US\$ 0.12 /kWh and US \$0.13/kWh respectively. The payback period was estimated to be 6 Years and 4 Months with owner's full contribution. LCOE reduces to US \$ 0.11 /kWh with the effect of a bank loan at 6% interest rate and increases to US \$ 0.12 /kWh at a 12% interest rate.

S. I.4  
(Virtual)

### **Low Electricity Access Rate as a Barrier to Achieving the Global Goal of Providing Affordable and Cleaner Energy for All in Burundi**

*Gatoto Placide<sup>1</sup>, Michel Roddy Lollchund<sup>2</sup>, and Gace Athanase Dalson<sup>3</sup>*

<sup>1</sup>African Center of Excellence in Energy for Sustainable Development, University of Rwanda, Kigali, Rwanda

<sup>2</sup>Department of Physics, University of Mauritius, Réduit, Mauritius

<sup>3</sup>Department of Physics, University of Rwanda, Kigali, Rwanda  
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This paper analyses the current energy access rate situation in Burundi, which is relatively low compared to other countries. The paper aims to identify the key gaps in improving the electrical energy access in Burundi and proposes a solution to overcome these gaps. It is shown that the electrical power grid is old and concentrated in the north-western Burundi and in Bujumbura while other regions lack access to national grids. Next to that, the link between electricity access and sustainable development in Burundi is clarified. Further, some solutions are suggested to solve energy access problems such as the electricity transmission lines extension and renovation, diversification of energy sources.

S. I.5  
(Virtual)

### **Dielectric Strength of Kenaf/Glass Fiber Reinforced Unsaturated Polyester Hybrid Composites Used as**

**Insulator** *Alaseel Bassam, M.N.M. Ansari, Fairuz Abdullah, A.R.M. Nazim, K.S. Vinoth, Noor Afeefah Nordin, and S. Thilageshwaran*

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Ceramic insulators are usually consisting of polymeric housing material, metal end fittings, and core. The core part, commonly made from glass fiber reinforced polymer is intended to withstand the mechanical strength and to function as an insulator. Given the daily rising concern about changing climate, researchers and manufacturers pay attention to degradable natural fiber to replace the non-degradable synthetic fiber. Kenaf fiber has shown some considerable improvements when it is used as a replacement for glass fiber due to its excellent toughness and high aspect ratio for a wide range of applications. The hybridization of natural fiber with synthetic fiber has become a significant research topic over the recent decade. However, the dielectric strength of the bio-composite was affected by hybridization. This paper discusses the dielectric strength of kenaf/glass fibers hybrid composite reinforced unsaturated polyester UPE used as an insulator in high voltage transmission lines. The composite rods were fabricated by using three volume fractions of kenaf fiber (20%, 30% and 40%) to replace glass fiber as reinforcement. Three arrangement profiles of kenaf/glass fibers hybrid composite reinforced UPE were fabricated with a 24.7 mm circular cross-

section. The results showed that the hybridization decreased the dielectric strength of the composites. The dielectric strength of the hybrid composite was influenced by the volume fraction of fibers and the arrangement profile. The 30KGPE hybrid composite material showed the highest dielectric strength (2.73 kV/mm) while the GUPE (control) composite materials had the lowest value with (1.30kV/mm).

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## PLATINUM SPONSOR



### **Electricity Generating Public Company Limited (EGCO)**

EGCO Group, the first Independent Power Producer in Thailand, is a holding company which has focused on power business investment both in Thailand and overseas and seen investment opportunities in other related power business. The Company's power plants presently generate electricity using several fuel sources such as natural gas, coal, biomass, hydro, solar, wind, and geothermal which partly enhance power security.

EGCO Group aims to achieve its continuous sustainable growth by deploying three key strategies which have been continuously and earnestly implemented including ensuring maximum efficiency of existing power plants, managing projects under construction to be completed as plan and budget, and seeking continuous investment opportunities. Project selection criteria have been set to ensure quality investment and EGCO Group places high priority in its overseas asset management to suit the business environment of the target countries including political and socio-economic policies and directions.

## GOLD SPONSOR



### **Electricity Generating Authority of Thailand (EGAT)**

EGAT is Thailand's leading state-owned power utility under the Ministry of Energy, responsible for electric power generation and transmission for the whole country as well as bulk electric energy sales. We are the largest power producer in Thailand, owning and operating power plants of different types and sizes which are located

in 45 sites across the country with a total installed capacity of 15,757.13 MW (as of March 2018). Our power generation facilities consists of 3 thermal power plants, 6 combined cycle power plants, 24 hydropower plants, 9 renewable energy plants, 4 diesel power plants, and Lamtakong Jolabha Vadhana Power Plant. We also own and operate a high voltage transmission network which covers all parts of the country. Under Thailand's electricity supply industry, EGAT purchases bulk electricity from private power producers and neighboring countries and sells wholesale electric energy to two distributing authorities and a small number of direct industrial customers as well as neighboring utilities.

EGAT also engages in energy-related services businesses and expands, through the EGAT Group, our business and investment in electricity and other energy-related businesses at home and abroad.

## TECHNICAL COLLABORATOR



### Provincial Electricity Authority (PEA)

Provincial Electricity Authority (PEA) is a government enterprise under the Ministry of Interior. PEA was established by a Royal Decree executed on March 6, 1954 and then published in the Government Gazette on March 16, 1954. The appointment of the board of directors as the control of the management is under the control of the Department of Public Works, Municipal of the Ministry of Interior and the Government by the Minister of Interior has the power to general supervision. The Provincial Electricity Organization was the initial capital in accordance with the laws of 5 Million Baht with the power in the number of 117 areas, consequently, PEA was established in accordance with the law of PEA BE. 1960, as at September 28, 1960, by taking over the mission from the Provincial Electricity Organization action continues.

Provincial Electricity Authority (PEA) is a leading organization in the region, which is focused on providing efficient, reliable electricity services, related business for developing quality of life, sustainability of economics and society. PEA is responsible for the provision of standardized electricity



services and related business to attain the customer's satisfaction on products and services through PEA's continual corporate development plan with the recognition of social and environmental responsibility.

## ACADEMIC COLLABORATORS



### **College of Water Sciences, Beijing Normal University (BNU)**

The College of Water Sciences (CWS), Beijing Normal University was formally founded in January 2005, on the initiative of two academicians of Chinese Academy of Sciences, i.e., hydrologist Changming Liu and hydrogeologist Xueyu Lin. Since then, the CWS has always been academics-oriented and actively adapted to the need of social development, with a focus on fostering the students' research ability, practice ability, and team spirit. Our graduates can be found all over China and have been approved by many employers.

In the past few years, more than a hundred of research projects were successively completed, including those funded by the 973 Program, the 863 Program, the National Natural Science Foundation, the Major Project of the National Social Science Foundation, the National Science and Technology Support Program, the National Major Science and Technology Project of Water Pollution Control and Treatment, the Major Project of Beijing Municipal Science and Technology Commission, and the Beijing Municipal Natural Science Foundation. In addition, close cooperation and exchange relationships were established with many universities in the United States, Canada, the United Kingdom, Japan, and Australia.

Today, while Beijing Normal University is developed as a "Double First-Class" university in China, the CWS is also having great opportunities for development. Based on the joint efforts of all staff and students as well as the substantial support of all sectors of the society, the CWS will adhere to the spirit of the college motto "as good as water and be realistic and innovative", firmly conduct the

work of teaching, research, social services, and determine to make positive contributions to the blue water and sky and the ecological civilization of China!



## **Mastering Energy Supply for Isolated Areas (MESfIA)**

Mastering Energy Supply for Isolated Areas (**MESfIA**) aims to provide high quality postgraduate education on energy supply systems for engineers and graduates from science departments, aiming to have activity or to be employed in projects in countries with many isolated areas and insular systems. It is a co-operation activity between EU and S.E. Asian Countries (namely Thailand, Vietnam and Indonesia) to improve capacity of Postgraduate Students in S.E. Asian Universities.

## **NOTES**

## **NOTES**

## **NOTES**

**ICUE  
2020**



ICUE 2020 aims to contribute to the global balancing action by offering a platform to academic research and initiatives, not only in Asia but also from other parts of the world. ICUE 2020 will be a good venue to share and exchange research ideas, experiences and insights especially in these times when there is a need to look at innovative ways to address issues of energy, environment and climate change through technology, policies and outreach, using new and emerging tools of digitalization, big data, data analytics and artificial intelligence.

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Sustainable Energy Transition Program  
Department of Energy, Environment, and Climate Change  
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