A NEW COLLABORATION INITIATIVE FOR SUSTAINABLE DEVELOPMENT RESEARCH

JAPAN-ASEAN SCIENCE, TECHNOLOGY AND INNOVATION PLATFORM

Akira Takagi[a], Hideaki Ohgaki[b], Yoshimi Osawa[c] and Yasuyuki Kono[d]

[a](Corresponding author)
Japan-ASEAN Science, Technology and Innovation Platform (JASTIP)
Room 208 Innovation Cluster1 Building, National Science and Technology Development Agency (NSTDA). 111 Thailand Science Park, Phahonyothin Road, Khlong Nueng, Khlong Luang Pathum Thani 12120, Thailand
Tel: +66-(0)-64-153-7969
E-mail: takagi@cseas.kyoto-u.ac.jp, jastip-contact@kura.kyoto-u.ac.jp
Web: http://jastip.org
https://www.facebook.com/jastip/
[b]Institute of Advanced Energy, Kyoto University.
[c]Research Administration Office, Kyoto University.
[d]Center for Southeast Asian Studies Kyoto University.

Abstract

Started in 2015, the Japan-ASEAN Science, Technology and Innovation Platform: Promotion of Sustainable Development Research (JASTIP) started aims to promote Japan-ASEAN collaboration on science and technology research and accelerate the application of its outcomes for social innovation to achieve Sustainable Development Goals (SDGs). JASTIP is the first STI platform mainly led by scientists from ASEAN countries and Japan. The Platform has established joint laboratories focusing on three fields: energy and environment, bio-resources and biodiversity, and disaster prevention.

This article introduces about the current research activities on energy and environment under the JASTIP project. It is an important responsibility for researchers to convey their research activities accurately and understandable to all stakeholders to promote implementation of scientific result to society. Natural scientists and scientists from other fields including social science and humanities are an essential foundation for accelerating STI.

Introduction

Establishing mechanisms for international cooperation in STI (Science, Technology and Innovation) is essential to achieve the United Nation's Sustainable Development Goals: SDGs (United Nation Website). The Japan-ASEAN Science, Technology and Innovation Platform (JASTIP) has established joint laboratories focusing on the three fields; energy and environment, bioresources and biodiversity, and disaster prevention in order to strengthen the cooperative research network between ASEAN and Japan. JASTIP is carrying on within the framework of the collaboration Hubs for international research program 2015 initiative, which is funded by the strategic international collaborative research program of the Japan Science and Technology agency (JST) (JST Website). JST is one of the biggest Japanese funding agency for STI and support many researchers through the several funding programs (Aizawa, 2016).

A Memorandum of Cooperation (MOC) was signed by four parties; Kyoto University, Japan; National Science and Technology Development Agency (NSTDA), Thailand Ministry of Science and Technology, Indonesian Institute of Sciences (LIPI); and Malaysia-Japan International Institute of Technology (MJIIT). JASTIP's objective is to conduct and produce innovative research and promote research cooperation between Japan and ASEAN countries lead by researchers. JASTIP will be more than mere networking for the research community, and will serve as a platform to connect research results and feed them back into society.

JASTIP will accelerate the promotion of research based on Japanese-ASEAN cooperation, and encourage discussions toward building a collaborative system with ASEAN in the areas of science, technology, and research education that moves beyond the walls of institutions or the confines of a particular project. It also aims to contribute to the efficient operation of individual projects, and to the utilization of effective results.

In December 2015, the ASEAN Economic Community came into formation, comprising a population of over 600 million people. The international position of Japan within ASEAN is being further cemented, and the fact that ASEAN growth will be a driving force in sustainable development. In particular, for science and technology, as well as research, to assume an important role, the results need to be linked to societal innovation, and their positive effects on society more clearly demonstrated.

The purpose of this paper is to clarify the situation of the current research activities of energy and environment research under the JASTIP and to demonstrate how these researches relate each other. To promote collaborative research that can be used to resolve social issues to ultimately build a sustainable society in ASEAN countries and Japan.

Energy and environment research

The JASTIP project is conducting collaboration research between Japan and ASEAN on the energy and environment field. The biomass energy is one of the important research topics especially among ASEAN which has

abundant number of residuals from agricultural sector. These abandoned residuals have been simply burnt in the field and this causes serious environmental issues. Therefore, we are working on the effective utilization of such biomass resource as fuels and value-added chemicals as presented below.

Photocatalytic conversion of biomass to value-added fuels and chemicals

Professor Takeshi Sagawa (Kyoto University)

Assistant Professor Surawut Chuangchote (JGSEE, King Mongkut's University of Technology Thonburi), Dr. Verawat Champreda (BIOTEC, NSTDA), Professor Navadol Laosiripojana (JGSEE, King Mongkut's University of Technology Thonburi)

Biomass conversion to useful materials and development of bio energy devices in combination with efficient utilization of solar energy are conducted. In particular, "Evaluations of photocatalytic conversion of biomass to value-added fuels and chemicals" has been addressed in Thai side while, "Fabrication of high-selectivity photocatalysts and development of photo-bio flow reactor for conversion of lignocellulose-derive components to chemicals" has been performed in Japan side. After the bilateral research groups obtain the results based on their expertise, those results will be integrated to construct bio energy devices in combination with efficient utilization of solar energy. Particularly, high-value products from sugars and lignocellulose-derived components with photocatalysts have been focused and the materials design and improvement of metal oxides as the photocatalysts have been investigated.

So far, materials design of hollowed TiO_2 nanofibers and their application for glucose conversion as the photocatalysts have been performed. Formic acid, gluconic acid, arabinose and xylitol are detected as the products by HPLC analyses. Ag-loading onto the surface of the electrospun TiO_2 nanofibers has also been examined in order to improve the photocatalytic activities.

Photo-induced lignin degradation to convert some useful compounds by using TiO_2 nanoparticles has also been examined. In this FY2016, Ag-loaded onto P25 TiO_2 nanoparticles were prepared and characterized in terms of their morphology, porosity, crystallinity, absorption, photoluminescence and photoelectron properties in addition to their band-gap energy diagrams.

On the other hand, for further extensions of light-driven electrochemical conversion of glucose and lignin, nanostructured ZnO-based hybrid photovoltaic cells have been developed and evaluated. Although they have not yet attained the potential of generating a high current density at the required electrochemical potential such as NHE 1.23 V for H_2 and O_2 evolution, fine tuning of the length (viz. thickness) and the density of ZnO nanorods, surface modification of ZnO nanoparticles with dispersing reagents are found to be effective to improve the interface between the electron transporting layer and the conducting polymer in terms of generating a high current density for highly efficient photovoltaic performance. Ag-In-Zn-S quantum dots-based hybrid photovoltaic cells have also been prepared and revealed that the band gaps of the metal sulfides are adjustable in some extent by changing both of the ratios of Ag-In and Zn elements, and the capping reagents such as oleylamine, pyridine, and so on.

Development of carbon materials from biomass for energy storage applications

Associate Professor Tomokazu Fukutsuka (Kyoto University), Assistant Professor Kohei Miyazaki (Kyoto University), Mr. Yuto Miyahara (Kyoto University), Dr. Sumittra Charojrochkul (MTEC, NSTDA), Dr. Yatika Somrang (MTEC, NSTDA), Mr. Thanathon Sesuk (MTEC, NSTDA), Dr. Worapon Kiatkittipong (Silpakorn University), Ms. Chulita Pornpitakdamrong (Silpakorn University)

Plantation of palm trees has been a big industry in ASEAN countries. While palm fruit is widely used for production of palm oil, other residues such as palm empty fruit bunches (PEFBs) and kernel shell have much lower value as biomass. Therefore, a lot of studies on functionalization of these residues have been extensively conducted. Among various kinds of functionalized materials, activated carbon from PEFB can be an attractive material for energy storage applications such as electric double-layer capacitors (EDLCs) and metal air rechargeable batteries (MARBs). Activated carbons are used as positive and negative electrodes, on which ions adsorb/desorb during charge–discharge process in EDLCs. The performance of activated carbon is one of the most influential factors to decide EDLCs performance. In MARBs, positive electrode reactions are oxygen reduction reaction (ORR) and oxygen evolution reaction (OER). While carbon in the positive electrode catalysts had been considered to work only as an electronic conductive material, our group directly observed that carbon in composite electrodes functioned not only as the electronic conductive material but also as the ORR electrocatalyst. This observation motivated us to use another kind of carbons for the oxygen electrode catalyst. Therefore, electrochemical performance of biomass carbon obtained from PEFB as EDLCs and MARBs electrodes was investigated. In this report, we evaluated the electrochemical performance of the PEFB-derived biomass carbon as the electrodes for EDLCs and MARBs.

So far, electrochemical performance of CO_2-activated carbon from oil PEFB was investigated. While the particle sizes of the resultant powders after the activation were similar to those without activation, the surface area of the powders after activation was much larger than that without activation, indicating that pore development was achieved through successful activation by CO_2.

EDLC performance of the CO_2-activated carbon was much higher than that without activation, indicating that CO_2-activation process should play an important role to enhance the capacitance. On the other hand, the performance of the CO_2-activated carbon as the MARB electrocatalyst was low possibly because of large particle size and low dispersibility.

Innovations in biomass application for catalytic material synthesis and energy devices

Assoc. Prof. Noriaki Sano (Kyoto University), Dr. Kajornsak Faungnawakij, (NANOTEC, NSTDA), Dr. Vorranutch Itthibenchapong (NANOTEC, NSTDA), Dr. Pongtanawat Khemthong (NANOTEC, NSTDA),

Dr. Sanchai Kuboon (NANOTEC, NSTDA), Dr. Supawadee Namuangruk (NANOTEC, NSTDA), Dr. Chompoonut Rungnim (NANOTEC, NSTDA), Dr. Pussana Hirunsit (NANOTEC, NSTDA), Dr. Chalida Klaysom (Chulalongkorm University), Assoc. Prof. Tawatchai Charinpanitkul, (Chulalongkorm University), Dr. Sareeya Bureekaew (VISTEC), Miss. Chuleeporn Luadthong (NANOTEC, NSTDA), Miss. Rungnapa Kaewmeesri (NANOTEC, NSTDA).

The catalytic production of carbon-based materials, biofuels and biochemicals is a key activity in biorefinery industry. Also, developments in catalytic energy conversion and energy storage using bioactivities are important for sustainable societies. Consequently, searching for renewable resources that are reliable, sustainable and environmentally friendly is the big challenge, and these lead to green concepts including biorefinery and bio energy devices where renewable resources drive the world. Under such circumstances, the collaborative researches carried out by the groups in NANOTEC/NSTDA (Faungnawakij's team) and Kyoto University (Sano's team) will attack this issue via accumulating innovative knowledge about biomass conversation to useful materials and development of bio energy devices.

Extension of "Solvent Treatment Method" developed by Science and Technology Research Partnership for Sustainable Development: SATREPS (SATREPS Website) program to ASEAN region

Specially Appointed Professor Kouichi Miura (Kyoto University), Senior Vice President for Research and Innovation Bundit Fungtammasan (King Mongkut's University of Technology Thonburi), Proferssor Hideaki Ohgaki (Kyoto University), Lecturer Ryuichi Ashisa (Kyoto University), Dr. Janewit Wannapeera (Kyoto University), Professor Katsuyasu Sugawara (Akita University), Assoc. Professor Nakorn Worasunarak (JGSEE/KMUTT), Assoc. Professor Suneerat Fukuda (JGSEE/KMUTT).

We have been developing the so called "Degradative Solvent Extraction" technology under a SATREPS project between Japan and Thailand. The technology dewaters and upgrades low carbonaceous resources such as low rank coals, biomass, wastes, etc. under rather mild conditions. The upgraded products are expected to be utilized as high-quality fuels, precursors for advanced materials, etc. The purposes of our collaborative research are to extend the outcome of the SATREPS project to ASEAN countries through several schemes, including joint researches and human exchanges.

So far, low grade carbonaceous resources such as low rank coals, biomass wastes, etc. are converted to three solid products called Soluble, Deposit, and Residue, depending on their solubility. The three fractions are all free from water. Soluble which is free from ash and high carbon content is the smallest molecular weight fraction and its properties are almost independent of raw materials. The SATREPS project intends to establish the Degradative Solvent Extraction technology using a relatively large extraction apparatus and to propose the methods to utilize Soluble and Residue. Now we are designing the large extraction apparatus and have already succeeded in preparing unique carbon fiber from Soluble and to use Residue as high quality solid fuel. Residues prepared from several raw materials have been tested for combustion/gasification tests using TG and DTF. We invited researchers from Loa PDR and started transferring this technology.

We are also conducting the development of new functional materials applicable for energy and environment.

Synthesis and characterization of new photocatalytic nano-materials

Prof. Keiichi N. Ishihara (Kyoto University), Assoc. Prof. Dr. Wisanu Pecharapa (King Mongkut's Institute of Technology Ladkrabang), Asst. Prof. Dr. Wanichaya Mekprasart (King Mongkut's Institute of Technology Ladkrabang).

This research is focused on the survey of new photocatalytic nano-materials to improve the functionality of new functional materials. Meanwhile, the appropriate preparation of new nano-materials based on metal oxide have been investigated. The crucial properties especially the optical properties of new nano-materials and their mechanism were analyzed and utilized as photocatalysts and luminescent materials.

We are focusing on synthesis and characterization of two materials for optical applications. First, synthesis and development of zinc aluminate ($ZnAl_2O_4$) nanomaterial and its composite utilized as photoluminescent application by rare-earth doping based mechanical milling process were investigated. Samarium (Sm) metal phase was an alkaline element represented as doping material in $ZnAl_2O_4$ host matrix (Sm: $ZnAl_2O_4$) synthesized by vibrational milling process assisted with calcination treatment. Well-defined $ZnAl_2O_4$ spinel phase in Sm: Zn Al_2O_4 was enhanced by several milling and calcination process analyzed by XRD patterns. The emission spectra are in red-orange region comprising three strong peaks at 562, 600 and 645 nm due to the influence of Sm dopant. However, the prominent structured band in the spectra was related to the emission of residual chromium impurity during high speed vibrational process. The strongest emission was achieved at 0.5 wt.% Sm in $ZnAl_2O_4$ owning to the energy transfer from Sm to $ZnAl_2O_4$ matrix.

The second project is focused on the synthesis of bismuth oxide optical material via thermal treatment assisted quenching process that is proposed to show the facile synthesized process and efficient photocatalyst in dye degradation. The enhancement in the absorption in visible region of Bi_2O_3 photocatalyst is studied and compared with TiO_2 conventional material. Owing to high absorption in visible region, β-phase Bi_2O_3 could be efficiently active in the catalytic performance in the photodegradation of aqueous MO. Moreover, the exchanged researchers under this program have improved research skill to make an excellent collaboration between both universities.

JASTIP WP2 is promoting collaboration researches on the implementation of renewable energy issues as well.

RE implementation – PV installation program in University of Yangon

Rector Pho Kaung (University of Yangon), Associate Professor Hla Toe (Pyay University/ Univesity of Yangon), Associate Professor Aye Thant (Univesity of Yangon), Professor Hideaki OHGAKI (Kyoto University).

University of Yangon wants to supply stable electricity by using renewable energy. Electricity requirement of the university is about 2 MW. A pilot project has been launched for installation of a PV system for a basic research and education in University of Yangon. A 20-kW grid-tied PV system has been designed and installed in the newly built research compound which has the maximum available capacity of up to 48 kW PV modules in the roof. Therefore, a design work for the additional 30 kW grid-tied PV system has been started. We also continuously collect the electricity consumption pattern in the building and the grid stability, as well as the electricity generation from the installed PV system to optimization of the future PV system.

We started a basic data collection of the electricity consumption of the science building from March 2016 by using power logger PW 3365A (Hioki) and found that there were black-outs almost once in a day. However, the duration of the black-out was less than 10 minutes. The longest duration of the black-out was 40 minutes from June 6 to 7, 2016. The diesel back-up generator (750 kW) has been installed in the power distribution station and it has been manually operated. Therefore, the black-out of the grid power line could be longer than the observed one. Currently the peak electricity consumption does not exceed 50 kW, but it should be larger in the new research building. Therefore 100 kW PV system should be prepared. However, due to the limitation of the budget, the designed system is targeting only partial equipment and emergency lights which require about 3 kW.

According to the collected data and due to the limited budget, a 20kW grid-tied PV system has been designed and installed in the new research building in University of Yangon. The designed PV system consists of 72 PV modules and each module has 270 W capacity which will be installed on the 6th floor of the new building without any shadowing from surrounding objects. The Li-ion battery of 9.6 kWh has been installed at the same floor so that it can support maximum 3 hours in the night time via the emergency power supply line. During the day time, the power from the PV system will be supplied to the emergency power supply line as well as the battery charging. The surplus PV power will be supplied to the general power line which is connected to the grid to reduce the power consumption.

Study on energy usage and quality of life for rural community through rural electrification using renewable energy

Professor Nasrudin Abd Rahim (University of Malaya), Lecturer Che Hang Seng (University of Malaya), Associate Professor Wallace S.H. Wong (Swinburne University of Technology Sarawak), Associate Professor Mohd Amran Mohd Radzi (University Putra Malaysia), Professor Hideaki Ohgaki (Kyoto University)

This project aims to study the energy usage pattern and lifestyle before and after rural electrification of rural community in interior Sarawak, Malaysia. Several rural villages in Sarawak, where some of the villages received electrification via renewable energy sources, particularly solar energy, while some others remained unelectrified due to their more remote geographical locations. This project will study the energy usage pattern and living life style of the villagers under different rural electrification scheme. Based on the findings on the differences and similarities between the energy usage pattern and life style of the villages under different rural electrification schemes, the more effective approach of implementing rural electrification can be deduced.

So far, four Iban villages have been surveyed and interviews have been conducted, namely Menangkin, Tabong, Jenggin and Kampung Sungai Merah. The first two villages are in the process of being electrified through extension of power grid while Jenggin have been provided with standalone PV solar systems. Kampung Sungai Merah has not received any form of electrification, and will be electrified using standalone solar system in this project. Based on the survey conducted so far, the following findings have been made:

- Most of the villagers (75%) have received education only up to primary school level.
- Their incomes are lower than average (RM 3,831/month).
- 90% villagers are satisfied their lives.
- The villagers give importance to connect with neighbors, and are in good health/mental conditions.
- Personal activities, i.e. watching movies or going for shopping, are at very low level because their access to transportation is very poor.

Apart from the quality of life, the electricity consumption pattern will be monitored to understand how the rural electrification schemes change the way the rural communities consume electricity, and how the change in electricity consumption pattern is beneficial to the communities.

Local energy governance and Community renewable energy (CRE) in Viet Nam

Mr. Ryo Takeuchi (Kyoto University), Asst. Prof. Takuo Nakayama (Kyoto University), Professor. Keiichi Ishihara (Kyoto University), Professor Ialnazov Dimiter Savov, (Kyoto University), Professor Toru Morotomi (Kyoto University), Lecturer Nguyen Thi Hoang Lien (Vietnam National University of Science, Hanoi), Research Fellow Dr. Yao Lixia (University of Singapore), Dr. Danh Tanh Tu (Vietnam Academy of Science and Technology), Mr. Kazuki Hao (Kyoto University).

The purpose of this project is to attain sustainable development in ASEAN, especially Viet Nam, through expanding Community Renewable Energy (CRE) as a tool for Local Energy Governance. CRE is the renewable energy system, which is initiated, operated and owned mainly by a community such as a group of residents. Most of them are small scale energy systems such as small hydropower, biomass power or biogas. CRE has significant benefits for the social and the environmental sustainability by 4D: Decarbonizing, Decentralizing, Democratizing and Demonstrating. CRE also improve the lives of community by providing low-cost energy. Our study will give a proposal to expand it to ASEAN.

So far, we focused on how to introduce and expand CRE into Viet Nam. Previous

studies show that biogas system is familiar at the household level and small hydro system at the private company level as RE in Viet Nam. It is a big challenge for Viet Nam to develop such RE to CRE. There are mainly three steps in this study. Firstly, this study will clarify the present situation of RE and CRE in Viet Nam. Although there exists a lot of previous studies focusing on RE, there are few studies from the point of view of community. Second, based on the present situation, this study will clarify obstacles to and concrete benefits from introducing CRE into Viet Nam. There are expected to be obstacles to develop RE to CRE, laws such as the regulations of land use and the regulations of cooperative association and economic system such as electricity pricing will be obstacles. Finally, this study will propose a concrete project on introducing CRE and how Japan and Viet Nam can cooperate for it.

During 2016, we had tackled the first step and grasped the present situation of household and enterprise-level RE. As a result of the field studies in northern Viet Nam, we found some obstacles to developing RE to CRE such as low electricity pricing and stagnation of household raising pigs, and found promising initiators and operators. In the next term, we will try simulating the cost and benefit of introducing CRE in Viet Nam by inter-industry relations analysis to propose a desirable way.

Community renewable energy implementation in Thailand

Associate Professor Chatchawan Chaichana (Chiang Mai University), Assistant Professor Wongkot Wongsapai (Chiang Mai University), Professor Keiichi Ishihara (Kyoto University), Ms. Nilubon Luangchosiri (Kyoto University).

During 2013-2016, the Ministry of Energy of Thailand and Chiang Mai University supported 26 communities to establish community-scale Renewable Energy (RE) projects. Apart from these communities, there are more than 100 communities interested in the program but cannot participate in the program. It is very interesting to learn about factors that prevent them from successfully involved in the program. Then, recommendations can be made in order to improve the future program.

Visualization of research "Catalog"

We introduce about the current research activities of energy and environment research under the JASTIP project. It is an important responsibility for researchers to convey their research activities accurately and understandable to all stakeholders especially to those from non-academic fields. Toward the social implementation process from research to private companies, administrators, and venture capitalists should distinguish research results which can be useful for solving the social issues, commercialization etc.

As scientists have their own strength which is surely research, even for the case of industry-academia collaboration, researchers tend not to focus on commercialization and business models. However, we suppose that research activities and their results can be understood by experts including entrepreneurs and venture capitalists.

First of all, as shown in this paper, it is necessary to clarify the position of each research and concrete research activities like a research catalog in order to make them available for stakeholders to promote implementation of scientific result to society. Furthermore, as a way to explain the position of research for understanding, is it possible to reveal the relationship among researches like a map?

Visualization of research "Relationship map"

Tentatively, we tried to make a map of the research activities already mentioned above, with the vertical axis as basic research and applied research, with the horizontal axis as energy field and biology field (Figure 1). As an example, this map explains a relationship and position of energy research within JASTIP. It can be seen in the map that the energy researches are closer to the biology side. As a proof, energy research and biological research groups already have started carrying out the joint study under JASTIP.

There are gaps between social implementation and fundamental research activities. It is suggested that research collaboration is not enough even among researchers of same academic field of study. Before focusing the promotion of industry-university collaboration, there is not enough number of research collaborations both in quality and in quantity between natural science and non-natural science. Even though researchers are of the same field, they did not understand

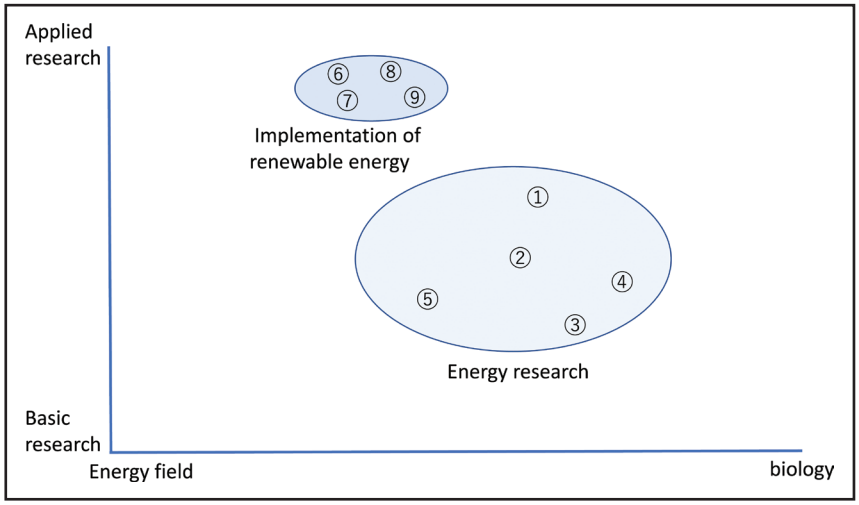

Figure 1: Research relationship map between energy and environmental research under the JASTIP platform

well what kind of studies carry out in other laboratories. It might be necessary to bridge the gap as "the valley of death" of research (Branscomb 2001 and 2003). We believe that it is the first step to promote STI by visualizing its own research to promote dialogue and collaboration with researchers in other fields near them.

Overcoming problems and future development

We believe that active cooperation with natural scientists and scientists from other fields including social science and humanities is necessary as a foundation for collaboration that will cover gaps in the research. JASTIP is first STI platform that is mainly led by scientists from ASEAN and Japan. JASTIP actively promotes and supports efforts to show the activities of researchers to researchers, private companies, governments and societies of ASEAN and Japan as a platform to encourage various kinds of collaboration. We hope that social challenge will be succeeded.

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ASEAN-EU Cooperation in Science, Technology and Innovation

(SEA-EU-NET)

The "SEA-EU-NET" project has been set up to expand scientific collaboration between Europe and Southeast Asia in a more strategic and coherent manner. The project increases the quality, quantity, profile and impact of bi-regional Science and Technology (S&T) cooperation between Southeast Asia and Europe. The project supports the internationalisation policy of the EU, the specific objectives of FP7 but also contributes to building the S&T foundation essential to the EU achieving its political, economic and social objectives.

"SEA-EU-NET 2" is the second project that has been set up to expand scientific collaboration between Europe and Southeast Asia (SEA) in a more strategic and coherent manner. The four-year long project was launched in October 2012, involves 21 institutions from the two regions and is coordinated by the Project Management Agency at the German Aerospace Center (DLR). SEA-EU-NET 2 is deepening collaboration by:

- Continuing and intensifying the bi-regional dialogue between EU and ASEAN S&T policy makers on Senior Officials level as well as creating an annual exchange forum for researchers, innovation stakeholders, policy makers and private business to improve EU-SEA cooperation and exchange through the series of the ASEAN-EU Science, Technology and Innovation Days.
- Jointly tackling societal challenges in the fields of Health, Food Security and Safety, Metrology as well as Water Management with relevance to both regions by organising events, providing fellowships for SEA researchers and conducting studies on future collaboration potentials.

For more information, contact:

Centre for Social Innovation (ZSI)
Linke Wienzeile 246, A – 1150 Vienna, Austria
Tel: +43 1 495 04 42 - 0
E-mail: institut@zsi.at
Web: https://www.zsi.at/
https://sea-eu.net