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### **The Transfer of Advanced Biogas Production Technology (HyMeTek) from Taiwan to Manado, Indonesia**

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#### ABSTRACT

*Renewable energy technologies offer the promise of clean, abundant energy gathered from self-renewing resources such as the sun, wind, water, earth, and plants. According to United Nations Sustainable Development Goals, number 7 is to provide an Affordable Energy, and number 4 for Sustainable Education. To reach and compile these goals, Feng Chia University, Taiwan, in collaboration with Asia-Pacific Economic Cooperation Research Center for Advanced Biohydrogen Technology (APEC-ACABT), Manado city Government, and Sam Ratulangi University, Indonesia, had built the advanced biogas production system using Two-stage Biohythane Production Technology (HyMeTek) to Manado city as Demo and Training center of Bioenergy System. Through this system students are expected to be able to learn about biogas technology as a renewable energy source, under supervision of Sam Ratulangi University. Thus, the two Sustainable Development Goals number 4 and number 7 are achieved.*

#### INTRODUCTION

The idea appeared in Asia-Pacific Economic Cooperation Energy Working Group (APEC EWG) 54<sup>th</sup> meeting at Wellington, Australia on November 22, 2017, when North Sulawesi, Indonesia Vice Governor delivered his presentation and stated that “North Sulawesi Province as a Promising Land of Renewable Energy needs to be utilized and to be conserved.” This statement had attracted the two Feng Chia University Professors who are active in Asia-Pacific Economic Cooperation Research Center for Advanced Biohydrogen Technology (APEC-ACABT) organization. They are Prof. Shu-Yii Wu, Dean of College of Engineering, as also a CEO of APEC ACABT, and Associate Prof. Chen-Yeon Chu, Director of Master’s Program of Green Energy Science and Technology, also as an Executive Secretary of APEC ACABT, who attended that meeting and watched the North Sulawesi Vice Governor presentation.

With this early information of North Sulawesi situation, these professors continued their curiosity to find more detailed information. The opportunity came in December 2017 when Assoc. Prof. Chen-Yeon Chu from Feng Chia University (FCU) and Assoc. Prof. Keng-Tung Wu from the National Chung Hsing University (NCHU), had been invited by Manado City government to attend the Workshop on Renewable Energy Application for Tondano River and Surrounding Areas. In this workshop, they gained more information about the energy supply condition in Manado city and its surrounding, especially after the Manado city flood disaster in 2014. The workshop was

continued by field survey in Pandu Village, Manado, where the refugees from Tondano River impacted by climate change were ready to be relocated.

According to the Data from the Regional Disaster Management Agency (BPBD) of Manado City in 2014, 101 houses were lost, 18 died, 2 were missing, and 86,355 people or 25,103 families were displaced by the floods. To overcome the housing problem and to replace the lost houses for the victims and refugees of the flood disaster impact, the Manado city government has built a simple housing in Pandu village. And since January 2017, the victims of the floods can be relocated to Pandu village, in Bunaken District, Manado City, by the support of the Manado city government. But even though the houses were built in the new area and the flood disaster victim were ready to be relocated, there was still a problem that needs to be solved. The electrical power shortage is still a problem because of the high cost of power transmission.

After the workshop and field survey in Manado city, the Asia-Pacific Economic Cooperation Research Center for Advanced Biohydrogen Technology (APEC-ACABT) team have some discussions, i.e.: it seems that Pandu Village can be a model of renewable energy (biomass and solar farm) in collaboration with Manado Government and APEC ACABT, supported by Feng Chia University (FCU), Sam Ratulangi University (UnSRAT), Indonesia Institute of Science (LIPI) and National Chung Hsing University (NCHU). To answer this discussion, APEC ACABT by FCU support, planned to build a Pilot Project on Biowaste to Bioenergy System model by using their Two-stage Biohythane Production (HyMeTek) patent technology, that can help the people in Manado relocation area. This Pilot Project also can be a place for students to learn about Renewable Energy focused on Biogas Power Plant.

## THE RESPONSE FROM TAIWAN

As a response to the good relationship with Manado city and Indonesia, APEC ACABT invited Dr. Cynthia Wuisang, lecturer from Sam Ratulangi University (UnSRAT) for Green Urban Planning and Dr. Dwi Susilaningih from Indonesian Institute of Sciences (LIPI) to visit Taiwan from March 28 to April 1, 2018. Actually, the purpose of the invitation is to share the new idea and knowledge about Renewable Energy in Taiwan. These two delegations from Indonesia were brought to have visiting experience to: (1) Municipal City Visits: to learn the technology of disaster prevention, waste management, and tourism low-carbon city policies; (2) Green Energy and Disaster Prevention and Warning Technology (3) Climate refugees' resettlement; (4) Implementation project of filming the new energy in Manado City, and (5) Visit solar panel training center at Hsiuping University of Science and Technology, Taichung city. During this few days visit, both of them also join an APEC-ACABT mini workshop in Feng Chia University, and Dr. Cynthia has given a speech with topic of "MANADO RUMAH KITA BERSAMA", that means "Manado, our home together". Another response from APEC ACABT through Feng Chia University Master Program in Green Energy Science and Technology, was the invitation sent to UnSRAT to invite two lecturers to join the Taiwan Education Experience Program (TEEP@AsiaPlus2018) as participants of exchange students. UnSRAT has sent Ms. Saartje Silimang and Alicia Sinsuw to join the program from June 1 to November 1, 2018 to learn the process of the biogas plant and maintenance and operation of the solar panel system. They learned many things during this 5 months program, and by this opportunity, Ms. Alicia finally decided to join the PhD study in FCU which started on February 2019, spring semester.

It can be said that TEEP is a successful program in widening the networks and strengthening the collaborations. The "sleeping" relationship between FCU and Manado city government after the workshop in December 2017 was "awake" during TEEP 2018 program, since the participants from UnSRAT Manado became a bridge to reconnect the sleeping parties.

## IMPLEMENTATION PROCESS

### Action

The communications between FCU and Manado city government became more intense with the help of UnSRAT Manado city exchange student participant on TEEP 2018. In preparation for project funding, Assoc. Prof Chen-Yeon Chu had made his presentation about the idea and the planning system of this project, to National Energy Program II (NEP II) in Taipei. And this idea was approved, from the system installation to community sustained during five years.

While communication with Manado city kept going well, the installation of HyMeTek system (Fig 1) lead by Engineer Arlex Chen is going on, and Feng Chia University takes action by sending students to Manado city.

FCU sent Mr. Chang-Yu Chen an undergraduate student to study and develop an international joint-project with Manado City Government in the field of Urban Planning and Green Energy and focus on “Solar Panel Photovoltaic and Biogas technology” in Manado City, Indonesia, and Mr. Lo Chin, a Master Student, to study and develop an international joint-project with Manado City Government in the field of Urban Planning and Green Energy and focus on “Biogas technology” of Bailang Slaughterhouse site in Manado City, Indonesia. Also FCU sent his Research Assistant and Engineer, Mr. Tsung Hsien, Chen – known as Arlex Chen – to do a research project on Green Energy and Green Urban Planning, associated with the Demo and Training Power Station of Two Bio Hythane Production (HyMeTek) of Bailang Slaughterhouse site, Manado City, Indonesia. Each one stayed one month in Manado.

Fig 1. The pilot project of HyMeTek demo and training of two-stage biowaste to bioenergy system



### Memorandum of Understanding Signing

Meanwhile, the intense discussion and communications between Manado party and FCU party regarding to the project run well, and both parties planned for Memorandum of understanding (MoU) signing on August 24, 2018 between APEC ACABT and Manado City Government, continued with International Seminar on “*Manado Reaching the Dream of Renewable Energy.*” On the other side, the engineers’ work continued on the designing of the system of “Power Station of Two-stage Biohythane Production Technology (HyMeTek)” with output electrical capacity of 10 kW. The tasks to be finished are (1) to build the system designed, (2) to ship the built system to Bitung Harbour, and (3) to install the system at Manado site. All members of the team worked together simultaneously.

The team, composed of professors, Chief Executive Officer (CEO) and engineers, flew from Taiwan and arrived in Manado city. On August 24, 2018, a MoU signing between APEC ACABT – Manado city Government (Fig 2), and International Seminar took place. This was attended by Manado city Vice Major, Mr. Mor Bastiaan, and CEO of APEC ACABT, Prof. Shu-Yii Wu, with Executive Secretary of APEC ACABT, Assoc. Prof. Chen-Yeon Chu, and Dr. Peter Karl Bart Assa, the Manado city Secretary, as witnesses. The content of the MoU is about collaboration between APEC ACABT and Manado city government in exchanging researchers, exchanging data, joint research and publications.

Fig 2. MoU signing between APEC ACABT and Manado City Government



### International Seminar

The International Seminar, attended by 250 participants from government, universities, companies, and private sectors, put attention on the Renewable Energy technologies issues. The Keynote speakers (Fig 3) of this seminar are Prof. Shu-Yii Wu (CEO APEC ACABT/FCU), Assoc. Prof. Chen-Yeon Chu (Executive Secretary APEC ACABT/FCU), Assoc. Prof. Keng-Tung Wu (Secretary of APEC EGNRET/NCHU), Dr. Dwi Susilaningih (Indonesia Institute of Science/LIPI), Mr. Zulfan Zul (Bioenergy Engineering, Indonesia Energy and Mineral Resources Ministry), Dr. Pi-Fuang Chen (CEO Zolargus Inc/Private Sector) and Alicia Sinsuw (Sam Ratulangi University). The chairman of Board of Regional Research, Planning and Development of Manado city (BAPELITBANGDA), Dr. Liny Tambajong, MSi., also followed the seminar with enthusiasm. She is the key person of this Pilot Project between APEC ACABT and Manado city government.

With the International Seminar and the MOU signing finished, the professors and the whole team flew back to Taiwan. Next came the shipment of Two-stage Biohythane Production Technology (HyMeTek) system. It started from Taiwan to Bitung International Harbor, North Sulawesi, Indonesia, the nearest harbor to Manado city. The shipment itself took time more than it was planned.



Fig 3. International seminar speakers from APEC ACABT, LIPI and Manado City Government

### Field Survey and Feedstock Test

While waiting for the Two-stage Biohythane Production Technology (HyMeTek) system to arrive in Manado, the team, led by Arlex Chen, the HyMeTek Engineer – he had to stay in Manado more than a month while waiting for the shipment - was doing some preparation (Fig 4). The master student that was sent by FCU started to prepare the material to produce some biogas that was planned for demo when the system arrived, and Arlex was preparing the place where the system is going to be seated, and doing some measurements to make sure that the system will fit on the site. Also, there was a documentary filming preparation that made a story about the Flood Victim Relocation area and the community's sustainable activities.

Manado city government has chosen the Slaughter House location, in Bailang Village, Manado city as the location to put the Two-stage Biohythane Production Technology (HyMeTek) System with a consideration that in Bailang Village there are some victims of the previous flood, and the electric power capacity over that area were not enough to supply power to the whole village. They hoped that with the HyMeTek, the Biogas Power Plant can help

the people in that area, at least, a public place that constantly needs electricity. It is located on the hill, with a very nice view to Manado Bay. The main purpose of this Pilot Project Implementation is to give the alternative model and to introduce the technology of Biogas system to Manado City, with consideration that based on Manado surrounding area which has many plantations and farming, Biogas is suitable for sustainable renewable energy system. Therefore, this Pilot Project Plant was given the name of *Demo and Training Power Station of Two-stage Biohythane Production (HyMeTek) Manado Project*. With this Pilot Project, a capacity of 10 kW, it can only power a church as a public place that is located about 300 meters from the slaughterhouse. In the future, this project can be duplicated or built into a bigger capacity according to what Manado city needs.

Assoc. Prof. Chen-Yeon Chu as a Principal Investigator of this Pilot Project flew back to Manado to bring the Video Documenter Team from Taiwan. Their job is to record all the activities during implementation the HyMeTek system, and do video documentation of the villagers to see the activities of the community and its surroundings where HyMeTek locates. The purpose is to show that the system has real positive impact to the community's sustainability. Also, they have to capture on film the learning process that is experienced by the Sam Ratulangi University students, the lecture of which will be given by Prof. Chen-Yeon Chu. They worked together with a local fixer, Ivana Marcia who has done the pre shoot, a week before the video team arrived. The video team itself, had worked in Manado for ten days, at the same time with the FCU team.



Fig 4. Field Survey of HyMeTek location: Church (left), Slaughterhouse (right)

## HYMETEK SYSTEM BUILD UP

Finally, the day has come. The ship which is carrying the HyMeTek system has arrived in Bitung harbor. With lots of efforts, our Pilot Project PI, Prof. Chu led the process of bringing the system that was put in a container to the pointed location. It was not an easy work. In the middle of the night, the team members were still in the rural area, trying to figure out how to bring the system in. The access road was very small, but the crane which is needed to lift up the container and put on its right position was too big, and it cannot enter the access road to Slaughter House. Some friends of local people in Manado city helped the team. They are friends from the church networks and also from the Eben Haezar Christian Education Foundation, who help the team find some solutions, especially on how to manage the system and put in the location. The people surrounding the Slaughter House were also helpful, especially the Priest of the nearby church.

## TESTING AND HANDOVER

The next day, the Board of Regional Research, Planning and Development of Manado city has arranged the program of Manado City Vice Mayor to visit Slaughter House for the Pilot Project of Demo and Training Power Station of Two-stage Biohythane Production (HyMeTek) on September 21, 2019 (Fig 5). It was well arranged, and at 10 am the Vice Mayor came. Prof. Chu welcomed him and escorted him to look around the HyMeTek system in the container. There were a lot of explanation regarding the general process and the objectives of the project especially in the area of community sustainability. The video team recorded the process and also did some interviews with Prof. Chu and Vice Mayor about their response and future expectations on this project. It was a good impression from the

Vice Mayor, and he was very supportive. This project will be put as a part of his planning for Manado Smart City in 2021.

The installation process with the engineering team of FCU and UnSRAT continued. Lifting up the container by using forklift was not an easy job. It needed focus and right prediction, skills and logic. Those are the tasks of engineers. With all the efforts and co-operations, finally the container can be put at the right place of Slaughter House location. For a week, the team continued their job. Installations by engineers, documentary filming by the video team, and teaching the students on Learning with experience of Renewable Energy, by the professor. It was very good to have such a collaboration with all parties. Those activities kept going on until the time that the team has to go back to Taiwan.



Fig 5. Manado city Vice Mayor first visit to the HyMeTek System

## ACHIEVEMENTS AND RECOMMENDATIONS

### Outcomes

After the installation processes have been done, it needs a roadmap for its five-year project follow ups. Back to Taiwan, the team defined the pathway of the Manado city Pilot Project, with the results: the roadmap started with year 0 in 2018 to year 5 in 2023. The year 0, called as Initial Phase, started with Biogas system installation. In year 1, Hybrid Phase, the plan is to build Solar PV installation for learning materials. There is also the building of an education room for students to have a place for studying about renewable energy at the site, and to protect them from sun or rain. Then, in year 2 it will be a Smart Power Management, whereby the two system are going to be connected through a smart grid, and to produce electric power for the community. At the same year, the community who lives nearby the location can be empowered to collect agricultural waste for biogas system feedstock, and also plant some fruits or other plants by using the organic fertilizer and effluent from the biogas system, so those people also may gain more income.

Year 3 is predicted to have Green Products. By harvesting the organic plantations, the community may sell it to have income, especially for women, so they may help their husbands support the families. In year 4, the plan is to have Green Neighborhood, which means that the citizens of the community already have more understanding about green life. They will have more knowledge to live clean, not to throw rubbish just anywhere, and even how to classify waste accordingly. Finally, in year 5, the community is supposed to have economy impact from this implemented system, by collecting the waste for feedstock, planting or farming with organic fertilizers, selling of

green products, getting more knowledge from the teachers who give lectures on site, and maybe getting some extra income by selling organic juices from their plantation to the guests who come to the location.

By the fifth year, it is supposed to have a sustainable community in the Slaughter House area. This five-year roadmap was submitted to Manado City government through BAPELITBANGDA and had been followed accordingly to continue the collaborations based on the MoU. In order to do some testing after installation, the Master's Program of Green Energy Science and Technology in FCU sent another two master students Mr. Tantrung, Nguyen and Mr. Chiawei, Lai to do a small research project on Green Energy and Green Urban Planning, that was associated with the Demo and Training Power Station of Two Bio-hythane Production (HyMeTek) of Bailang Slaughterhouse site, Manado City, Indonesia.

By the end of the year 2018, Sam Ratulangi University held the 1<sup>st</sup> International Conference IConSEP (International Conference on Sustainable Engineering Practices) on November 8-9, 2018, and invited Assoc. Prof. Chen-Yeon Chu, and Prof. Shang-Yuen Chen from FCU to be the keynote speakers. In his presentation for the Conference, Prof. Chen-Yeon Chu explained about the Biogas Demo and Training Center that has been implemented in slaughterhouse, so that the students and lecturers of UnSRAT know about the power plant. At the same time, after the long preparation since July 2018, finally UnSRAT and FCU came to an agreement to sign the MoU between Universities, in late October. The MoU itself contains the agreement to collaborate in Joint Research, Journal Publications, Exchange students and lecturers, also some other collaborations within Academic issues. The visit of the FCU team in the late 2018 had three main objectives, i.e.: (1) to sign MoU between FCU-UnSRAT, (2) to be Keynote Speakers for International Conference on Sustainable Engineering Practices (IConSEP) 2018, and (3) to hand over the Demo and Training System of HyMeTek to Manado city government. The objective number (1) and (2) were done in UnSRAT, and the third activity was held in slaughterhouse office. The Demo and Training Power Station of Two-stage Biohythane Production (HyMeTek) System was successfully installed, handed over from APEC ACABT and FCU to Manado city government, with future hope that, this technology transfer can be very useful for all the students, teachers, researchers, public or private sectors who are willing and curious to learn about renewable energy (Fig 6).



Fig 6. Manado city reaching the dream of Agro-renewable Energy Technology through the HyMeTek System

## Recommendations

Since HyMeTek technology comes from Taiwan, we suggest that the Taiwan government may assist the private sector to build up the comprehensive industrial chains for the advance bioenergy system. Also Taiwan and Asian countries may set up the Free Trade Agreement (FTA) to implement the Taiwan benchmark technology in Asian countries.

Based on the implementation of HyMeTek System as a Demo and Training Center for Biowaste-to-Bioenergy Technology, it is expected that the Manado city government may consider how to manage the agriculture wastes from the community, and convert it into bioenergy.

For Indonesian government, it is suggested to set up a regulation about incentives for organization or private sectors who provided bioelectricity power to support the remote area or isolated islands.

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