



**Asia-Pacific
Economic Cooperation**

Advancing Free Trade
for Asia-Pacific **Prosperity**

APEC Workshop on Community-based Waste to Energy Management

APEC Energy Working Group

January 2022



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FOREWORD

Waste management has been an issue in many growing economies. APEC economies are responsible for a large share of global solid waste, 43 percent of global solid waste originated from APEC economies in 2016. This waste crisis emerges due to the increasing amount of waste coupled with weak management and regulations. APEC Leaders have frequently called for a regional approach for better waste management to address this.

A community-based waste management is an alternative to overcome or minimize waste accumulation in sites managed by the local or regional government. The objective of this project is to encourage application of waste management to renewable energy project through community involvement and engagement, as one of sustainable solutions for the waste crisis. This project also responds to APEC energy goals of doubling the share of renewable energy by 2030.

The project aims to share best practices in community-based waste management and to give insights on policy recommendations considering legal, financial, institutional, and social aspect of waste management programs which could be served as a reference for the policy makers in the APEC Economies to replicate the best practices and adapting it to their local situation.

In this context, the Ministry of Energy and Mineral Resources (MEMR) commissioned Castlerock Consulting to support the Project Overseer of the workshop through the following activities:

1. Facilitation during workshop preparation.
2. Supporting the workshop organization through note taking, moderate the breakout session, and presenting recommendations.
3. The preparation of the post-workshop project report.

This final report for the *APEC Workshop on Community Based Waste to Energy Management* has been prepared by Castlerock Consulting, on behalf of the Project Overseer – Ms Dian Prasomya Ratri from MEMR, Secretariat General, Bureau of the Communication, Public Information Service, and Cooperation, Indonesia.

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ACRONYMS AND ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
CFPP	Coal-Fired Power Plant
CGSS	Centre for Global Sustainability Studies
CIMT-GT	Centre for Indonesia-Malaysia-Thailand Growth Triangle
CO ₂ e	Carbon dioxide Equivalent
CSR	Corporate Social Responsibility
CSWB	Community-based Solid Waste Bank
CWB	Central Waste Bank
DED	Detail Engineering Design
FIT	Feed-In Tariff
FGDs	Final Garbage Disposal Sites
GESI	Gender Equality and Social Inclusion
GHG	Greenhouse Gases
JASE-W	Japanese Business Alliance for Smart Energy Worldwide
LFG	Landfill Gas
MEMR	The Ministry of Mineral and Energy Resources
MJ-SWB	<i>Miftahul Jannah</i> Solid Waste Bank
MoEF	The Ministry of Environment and Forestry
MPWH	The Ministry of Public Works and Housing
NDC	Nationally Determined Contribution
NGOs	Non-Governmental Organizations
QWTEI	Quality of Waste to Energy Infrastructure
RDF	Refuse Derived Fuel
SMEs	Small-Medium Enterprises
SWM	Solid Waste Management
TOSS	<i>Tempat Olah Sampah Sendiri</i>
TPA	<i>Taman Pendidikan Al-Quran</i>
TPS3R	<i>Tempat Pengolahan Sampah - Reduce Reuse Recycle</i>
UCO	Used Cooking Oil
USAID	United States Agency for International Development
WtE	Waste-to-Energy

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1. INTRODUCTION

1.1 BACKGROUND

Asia-Pacific Economic Cooperation (APEC) economies contributed a significant amount to global solid waste. In 2016, 43% of the global solid waste was generated from APEC economies. An APEC economy resident generated 0.8 kg of solid waste per day in 2016, and this number is expected to increase to 1.1 kg per day by 2050¹. Opportunities to turn waste into economic value are available through the reuse of organic solid waste as compost for agriculture activities and/or gardening, or as feedstock to generate bioenergy.

Community-based waste management provides an alternative to overcome or minimize waste accumulation in sites managed by the local government. The local government approach to waste management traditionally consisted of three parts; collection; transporting and disposal at the Final Garbage Disposal Sites (FGDSs). This method has several shortcomings, such as high operational cost; the constant need to open new locations; and social, environmental, and health problems related to garbage build-up.

The Community-based Waste Management to Renewable Energy Workshop on 27th – 30th July 2021 aims at providing a platform to exchange ideas and formulating recommendations to further develop the practice of alternative waste management that promote the Waste-to-Energy (WtE) concept developed by local communities and supported by the local/regional government. The Ministry of Energy and Mineral Resources, Secretariat General, Bureau of the Communication, Public Information Service, and Cooperation, Republic of Indonesia², is the lead organizer/implementor of this workshop.

This workshop that has been held through four half-day virtual events in Indonesia is aimed to encourage the application of waste management to renewable energy projects through community involvement and engagement, as one of the sustainable solutions for the waste crisis. The purposes of the workshop are: 1) increasing knowledge and understanding of waste management to renewable energy in Asia Pacific economies; 2) fostering community self-reliance in waste management.

1.2 OBJECTIVES

The overall objective is to build the capacity of project participants through this workshop and build policy recommendations. Key activities are mentioned as follows:

1. Sharing best practices of current waste to energy technologies with highlights on how policy and regulations play important roles in creating and supporting community-based waste to energy initiatives, with contractors and experts from APEC economies.
2. Brainstorming activities of necessary policy & regulations and integrating gender equality & social inclusion in community-based waste to energy programs. Brainstorming activities will help identify additional policy and regulations, as well as those need improvements, from the perspective of users (such as policymaker) and experts (such as technology provider). Brainstorming activities on inclusivity takes

¹ Singh, SK. (2020). *Circular Economy: Don't let Waste go to Waste (Policy Brief)*. APEC Policy Support Unit

² Biro Komunikasi Layanan Informasi Publik dan Kerjasama, Sekretaris Jendral, Kementerian Energy dan Sumber Daya dan Mineral

1. Introduction

into account that the involvement of women and vulnerable groups is an important aspect in the success of community programs.

3. Build policy recommendations across APEC economies to fit their need and to encourage practices within their context beyond this workshop.

2. WORKSHOP IMPLEMENTATION

2.1 ORGANIZATION OF PROGRAM

Target audiences of this workshop are related stakeholders from the international communities, including but not limited to policymakers in APEC economies in charge of waste management and waste to energy. Other beneficiaries and stakeholders as secondary target groups are invited to attend as observer participants. Academics, researchers, non-profit organizations, and other communities who are interested in the WtE area and are willing to have benefited from discussion and knowledge dissemination are welcome.

The four half-day workshops have been held virtually via *Zoom* application and the participants from APEC member economies have to join online from various time zones. On day 2 and day 4, there were breakout discussion rooms that were concluded with a presentation of policy recommendations.

2.2 WORKSHOP DAY-1

The first day of the workshop was discussing WtE technology for a community-based approach. These technologies aim to create a sustainable way of waste management, particularly for a dense population in urban areas. Here are the key points which have been delivered by each speaker.

1. *Yukihisa Sakata, Japanese Business Alliance for Smart Energy Worldwide (JASE-W) Working Group, EX Research Institute Ltd, Representative from APEC Economies – Japan*

The WtE handbook published by JASE-W consists of various smart energy products and technologies applicable to the world. The objectives are to facilitate the readers, such as central or local government, in understanding how WtE infrastructure is ordered, constructed, and operated, also provide and share useful suggestions for securing the Quality of WtE Infrastructure (QWTEI). QWTEI is a concept introduced by JASE-W to guide the stakeholders in building their WtE facilities to become stable, durable, and safe as truly socially and environmentally sound infrastructure system consistent with the situation of each member.

2. *Inge Johansson, RISE Research Institutes of Sweden*

There are some examples of matured WtE technologies such as landfill gas (LFG), anaerobic digestion of food waste, waste incineration/combustion, gasification, and pyrolysis. According to the speaker, WtE cannot solve the increasing amounts of waste and extraction of the resource. However, it can be a part of an integrated solution to a more sustainable future, together with the basic hierarchy of waste handling i.e. reduce (minimization), reuse, and recycle. It is important to be noted that no one solution fits all, the number of different technologies available has its advantages and disadvantages. The solutions must be tailored according to the needs and priorities of each member economy/area, as a part of an overall waste treatment strategy. Moreover, all technologies need a proper operational, management, and sufficient knowledge level, otherwise they will become more risk than an asset.

3. *Dr Elisabeth Rianawati, Resilience Development Initiative Institution, Doctoral Graduate from Bandung Institute of Technology*

The challenge of potential WtE as a waste management solution is necessary to be observed based on the community's perspective as the beneficiaries. It includes inadequate knowledge, low awareness, financial constraint/expense, which is not a

2. Workshop Implementation

priority compared to fulfilling people's daily needs, and the toxic emission from some WtE technologies such as incinerators. Having the lesson learnt from the existing programs, the speaker proposed a concept entitled "Urban Organic Waste Management Strategy" utilizing the anaerobic digestion technology to process organic waste from the urban community (e.g. society, restaurant, hotel) into biogas or fertilizer. This concept would create a circular economy benefit for a wide range of stakeholders. At the same time, local governments could reduce costs of waste transport and substitute it into incentives for installed Anaerobic Digester operation at the community level.

4. *Ernest Layman, CEO of Rekosistem – Waste Management Start-up*

The speaker presented the application of information technology in Waste Management and established Rekosistem as a start-up company in 2018 that focuses on an integrated waste solution. In 2020, the company expanded their services to waste pick-up services for reducing the waste from the primary source that dumps to the final disposal site. With the support and collaboration work from local governments and other stakeholders, it would accelerate building WtE awareness, acceptance, and adoption in society. The takeaway from this session presents that information technology offers a sustainable ecosystem by using a technology-based platform in managing waste. Using the mobile application, the IT provides an ability to gather real-time online information to understand the behaviour of the people in managing their waste and offers an integrated waste collection and reporting system for improving urban waste management.

5. *Arief Noerhidayat, S.I.Kom., M.SC., CEO of Comestoarra.com (Start-up Company)*

The speaker initiated the concept of Supply-Value Chain Management for managing and processing domestic waste and/or biomass into bio-coal as raw materials for renewable energy, known as Refuse Derived Fuel (RDF) technology, as well as established a blueprint design for shredding and pelletizing machines produced by Small-Medium Enterprises (SMEs) throughout Indonesia. The main concept of WtE technology proposed by Comestoarra.com consists of three parts i.e. bio-drying process to reduce waste's moisture, waste shredding process, and pelletizing process as a final product. Those aforementioned processes could be implemented at the community level as a Waste Generation Management at The Source (*Tempat Olah Sampah Sendiri – TOSS*) facility. Afterward, the waste pellet produced in TOSS could become fuel for co-firing a Coal-Fired Power Plant (CFPP) as it already met the criteria required. Additionally, the speaker presented a case study of the TOSS program that had been conducted in Ende Regency, East Nusa Tenggara, Indonesia and it solved waste problems there which were dominated by organic waste and biomass while creating new resources of energy and income (financially) for local people.

2.3 WORKSHOP DAY-2

The second day of the workshop was discussing policies and regulations to promote community-based waste management. It was mainly talking about the role of central and local governments in accelerating WtE management and how effective those roles are in escalating community awareness through some waste management programs initiated by not only the governments but also the other stakeholders such as NGOs or academic institutions. Here are the key points which have been delivered by each speaker.

1. *Zi Jun Yong, Centre for Global Sustainability Studies (CGSS), Institute of Postgraduate Studies, Representative from APEC Economies – Malaysia*

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Malaysia's urban waste comprises 61% organic composition, still applying landfill and open dumping with minimal environmental hazards control. Considering this current application and its impact on the environment and Greenhouse Gasses (GHG) emissions, an alternative framework for delivering sustainable organic waste management is applying anaerobic digestion technology to convert waste into biogas as a raw material to generate electricity. There are several considerations in selecting WtE technology which needs to account for technical, economic, and environmental basis. Additionally, an ineffective law implementation from the government could be challenging to ensure that waste management programs are well implemented.

2. *Andriah Feby Misna, Directorate General of New & Renewable Energy and Energy Conservation, The Ministry of Energy and Mineral Resources (MEMR), Indonesia's Central Government Representative*

The main objective of bioenergy development in waste management is utilizing waste as a source of sustainable energy. It is based on the emission reduction commitment by the Indonesian Government in Paris Agreement. Therefore, MEMR, as a regulator, creates some general policies in the WtE business, including the finalization of a Ministerial Regulation on Implementation of co-firing in existing CFPPs to address waste problems and increase renewable energy share total energy produced emission from coal combustion. To accelerate the WtE program, MEMR imposes pricing formula for the electricity tariff from WtE Power Plant. However, the program is still staled due to the high investment cost which makes WtE Power Plant project becoming not economically profitable. It requires further collaboration among stakeholders and harmonization of policies and regulations to implement an integrated upstream-to-downstream waste management program.

3. *Ir. Prasetyo M.Eng., Directorate General of Human Settlements, The Ministry of Public Works and Housing (MPWH), Indonesia's Central Government Representative*

Human Settlements Directorate of MPWH delivers a program entitled "Community Based Solid Waste Treatment Facilities (*Tempat Pengolahan Sampah 3R – TPS3R*)" using a 3R approach, i.e. reduce, reuse, and recycle. TPS3R main aims are to increase public awareness of waste reduction (especially in landfills), preserve natural resources with reuse and recycle activity, and increase employment opportunities for communities. A high density and slum area and a high sanitation risk index are suitable for building the TPS3R facility. It could be upgraded to generate electricity or renewable energy resources, e.g. biogas and waste pellets. Although the program has already been initiated and Indonesia's solid waste management policies have mentioned community participation in handling waste, it still needs a strong commitment from the central and local governments to build community empowerment in managing waste.

4. *Novrizal Tahar, Directorate General of Solid Waste, Hazardous Waste and Hazardous Substance Management, The Ministry of Environment and Forestry (MoEF), Indonesia's Central Government Representative*

Indonesia's Nationally Determined Contribution (NDC) targets in the waste sector intend to reduce GHG emissions. The allocation of GHG emissions reduction from domestic solid waste is 8.16 million tons of Carbon dioxide equivalent (CO₂e), including four main programs, i.e. landfill equipped with LFG recovery, energy recovery, paper recycling, and composting. The RDF technology is implemented as one of the solutions in an energy recovery program to introduce a technology utilization plan for co-firing raw material in CFPP or Cement Plant. At the community level, this program has supported the TOSS program in Ende Regency, East Nusa Tenggara, by setting up a Detail Engineering Design (DED) for communal scale RDF facilities (in collaboration with Comestoarra.com), providing shredding and pelletizing machines in 2021, and will be constructing those facilities in 2022.

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5. *Febrina Kusumawati, Acting Head of City Development Planning Board of Surabaya, Indonesia's Local Government Representative*

The local government's support is essential to ensure the implementation of community-based waste management. It is shown from implementing waste management in Surabaya as the second-largest metropolitan city in Indonesia, located in East Java. They deliver campaign programs to encourage community participation in implementing the 3R movement while also supporting waste segregation centers, compost houses, and waste recycling centers. Moreover, Surabaya City has the first large-scale WtE Power Plant in Indonesia launched in 2021 with 11 Megawatts (MW) capacity, divided into 2 MW of LFG Power Plant and 9 MW of Gasification Power Plant. For the community level, they built a small-scale WtE Power Plant in several compost houses with the energy produced of 4 MW per 12 hours utilized for lighting in the facilities and surrounding settlements. Surabaya City Government emphasized regularly-held environmental activities as an effective method in exchanging ideas and obtaining inputs from the public to achieve a better urban environmental quality by managing waste properly.

6. *R.A. Nidha Nadia, The Centre for Indonesia-Malaysia-Thailand Growth Triangle (CIMT-GT) Subregional Cooperation*

The community-based programs through Waste Banks effectively offer support to 3R practices in municipalities with limited budgets and infrastructures. There are several obstacles in implementing the waste banks i.e. lack of institutional capacity in implementing the accountable and sustainable waste bank, limited technical capacity of the implementing unit, lack of engagement to community members due to lack of awareness or no sense of belongings, the financial burden due to unstable waste price, and high dependency of the cooperation or foundation to Corporate Social Responsibility (CSR) funding or other grants. Additional lesson learnt cases from local governments of Makassar City and Gowa Regency in South Sulawesi, Indonesia which provided intervention at the policy and operational level to solve those problems through establishing a government-owned Central Waste Bank (CWB). CWB successfully built-up local people's motivation to establish and join as members of waste bank units, reduced inorganic waste, improved waste treatment at a household level, and increased people's opportunity to obtain an additional source of stable earnings.

7. *Nur Indrianti, Department of Industrial Engineering, Universitas Pembangunan Nasional Veteran Yogyakarta – Academic Institution*

Community-based engagement is essentially proven in tackling the waste problem in cities. The lesson learnt from one of the community activities for managing waste in their area shows that the endogenous movement at the community level offers integrated and comprehensive understanding at all levels of communities on the waste problem. The speaker presented her concept of a Community-based Solid Waste Bank (CSWB) model for sustainable education and she presented her study case in a kindergarten-level school i.e. *Taman Pendidikan Al-Quran (TPA) Miftahul Jannah* located in Sleman Regency, Yogyakarta. The key success factors of MJ-SWB are good leadership from the community, knowledgeable committee members which are mostly college graduates, and highly enthusiasm of the program's participants. Additionally, the government programs in promoting waste management programs through issuing policies and regulations also accelerate and facilitate the implementation of MJ-SWB. The special takeaway from MJ-SWB is the knowledge of the participating community in implementing the waste management project voluntarily to improve their environment and well-being.

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2.4 WORKSHOP DAY-3

The third day of the workshop was discussing community engagement and participation for community-based WtE programs, mainly about the importance of engaging and empowering communities on early-stage implementation of WtE projects. Such projects are not only initiated by governments but also initiated by other stakeholders such as NGOs or academic institutions. There was also a sharing of WtE experienced from Korea. Here are the key points which have been delivered by each speaker.

1. *Lee Ki-Hyung, Seoul Initiative Network on Green Growth (SINGG), Representative from APEC Economies – Republic of Korea*
Waste management in Korea has successfully been implemented by applying waste management paradigm-shifting which involved the policy's objective and approach. The previous paradigm had an objective to shape a pleasant living environment by implementing the 3R concept and constructing a safe treatment of waste facilities. Whilst the new paradigm focused more on building a zero-waste society and recovering energy from waste to achieve a greater reduction of CO₂ and other greenhouse gasses emission. The WtE technology selection in Korea is mainly the anaerobic digestion method with several types of organic waste treated i.e. livestock manure, night soil, food waste, and sewage sludge. As a result, they have several biogas plant facilities all over the member economy, and the biogas produced is utilized for generating electricity as well as an eco-friendly fuel for vehicles. The success story of the zero-waste society additionally opens opportunities for the tourism sector by inviting visitors to learn and see as well as experiencing the better city.
2. *Agus Brotosusilo, Faculty of Law, University of Indonesia – Academic Institution*
The individual participation level of community in implementing effective solid waste management (SWM) policies, particularly in the Special Capital Region of Jakarta, Indonesia, is influenced by the frequency of involvement in social community activities and education level of the urban community as the main factors. The takeaway presented is the proposed solution to those problems by empowering individuals and raising the frequency of Jakarta Citizens' involvement in social community activities at the grassroots level that along with educating people about waste management hierarchy. Furthermore, the social activities organized should provide another interesting benefit to residents e.g. economically profitable as an additional income for their community. It will eventually enhance the social acceptance of SWM programs initiated by the government.
3. *Annisa Noyara Rahmasary, Utrecht University alumni, Master's Graduate of Water Science and Management*
The research on profiling 11 large cities of Asian countries, including Jakarta and Bandung City in Indonesia, aims to identify governance capacity in tackling waste management problems of urban population. The study has shown a rising urban population means more urban challenges faced, especially the urban slum expansion which created solid waste and wastewater issues. Seoul City and Singapore have successfully solved those problems and have been categorized as resource-efficient and adaptive cities that sufficiently implemented waste management practices, whilst Jakarta and Bandung City are still categorized as wasteful cities with poor waste management systems. However, the government's effort in providing WtE facilities should be supported by the change in public behavior to minimize people discharging their solid waste and wastewater directly into the environment. In other words, public or community participation would play a great role in the overall effort of WtE programs. Additionally, there is a problem of local community reluctance to change their current living situation and local authorities must give more attention to local characteristics by

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engaging them in decision-making processes as it would increase their sense of belongings and willingness to cooperate.

4. *Eko Nugroho (Director) and Antonia Yosephine R. Pramudita (Staff), The Centre of Urban Community Empowerment (PUSDAKOTA) – Surabaya City, Indonesia*
Household waste disposal in Surabaya City was generally managed by the municipal government in coordination with the leaders of small-scale communities that covered up to 90 households. However, most of the residents assumed that they did not have to segregate waste produced as they had paid waste disposal fees to their leader. Therefore, PUSDAKOTA as an urban community empowerment center conducted a pilot project with a leader in Kalirungkut Residence, Surabaya to implement a waste sorting program by using behavior modification strategies i.e. all of the residents are required to sort their household waste into organic and inorganic waste as their unsorted waste would not be picked up by officers, PUSDAKOTA would collect organic waste for composting process, and the residents would receive profit earned from compost's sale as additional funding for community activities or events. Those strategies have a significantly positive impact in enhancing community engagement and participation to manage household waste properly. The collaboration work initiated has also strengthened the fruitfulness of household waste segregation programs in small-scale communities.
5. *Rebekka S. Angelyn, Yayasan Rumah Energi, Indonesia's NGO*
Indonesia Domestic Biogas Programme (IDBP) initiated in 2009 with its mission as a renewable energy access provider for cooking to Indonesian people towards the application of a circular economy through the distribution of biogas as an energy source for energy security and the use of bio-slurry as a natural fertilizer that contributes to food security. The WtE technology used is a biodigester equipped with Internet of Things (IoT) technology for sophisticated operation and easier maintenance by users. IDBP framework consists of four fundamental aspects i.e. technical training, R&D and quality control, education-promotion-advocacy, and business and management training. The special takeaway delivered is the challenging issue of how to create an established value chain of IDBP by developing and empowering biogas markets through the capacity-building improvement of its players and beneficiaries. It covered not only the biogas and bio-slurry users but also the construction material suppliers and partners, agriculture start-ups, IoT providers, and cooperatives or fintech institutions as players of an integrated business model.
6. *Mohamad Bijaksana Junerosano, Representative of Indonesia Renewable Energy Society, CEO of Waste4Change Company*
The speaker emphasized waste as a resource that needs to be managed responsibly by segregating it in the first place. It would lead to a more advanced waste processing such as recycling, composting, or WtE implementation using two approaches i.e. *bioconversion* by utilizing methane gas produced from organic waste to generate electricity and energy recovery focused on residual waste such as RDF technology. Furthermore, waste management is still a public service that required a structured and systematic government role to achieve good standards of service coverage. The presence of community-based waste management programs might help, however, it is very dependent on local leader's encouragement. Local governments should overcome the problem by enforcing WtE policies and regulations, creating a clear partnership with all stakeholders including local entities, and providing an adequate and fair financing scheme to WtE programs.
7. *Mohammad Ramdhan Pomanto, The Municipality of Makassar City, Indonesia's Local Government Representative*

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The community-based waste management in Makassar City is organized by using several approaches i.e. socialization, accompaniment, potential waste mapping, waste recycle training, WtE program's launching, discussion, monitoring, and evaluation. Whilst the community-based WtE projects implemented are including central waste bank innovation and waste exchange for products e.g. rice, ice cream, gas, or gallon water. It is challenging to shift community perception about waste as a valuable resource. Furthermore, some technical issues arose in implementing waste banks such as slow data integration process between all waste banks in the city and low adaptation of cashless payment in waste sales transactions. The transformation of waste bank operational and administrative is necessary to create an advanced and transparent system as well as utilize the IoT technology for engaging more people in participating.

2.5 WORKSHOP DAY-4

The last day of the workshop was discussing Gender Equality and Social Inclusion (GESI) in community-based WtE programs, especially about integrating women and vulnerable groups in those projects or businesses. They have an equal position as others to give impactful contributions in protecting the environment. Here are the key points which have been delivered by each speaker.

1. *Leuserina Garniati, Senior Consultant of Aquatera Ltd., Honorary Assistant Professor of Heriot-Watt University at The United Kingdom*
The vulnerable groups at any projects are not only considered as women but also considered based on people's religion, wealth, physical disability, sexual orientation, ethnicity, and employment status. Those groups frequently have limited access to their opinions and social standing whereas diversity is substantively a trigger to innovation and profitability. The lesson learnt in two different countries, i.e. Zambia and Indonesia, shows that impoverished villages could also get a lot of advantages from implementing WtE technology as solutions to unseemliness waste disposal facilities. Additionally, the programs implemented have involved vulnerable groups from the very beginning, including the design and execution processes.
2. *Fuji Riang Prastowo, Gadjah Mada University – Academic Institution*
There are three critical things about waste issues related to education and gender i.e. lack of meaningful involvement of women throughout the decision-making processes, lack of inclusion in gender-specific designs and gender-sensitive approaches in waste management programs, and the tendency to devise and invent strategies that are only directed to women while exempting another stakeholder. Therefore, the speaker presented best practices of gender-transformative approach in addressing the cause of gender-based inequalities and working to transform harmful gender roles and norms. It must be highlighted that both women and men are equally responsible to actively participate in WtE programs.
3. *Febriarti Khairunnisa, Bintang Sejahtera Social Enterprise, Indonesia's NGO*
The speaker delivered a lesson learnt from West Nusa Tenggara, Indonesia, in mapping the community intervention strategy and approach to obtain high participation rates by providing social campaigns and intensive mentoring. It could drive the local people to initiate waste management programs in their neighborhoods and would engage more people to maximize their waste as a resource. Additionally, the special takeaway presented is Bintang Sejahtera Social Enterprise's achievement in engaging 12,550 women over 11 years of operation and it represents 73% of participants involved which means women have an essential role in community-based WtE programs as the majority of beneficiaries.
4. *Ricky Amukti, Engagement Manager of Traction Energy Asia – NGO*

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Indonesia produced a large amount of Used Cooking Oil (UCO) with up to 16.2 million kiloliters per year and it leads to a highly potential of economic empowerment impacts for households and SMEs to supply UCO as WtE solution e.g. feedstock for biodiesel fuel. The takeaway focused on empowering small-scale groups, such as SMEs, that could be categorized as vulnerable to play an important role in waste management program implementation.

5. *I Kadek Agus Arya Wibawa, The Municipality of Denpasar City, Indonesia's Local Government Representative*

The speaker presented Denpasar City's government strategy to manage waste problems in the urban area i.e. socialization on waste sorting and segregation, optimization of self-waste management on every household, the establishment of 224 community-scale waste banks, development of integrated waste treatment facilities including RDF pellet production as WtE products, reduction of plastic waste, and development of waste management application entitled "SIDARLING" to push more participant and involve all stakeholders, as well as student, housewives, and elder people to become more aware in waste management activities. The special takeaway from this session presents that information technology offers a sustainable ecosystem without marginalizing any vulnerable groups.

2.6 DEEP DIVE ON WASTE TO ENERGY

The workshop delivered two breakout sessions on the second and the fourth days. The breakout session delivered collaborative discussions with brainstorming activities where the participants were divided into two discussion rooms led by moderators. Those aforementioned activities encourage participants to express their point of view regarding the current condition of community-based WtE management especially in Indonesia e.g. how effective policies and regulations are in empowering public involvement, what kind of obstacles are faced from the perspective of policymakers or technology providers, and how important gender equality and social inclusion issues are in the success of community programs. The discussion was conducted for around 30 minutes each and it delivered some suggestions to strengthen existing strategy of waste management problems.

2.6.1 BREAKOUT SESSION DAY-2: TECHNOLOGIES, POLICIES, AND REGULATIONS

The issue raised on the second day's breakout session is the role of policies and regulations in accelerating WtE management of urban communities. The central and local governments have provided necessary regulations to encourage rapid adoption and implementation of WtE technologies. For instance, governments have released regulations regarding the certainty of financial feasibility in building WtE Power Plant i.e. Feed-In Tariff (FIT) arranged by MEMR and Tipping's Fee arranged by MoEF. Surabaya City has successfully taken the advantage of those regulations by establishing Indonesia's first WtE Power Plant (Benowo WtE Power Plant) launched in 2021. It is a good example of how important the harmonized policies and regulations are in developing WtE infrastructure to achieve a better urban environmental quality. As time passes, amendments would be needed to upgrade the relevance of existing policies and regulations. However, as long as waste management programs have been initiated in the first place, all obstacles faced could be detected and solved immediately as a part of continuous improvement.

The effectiveness of government policies and regulations as accelerators should also be supported by good capacity building and technical assistance regarding the WtE management hierarchy and selection of WtE technologies to communities involved. It could be achieved by collaboration works with the other stakeholders, e.g. academic institutions and NGOs, to gain a higher people engagement and sense of belongings in managing

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waste properly. Furthermore, central and local governments could organize several public discussion forums with those well-educated communities to create two-way communication between leaders and society as a sign of good leadership. Those communities could convey their thoughts and suggestions based on actual conditions experienced. It would significantly assist governments in complementing the existing WtE policies and regulations. Eventually, it would also trigger communities to participate in any WtE programs implemented.

2.6.2 BREAKOUT SESSION DAY-4: COMMUNITY PARTICIPATION AND GESI (GENDER EQUALITY AND SOCIAL INCLUSIVENESS)

The issue raised on the fourth day's breakout session is the potential of marginalizing vulnerable groups, including women, in community-based WtE programs. Based on some cases delivered by the participants, waste management or other social programs do not intentionally ignore the role of women. However, the decision-making processes often exclude women unconsciously as the superiors in the project's organization are mostly men. Therefore, it is important to provide a carefully designed approach in ensuring both men and women can work together and benefits equally by obtaining the same access and opportunity in the projects.

There are some suggestions to ensure social inclusiveness especially in WtE programs initiated. It must begin with addressing and minimizing gaps between men, women, and other vulnerable groups by providing capacity building and technical assistance for all of them related to WtE technology and its implementation. It will raise awareness and social acceptance about GESI from the public's perspective as well as removing old social stigmas. Additionally, these social dimensions are something that must be managed seriously because it is as equally important as the technical dimension of the projects. Thus, everyone can actively involve in WtE programs with the right incentive, approach, access, and the same opportunity without worrying to be marginalized.

2.7 EVALUATION

Participants are required to complete and return a pre-test, a post-test, and an evaluation form by the end of the event. In the pre-test and post-test form, each participant is required to answer the questions based on his/her understanding with regards to community-based WtE management. Whilst in the evaluation form, each participant is encouraged to share their views and advice on the event's impact and efficiency as well as possible suggestions and policy implications for future APEC-related cooperation programs and activities. The four-day workshop was attended by 329 participants which 47% of them are women.

The pre-test and post-test form, with the same questions for both forms, asked attendees to give a score regarding the workshop's topic on a scale from *one* (1) to *nine* (9) where *one* means really not understand and/or disagree and *nine* means fully understand and/or strongly agree. The pre-test was filled before attendees joined the workshop, while the post-test was filled after the workshop was finished. Table 2-1 shows the results for the answers of those questions.

Table 2-1. Questions on Workshop Pre-Test and Post-Test Form

	Question(s) on Workshop Pre-Test and Post-Test Form	Pre-Test Average Score*	Post-Test Average Score*
1	Please mark your level of understanding about waste management hierarchy, e.g., Reduce, Reuse, Recycle.	6.99	7.97

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2	What is the level of relevance to have a community-based waste management in urban area?	7.19	7.98
3	What is the level of urban waste will affect climate change and sustainable development?	7.56	8.08
4	What is the level of importance to urban community participation in waste management?	7.70	8.16
5	What is the level of relevance to encourage the waste-to energy in urban area?	7.50	8.01
6	Please mark your level of understanding about waste-to energy technologies.	6.70	7.77
7	How relevant the national policy to encourage the community-based waste-to energy management?	7.25	7.98
8	How effective the national policy to encourage the community-based waste-to energy management?	6.94	7.78
9	How effective the local government to support the community-based waste-to energy programs?	7.04	7.82
10	Please mark your level of understanding about community engagement and participation for community-based waste-to energy programs.	6.69	7.81
11	How relevant the private sector engagement in community-based waste-to energy programs?	7.22	7.95
12	Please mark your level of understanding about Gender Equality and Social Inclusion (GESI) in the implementation of community-based waste-to energy management.	6.64	7.77

*the maximum score is 9

There is an increase of knowledge and better understanding about community-based WtE management after attending the workshop. This positive change also indicates a great willingness from participants to implement the WtE program delivered during the workshop.

The evaluation form asked attendees to score several attributes of the workshop on a scale from *one* (1) to *three* (3) where *one* is disagree, *two* is agree, and *three* is strongly agree. Table 2-2 shows the results for the main attributes.

Table 2-2. Main Attributes on Workshop Evaluation Form

	Attribute(s)	Score*
1	The objectives of the training were clearly defined	2.34
2	The project achieved its intended objectives	2.27
3	The agenda items and topics covered were relevant	2.41
4	The content was well organized and easy to follow	2.35
5	Gender issues were sufficiently addressed during implementation	2.23
6	The trainers/experts or facilitators were well prepared and knowledgeable about the topic	2.40
7	The materials distributed were useful.	2.47
8	The time allotted for the training was sufficient.	2.26

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Overall participants provided their self-evaluation that turns out the event was successful with very strong results. The participants highlighted that the workshop demonstrate a strong appetite and need for further projects with highly relevant skills and knowledge in implementing the WtE program.

The APEC Workshop on Community Based Waste to Energy Management was presenting 26 speakers that come from APEC Economies, research institutions, universities, Non-Governmental Organizations (NGOs), technology developers, private sectors, also including the national and the local government from Indonesia. The workshop was divided into 4 thematic days.

3. KEY TAKEAWAYS AND LESSONS LEARNT

The APEC Workshop on Community-based WtE Management provides several key outputs and takeaways for the WtE program i.e. WtE technologies for community-based approach, policies and regulations to promote community-based waste management, community engagement and participation for community-based WtE programs, and GESI in community-based WtE programs which involved women and vulnerable groups. The workshop also conducted breakout session discussions that produced outcomes in the form of recommendations to encourage and emphasize the implementation of community-based WtE programs. To summarize, here are the key takeaways and lessons learnt that can be used as references for a better plan of waste management practices.

3.1 WASTE TO ENERGY TECHNOLOGIES FOR COMMUNITY-BASED APPROACH

It is important to have a good framework for WtE technology selection and the following way of thinking should be considered before implementing it to the community level.

1. It is necessary to create high-quality WtE infrastructures by using a systematic and structural approach, especially the principle and essential components which are required to be considered carefully i.e. safety, security, stability of the technology, social and environmental sustainability of the technology that aligned with the national development strategy, and financial feasibility.
2. The selection of WtE technologies is ultimately depending on the variety of the local factors, including social-economic and political factors. There is no such thing as one fits for all solutions to tackle waste problems, particularly in city level.
3. The reliability of WtE technologies is important in ensuring social acceptance of waste management programs. However, social and cultural aspects place a much bigger role than the technical issues in scaling up the projects throughout the region/member economy.
4. The segregation and sorting processes are fundamental in the WtE management which will ensure the performance of any selected technologies. Therefore, community engagement is essential to sort the waste from the source at the household level.
5. WtE programs open financial opportunities and provide economic solutions at any level from the household up to city-wide. The selection of technology, therefore, must consider the capacity of the stakeholders in optimizing the additional value from the overall processes.

3.2 POLICIES AND REGULATIONS TO PROMOTE COMMUNITY-BASED WASTE MANAGEMENT

Policies and regulations are prominent requirements to promote community-based waste management programs. However, several things need to be considered to support its effectiveness.

1. Policies and regulations play a great role in creating a supportive environment and conditions to ensure the WtE community-based project can take off the grounds, such as simplifying and streamlining the permit processes. Additionally, transparency and accountability of the planning process are essential to ensure public participation and the private sector's engagement who will deliver the success of WtE projects implementation.
2. Policies and regulations play a great role in enhancing the economic viability of WtE projects by providing incentives and support for tipping fees as well as infrastructure supports, which will reduce impose risks of the projects. It would also create a more attractive investment for any investors to involve in supporting the WtE projects.

3. Key Takeaways and Lessons Learnt

3. Coordination among governments at all levels and coherent policy and regulation between central and local governments are essential, as the local governments directly execute the waste management programs whilst the central governments play a role in steering them and ensuring the regulations are supportive for the program's implementation. Furthermore, the coordination has to be in a feedback loop that is iterative based on the participatory mechanism that allows a top and bottom interaction. It would be more productive and useful for the continuous improvement of waste management programs conducted.
4. The central governments should encourage local entities to select the best type of technology and business model of WtE projects based on both technical and financial standpoints. Therefore, capacity building of local entities is important to increase the knowledge and technical expertise in ensuring the success of projects.
5. Policies and regulations would shape and support the WtE value chain, as well as the education to encourage people's behavior change about waste management. Policies and regulations are also the signs of responsible leadership. It would affect to the higher engagement from the community as their leaders are good role models.

3.3 COMMUNITY ENGAGEMENT AND PARTICIPATION FOR COMMUNITY-BASED WASTE TO ENERGY PROGRAMS

Community engagement and participation could not be separated at any WtE projects. It is noted that several takeaways from the successful WtE programs are indeed supported by a high engagement and participation from society.

1. There are many proven applications for applying community-based WtE such as biogas application under the IDBP project. The application generates economic and financial benefits to the communities.
2. The waste to energy project can address not only an environmental issue but it also opens opportunities to develop an integrated solution at a city-wide scale to create 'a green city' that can develop a tourist destination. This practice has been proven in several member economies such as Korea and China. Social acceptance is essential in developing and implementing the WtE project in particular at the community level.
3. Local governments are the prominent actor as a catalyst to community-based WtE project. However, they need to open their further understanding and perspective to ensure the buying in as well as the sense of belonging and willingness to cooperate from the community.
4. Learning from many successful projects, the community leader (can be an informal leader) and the champion focal person at the community level are effectively and essentially influencers. The community project is quite effective, but it will only deliver a limited impact. Collaboration among stakeholders is a key to enhance and leverage the impact.
5. The blended financing is doable, a lesson from the Yayasan Rumah Energy, the application of community-based WtE open wide opportunity to get additional support from CSR and also the carbon credit. This may tackle the financing burden from the local governments to deliver an integrated solution since local government's allocation and resources only cover between 5-49% of the required funding to manage urban waste in a sustainable fashion.
6. An integrated solution is a must, the collaboration is one of the key success factors to deliver integrated waste management. The community-based WtE programs could not be implemented without a structured, systematic, and massive governments role as waste management is fundamentally a public service. It required a bottom-top communication approach to increase community involvement at the grassroots level and trigger the sense of belongings and willingness to cooperate, which eventually led to a regional movement. Several tactics to a successful community engagement including influencing local leaders or early adopters, organizing a recognized event of

3. Key Takeaways and Lessons Learnt

WtE programs, and utilizing the latest communication platform e.g. WhatsApp, Facebook, Instagram.

7. The institutional relationship-building needs to be emphasized between the governments, NGO entities, and the local communities to achieve advanced public participation of community-based WtE programs through clear policies and regulations, law enforcement, and financial support.

3.4 GENDER EQUALITY AND SOCIAL INCLUSIVITY IN COMMUNITY-BASED WASTE TO ENERGY PROGRAMS: INTEGRATING WOMEN AND VULNERABLE GROUPS

Women and vulnerable groups have the same right to be involved in community-based WtE programs. They are very good at being the agent of change as some of them are the majority beneficiaries of the programs implemented.

1. GESI is an essential theme to ensuring gender equality and inclusiveness which may mitigate marginalization of the vulnerable groups. A lot of initiatives from the community level already addressed the GESI in doing their activities related to WtE which also actively engages the women into the overall process. However, it is challenging to ensure the GESI at any project. Thus, every project must take into account the existing social structure to address and deliver essential GESI activities in the WtE starting from an early stage of the project's preparation.
2. The effectiveness of WtE programs among women and vulnerable groups can be achieved by providing the same space and taking an additional effort to ensure that their participation is being accounted for. It would need extra cost, extra investment, and extra attention to facilitate them. However, when it comes to community-based programs or businesses, they should be treated as a beneficiary partner in the implementation.
3. Integrating women and vulnerable groups is not only the homework for governments or other formal institutions but also everyone else in the sector. It has to be collaborative efforts as the key successful aspect to ensure that they are being included in the waste management strategy from the very beginning.

4. CONCLUSION

The WtE programs offer mitigation actions towards climate change challenges in mitigating GHG emissions from waste management in cities. There are robust and proven options of technology to implement the waste to energy with fully community engagement to deliver the program. Supports from national and local governments are essential in ensuring the successful WtE program. Learning from Japan, the Republic of Korea, Indonesia, and Malaysia, the WtE program provides financial and economic benefits for the city and member economy. It opens opportunities to abate GHG emissions, increase the quality of life and well-being, and initiate tourism activities for the modern city – such as in Korea. Therefore, robust policy and regulation are a must to initiate the successful WtE project.

Community engagement is essential in waste management, considering one of the main sources of solid waste. The engagement starts from developing knowledge and technical capability essential to increase the community understanding and develop their sense of belonging to operate and maintain the WtE program. Additionally, the social acceptance of the WtE program is one of the critical success factors in delivering waste management despite any selected technology. Several lessons learnt from the implementation of the WtE, without strong social acceptance, the project faces a challenging stage in ensuring sustainability. The implementation of information technology initiates and accelerates the WtE program, which can open the engagement of a wide range of stakeholders in implementing integrated waste management.

Many success stories on waste management deliver the program without marginalizing vulnerable groups, women, children, and disabilities. The waste bank systems, such as in several cities, have successfully engaged women and vulnerable groups. The support from the power holders from the community level up to the local government levels is essential to ensure gender equality and social inclusiveness. The social structure, norm, culture, and local wisdom are the critical dimensions required for the entire project timeline. Ideally, the project must assess the social context and local culture at the initial stage to address the required gender equality and social inclusiveness agendas to ensure the program's overall social acceptance and sustainability.

Urban waste counted as 2.01 billion tonnes a year³ which contributes significantly to the GHG emissions from the urban sector. Community-based waste management contributes to mitigating emissions, improving health conditions for the community, and improving urban areas' well-being. The takeaways from the series of the sessions during the four-day workshops might contribute to the collaborative knowledge in designing required policy and regulation between APEC member economies, formulating the programs, selecting suitable technologies for urban waste management, establishing social acceptance, and ensuring the sustainability of the waste management. Additionally, IT provides tools to accelerate the penetration of waste management which may engage a wide range of beneficiaries while ensuring economic and financial benefits from the waste management program.

The workshop delivered a gender-balanced event where 44% of the participants are women. The participants expected for having a follow-up workshop considering this workshop is useful for them with relevant material for improving knowledge and skills which in line with the objectives of the workshop.

This event is essential for Indonesia to abate the GHG emissions in achieving the NDC target of abating 29% of CO₂ as an unconditional scenario and 41% of CO₂ with international

³ https://datatopics.worldbank.org/what-a-waste/trends_in_solid_waste_management.html

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support. Indonesia will be hosting the G-20 meeting in 2022, therefore the collaboration with the APEC economies is essential to support Indonesia for becoming greener member economies. It is expected a similar collaboration with APEC for the referring knowledge sharing especially related to energy transition could be beneficial for Indonesia and the APEC member economies.