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Techniques of Renewable Energy Generation from Waste

JYOTI CHOUDHARY

LECTURER, DEPT. OF CIVIL ENGINEERING, GOVT. POLYTECHNIC COLLEGE, ALWAR, RAJASTHAN, INDIA

ABSTRACT: Waste-to-energy plants burn municipal solid waste (MSW), often called garbage or trash, to produce steam in a boiler, and the steam is used to power an electric generator turbine.

MSW is a mixture of energy-rich materials such as paper, plastics, yard waste, and products made from wood. For every 100 pounds of MSW in the United States, about 85 pounds can be burned as fuel to generate electricity. Waste-to-energy plants reduce 2,000 pounds of garbage to ash that weighs between 300 pounds and 600 pounds, and they reduce the volume of waste by about 87%.

The most common waste-to-energy system in the United States is the mass-burn system. In this system, unprocessed MSW is burned in a large incinerator with a boiler and a generator to produce electricity. A less common type of system processes MSW to remove noncombustible materials to produce refuse-derived fuel (RDF).

KEYWORDS-renewable, waste, energy, municipal, solid, resource

I. INTRODUCTION

Generating electricity in a mass-burn waste-to-energy plant is a seven-step process:

1. Waste is dumped from garbage trucks into a large pit.
2. A giant claw on a crane grabs waste and dumps it into a combustion chamber.
3. The waste (fuel) is burned, releasing heat.
4. The heat turns water into steam in a boiler.
5. The high-pressure steam turns the blades of a turbine generator to produce electricity.
6. An air-pollution control system removes pollutants from the combustion gas before it is released through a smoke stack.
7. Ash is collected from the boiler and the air-pollution control system.

Wet waste, solid waste, and gaseous waste streams are potential high-impact resources for the domestic production of biofuels, bioproduct precursors, heat, and electricity. Wastes represent a significant and underutilized set of feedstocks for renewable fuel and product generation.[1,2,3]

DC Water's Blue Plains Advanced Wastewater Treatment Plant. Photo courtesy of DC Water.

These streams are available now without land-use change and in many cases their utilization helps to address the unique and local challenges of disposing of them. These resources are unlikely to diminish in volume in the near future, and as a result (in the short and medium term), they represent a potentially low-cost set of feedstocks that could help justify broader investment.

The U.S. Department of Energy (DOE) Bioenergy Technologies Office (BETO) is interested in the area of converting waste-to-energy—specifically the potential of the following waste streams:

- Commercial, institutional, and residential food wastes, particularly those currently disposed of in landfills
- Biosolids, organic-rich aqueous streams, and sludges from municipal wastewater-treatment processes
- Manure slurries from concentrated livestock operations
- Organic wastes from industrial operations, including but not limited to food and beverage manufacturing, biodiesel production, and integrated biorefineries, as well as other industries such as pulp and paper, forest products, and pharmaceuticals
- Biogas derived from any of the above feedstock streams, including but not limited to landfill gas.

Beyond its interest in these traditional organic waste streams, BETO is interested in promoting novel, non-photosynthetic carbon-cycling strategies that would support the valorization of inorganic carbon oxides, such as carbon dioxide and carbon monoxide, found in industrial gaseous waste emissions and biogas. In general, BETO's efforts aim to improve waste-stream management by closing waste loops and generating additional value streams from waste.

PRODUCTION POTENTIAL

Drawing on the workshops listed below, BETO published a report in January 2017, titled Biofuels and Bioproducts from Wet and Gaseous Waste Streams: Challenges and Opportunities. The report found that the United States has the potential to use 77 million dry tons of wet waste per year, which would generate about 1.079 quadrillion British thermal units (Btu) of energy. Gaseous feedstocks (which cannot be “dried” and therefore cannot be reported in dry tons) and other feedstocks assessed in the report could produce an additional 1,260 trillion Btu of energy, bringing the total to more than 2.3 quadrillion Btu annually. For perspective, in 2015 the United States’ total primary energy consumption was about 97.7 quadrillion Btu.

CONVERSION OF WASTE STREAMS

Wastes present a unique set of challenges in terms of conversion processes, and BETO has identified and is exploring a number of conversion possibilities at a range of technology-readiness levels.

Hydrothermal Processing

One technology option BETO is considering is hydrothermal processing. Efforts to advance this technology have benefited from prior funding under BETO’s algae and conversion research and development platforms. Research indicates that hydrothermal processing and related technologies could process diverse blends of wet waste feedstocks, offering potential for widespread deployment. For example, the Pacific Northwest National Laboratory has successfully produced a diesel blendstock from municipal sludge, and larger scale pilot efforts are under way. The hydrothermal research efforts so far represent only a few of the possibilities in this area. Supercritical water also offers intriguing options, as do other fluids at high temperature and pressure, such as carbon dioxide.

Alternatives to Traditional Anaerobic Digestion

Anaerobic digestion (AD) has been widely deployed worldwide as a part of waste treatment for sewage, animal manure, and other organic wastes. It produces biogas, primarily comprised of carbon dioxide and methane, which can be combusted to produce both heat and electricity. However, AD only reduces waste volumes by roughly 50%, and the biogas requires substantial (and costly) cleanup before it can be used as a vehicle fuel or injected into natural gas pipelines. Also, it is capital-intensive, and therefore uneconomic at smaller scales.[4,5,6]

In addition to hydrothermal processing, which could conceivably replace AD, BETO is exploring several alternatives to traditional AD. AD is a multi-step biological process. By arresting the final stage, it is possible to produce higher-value precursors to bioproducts and liquid biofuels rather than biogas. Alternative reactor designs, such as anaerobic membrane bioreactors, have the potential to reduce capital costs dramatically, and possibly to produce biogas with substantially more methane. There are also several promising possibilities to use both the carbon dioxide and the methane from biogas to produce higher-value fuels and products.

TECHNICAL ASSISTANCE

The Waste-to-Energy (WTE) Technical Assistance for Local Governments pairs national laboratory experts with U.S. local governments and decision makers, and provides technical assistance to advance WTE technologies, including addressing knowledge gaps, specific challenges, decision making considerations, planning, and project implementation strategies. WTE resources considered include organic waste, such as food waste, wastewater sludge, animal manure, and fats, oils, and greases.

BETO provides subject-matter assistance to local governments on a variety of topics including waste resource information, techno-economic comparison options, and market evaluation, among other topics of interest.

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2017 Waste-to-Energy Technical Assistance for Local Governments Announced

BETO and the National Renewable Energy Laboratory (NREL) have launched the next phase of the organic Waste-to-Energy Technical Assistance for Local Governments. The data from this program can help communities evaluate the most sensible end-uses for their waste, such as repurposing for: on-site heat/power, transportation fuels, nutrient recovery, or other options.

2018 DOE Announces Technical Assistance for Local Governments on Waste-to-Energy

BETO and NREL announced the Phase 1 selections for the Waste-to-Energy Technical Assistance for Local Governments. Phase 1 funded collaborations between NREL and sixteen local government entities to provide strategic planning support, quantification of local organic waste resources, and mitigation approaches for localized environmental impacts, among other high priority concerns.

SMALL BUSINESS INNOVATION RESEARCH OPPORTUNITIES

BETO is exploring a broad range of possibilities to identify small businesses with early-stage technologies that qualify for DOE's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs, which increase U.S. private-sector research on innovations to build a strong national economy. The early-stage nature of many waste-to-energy technologies, and the observation that the waste feedstock is readily available in many cases makes them good candidates for the SBIR/STTR programs. SBIR/STTR technical topic areas for both the Fiscal Year 2016 (topics 10 b and c) and Fiscal Year 2017 (topics 14 a and b) included aspects of waste to energy.

WORKSHOPS

BETO regularly hosts workshops and listening days to enhance its portfolio and engage key stakeholders in discussion. These workshops seek to integrate the activities of federal agencies to address research that is relevant to industry but which is appropriate to the unique role of government.

Advancing the Bioeconomy: From Waste to Conversion-Ready Feedstocks Workshop: February 19–20, 2019

In recent years, BETO has expanded its portfolio beyond traditional biomass feedstocks to include using waste resources, such as municipal solid waste (MSW), biosolids from municipal wastewater, and industrial waste gases. BETO conducted a workshop to understand the current state and potential trajectories of technologies to support MSW as a feedstock for producing fuels, value-added products, and power.

Engineered Carbon Reduction Listening Day: July 8, 2017

The purpose of this listening day was to understand how the novel concept of engineered carbon reduction could potentially rewire the bioeconomy. Engineered carbon reduction proposes solutions for challenges in the carbon capture and grid modernization sectors. Non-photosynthetic conversion technologies could—by leveraging excess or inexpensive energy when available—chemically reduce the carbon in waste carbon dioxide to intermediates. The intermediates could be further upgraded to fuels and products. Non-photosynthetic technologies discussed included both biological and non-biological approaches. Overarching themes of carbon efficiency and management, techno-economic analysis, life-cycle analysis, and supply chain sustainability analysis were also discussed.

Biofuels and Bioproducts from Wet and Gaseous Waste Streams: Market Barriers and Opportunities Workshop: June 6–7, 2017

This meeting had a strong pragmatic emphasis, with a focus on tangible challenges and potential solutions in

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facilitating cost-effective technologies in the waste-to-energy platform. Participants included feedstock providers, technology developers, potential customers, and relevant state actors. Participants told BETO that increased communication across federal and local levels was encouraging, because waste-to-energy research and development should not live in a vacuum without regional considerations. Participants explained that waste feedstock characteristics are regionally unique, and waste management decisions are driven by state and municipal policy.

Waste-to-Energy Roadmap Review: June 22–23, 2016

This meeting provided an opportunity for key stakeholders to provide focused input on future challenges, opportunities, and possible strategies regarding the conversion of wet and gaseous waste streams into drop-in biofuels and bioproducts. Participants received a preliminary draft of the "Challenges and Opportunities" report in advance in order to inform discussion.

Biogas Opportunities Roadmap Progress Report: December 2015

The U.S. Department of Agriculture (USDA), U.S. Environmental Protection Agency (EPA), and DOE collaborated to update the Biogas Opportunities Roadmap. This effort extends the scope beyond the municipal wastewater community to include other relevant feedstocks, such as animal husbandry wastes. A key theme is that early opportunities may lie in feedstocks that currently pose disposal costs and challenges.

Energy-Positive Water Resource Recovery Workshop: April 28–29, 2015

The National Science Foundation, DOE, and EPA jointly hosted this workshop to better define the industry's long-term vision (20+ years) for water resource-recovery facilities and the actions needed to make that vision a reality.

Hydrogen, Hydrocarbons, and Bioproduct Precursors from Wastewaters Workshop: March 18–19, 2015

Hosted by BETO and DOE's Fuel Cell Technologies Office, this workshop focused on anaerobic membrane bioreactors and microbial electrochemical fuel cells. Approximately 40 attendees discussed the topics over two days, identifying ways to advance the sustainable utilization of wet waste streams, complement the work of other agencies, and maximize the value of research investment.

Waste-to-Energy Workshop: November 5–6, 2014

Hosted by BETO, this workshop focused on AD, hydrothermal liquefaction, and other technologies for the production of energy products beyond biogas. Approximately 85 attendees identified 17 key ideas, including alternative reactor designs—which prompted further discussions .

EPA Nutrient Recycling Challenge: Launched 2015 (Ongoing)

In collaboration with USDA, private stakeholders, and DOE, EPA launched the Nutrient Recycling Challenge, focused initially on recovering nutrients from dairy and swine manure. Phase I awarded four primary and six secondary prizes and encouraged multiple additional applicants to move on to subsequent phases.

II. DISCUSSION

With world resources finite, and increasing public awareness of the harmful effects of our 'throwaway culture', a move towards what's known as a circular economy seems a sensible option. In short, this means making products last longer, and recovering materials or other benefits from them when they can't be fixed.

Generating energy from waste – whether that's electricity or heat – that can then be used in homes and businesses is a logical part of this move towards circular thinking.

How green is waste-to-energy?

It's important to place the idea of generating energy from waste in its proper context – and the waste hierarchy does this best. The waste hierarchy tool indicates an order of preference for actions to reduce and manage waste.

It places energy generation (recovery) below reducing waste, re-use, and recycling and composting, meaning it's those options that should be considered first when managing waste; but above waste disposal meaning that waste-to-energy is preferable to landfill.

How truly 'green' waste-to-energy is depends on the efficiency of the plant turning the waste into energy, and the proportion of the waste that is biodegradable. This affects whether the approach is considered to be 'recovery' or simply 'disposal' of waste.[10,11,12]

There are number of ways of generating energy from waste. These include combustion, gasification, pyrolysis, anaerobic digestion and landfill gas recovery.

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Combustion: Burning up what's left behind

First up, combustion. This is where heat produced by burning waste produces heat, driving a turbine to generate electricity. This indirect approach to generation currently has an efficiency of around 15-27%, albeit with a lot of potential for improvements. Whether any approach to generating energy from waste can be considered sustainable depends on the 'net calorific value' of the waste going into the process. Where incineration of waste is concerned, that figure must be 7 MJ/kg, meaning the likes of paper, plastics and textiles are best suited to the combustion method of generating energy from waste.

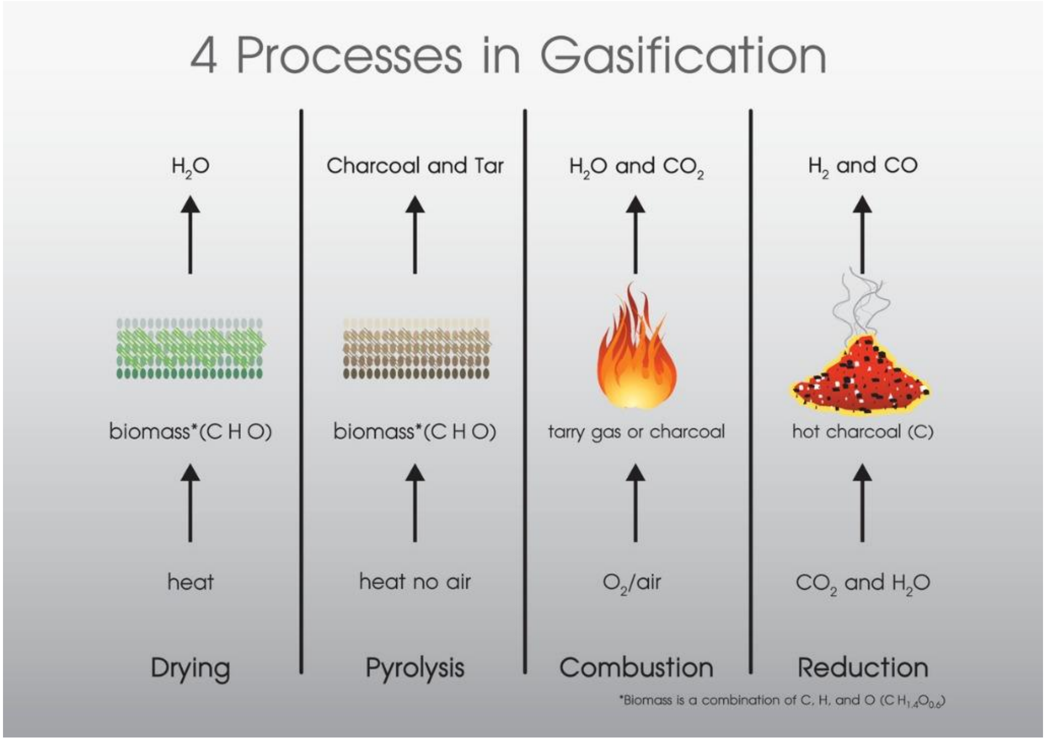
Of course, combustion produces emissions – 250-600 kg CO2/tonne of waste processed – but this is offset by the fact that fossil fuels don't need to burned. There are, however, other pollutants emitted from combustion in the form of flue gas.

Gasification: waste's a gas

Gasification, rather than being the business of driving turbines directly, is about the production of gas from waste. Our everyday rubbish, consisting of product packaging, grass clippings, furniture, clothing, bottles, appliances and so on, is not a fuel as much as the feed for chemical conversion at very high temperature. The rubbish is combined with oxygen and/or steam to produce 'syngas' – synthesised gas which can then be used to make numerous useful products, from transport fuels to fertilisers or turned into electricity.

But a problem here is that gasification is often followed by combustion, leading to some of the same emissions issues as combustion. The same issue can apply to what happens after the pyrolysis of waste.

Gasification is also not a particularly efficient mechanism of producing energy, as the pre-processing requires a lot of energy and the reactors need to be closed down for regular cleaning.[13,14,15]



Pyrolysis: no oxygen, no trouble?

Where pyrolysis is different from other methods listed so far is that decomposition of various solid wastes takes place at high temperature, but without oxygen or in an atmosphere of inert gases. This means the process requires lower temperatures, and has lower emissions of some of the air pollutants associated with combustion.

It's worth noting, however that Friends of the Earth doesn't consider the energy generated through either gasification or pyrolysis as truly 'renewable' due to the fact that they release CO_2 from both fossil fuel origins such as plastics and synthetic textiles as well as biological materials.

Tackling organic matter

Anaerobic digestion can be used to generate energy from organic waste like food and animal products. In an oxygen-free tank, this material is broken down to biogas and fertiliser.

It's an approach with big potential. If we treated 5.5 million tonnes of food waste this way, we'd generate enough energy to serve around 164,000 households while saving between 0.22 and 0.35 million tonnes of CO_2, in comparison to composting.

Extracting the biogas produced by biodegrading materials on landfill sites is another way of getting useful energy from waste. Although it's an approach that's in decline due to the reduction of the amount of organic matter going to landfill, it's making a notable contribution to UK energy supply: the source 3.04TWh of green electricity in the last year, in fact.

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Tackling the plastic problem

Plastic waste has risen to significant levels of public consciousness in recent years, for its negative impact on habitats and species. In response, the UK Government's 25-year Environment Plan pledges to eliminate all 'avoidable' plastic waste by the end of 2042 – and it's not alone in making such political commitments. Can waste-to-energy step in here?

Converting plastic waste to energy certain makes sense from a chemical perspective, given plastics come from the same origin as fossil fuels. We've already looked at the two main techniques involved: pyrolysis, where plastic is heated in the absence of oxygen, and gasification, where air or steam heats the waste, creating gases that either produce petrol or diesel, or are burned to generate electricity.[16,17,18]

New techniques such as cold plasma pyrolysis, provide the potential to create fuels such as hydrogen and methane, as well as useful chemicals for industry.

But there are barriers in the way of wider uptake of plastic-to-energy techniques. Gasification of plastics requires significant investment, including advanced controls and pre-treatment facilities. Also, developing plastic-recycling plants presents a risk of limiting those facilities, when decision-makers may instinctively opt for waste strategies where general waste is processed together, rather than separating out different elements.

Novel approaches to waste management in the UK will surely rise in the coming years. Recycling rates seem to be plateauing, with only minor increases seen. While generating energy from waste has a lot of promise, we need to focus on making products last longer, and when they really can't be fixed, finding ways to recycle and reuse them. Only when those options are exhausted should we turn to waste-to-energy.

III. RESULTS

Governments across the emerging markets are eager to tap into waste-to-energy (WTE) technologies

But many are learning that it takes more than the granting of licenses to create economically and environmentally sustainable WTE solutions. In this article, we look at a number of Southeast Asian markets to identify both new

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projects and barriers to adoption. We also provide several tips to help governments and planners in the successful development of their WTE initiatives.

New solutions for new imperatives

WTE technologies convert non-recyclable waste into usable forms of energy. The heat from the combustion of waste generates superheated steam in boilers, and the steam drives turbogenerators to produce electricity.

Waste management has become an imperative given that most cities are running out of landfill sites - the traditional method of disposing waste. With increasingly limited land availability and the steady growth of cities, governments need to implement effective and sustainable waste management solutions including WTE technologies.

WTE is only one part of a comprehensive, waste management plan," says Edwin Yuen, Senior Private Sector Operation Specialist at the Asian Infrastructure Investment Bank. "Projects should begin with waste minimization as a public policy, followed by waste recycling and WTE incineration, and ending with the remaining ash delivered to local landfills."

WTE systems provide a highly valued source of renewable energy, but perhaps the greatest benefit of WTE today comes from its ability to convert waste into ash, reducing by up to 90 percent the volume of waste going to landfills.[1] This reduction in waste can also help contain the amount of methane emissions from landfills with decomposing organic materials.[2] These issues are especially important in Southeast Asia, where the urban population is projected to rise to nearly 400 million by 2030,[3] requiring significant investments to cope with the rapid increase in garbage. In some areas such as Singapore, the relative lack of land for landfills is also a key factor in adopting WTE solutions.
WTE is one of several imperatives for sustainable waste management. WTE systems can be an effective supplement to fossil fuel-based power sources while also reducing landfill requirements in urban environments, generating renewable energy and producing revenue for municipalities and governments.

Proven technologies

WTE technology has been developed and implemented for decades. The most robust technology is 'moving grate, mass burn' technology featuring a moving grate that burns Municipal Solid Waste (MSW) on a grate travelling from a feed shaft to the ash pit. The moving grate technology does not require pretreatment or sorting of MSW, allowing it accommodate large quantities and variations of waste composition and calorific value. The technology has been used for over a century, with a proven track record of operation for mixed MSW treatment.

Between 2003 and 2011, at least 106 moving grate incineration plants were built worldwide for MSW treatment.[4] One of the world's largest moving grate incineration plants was installed in Singapore by Mitsubishi in 2000, providing a capacity of 4,300 tons per day (tpd) of waste.[5]
A wide range of technology solutions for WTE ─ some already used in developed markets ─ is expected to be implemented in Southeast Asia in the years to come. 'Fluidized bed' is a cleaner and more efficient technology for converting waste to electricity, but the process needs a more uniform waste size to operate, making it more complicated and expensive compared to moving grate systems. 'Gasification' plants use plastic and organic solid waste in a chemical conversion process that creates and burns synthesis gas at high temperatures.[18,19]

The economics of WTE

The Asia-Pacific WTE market is projected to grow at an annual rate of over 15 percent and reach a value of US$13.66 billion by 2017.[6] Tapping into this market is a variety of commercial banks, multilateral development banks, financial sponsors, and private equity firms. In general, financial equity is less available in emerging markets but more common in developed markets such as Australia.
Public Private Partnerships (PPPs) are a favored development strategy in the region. In Singapore, the NEA develops WTE facilities both on its own and through private sector developers under a PPP structure, according to Ananda Ram Bhaskar, Deputy Chief Executive Officer (Environmental Protection) & Director-General of Environmental Protection Division at Singapore's National Environment Agency (NEA).

In a typical PPP structure for WTE projects, the developer undertakes the development of the project under the Design-Build-Own-Operate (DBOO) model. In the DBOO model, the developer secures its own financing and builds, owns, maintains and operates the WTE facility to meet the contracted WTE capacity over the lifespan of the facility, which is about 25-30 years. WTE facilities require significant upfront investments and developers and their financiers require assurances from the government agency commissioning the project that enables the investment to be recovered over time.

Yuen points out that any development strategy involves the basic economics of how a WTE facility makes money. Along with government incentives, WTE is based mainly on two sources of revenue. The first source is a gate fee charged when municipalities, businesses or other organizations deliver their waste to the facility for disposal. The second source is the generation of electricity that is sold to local power grids. (End products of WTE incineration like ash represent a third but smaller source of revenue.)

Yuen explains that the gate fee is driven by the volume of waste, and electricity sales are driven by the heat produced. This fact, in turn, can influence the business model of the WTE project. The more waste that is combustible, like plastics, paper or wood, the hotter the furnaces burn and the higher the caloric value (CV) produced. The more non-combustible waste, like bricks or glass, the lower the CV. This mix determines the facility's revenue streams.

In addition, safety regulations require that the facility is designed for a certain thermal capacity. If the percentage of combustible waste is too high, the CV value will be above the designated level, and the operator will have to reduce the amount of waste going through the facility. This reduces gate fees. However, if the CV is too low, the facility generates less electricity that it can sell.

“The single biggest challenge for WTE,” says Yuen, “is to balance the right CV and quality of the waste to optimize both waste volumes and electric sales.”

Developments across Southeast Asia

Currently, there are 10 waste-to-power plants or trial projects across the 10 member states of the Association of Southeast Asian Nations, including developments in Singapore, Thailand, Indonesia, and Vietnam.[7]
Not surprisingly, China is a major player in the region, marketing waste-to-energy technology developed over the years for its domestic WTE plants. China had 7.3 gigawatts of energy production across 339 power plants in 2017.[8] This is expected to grow to 10 gigawatts and 600 plants by 2019.
However, Japan runs a close second in exporting its expertise and technology. The country has 380 waste-to-energy plants nationwide, and almost a third of the country's refuse—incineration facilities turn garbage into electric power.[9] In some ways, Japan is taking a more aggressive approach than China by offering combination packages that include WTE backed by a range of services such as waste sorting, waste reduction, personnel training, and recycling. Hitachi Zosen, JFE Engineering, Mitsubishi Heavy Industries and other Japanese exporters are expected to join consortia to bid for plant orders in Southeast Asia. As of mid-2019, Japan has pursued agreements with Vietnam, Indonesia and the Philippines,[10] and the Japanese ministry has set aside 2 billion yen (US$18.49 million) in its fiscal 2019 budget to support field surveys and other pre-bid activities.
To give a sense of the range and volume of WTE activity in Southeast Asia, we can note the following projects and initiatives now in play:

Singapore has long been a regional leader in WTE development. Bhaskar shares that Singapore aims to reduce the average daily amount of waste sent to Semakau Landfill by 30 percent, or from 0.36 kg/capita in 2018 to 0.25 kg/capita by 2030. Currently, the country's solid waste disposal infrastructure consists of four WTE plants: Tuas, Senoko, Tuas South and Keppel Seghers Tuas Plant (KSTP), in addition to the Semakau Landfill. In the country's upcoming WTE-based Integrated Waste Management Facility (IWMF), treatment facilities for multiple waste streams will be catered for. To be developed in phases, the first phase of the IWMF will be capable of handling 2,900 tpd of incinerable waste; 250 tpd of household recyclables, 400 tpd of source segregated food waste and 800 tpd of dewatered sludge from the future Tuas Water Reclamation Plant (TWRP), which will be integrated with the IWMF to form the Tuas Nexus.[11] The Tuas Nexus allows synergies to be derived from the water-energy-waste nexus and improve energy and resource recovery efficiencies and enhance land use optimization for Singapore.[12]

Indonesia is moving forward on plans for 12 WTE plants, starting with auctions for three WTE projects in 2019/20 — one in the West Java capital of Bandung and two more in Banten -- Tangerang and South Tangerang.[13] Similar plants are set to be developed in Jakarta, in the South Sumatra capital of Palembang, the West Java city of Bekasi, the Central Java cities of Semarang and Surakarta, Bali's capital city of Denpasar, East Java's capital of Surabaya, South Sulawesi's capital of Makassar and North Sulawesi's capital city of Manado. All 12 waste-to-energy plants are expected to be completed in 2017 and produce 234 MW of electricity.
Thailand has established subsidies and tax incentives for various WTE plants that include incineration, gasification, fermentation and landfill gas capture.[14] The country has also set 500 MW as the target for WTE in the new Power Development Plant 2018-37, which represents 30 percent of total renewable energy resources by 2037.[15] The tentative feed-in tariff given for the WTE plants is THB3.66/kWH.
Vietnam is attracting investor interest from China, Japan and other countries. Several municipal authorities have accepted WTE plant projects and called for investment from different economic sectors. Ho Chi Minh City Municipality has released a set of criteria for investing in WTE projects that can process domestic waste up to 9,300 tpd. The government has set a high electricity purchasing price for WTE up to USD10.05 cents/kWh, which is even higher than prices for wind and solar power.[19]
Malaysia will have its first WTE plant in operation in June this year.[16] Located in Tanah Merah, Negeri Sembilan, the project is planned to handle 1,000 metric tons of solid waste daily and to produce 20 to 25 MW of electricity to power 25,000 households.
Australia now has its first WTE project, the 400-ktpa Kwinana facility currently under construction. More than 30 proposed WTE projects are also under consideration, including a AUD300 million facility in Ballarat and a AUD400 million facility at Swanbank west of Brisbane.[17]

IV. CONCLUSION

Southeast Asian countries have a number of public policies to encourage and support WTE projects. For example, the Indonesian government has declared WTE plant projects as national strategic projects. To achieve a viable risk structure for WTE projects, however, initiatives will require close coordination and cooperation among multiple government stakeholders, including the state utility as an off-taker of electricity, municipalities for a supply of waste, and land sites to achieve a bankable PPP structure that ensures stable, predictable cash flow for the WTE plants.

Consistency and quality of waste is also a key risk factor to lenders and investors. Many emerging economies have limited waste-sorting processes and regulatory requirements to separate different types of waste. Furthermore, Southeast Asian waste can have a significant amount of “wet” waste that includes food waste which is harder to burn, provides a lower caloric value, and can vary in waste type and quality from year to year. For incineration plants, this means a fluctuation in electricity output and revenue uncertainty.

In addition, WTE plants produce ash that needs to be disposed of safely, usually in landfills that are lined with barriers to prevent ground water contamination.

Whether incineration, and waste to energy, is a net positive, can depend on the efficiency of the process, and the energy mix that waste to energy is replacing. The newest incineration plants have far better pollution and dioxin filters to protect the environment and human health. That technology will require governments in emerging markets to make additional investments for products and resources.

Steps to consider

Yuen suggests a number of key steps to consider when launching a WTE initiative. Project planners should gauge how much WTE capacity is needed and then plan a pipeline of projects to support this capacity. This support should include waste collection logistics and quality in the way that waste is collected and processed. Economic feasibility should be based on affordable gate fees and electricity fed-in tariffs if applicable.

At every stage, the project should be marketed and explained to the general public, including a full description of the challenges and benefits of WTE technology. Finally, planners should incur full buy-in by the local municipal and national governments to help ensure the long-term support and viability of the project.

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Municipal governments can leverage skill sets from the private sector in implementing WTE projects with state-of-the-art technology. Financing is available, along with long-term, predictable-quality waste contracts that help ensure reasonable tipping fees. Power-offtake contracts can include tariff levels that support the commercial viability of WTE projects. Singapore and other countries in the region are setting the right benchmark in this regard. Successful projects can serve as a template for other countries in the region.[20]

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