



# 2016 Top Markets Report **Environmental Technologies** Regional Supplement

## Southeast Asia

The members of the Association of Southeast Asian Nations (ASEAN) are pursuing comprehensive regional integration initiatives that by 2020 aim to reduce all barriers to the free flow of goods and services and provide national treatment to foreign investors. These initiatives parallel developments in environmental activism and regulatory stringency across a region that boasts some of the world's most biodiverse areas. Rapid population growth, along with increasing urbanization, industrialization and investment in infrastructure, complement the projected healthy economic growth rate (above 5 percent) for the region in the medium-term.

### Regional Market Overview

In 2014, if the members of ASEAN had been a single country, they would have been the seventh largest economy in the world (USD 2.6 trillion) and the third largest country by population (622 million).<sup>1</sup> The regional market for environmental technologies is similarly large and growing. If it had been scored as a single country for this report, it would rank among the top three.

Rising demand for transportation, clean water, energy and solid waste management infrastructure in this vibrant region pose a significant challenge to all ASEAN countries and their governments. Several recently have adopted stricter environmental governance policies and judicial frameworks to try to tackle some of these issues. For example, Thailand has established environmental divisions in its Supreme, Appellate and Trial courts. Despite these positive developments, however, most ASEAN member nations still face similar challenges in implementing and enforcing environmental laws and regulations. The Asian Development Bank's Environment Operational Directions 2013-2020 recommends that its developing member countries, including those in Southeast Asia, take transformational action for green growth by investing more resources in large-scale innovative programs that may include sector-wide demonstration

projects, aggressive barrier removal, policy initiatives, scaled-up deployment programs, and diffusion and transfer of clean technologies.

The ASEAN Socio-Cultural Community Blueprint (2009-2015) also highlights the use of "environmentally sound technologies" to promote sustainable development in the region. To grow sustainably, the Blueprint states that Southeast Asian nations must address deforestation, biodiversity loss, trans-boundary haze and areas with severe air and water pollution. Southeast Asia also is highly vulnerable to the effects of climate change. With extreme weather events projected to increase in frequency and severity and rising sea levels threatening the region's heavily populated and economically critical coastlines, adaptation and mitigation efforts are imperative. A number of ASEAN countries have now set climate targets. Specifically, Malaysia aims to reduce the carbon intensity of its gross domestic product (GDP) by 40 percent by 2020 from 2005 levels; Thailand has proposed a 20 percent reduction in emissions by 2030, compared to business-as-usual levels, that could increase to 25 percent with international support, and Singapore has committed to reduce greenhouse gas (GHG) emissions by 16 percent from business-as-usual levels by 2020.<sup>2</sup>

The ASEAN Economic Community (AEC) is a newly-launched initiative that aims to promote freer trade

and capital flows among member states. In addition, four Southeast Asian nations (Singapore, Malaysia, Vietnam and Brunei) are parties to the Trans Pacific Partnership Agreement (TPP), which has the highest environmental standards of any trade deal. As such, the TPP Agreement upgrades the environmental provisions in the U.S. Free Trade Agreement (FTA) with Singapore. The Government Procurement chapter of the TPP Agreement also contains additional commitments beyond previous agreements and affirms the parties' commitment to ensure transparent bidding procedures, non-discriminatory technical specifications and objective review of procurement decisions. The TPP Agreement was concluded in October 2015 and signed in February 2016. It is currently undergoing ratification processes in each of its 12 partner countries. This high-standard agreement will help to facilitate trade in environmental goods and services through both strengthening environmental regimes and eliminating tariffs on environmental goods, thus increasing competitiveness of U.S. technologies in TPP markets in Southeast Asia and elsewhere. Increased attention to environmental matters from policymakers, along with freer-flowing trade, aggressive project pipelines and innovative financing models, should result in numerous opportunities for U.S. companies interested in capitalizing on robust growth in the region.

### Market Barriers

Commerce's Environmental Technologies Trade Advisory Committee (ETTAC) and the Office of Energy and Environmental Industries have identified the following barriers as the most problematic for environmental technologies companies attempting to export to or work in Southeast Asia:

- 1. Corruption**  
Some countries in the region are perceived to be highly corrupt, while others much less so. In Transparency International's 2015 Corruption Perceptions Index, of ASEAN member states, only Malaysia and Singapore scored above 50 out of 100, with 100 being extremely clean.
- 2. Preferential Treatment/Procurement**  
The ETTAC reports instances of preferential treatment for companies from certain countries (e.g. China, Japan) over companies from other countries, in either the public or

private sectors or both, depending on the country.

### 3. Regulatory Enforcement

While regulatory structures support environmental technology market growth in general in the region, weak regulatory enforcement in some markets reduces technology demand and impedes market growth and export opportunities.

## Philippines

### Air Pollution Control

The Philippine Clean Air Act of 1999 (Rep. Act No. 8749) charges the Department of Environment and Natural Resources (DENR) with developing an Air Quality Control Action Plan; designating ambient air quality standards in coordination with other concerned agencies to protect public health, safety and general welfare; and issuing or denying permits. The Air Quality Control Action Plan under the Clean Air Act provides for the establishment and operation of appropriate devices, methods, systems and procedures necessary to monitor, compile and analyze data on ambient air quality.<sup>3</sup> The Clean Air Act also stipulates an Integrated Air Quality Improvement Framework, which charges local government units (LGUs) with developing an action plan aimed at attaining and maintaining ambient air quality standards.

DENR's Environmental Management Bureau (EMB) data show that the average pollutant concentration in the National Capital Region reached 101 micrograms per normal cubic meter ( $\mu\text{g}/\text{Ncm}$ ) in terms of total suspended particulates (TSP) in the second half of 2015, down from 106  $\mu\text{g}/\text{Ncm}$  during the same period of 2014. According to the results of the 2012 National Emissions Inventory, 69 percent of air pollution comes from mobile sources.<sup>4</sup> The remainder comes from stationary and area sources, such as construction activities and unpaved roadways.<sup>5</sup> In Metro Manila, 90 percent of the air pollution comes from mobile sources.

In response to growing demand for electricity and lower coal prices, in June 2015, the Filipino government announced that 23 new coal-fired power plants would come online by 2020, including two in Davao City, a 400 MW expansion of existing facilities in Quezon Province, a 600 MW plant in Subic and a 600

MW plant in Bataan.<sup>6</sup> Coal is projected to make up a significant percentage of the energy mix into the future, even as the Philippines strives to meet its climate commitments, which include tripling installed generating capacity from renewable sources by 2030. In addition to emissions control technologies, those associated with emissions inventories, source testing, evaluation and installation, and system maintenance and repair are in demand and are typically purchased abroad and shipped to the Philippines for installation by local distributors or agents.<sup>7</sup>

#### Key Technologies in Demand:

- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Flue gas desulfurization equipment
- Electrostatic precipitators
- Catalytic converters
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Inspection, adjustment, maintenance and repair services

#### Waste Management and Recycling

Waste management in the Philippines is regulated by the Ecological Solid Waste Management Act of 2000 (Rep. Act No. 9003 (2000)) and the 1990 Toxic Substances and Hazardous Wastes Control Act (Rep. Act No. 6969). There is a robust informal sector, with a large number of people actively involved in waste collection, separation and recycling. Local government units (LGUs) are officially responsible for solid waste management, including collection and disposal. Delivery of these services, however, often remains challenging due to capital constraints, budget and personnel constraints, as well as physical infrastructure limitations, particularly in urban areas. Currently only about 85 percent of the more than 9,000 tons of garbage produced every day in Metro Manila is collected. Nationwide, the estimated amount generated per day is 40,000 tons, of which between 40 and 85 percent is collected. Most of the solid waste that is collected is taken to open dump sites that often catch fire and contaminate local water supplies with untreated leachate.<sup>8</sup> As of the end of 2015, the Philippines had 350 open dump sites, 203 controlled disposal facilities and 84 sanitary landfills. There are 17 sanitary landfills currently under construction.

In 2016, the Department of Environment and Natural Resources (DENR) received P500 million (about USD 10.8 million) from Congress for solid waste

management capacity building to help local governments comply with the Solid Waste Management Act. The Act stipulates the replacement of open dumps with sanitary landfills or materials recovery facilities and, together with the recent allocation of funds, may present opportunities for U.S. companies in this area.<sup>9</sup>

#### Key Technologies in Demand:

- Waste collection technologies
- Sanitary landfill systems
- Materials handling equipment
- Recycling equipment
- Environmental monitoring and analytical equipment

#### Water and Wastewater Treatment

##### Municipal Water Treatment and Supply

There is a need to expand drinking water treatment and conveyance in the Philippines. Approximately 43 percent of the population has mains access for drinking water concentrated mostly in urban areas, where access nears 61 percent (as opposed to rural areas where access is just 25 percent).<sup>10</sup> Demographic trends, including rapid urbanization and an overall growing population, are placing pressure on existing system's ability to meet demand and subsequently widens the access gaps further. For instance, it is estimated that Manila, the Philippines' industrial and population center, currently suffers a 400,000 m<sup>3</sup>/D water deficit with shortfalls expected to grow rapidly in the coming years.<sup>11</sup>

To meet the existing access gap and address projected future needs, the government is placing significant focus on the development of water treatment and supply projects. In December 2015, the Metropolitan Waterworks and Sewerage System, the government agency in charge of the water and sewerage system in Metro Manila, awarded the Bulacan Bulk Water Supply Project to the Luzon Clean Water Development Corporation. It is currently bidding the USD 398 million New Centennial Water Supply Project. Both projects are under the Philippine government's public private partnership program.<sup>12</sup> Despite the government's ambition, most public sector infrastructure projects are co-financed through a combination of federal funds, multilateral development banks and bilateral aid, which dampens the likelihood all planned projects will come to fruition in the near-term.<sup>13</sup> Through

specialized financing vehicles at the Asian Development Bank, however, a variety of projects are expected to be delivered, including the Angat Water Transmission Improvement Project, Water District Development Sector Project, and Metro Manila Water and Sanitation Development Project.

**Key Technologies in Demand:**

- Engineering, procurement and construction services
- Filtration
- Advanced filtration
- Chemical disinfection
- UV disinfection
- Ozone disinfection
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems

**Municipal Wastewater Treatment and Sludge Management**

Corresponding to a lack of access to drinking water mains is limited access to wastewater treatment, with less than 5 percent of households connected to the sewerage network.<sup>14</sup> Maynilad, the utility serving western Manila, announced that it will invest USD 129 million for wastewater projects in 2016.<sup>15</sup> Maynilad has five ongoing sewerage system projects, namely the 66 million liters per day (MLD) Muntinlupa Sewerage System, the 60 MLD Valenzuela Sewerage System, the 76 MLD Paranaque Sewerage System and the 21 MLD Cavite Sewerage System. The 140 MLD Central Manila Sewerage System will be bid out as soon as Maynilad acquires land for the project.

Manila Water, the utility serving eastern Manila, has four ongoing sewerage system projects: the 100 MLD Marikina North Sewerage System, the 100 MLD North and South Pasig Sewerage System, and the 75 MLD Taguig North Sub-Catchment Sewerage System. The 5 MLD UP Sub-Catchment Sewerage System will be bid out in 2016.

**Key Technologies in Demand:**

- Pumps, pipe and valves
- Anaerobic digestion
- Sludge dewatering systems
- Sludge treatment systems
- Monitoring equipment
- Testing equipment

*Process and Produced Water*

The industrial water sector in the Philippines focuses on private water needs for production processes and wastewater treatment.

**Key Technologies in Demand:**

- Pumps, pipes and valves
- Storage technologies
- Anaerobic digestion
- Advanced chemical treatment
- Membrane technology
- Advanced filtration

**Market Links and Contacts**

Department of Environment and Natural Resources  
<http://www.denr.gov.ph>

Local Water Utilities Administration  
<http://www.lwua.gov.ph>

Metropolitan Water and Sewerage System  
<http://www.mwss.gov.ph>

Philippine Government Electronic Procurement System  
<http://philgeps.gov.ph>

Public-Private Partnership Center  
<http://www.ppp.gov.ph>

Manila Water Corporation Inc.  
<http://www.manilawater.com>

Maynilad Water Services Inc.  
<http://www.mayniladwater.com>

Asian Development Bank  
<http://www.adb.org>

U.S. Commercial Service Liaison to the ADB  
<http://www.export.gov/adb>

U.S Commercial Service Philippines  
<http://www.export.gov/philippines>

## Malaysia

### Air Pollution Control

The Government of Malaysia is aware of the country's vulnerability to climate change. Malaysia's recent climate goals include reducing its greenhouse gas emissions intensity by 35 percent based on GDP by 2030, with the possibility of increasing to 45 percent upon receipt of financial and technical assistance from other countries, as indicated in its Nationally Determined Contribution under the December 2015 UNFCCC Paris Climate Agreement.<sup>16</sup> Providers of air quality monitoring technologies and emissions inventory expertise may find opportunities here as a result of these new climate-related targets.

Though Malaysia enjoys good to moderate levels of air quality overall, air pollution continues to be a severe problem in cities and industrial zones such as Selangor, Johor and parts of Sarawak. Land transportation, industrial production for electronics, rubber and palm oil, smelting, and petroleum production and refining, as well as open burning activities, are the major sources of air pollution.<sup>17</sup> Land transportation is currently the country's most significant source of air pollution, accounting for approximately 70 percent of annual totals.

Malaysia's Ministry of Natural Resources and Environment (NRE) specifies conditions for emission, discharge or deposit of environmentally hazardous substances, pollutants or wastes or the emission of noise into any area, segment or element of the environment. Air quality is regulated by the Environmental Quality Act (Clean Air) 2014 and by the New Ambient Air Quality Standard (2013). The 2013 Standard updates the 1989 Standard by adding PM 2.5 to the list of covered criteria pollutants, which also includes PM 10, NO<sub>x</sub>, SO<sub>x</sub>, carbon monoxide and ground-level ozone. According to the government's 11<sup>th</sup> Malaysia Plan (2016-2020), air quality standards must be refined and localized emissions and open burning activities must be controlled in order to mitigate air pollution.<sup>18</sup>

In addition to localized air pollution issues, "transboundary haze" is also an annual problem that is especially prevalent during the drier summer months, when monsoon winds blow smoke from slash-and-burn land-clearing for palm oil production in Indonesia (Sumatra and Kalimantan) across the Malacca Strait to

Malaysia and Singapore.<sup>19</sup> In 2013, and again in 2015, the haze regularly shut down schools and airports. The ASEAN Agreement on Transboundary Haze Pollution was initiated in 2002 and ratified by all ASEAN members as of 2014; however, at this time, there is no mechanism in place to enforce the agreement.

The Commercial Service Kuala Lumpur notes that sales to the government require a local agent and/or a joint venture partner and generally necessitate a local partner that is *bumiputra* (ethnic Malay). Additionally, direct involvement and demonstrations of long-term commitment to the local market are essential for contracts of significant size.<sup>20</sup>

#### Key Technologies in Demand:

- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems

#### Waste Management and Recycling

According to Urban Wellbeing, Housing and Local Government Minister Datuk Abdul Rahman Dahlan, Malaysia currently has 170 waste disposal sites, only 14 of which are sanitary landfills. As of 2012, approximately 50 percent of the country's municipal solid waste was deposited in open dumpsites. A mandatory household source separation program was introduced last year with the aim of reducing the amount of solid waste sent to dumpsites by 40 percent by the year 2020. Eight states and federal territories are involved in this initiative so far, including Johor, Pahang, Selangor, Kedah, Malacca, Negri Sembilan, Perlis, Kuala Lumpur and Putrajaya.<sup>21</sup>

Local municipal and district governments are responsible for municipal solid waste (MSW) management in Malaysia, including collection, transportation, treatment and final disposal, while state governments are charged with siting landfills and treatment facilities. The system was partially privatized in the mid-1990s to help relieve the financial burden on localities. Partial privatization created opportunities for growth and specialization of private service providers to complement those provided by the public

sector.<sup>22</sup> In 2007, the Solid Waste and Public Cleansing Management Act (Act 672) bestowed authority on the Solid Waste and Public Cleansing Management Corporation (PPSPPA), under the Ministry of Housing and Local Governments (MHLG), for monitoring local privatization activities. Only some states, however, have adopted Act 672. Funding constraints have further limited adoption of the latest collection, separation, treatment and disposal technologies.<sup>23</sup>

A majority of the composition of Malaysia's MSW is organic matter with high moisture content. In recent years, landfill gas (LFG) recovery systems have gained increased attention and may present opportunities for U.S. providers of LFG recovery technologies. LFG systems are well positioned in the market because of the relatively high cost of incineration and the suitability of LFG recovery systems to the climate and waste composition.<sup>24</sup>

#### Key Technologies in Demand:

- Waste handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste treatment technologies
- Waste-to-energy
- Landfill gas recovery systems

### Water and Wastewater Treatment

#### Municipal Drinking Water and Wastewater

The government aims to have 99 percent of the population served by "clean and treated" water by 2020.<sup>25</sup> Malaysia appears to be close to reaching that goal, as roughly 98 percent of the population had access to an improved water source as of 2015.<sup>26</sup> The Government of Malaysia's predominant focus in the water area is the production and supply of clean potable water by investing in improved water infrastructure and rehabilitating and expanding existing drinking water treatment plans and distribution networks.<sup>27</sup>

Malaysia's wastewater and sewage treatment segment lags behind its drinking water counterpart in terms of development. The Indah Water Konsortium, the country's main sewerage operator, highlights that the country has not developed tertiary treatment capabilities and relies principally on primary and secondary treatment.<sup>28</sup> Opportunities are growing, however, in tertiary treatment systems as removal of agricultural run-off has presented itself as a treatment

challenge.<sup>29</sup> Furthermore, only 56 percent of the population is served by a wastewater treatment plant, with the remainder relying on septic tanks and pour flush systems.<sup>30</sup> Limited connectivity to sewerage networks, as well as limited coverage of those networks, has stymied growth in the sector; however, there is a strong expectation that that will change in the coming years as large wastewater infrastructure projects are introduced and come on-line. Within existing and expected plants, the suite of treatment technologies is also advancing with an increased interest in mechanical treatment methods such as Extended Aeration (EA), Oxidation Ditch (OD), Rotating Biological Contactors (RBC), Sequenced Batch Reactors (SBR) and Trickling Filters.<sup>31</sup> Malaysian utilities favor build transfer (BT) models for project development where the capital ownership, operations and maintenance remain the purview of the utility.<sup>32</sup>

Currently, Malaysia's project pipeline remains limited to the Sungai Perak raw water supply scheme, which promises construction of a 1 million m<sup>3</sup>/D drinking water plant in addition to pumping stations and transmission infrastructure. The Sungai Perak project itself has been subject to years of delays related to local government disputes on project scope, management and distribution of tariffs,<sup>33</sup> revealing the difficulty in Malaysia of moving projects past the conceptual phase.

#### Key Technologies in Demand:

- Engineering, procurement and construction services
- Advanced filtration
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment
- Extended Aeration
- Oxidation Ditch
- Rotating Biological Contactors
- Sequenced Batch Reactors
- Trickling Filters

#### Industrial Water

The industrial water market in Malaysia is focused on the food and beverage, power, automotive, and palm oil industries.<sup>34</sup> Malaysia produces more than a third of the world's certified sustainable palm oil<sup>35</sup> and correspondingly requires vast resources for palm mill effluent and solids management. With growth in the

palm oil sector expected to continue in order to meet global demands for biofuels, industrial wastewater technologies for palm oil production will remain in demand as Malaysia maintains high effluent standards for the palm oil industry in particular.<sup>36</sup>

#### Key Technologies in Demand:

- Waste handling equipment
- Dewatering equipment
- Engineering, procurement and construction services
- Advanced filtration
- Membrane filtration
- Waste to energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

#### Water Efficiency and Reuse

Widespread drought is drawing attention to the need for water efficiency practices in Malaysia. Malaysia is focusing on integrated water management in buildings, improved metering capabilities and reduction of non-revenue water.<sup>37</sup> This shift is fueling interest in water efficient consumer products as well as rainwater harvesting systems, smart meters and advance leak detection equipment.

#### Key Technologies in Demand:

- Engineering and design
- Monitoring equipment
- Smart meters
- Non-revenue water control software
- Rainwater collection technologies
- Low-loss distribution equipment
- Storage equipment

#### **Market Links and Contacts**

Indah Water Consortium

<https://www.iwk.com.my>

Foreign Commercial Service Kuala Lumpur

<http://www.export.gov/malaysia/>

## Singapore

### **Air Pollution Control**

Singapore enjoys one of the cleanest urban environments in Asia, including clean air for much of the year. During the summer months, however, slash-and-burn agriculture in Indonesia typically blankets Singapore in a thick smog known as “transboundary haze”. The resultant hazardous levels of air pollution have caused notable economic losses in the form of medical expenses, employment absences and business closures each year. The matter is addressed by the ASEAN Agreement on Transboundary Haze Pollution. After particularly severe issues in 2013, however, Singapore’s parliament passed the Transboundary Haze Pollution Act (2014), which now empowers regulators to prosecute firms and individuals that cause severe air pollution in Singapore by burning forests and peatlands in nearby countries.<sup>38</sup>

One key focus of air pollution mitigation efforts in the country has been on emissions from the transportation sector. Singapore has adopted Euro 5 standards for new diesel vehicles and will move to Euro 6 for all new gasoline vehicles on September 1, 2017. Under the Land Transportation Authority’s (LTA) Carbon Emissions-Based Vehicle Scheme (CEVS), new cars, taxis and newly imported used cars that meet LTA’s low carbon emissions requirements will qualify for rebates.<sup>39</sup>

Industrial emissions are another key contributing source of air pollution. Major emitters, such as refineries, power stations and waste incineration plants, must install stack emission monitors that are linked to the National Environmental Agency (NEA) telemetrically. Industrial facilities are required to conduct source emission tests regularly to ensure compliance with the NEA’s standards. Singapore has not yet met the 2020 air quality targets for particulate matter (PM) and sulfur dioxide (SO<sub>2</sub>) that are listed in the Ministry of the Environment and Water Resources’ Sustainable Singapore Blueprint 2015. The NEA has indicated that it plans to tighten industrial emissions standards in the near-term, which could generate opportunities for U.S. providers of advanced control technologies.

In its Nationally Determined Contribution under the December 2015 Paris Climate Agreement, Singapore committed to reduce its emissions intensity by 36 percent from 2005 levels by 2030 and to peak its emissions around 2030. Singapore has had success in reducing its carbon emissions by switching most of its energy production to natural gas. As of 2014, over 95 percent of the country's power was generated by natural gas fired plants.<sup>40</sup> Most of Singapore's new and proposed generation capacity is gas-based, as well, so this trend is expected to continue as the country's economy grows. Singapore's climate change strategy going forward will focus primarily on adaptation, given the country's vulnerability to high sea-level rise.<sup>41</sup>

#### Key Technologies in Demand:

- Continuous emissions monitoring equipment
- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Dry sorbent injection technologies
- Inspection, adjustment, maintenance and repair services
- Leak detection equipment
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems

#### Waste Management and Recycling

With a total land area that is just over 277 square miles, together with one of the highest population densities in the world, Singapore does not have the physical space to landfill much of its solid waste. The island nation's entire solid waste disposal infrastructure instead consists of four waste-to-energy (WtE) plants and one offshore sanitary landfill, Semakau, which handles incinerator ash and all non-combustible waste. Only about 2 percent of Singapore's solid waste ends up in the landfill; 38 percent of it is incinerated to generate electricity, and the remaining 60 percent is recycled.<sup>42</sup>

The National Environment Agency (NEA) has stated that it is planning a fifth waste-to-energy plant to be operational by 2019. NEA also has plans for a new solid waste processing facility that will bring all types of waste-handling under one roof, along with a water-reclamation plant to boost energy efficiency and maximize resource recovery.<sup>43</sup>

The handling, transportation, treatment and disposal of toxic industrial waste in Singapore is controlled under the Environmental Public Health (Toxic Industrial

Waste) Regulations 1988. Singapore imports nearly all of its hazardous waste control equipment, and the United States currently is the leader in waste control equipment and technology exports to Singapore.<sup>44</sup>

#### Key Technologies in Demand:

- Solid and hazardous waste handling equipment
- Waste treatment technologies

#### Water and Wastewater Treatment

##### Municipal Water and Wastewater Treatment

Water resources in the Singaporean city-state are governed by the Public Utilities Board (PUB), which triples as a utility, research development center and water technology export platform in what the Singaporean state has dubbed its "global hydrohub." In its utility role, PUB has defined "Four National Taps," which include local water catchments areas and reservoirs (20 percent of supply); imported water from Johor, Malaysia (30 percent of supply); recycled wastewater dubbed "NEWater" (30 percent of supply) and desalinated seawater (10 percent of supply).<sup>45</sup> With the development of major national water projects such as NEWater (recycled water), the Deep Tunnel Sewerage System (DTSS), desalination and rainfall storage like the Marina Barrage, Singapore is becoming increasingly independent when it comes to water.

Singapore has invested heavily in research and technology over the last four decades and has become a center of excellence in water resource management. The result is a thriving industry with more than 180 international and local companies active in the market. The water technologies market has been, and will continue to be, large and highly sophisticated as the country aims for water independence. Reaching this goal will continue to require investments in water storage, pollution mitigation, reuse and efficiency technologies. Over the past decade, PUB has outsourced some USD 3.0 billion worth of water infrastructure projects, such as the Deep Tunnel Sewerage System, Marina Barrage, NEWater facilities and desalination plants, to the private sector.<sup>46</sup>

Demand for advanced water technology and infrastructure in Singapore presents commercial opportunities for U.S. water technology providers. According to PUB's former CEO, Khoo Teng Chye, the agency has plans to increase the country's desalination and NEWater capacities enough to meet up to 50

percent of freshwater demand by 2060.<sup>47</sup> Singapore has five NEWater treatment facilities and one operational desalination plant, with plans to construct up to five more desalination plants in the near future.<sup>48</sup> Key opportunities include the Water Reclamation Plant (WRP) in Tuas, with an expected capacity of 228,000 m<sup>3</sup>/d, and the Singapore Marina East desalination plant, with an expected capacity of 136,380 m<sup>3</sup>/d.<sup>49</sup> The Tuas WRP will have an integrated NEWater factory to facilitate large-scale water recycling and will be co-located with National Environment Agency's Integrated Waste Management Facility (IWMF) in an effort to reap the potential synergies of used water and solid waste treatment processes while minimizing the land footprint.<sup>50</sup>

#### Key Technologies in Demand:

- Waste handling equipment
- Engineering, procurement and construction services
- Advanced filtration
- Membrane filtration
- Chemical disinfection
- UV disinfection
- Ozone disinfection
- Waste-to-energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment
- Non-revenue water control software
- Low-loss distribution equipment
- Storage equipment

#### Water efficiency and reuse

The increase in water self-sufficiency has only been made possible with an increased use of energy. The water sector uses an exceptional amount of energy to pump, treat, recycle, desalinate and produce NEWater. Since Singapore lacks both water and energy sources and has to import both, there are debates on the desirability of improving water security at the cost of increasing energy insecurity.<sup>51</sup> Technologies for efficiency both in the water sector and the energy sector will be required to help with the paradox of water security and energy insecurity. Between 2011 and 2012, the Singaporean government announced more than USD 584 million of new public sector R&D funding to address energy, water, green buildings and land scarcity issues<sup>52</sup>.

#### Key Technologies in Demand:

- Engineering and design
- Energy efficient pumps
- Automation equipment
- Monitoring equipment
- Non-revenue water control software
- Membranes
- Advanced filtration
- Low-loss distribution equipment
- Storage equipment

#### Process and Produced Water

In addition, the Government of Singapore (GOS) is encouraging industrial users to conserve and recycle water through media campaigns, legislation and economic incentives.<sup>53</sup> Key industrial water clients in Singapore include construction, hotel and restaurant services, as well as manufacturers in the electronics, chemical and petroleum industries. Currently, Singapore's water demand is about 400 m<sup>3</sup>/D, with household water consumption accounting for about 45 percent of total water use and industrial and commercial consumption accounting for the remaining 55 percent.<sup>54</sup>

#### Key Technologies in Demand:

- Engineering, design and construction services
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems
- Anaerobic digestion
- Advanced chemical treatment and rectification
- Membrane technology
- Advanced filtration

#### Market Links and Contacts

National Environment Agency

<http://www.nea.gov.sg/>

Ministry of the Environment and Water Resources

<http://www.mewr.gov.sg/>

PUB Tenders

<http://www.pub.gov.sg/tenders/Pages/TendersHome.aspx>

U.S. Commercial Service Singapore

<http://www.export.gov/singapore/>

## Thailand

### Air Pollution Control

Air pollution in Thailand comes from several major sources: vehicle emissions in urban areas, biomass burning and transboundary haze in rural and border areas, thermal power generation, and industrial emissions in concentrated industrialized zones.<sup>55</sup> Construction, coal-fired power plants, manufacturing, mining, refineries, cement plants and quarries are the main sources of industrial air pollution in areas such as Nah Pralan sub-district, Saraburi; Mae Moe, Lampang and Samutprakarn.<sup>56</sup>

The Ministry of Natural Resources and Environment's Pollution Control Department (PCD) maintains standards for ambient air quality, including limits for emissions of criteria pollutants and volatile organic compounds (VOC's) from both mobile and point sources. Despite technical training programs run by PCD's Thailand Air Pollution Center of Excellence (TAPCE), enforcement remains inadequate, particularly for mobile source emissions.

Pollution from mobile sources is of particular concern in urban areas like the Bangkok Metropolitan Region, as well as in Chiang Mai, Khonkaen, Songkhla and Phuket.<sup>57</sup> Recent air quality data suggest that particulate matter, specifically PM 10, is on the rise in both urban and rural areas. In Bangkok, air quality monitoring performed by the PCD for the past decade has revealed that the levels of PM 10 have regularly exceeded both annual ( $50 \mu\text{g}/\text{m}^3$ ) and 24 hour ( $120 \mu\text{g}/\text{m}^3$ ) national standards due to increasing traffic congestion in the city.

#### Key Technologies in Demand:

- Continuous emissions monitoring equipment
- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Particulate matter control systems
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems

### Waste Management and Recycling

Bangkok's Environmental Department and 50 district offices are responsible for collection of the city's municipal solid waste (MSW). Collected waste is transported to three transfer stations, where it is processed and sent to one of two sanitary landfills, located in Kumpae Saen district Nakhon Phathom province and Bang Plee district in Samut Prakarn province.<sup>58</sup> The Bangkok Metropolitan Authority (BMA) operates the country's largest single solid waste management system. BMA has promoted recycling through official programs in an effort to reduce the quantity of waste transferred to landfills for final disposal. Recycling, however, is still dominated by informal sector activities, such as waste picking, and recycling rates remain low (about 22 percent nationally).<sup>59</sup>

The Thai government recently adopted a national "Solid and Hazardous Waste Management Roadmap" that may provide the policy foundation to help address challenges faced in this area. Insufficient infrastructure and resources, as well as a poorly maintained fleet, limit solid waste collection rates in and around Bangkok, where more than 20 percent of the country's solid waste is generated. Open dumpsites are still common throughout the country, but economic and regulatory pressure is beginning to drive adoption of more modern and efficient waste management practices.<sup>60</sup>

Waste management in provincial municipalities in particular is often underdeveloped but will likely grow in tandem with an increasingly mature market. Management of non-hazardous industrial waste and waste from commercial residential sites may present additional near-term opportunities for U.S. products and services, especially for those that are adaptable to the waste composition and tropical climate.<sup>61</sup>

#### Key Technologies in Demand:

- Collection services, containers and vehicles
- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Compactors and bailers
- Materials handling equipment
- Recycling process expertise
- Sanitary landfill design, maintenance and associated technologies

## Water and Wastewater Treatment

Access to potable water remains limited in Thailand with just 47 percent of all households receiving piped water.<sup>62</sup> In rural areas, 62 percent of households consume water from unprotected sources, such as rainfall collection, rivers, canals and ponds.<sup>63</sup> Potable water is provided by the Ministry of Natural Resources and Environment's Wastewater Management Authority (WMA) in Bangkok and the Provincial Water Authority elsewhere. Despite major short-falls in drinking water access, the emphasis remains on mitigation of water pollution and treatment of wastewater.

Bangkok and the five surrounding provinces generate more than 3.05 million m<sup>3</sup> of wastewater daily but treat just 40 percent. WMA announced its plans in 2014 to introduce a series of wastewater treatment projects to address the shortfall. Four projects, Om Noi, Samut Prakarn, Krathum Ban and Rangist, will provide an additional 1.8 million m<sup>3</sup>/D of treatment capacity and are collectively valued at USD 308 million.<sup>64</sup> Thailand favors EPC project structure but, with a new PPP policy in place, is considering private sector operations and management (O&M) contracts once the infrastructure has been developed by an EPC.<sup>65</sup> Thailand's total market size for wastewater treatment is estimated at over USD 1 billion, with construction and engineering services accounting for 85 percent of the market.<sup>66</sup> Thailand imports approximately 80 percent of its water technology.<sup>67</sup> The main tenderers of water projects include the following: the Sewerage and Drainage Department (SDD), Bangkok Metropolitan Administration (BMA), Department of Local Administration (DOLA), Ministry of Interior, the Public Works Department (PWD) and the Industrial Estate Authority of Thailand (IEAT).<sup>68</sup>

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Operations services
- Advanced filtration
- Membrane filtration
- Waste-to-energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

## Process and Produced Water

Annual growth in the industrial water market is expected to reach 10 percent, fueled by expansion in real estate developments, manufacturing and agriculture.<sup>69</sup> Key industrial clients include food and beverage producers, paper and rubber processing plants, chemical industries, shopping malls, residential and commercial buildings, and livestock and aquaculture farms.<sup>70</sup> Growing areas of interest include anaerobic digestion, biogas development and waste-to-energy solutions.

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Primary and secondary treatment technology
- Advanced filtration
- Waste-to-energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

## Market Links and Contacts

Ministry of Natural Resources and Environment  
<http://webeng.mnre.go.th/>

NRE Pollution Control Department  
<http://www.pcd.go.th/indexEng.cfm>

Office of Environmental Policy and Planning  
<http://www.onep.go.th/>

Provincial Waterworks Authority (PWA)  
<http://en.pwa.co.th/>

[Wastewater Management Authority \(WMA\)  
http://www.wma.or.th/content/](http://www.wma.or.th/content/)

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## Vietnam

### Air Pollution Control and Monitoring

Like most other Southeast Asian countries, Vietnam is aware of its vulnerability to climate change. Saline intrusion and drought is already impacting the Mekong Delta region, and sea level rise is projected to adversely impact the economic activity of busy coastal regions as well as the Red River Delta.<sup>71</sup> In 2012, Vietnam's government approved the country's National Green Growth Strategy with the goal of reducing greenhouse gas emissions and boosting growth in "green" sectors. Then, in its Nationally Determined Contribution under the December 2015 United Nations Framework on Climate Change (UNFCCC) Climate Agreement in Paris, Vietnam committed to an 8 percent reduction in emissions by 2030 compared to a business-as-usual scenario, with the potential to increase this to 25 percent, conditional upon international financial and technical support.

Although two-thirds of Vietnam's population lives in rural areas, the two major cities - Hanoi and Ho Chi Minh City - are plagued by air pollution from vehicle emissions, largely motorcycles. More than 37 million motorcycles and 2 million cars are registered in Vietnam, which has a population of over 90 million. The number of cars and motorcycles on the road increased by 16 percent per year on average from 2000 to 2012 and is unlikely to slow in the near-term.<sup>72</sup> The Vietnamese government has plans to control motorcycle emissions, beginning with five cities - Hanoi, Ho Chi Minh City, Da Nang, Can Tho and Hai Phong - which will implement Euro 3 equivalent standards beginning next year. For cars, the government has adopted Euro 2 emissions standards, with plans to move to Euro 4 equivalent standards in 2017.<sup>73</sup>

The Ministry of Natural Resources and Environment's (MONRE) has drafted a National Action Plan on Air Quality Management (2020 to 2025). The draft Action Plan includes a 20 percent reduction target for NOx, SOx and particulate matter emitted by cement, chemicals, fertilizer and petroleum production facilities.<sup>74</sup> Separately, a draft National Technical Regulation on Emissions for the Steel Industry is in the works as well. Vietnam's new Environmental Law (55/2014/QH13) also contains air quality management requirements, including point source registration, emissions inventory and installation of continuous

emission monitoring systems for the biggest stationary source emitters. This increasing regulatory stringency is likely to drive growth in the air quality management market and provide opportunities for U.S. solution providers, especially in industrial sectors.

#### Key Technologies in Demand:

- Fenceline monitoring equipment
- Continuous emissions monitoring equipment
- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Wet/dry scrubbers (particularly systems that remove multiple pollutants)
- Particulate matter control systems
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems

### Waste Management and Recycling

Solid waste generation in Vietnam is growing on pace with its urbanizing population and economy; however, most solid waste is still inadequately managed. According to the Ministry of Natural Resources and Environment (MONRE), the majority of the country's solid waste (73.5 percent) is deposited in open dump sites. There are only 26 combined treatment plants in urban areas. Technologies currently in use include incinerators; combined incineration and composting; and, most commonly, composting combined with landfills.<sup>75</sup> Additionally, more than 60 percent of Vietnam's rural household waste and 16 percent of urban household waste is not collected.<sup>76</sup>

Urban Environment Company (URENCO) is the state-owned enterprise that manages solid waste collection and treatment in Hanoi. Residents there place their waste in open gutters in front of their homes for URENCO employees to pick up door-to-door on foot with handcarts. Waste pickers sell recyclable materials to dealers. Challenges to the system include aging and insufficient collections equipment. Source separation also is uncommon, resulting in hazardous waste mixing with non-hazardous waste during transportation and disposal.

In 2009, Vietnam adopted its "National Strategy for Integrated Solid Waste Management to 2025, with a vision toward 2050." The National Strategy sets goals

for management of municipal solid waste (MSW), industrial waste and medical waste, based on specific target years (2015, 2020 and 2025). Decision No. 798/QĐ-TTg (2011) approved a program for investment in solid waste treatment through 2020. The program's ambitious goals include collecting and treating "up to environmental standards" at least 90 percent of urban and 70 percent of rural solid waste, as well as 90 percent of both hazardous and non-hazardous industrial solid waste and 100 percent of healthcare waste. The Vietnamese government also is in the process of developing producer responsibility requirements for manufacturers and importers of electrical and electronic equipment to help address the country's e-waste in a more sustainable manner.

Rapidly growing industrial production has resulted in an equally robust industrial solid waste management market that was projected at an impressive 19 percent compound annual growth rate (CAGR) between 2011 and 2015.<sup>77</sup> Many of Vietnam's new solid waste management projects are being funded by donor-financing, as well as by foreign countries and international institutions. Strong market growth is expected to continue in most areas of solid waste management in Vietnam going forward.

#### Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Composting equipment
- Waste-to-Energy and landfill gas recovery
- Recycling process expertise
- Collection services, containers and vehicles
- Sanitary landfill design, maintenance and associated technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

### Water and Wastewater Treatment

With GDP growth hovering around 6 percent a year,<sup>78</sup> a rapidly growing industrial base and an expanding middle class, Vietnam has initiated an ambitious plan to address its water infrastructure needs. Vietnam's regulatory environment is shifting to accommodate improved water resource management and to spur development of water projects nationally. In June of 2015, the Vietnamese government issued Decree No. 54/2015/ND-CP, which provides incentives for economical and efficient water use activities and limits these incentives to economical and effective use of

water, water reuse and production, and importation of water-efficient equipment and technologies. In 2014, Vietnam drafted a new Law on Environmental Protection that went into effect on January 1, 2015. According to the new law, prior to being discharged into the environment, wastewater must be collected and treated to meet environmental technical regulations.

To meet the new regulatory burden, Vietnam is developing a series of nationally and development financed water projects. Overall, the Vietnamese government plans to invest USD 2.78 billion in the water sector by 2020. To support the Government of Vietnam (GVN) program, the Asian Development Bank (ADB) approved a multi-tranche financing facility (MFF) of up to USD 1 billion for 2011 to 2020 to finance water supply and sanitation projects in Danang, Haiphong, Ho Chi Minh City and Hue, as well as the National Nonrevenue Water (NRW) Program.<sup>79</sup> Additionally, in November 2015, the World Bank approved a USD 200 million financing package for water and sanitation, and the Vietnamese government will provide an additional USD 25.5 million to finance related projects.<sup>80</sup> Approximately, 23 major water treatment projects have been announced for the 2016 to 2018 tendering period, ranging in value from USD 635 million to USD 19 million.<sup>81</sup> Overall, the water infrastructure industry is expected to average 5.4 percent growth annually between 2014 and 2018.<sup>82</sup>

The aggressive project pipeline in Vietnam denotes the growing need for improved water infrastructure. Water mains access is limited with 10 percent of rural households and 61 percent of urban households.<sup>83</sup> Periodic drought, rapid industrialization and increasing household demand all place pressure on Vietnam's freshwater resources. Marquee opportunities include the Ho Chi Minh City NLTN wastewater treatment plant designed to address pollution in the Nhieu Loc-Thi Nghe Canal. With a capacity of 830,000 m<sup>3</sup>/D upon completion, it will become the largest wastewater treatment facility in South East Asia.<sup>84</sup> In the public private partnership (PPP) arena, the Tan Hoa Lo Gom canal basin wastewater treatment plant in Ho Chi Minh City is expected to have a capacity of 300,000 m<sup>3</sup>/D. Investment of USD 300 million is needed to bring the project to fruition. Finally, the Yen Xa wastewater treatment system will be Hanoi's largest wastewater treatment plant and attendant sewer network. The plant will have a capacity of 270,000 m<sup>3</sup>/D and will be situated on approximately 13 hectares of land in the Thanh Tri District of the city, treating the sewage from

the districts of Thanh Xuan, Dong Da, Ba Dinh, Hoang Mai, Ha Dong, Tu Liem and Thanh Tri. The project is valued at USD 635 million.<sup>85</sup>

#### Technologies and Services in Demand:

- Engineering, procurement and construction services
- Operations services
- Advanced Filtration
- Membrane filtration
- Waste to energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

#### Market Links and Contacts

Ministry of Natural Resources and Environment (MONRE): [www.monre.gov.vn](http://www.monre.gov.vn)

Vietnam Environment Administration:

[www.nea.gov.vn](http://www.nea.gov.vn)

Vietnam Water Supply and Sewerage Association (VWSA): [www.vwsa.org.vn](http://www.vwsa.org.vn)

Vietwater 2016, Ho Chi Minh City, November 9-11  
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<sup>1</sup> ASEAN Economic Community. <http://www.asean.org/asean-economic-community/>. Accessed 4/14/2016.

<sup>2</sup> International Energy Agency. "World Energy Outlook Special Report: Southeast Asia Energy Outlook 2015". p. 18

<sup>3</sup> Republic of the Philippines. 1999. REPUBLIC ACT No. 8749. Metro Manila: Congress of the Philippines. Retrieved from: <http://emb.gov.ph/ECA%20Center/RA8749.pdf>

<sup>4</sup> Macas, T. (2015). "Metro Manila's air quality even worse this year – data." *GMA News Online*. Retrieved 19 October 2015, from <http://www.gmanetwork.com/news/story/509142/lifestyle/healthandwellness/metro-manila-s-air-quality-even-worse-this-year-data>

<sup>5</sup> Macas, T. (2015). "Metro Manila's air quality even worse this year – data." *GMA News Online*. Retrieved 19 October 2015, from <http://www.gmanetwork.com/news/story/509142/lifestyle/healthandwellness/metro-manila-s-air-quality-even-worse-this-year-data>

<sup>6</sup> Williams, Diarmaid. "Philippines set for 23 new coal-fired power plants." *Power Engineering International*. June 30, 2015. <http://www.powerengineeringint.com/articles/2015/06/23-new-coal-fired-power-plants-for-philippines.html>. Accessed 4/14/2016.

<sup>7</sup> USA International Business Publications. 2008. *Philippines: Business and Investment Opportunities Yearbook*. 5<sup>th</sup> Edition. Int'l Business Publications, USA. p. 133

<sup>8</sup> "Philippines: Toward Greener Waste Management." The World Bank. October 24, 2012.

<http://www.worldbank.org/en/news/press-release/2012/10/24/philippines-toward-greener-waste-management>  
Accessed April 12, 2016.

<sup>9</sup> Nicholls, AC. "Gov't cracks down on local officials alleged of violating Solid Waste Management Act". February 10, 2016. CNN Philippines. <http://cnnphilippines.com/news/2016/02/10/ombudsman-investigate-government-officials-dump-site.html>. Accessed April 12, 2016.

<sup>10</sup> Montesines, B. (2015). U.S. Commercial Service. *Philippines: Opportunities in the Water and Wastewater Sub-Sector*. Presentation, WEFTEC.

<sup>11</sup> BMI Research,. (2015). Industry Forecast - Energy & Utilities Infrastructure - Q4 2015 (Philippines). Retrieved 19 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1087789&advanced\\_search=1&keyword=Philippines%20](https://bmo.bmiresearch.com/article/view?article=1087789&advanced_search=1&keyword=Philippines%20)

<sup>12</sup> Commercial Service Manila. Montesines, 2016.

<sup>13</sup> Export.gov,. (2014). Export.gov - Profile of the Philippine Market. Retrieved 19 October 2015, from [http://www.export.gov/philippines/eg\\_ph\\_030640.asp](http://www.export.gov/philippines/eg_ph_030640.asp)

<sup>14</sup> Commercial Service Manila "Philippines: Opportunities in the Water and Wastewater Sub-Sector" Montesines, 2015.

<sup>15</sup> Commercial Service Manila. Montesines. 2016

- 
- <sup>16</sup> Commercial Service Kuala Lumpur, 2015. Joanne Looi.
- <sup>17</sup> Shin, Dong-Chun, Ed. "Chapter 5: Air Pollution and Health in Malaysia". *Hazardous Air Pollutants: Case Studies from Asia*. CRC Press, Taylor & Francis Group: Boca Raton, FL. 2016. p. 108; See also <http://www.unep.org/Transport/Airquality/Malaysia.pdf>. Accessed 4/15/2016.
- <sup>18</sup> 11th Malaysia Plan. (2015). Sustainable Usage of Energy to Support Growth. Putrajaya, Malaysia: Federal Government Administrative Centre.
- <sup>19</sup> "Malaysia chokes as air pollution hits 16-year high". *The Japan Times*. June 24, 2013. <http://www.japantimes.co.jp/life/2013/06/24/environment/malaysia-chokes-as-air-pollution-hits-16-year-high/#.Vw7hV6Qrl2w>. Accessed 4/15/2016.
- <sup>20</sup> Commercial Service Kuala Lumpur, 2015. Joanne Looi.
- <sup>21</sup> Irsyad, Arief. "How Malaysians Are Coping With The Waste Separation Programme A Week After Implementation". *Malaysian Digest*. September 11, 2015. <http://www.malaysiandigest.com/news/568784-how-malaysians-are-coping-with-the-waste-separation-programme-a-week-after-implementation.html> Accessed 4/16/2016
- <sup>22</sup> Premakumara, Dickella G.J. and Toshizo Maeda. (2015). "Municipal Solid Waste: The burgeoning environmental threat". (p. 181). In Harris, Paul G. and Graeme Lang, Eds. *Routledge Handbook of Environment and Society in Asia*.
- <sup>23</sup> Abas, M., & Wee, S. (2014). The Issues of Policy Implementation on Solid Waste Management in Malaysia. *International Journal Of Conceptions On Management And Social Sciences*, 2(3). Retrieved from [http://www.researchgate.net/publication/271085392\\_The\\_Issues\\_of\\_Policy\\_Implementation\\_on\\_Solid\\_Waste\\_Management\\_in\\_Malaysia](http://www.researchgate.net/publication/271085392_The_Issues_of_Policy_Implementation_on_Solid_Waste_Management_in_Malaysia)
- <sup>24</sup> Tan, S., Hashim, H., Lim, J., Ho, W., Lee, C., & Yan, J. (2014). Energy and emissions benefits of renewable energy derived from municipal solid waste: Analysis of a low carbon scenario in Malaysia. *Applied Energy*, 136, 797-804. <http://dx.doi.org/10.1016/j.apenergy.2014.06.003>
- <sup>25</sup> PR Newswire,. (2013). *Water and Wastewater Treatment Market in Indonesia, Malaysia, the Philippines, and Thailand - A CEO's 360-Degree Perspective*. PR Newswire. Retrieved 29 October 2015, from <http://www.prnewswire.com/news-releases/water-and-wastewater-treatment-market-in-indonesia-malaysia-the-philippines-and-thailand---a-ceos-360-degree-perspective-236385751.html>
- <sup>26</sup> World Development Indicators. World Bank Group 2015.
- <sup>27</sup> Commercial Service Kuala Lumpur. "OPPORTUNITIES IN MALAYSIA Water Industry" 2015. Joanne Looi
- <sup>28</sup> BMI Research,. (2015). *Industry Forecast - Malaysia - 2015*. Retrieved 29 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1036577&advanced\\_search=1&keyword=Malaysia%20waste](https://bmo.bmiresearch.com/article/view?article=1036577&advanced_search=1&keyword=Malaysia%20waste)
- <sup>29</sup> BMI Research,. (2015). *Industry Forecast - Malaysia - 2015*. Retrieved 29 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1036577&advanced\\_search=1&keyword=Malaysia%20waste](https://bmo.bmiresearch.com/article/view?article=1036577&advanced_search=1&keyword=Malaysia%20waste)
- <sup>30</sup> BMI Research,. (2015). *Industry Forecast - Malaysia - 2015*. Retrieved 29 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1036577&advanced\\_search=1&keyword=Malaysia%20waste](https://bmo.bmiresearch.com/article/view?article=1036577&advanced_search=1&keyword=Malaysia%20waste)
- <sup>31</sup> Commercial Service Kuala Lumpur. "OPPORTUNITIES IN MALAYSIA Water Industry" 2015. Joanne Looi
- <sup>32</sup> Commercial Service Kuala Lumpur. "OPPORTUNITIES IN MALAYSIA Water Industry" 2015. Joanne Looi.
- <sup>33</sup> Global Water Intelligence Water Project Pipeline. 2015.
- <sup>34</sup> PR Newswire,. (2013). *Water and Wastewater Treatment Market in Indonesia, Malaysia, the Philippines, and Thailand - A CEO's 360-Degree Perspective*. PR Newswire. Retrieved 29 October 2015, from <http://www.prnewswire.com/news-releases/water-and-wastewater-treatment-market-in-indonesia-malaysia-the-philippines-and-thailand---a-ceos-360-degree-perspective-236385751.html>
- <sup>35</sup> Sarif, Edy (17 June 2011). "Malaysia expected to maintain position as world's largest producer of Certified Sustainable Palm Oil". *The Malaysian Star*.
- <sup>36</sup> J.C. Igwe and C.C. Onyegbado, 2007. "A Review of Palm Oil Mill Effluent (Pome) Water Treatment"
- <sup>37</sup> Commercial Service Kuala Lumpur. "OPPORTUNITIES IN MALAYSIA Water Industry" 2015. Joanne Looi
- <sup>38</sup> "STATEMENT: Singapore's New Haze Pollution Law 'A New Way of Doing Business'". *World Resources Institute*. August 5, 2014. <http://www.wri.org/news/2014/08/statement-singapore%E2%80%99s-new-haze-pollution-law-%E2%80%9Cnew-way-doing-business%E2%80%9D>. Accessed April 17, 2016
- <sup>39</sup> Tay, E. (2015). 2015 Guide to Singapore Government Funding and Incentives for the Environment | Green Future Solutions. *Greenfuture.sg*. Retrieved 30 October 2015, from <http://www.greenfuture.sg/2015/02/16/2015-guide-to-singapore-government-funding-and-incentives-for-the-environment/>
- <sup>40</sup> BMI Research,. (2015). Market Overview - Competitive Landscape - Q1 2016. *Business Monitor International (BMI) Research*. Retrieved 30 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1113474&advanced\\_search=1&keyword=Singapore%20](https://bmo.bmiresearch.com/article/view?article=1113474&advanced_search=1&keyword=Singapore%20)
- <sup>41</sup> Climate Action Tracker. (2015). Singapore. Retrieved 30 October 2015, from <http://climateactiontracker.org/countries/developed/singapore.html>
- <sup>42</sup> Yep, Eric. "Singapore's Innovative Waste-Disposal System". *The Wall Street Journal*. September 13, 2015.
-

- 
- <sup>43</sup> Yep, Eric. "Singapore's Innovative Waste-Disposal System". *The Wall Street Journal*. September 13, 2015.
- <sup>44</sup> BMI Research,. (2015). Market Overview - Competitive Landscape - Q1 2016. *Business Monitor International (BMI) Research*. Retrieved 30 October 2015, from [https://bmo.bmiresearch.com/article/view?article=1113474&advanced\\_search=1&keyword=Singapore%20](https://bmo.bmiresearch.com/article/view?article=1113474&advanced_search=1&keyword=Singapore%20)
- <sup>45</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>46</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>47</sup> BMI Research,. (2015). Market Overview - Competitive Landscape - Q1 2016. BMI Research. Retrieved 30 October 2015. [https://bmo.bmiresearch.com/article/view?article=1113474&advanced\\_search=1&keyword=Singapore%20](https://bmo.bmiresearch.com/article/view?article=1113474&advanced_search=1&keyword=Singapore%20)
- <sup>48</sup> BMI Research,. (2015). Market Overview - Competitive Landscape - Q1 2016. BMI Research. Retrieved 30 October 2015. [https://bmo.bmiresearch.com/article/view?article=1113474&advanced\\_search=1&keyword=Singapore%20](https://bmo.bmiresearch.com/article/view?article=1113474&advanced_search=1&keyword=Singapore%20)
- <sup>49</sup> Global Water Intelligence Project Database 2016.
- <sup>50</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>51</sup> Biswas, A., & Tortajada, C. (2015). *Urban Water Management in Singapore: Past, Present and Future*. *The Diplomat*. Retrieved 30 October 2015, from <http://thedi diplomat.com/2015/06/urban-water-management-in-singapore-past-present-and-future/>
- <sup>52</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>53</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>54</sup> Commercial Service Singapore "Singapore: Water Treatment & Wastewater Recycling Systems" Sherry Ng. 10/2015
- <sup>55</sup> Vichit-Vadakan, N., & Vajanapoom, N. (2011). Health Impact from Air Pollution in Thailand: Current and Future Challenges. *Environ Health Perspect*, 119(5), a197-a198.
- <sup>56</sup> UNEP Air Quality Policies: Thailand. December 2015. <http://www.unep.org/Transport/Airquality/Thailand.pdf>. Accessed April 17, 2016
- <sup>57</sup> Dr. Wijarn Simachaya. "Successful Air Quality Control Programs in Thailand". Pollution Control Department, Ministry of Natural Resources and Environment, Thailand, 2012. [http://www.aecen.org/sites/default/files/forums/2012/GHG%20-%20Air%20Quality%20Control%20Program-%20Thailand%20\(Wijarn\).pdf](http://www.aecen.org/sites/default/files/forums/2012/GHG%20-%20Air%20Quality%20Control%20Program-%20Thailand%20(Wijarn).pdf). Accessed April 17, 2016.
- <sup>58</sup> UNEP. (2009). "Technologies for Waste Management/Infrastructure – Bangkok (Thailand)." Retrieved October 16 2015 from [http://www.unep.org/ietc/Portals/136/Other%20documents/Waste%20Management/Waste%20Plastic/WP\\_3\\_T\\_TechnologiesForWM\\_Bangkok.pdf](http://www.unep.org/ietc/Portals/136/Other%20documents/Waste%20Management/Waste%20Plastic/WP_3_T_TechnologiesForWM_Bangkok.pdf).
- <sup>59</sup> "Thai style recycling". *Waste Management World*. October 12, 2011. <https://waste-management-world.com/a/thai-style-recycling>. Accessed April 17, 2016
- <sup>60</sup> IBP Inc. (2013). *Doing Business and Investing in Thailand Guide Volume 1 Strategic and Practical Information*. Int'l Business Publications. P. 195. Retrieved from: [https://books.google.com/books?id=yV-bAAAAQBAJ&pg=PA195&lpg=PA195&dq=environmental+technology+market+thailand&source=bl&ots=SiWjFV9\\_zH&sig=WnZNahECJ3tjhxhn-1TpZSPbkqQ&hl=en&sa=X&ved=0CC8Q6AEwA2oVChMlusjP6pyzyAIVQZoeCh3eRAA-#v=onepage&q=environmental%20technology%20market%20thailand&f=false](https://books.google.com/books?id=yV-bAAAAQBAJ&pg=PA195&lpg=PA195&dq=environmental+technology+market+thailand&source=bl&ots=SiWjFV9_zH&sig=WnZNahECJ3tjhxhn-1TpZSPbkqQ&hl=en&sa=X&ved=0CC8Q6AEwA2oVChMlusjP6pyzyAIVQZoeCh3eRAA-#v=onepage&q=environmental%20technology%20market%20thailand&f=false). Accessed 16 October 2015.
- <sup>61</sup> IBP Inc. (2013). *Doing Business and Investing in Thailand Guide Volume 1 Strategic and Practical Information*. Int'l Business Publications.
- <sup>62</sup> Thailand Board of Investment,. (2015). Water Supply. Retrieved 16 October 2015, from [http://www.boi.go.th/index.php?page=water\\_supply](http://www.boi.go.th/index.php?page=water_supply)
- <sup>63</sup> Thailand Board of Investment,. (2015). Water Supply. Retrieved 16 October 2015, from [http://www.boi.go.th/index.php?page=water\\_supply](http://www.boi.go.th/index.php?page=water_supply)
- <sup>64</sup> Global Water Intelligence. "Thailand looks to expand wastewater treatment" Vol 15, Issue 6 (June 2014)
- <sup>65</sup> Global Water Intelligence. "Thailand looks to expand wastewater treatment" Vol 15, Issue 6 (June 2014)
- <sup>66</sup> Ibp Inc,. (2013). *Doing Business and Investing in Thailand Guide Volume 1 Strategic and Practical Information*. Int'l Business Publications.
- <sup>67</sup> ThaiWater. (2015). ThaiWater Expo 2015. [Brochure]. Bangkok, Thailand: UBM. Retrieved from: <http://www.thai-water.com/Portals/3/2015/BrochureTHW2015-2.pdf>
- <sup>68</sup> Commercial Service Bangkok. export.gov,. (2014). *Doing Business in Thailand*. Retrieved 8 October 2015, from <http://www.export.gov/THAILAND/doingbusiness/index.asp>
-

- 
- <sup>69</sup> ThaiWater. (2015). ThaiWater Expo 2015. [Brochure]. Bangkok, Thailand: UBM. Retrieved from: <http://www.thai-water.com/Portals/3/2015/BrochureTHW2015-2.pdf>
- <sup>70</sup> Commercial Service Bangkok. export.gov,. (2014). *Doing Business in Thailand*. Retrieved 8 October 2015, from <http://www.export.gov/THAILAND/doingbusiness/index.asp>
- <sup>71</sup> Van, Thu. "Climate change: Rising sea levels pose salt threat in Vietnam". *Straits Times*. August 30, 2014.
- <sup>72</sup> "Can Hanoi tame its pollution nightmare, the motorbike?" *Asia Climate Journal*. October 9, 2014. <http://climate-journal.asia/motorbikes-make-space-for-bicycles-in-hanoi-vietnam/>. Accessed April 18, 2016.
- <sup>73</sup> Tuan, T. (2014). *Viet Nam update on Urban air quality management*. Presentation, Vietnam Environment Administration. Retrieved from: <http://cleanairasia.org/wp-content/uploads/portal/files/presentations/vietnam.pdf>
- <sup>74</sup> Tuan, T. (2014). *Viet Nam update on Urban air quality management*. Presentation, Vietnam Environment Administration. Retrieved from: <http://cleanairasia.org/wp-content/uploads/portal/files/presentations/vietnam.pdf>
- <sup>75</sup> Huy, Luong Quang. (2015). *Vietnam solid waste management: Developing crediting NAMA and employing market-based instruments*. Presentation, the 15th Climate Technology Initiative (CTI) Workshop on Market Mechanisms for Climate Action at the Urban Level.
- <sup>76</sup> "VN faces great environmental problems: deputy PM". *Tuoitrenews*. June 6, 2013. <http://tuoitrenews.vn/society/10390/vn-faces-great-environmental-problems-deputy-pm>. Accessed April 17, 2016
- <sup>77</sup> AmCham Vietnam. (2011). *Vietnam Solid Waste Market Analysis*. Retrieved 19 November 2015, from <http://www.amchamvietnam.com/4730/vietnam-solid-waste-market-analysis/>
- <sup>78</sup> The World Bank. "Vietnam Country Overview" <http://www.worldbank.org/en/country/vietnam/overview>
- <sup>79</sup> Doan Van. "Water Opportunities in Vietnam" U.S. Commercial Service, Ho Chi Min City, 2015.
- <sup>80</sup> TUOI TRE NEWS,. (2015). *Over 5 million Vietnamese to benefit from WB sanitation, water supply financing*. *TUOI TRE NEWS*. Retrieved 19 November 2015, from <http://tuoitrenews.vn/society/31610/over-5-million-vietnamese-to-benefit-from-wb-sanitation-water-supply-financing>
- <sup>81</sup> Global Water Intelligence Project Tracker 2016.
- <sup>82</sup> BMI Research,. (2015). *Energy And Utilities Infrastructure - Q1 2016*. BMI Research. Retrieved 19 November 2015, from
- <sup>83</sup> WHO,. (2015). *Viet Nam: Closer to bringing drinking water and sanitation to all*. WHO. Retrieved 19 November 2015, from <http://www.who.int/features/2015/viet-nam-water-sanitation/en/>
- <sup>84</sup> Global Water Intelligence Project Tracker 2016
- <sup>85</sup> Doan Van. "Water Opportunities in Vietnam" U.S. Commercial Service, Ho Chi Min City, 2015.