ARCOWA

WASTEWATER MANAGEMENT AND RESOURCE RECOVERY IN THE PHILIPPINES

Current status and opportunities

gef UNDP PEMSEA

About the author:
ARCOWA SA is an advisory firm that offers a fresh approach to sustainable development strategies, solutions and investments. Drawing together diverse people, disciplines and ideas, we translate leading thinking and practice into world-wide and locally grounded initiatives that catalyze new opportunities and investments with a lasting impact. ARCOWA helps creating water security through focusing on managing water scarcity and drought under climate change; transitioning wastewater treatment into resource recovery while safeguarding human health and restore water resources and, applying a combination of green and grey infrastructure to manage freshwater and marine ecosystems and resources.

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This report is based on the review of a wide range of documented sources and discussions with representatives from a large number of agencies, companies and organizations. All those that provided input into this assessment are kindly acknowledged for their valuable inputs, insights and foresights that formed the underpinning of this report.

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EXECUTIVE SUMMARY

Resource recovery from wastewater provides a significant opportunity in the Philippines. Overcoming some of the institutional barriers, operational shortcomings and financial constraints are critical to expand wastewater treatment and reduce pollution. Capitalizing on the new technologies to recover valuable resources from wastewater provides a new impetus for the sector and improve its financial viability.

The Philippines has enjoyed an abundance of water. Yet projected water availability and demand shows significant future water shortages for many urban areas throughout the country. At the same time, water pollution is seriously affecting surface and groundwater sources and coastal zones.

There is a growing consensus that action needs to be taken urgently and that significant steps need to be made to change the current conditions.

INSTITUTIONAL AND OPERATIONAL CHANGES REQUIRED

Key findings

A broad set of regulations, decrees, acts, orders and codes are in place that regulate wastewater management and aspects of resource recovery. A new effluent standard existing since 2016 provides a major opportunity for new and upgrading existing wastewater facilities and including resource recovery. However, the enforcement of existing regulations is hampered by the limited (financial) capacity of relevant agencies and implementing mechanisms.

Local governments have the responsibility to set-up adequate sanitation systems. However, few local governments or Water Districts have implemented sewerage or effective septage management schemes as they have limited capacity and weak incentives to comply with existing obligations and standards.

Recommendations

- Concerted action is required by government to promote, support and incentivize the use of advanced wastewater treatment and resource recovery technologies.

- To foster further expansion of wastewater collection and treatment, further reform of the sector needs to be accelerated, including through nominating a single lead agency for urban sanitation, establishing a single regulator for the sector, and amalgamating many local service providers in smaller municipalities.

- For municipalities and industries located in areas with (future) water scarcity, more effort should be focused on wastewater re-use in

particular for applications in industrial and agriculture settings. This requires a better cooperation between municipalities and their utilities and industrial establishments and agriculture producers for the off-take of treated wastewater for re-use.

FINANCIAL CHANGES REQUIRED

Key findings

To move towards universal coverage of sanitation services during the period 2015 - 2028, the total investment required is USD 619 million per year. Limited national financing is available compared to the financial resources required to achieve full coverage of wastewater collection and treatment in the Philippines.

Water re-use can avoid or delay expensive development of new water storage and supply infrastructure required to address growing water scarcity in the Philippines. Bio-energy generation from combined wastewater and organic waste could significantly reduce wastewater utilities' operating costs by reducing their power purchases.

Recommendations

- Further guidance and promotion of investments in wastewater systems is urgently required. There is an opportunity to use available government financing more effectively.

- Municipalities, industrial zones and utilities need to invest in feasibility studies to accelerate the recovery of bulk-water, the production of bio-energy, the creation energy-efficiency and the recovery of nutrients from wastewater.

- There is an opportunity to attract additional 'green' financing related to renewable (bio) energy to the wastewater sector. The existing programs with a number of national banks in the Philippines for financing water, wastewater and septic management need to continue and expand.

- In addition, the growing interest of national and foreign private companies to invest in the water sector needs to be harnessed to co-finance wastewater treatment and resource recovery systems at a larger scale.

- There is a need to further diversify financing mechanisms for wastewater treatment and resource recovery in the Philippines, including through the involvement of national and international private sector financing.

- To attract additional national private financing and foreign direct investments in the sector, further tariff reforms will be needed to allow utilities a more attractive rate of return. Such reforms will need to go hand-in-hand with improvements in utility performance and service delivery. Outcome based financing could be a valid

pathway for attracting additional financing to achieve agreed upon targets.

TECHNOLOGICAL AND CAPACITY CHANGES REQUIRED

Key findings

Important experiences exist and expertise is available in the Philippines with regards to wastewater treatment and resource recovery. However, resource recovery from wastewater is not a common practice in the Philippines to date.

Recommendations

- To capitalize on the opportunity to generate bio-energy from wastewater, a more rapid transition from septic tank systems towards centralized wastewater collection and treatment needs to be put in place, especially for the larger, densely populated urban areas.

- Government and business need to initiate new pilot schemes for the production of bio-energy, water re-use and high-quality fertilizer from wastewater. Cooperation between utilities, research centers and technology providers needs to be established to test and gain experience with the use of advanced technologies in this regard.

- New capacities for designing, building and operating advanced wastewater treatment and resource recovery facilities is required. Environmental engineering educations and professional updating canters need to pay more attention to advanced wastewater treatment and resource recovery.

1 INTRODUCTION

Investing in wastewater treatment facilities has been shown to be profitable. New technologies are available to extract water, energy and nutrients from wastewater streams.

Effective management of wastewater remains a persistent problem in East Asia, with discharge of untreated wastewater from domestic, industrial, and agricultural sources a common occurrence. Across Asia, a majority of sewage still finds its way to the rivers, lakes, coastal zones and oceans without any treatment. The impacts on freshwater, coastal and marine ecosystems and communities have been significant, including hypoxia, loss of fisheries productivity and biodiversity, and impacts on human health. Proper wastewater management in river basins and coastal areas presents a complex challenge involving aspects of policy, governance, behavior and investment.

Investing in wastewater treatment facilities, however, can be profitable. New technologies are available to extract water, energy and nutrients from wastewater streams. Products derived from these can be marketed to make the treatment of wastewater —a service each municipal government should provide to its citizens and each industry should actively implement — a profitable business not depending only on government taxes and tariffs. Indeed, combining wastewater treatment with recovering water, energy and nutrients has the potential to provide commercially acceptable returns on investments.

While the business case for recovering resources from wastewater has been proven in particular cases at demonstration, pilot and full-scale applications, there is a need to further understand the potential for wastewater treatment and resource recovery in East Asia.

To that end, country overviews of wastewater management and resource recovery have been prepared for three countries in East Asia: the Philippines, Vietnam and Indonesia. This report, focuses on the Philippines, and aims to improve the understanding of its urban and industrial wastewater sector as a basis for further analyzing opportunities to invest in wastewater treatment and resource recovery. It thus forms an initial step in the potential mobilization of public and private investments in wastewater treatment and resource recovery in the Philippines.

Key questions that the report addresses include:

- What is the current status of water resources in the Philippines?
- What are the common characteristics of urban and industrial wastewater management in the Philippines?
- What are the in-country experiences to-date with different aspects of wastewater resource recovery, including water re-use, bio-energy production and nutrient recovery?

- What is the institutional and regulatory setting for development of the water and wastewater services sector in relation to wastewater treatment and resource recovery?

- What is the capacity at the national level regarding wastewater management and resource recovery?

- What are potential sources of (co-)funding for wastewater treatment facilities in the Philippines?

The report has been prepared based on extensive desk studies and discussion with key actors in the water and wastewater sector in the Philippines.

This study forms part of a collaboration between ARCOWA and PEMSEA – Partnerships in Environmental Management for the Seas of East Asia. It forms a contribution to the further development of an ocean investment facility that aims to mobilize investment in the seas of East Asia's blue economy. The East Asia Ocean Investment Facility (EAOIF), managed by PEMSEA, offers investment services to local governments and project stakeholders, as well as regional and global investment funds, assisting in the identification, development and consolidation of blue economy investment projects in East Asia. The EAOIF targets development of projects that are financially sustainable and generate measurable positive social and environmental impact.

2

2 GENERAL STATUS OF WATER RESOURCES IN THE PHILIPPINES

The Philippines has enjoyed an abundance of water. Yet projected water availability and demand shows significant future water shortages for many urban areas throughout the country. At the same time, water pollution is seriously affecting surface and groundwater sources and coastal zones. There is a growing consensus that action needs to be taken urgently.

Historically, the Philippines has enjoyed an abundance of water. However, this is likely to change in the near future. It is estimated that in 2025, water availability will be marginal in most major cities and in 8 of the 19 major river basins in the country (see Table 2.1). The water availability per capita of 1,907 cubic meters is the second lowest in Southeast Asia with the bulk of water demand coming from irrigated agriculture.

The situation is particularly challenging for Metro Manila. Here, the Angat Dam supplies 97 percent of the Metropolitan Waterworks and Sewerage System (MWSS) service area. By 2025, the projected water demand in Metro Manila is expected to have risen further, requiring the development of supplementary sources of water.

Table 2.1 Water demand in major cities of the Philippines[1]

City	Water Available 1995 (m^3/year)	Water Available 2025 (m^3/year)	Groundwater Available (m^3/year)	Surplus / Deficit 1995 percent	Surplus / Deficit 2025 percent
Metro Manila	1,068	2,883	191	-82	-93
Baguio City	12	87	15	21	-83
Metro Cebu	59	342	60	2	-82
Zamboanga City	28	203	54	92	-73
Cagayan De Oro City	29	98	34	18	-65
Davao	50	153	83	69	-45
Bacolod City	37	111	103	179	-7
Iloilo City	9	47	80	788	70

The water supplies for eight other urban areas (Metro Cebu, Davao, Baguio, Angeles, Bacolod, Iloilo, Cagayan de Oro, and Zamboanga) are also at critical levels, according to various studies. However, consensus has been achieved in several focus group discussions and public forums on the need to identify reform measures to alleviate the looming water crisis in these major cities.

[1] World Bank 2003. Philippines Environmental Monitor.

The situation with water quality also raises concerns. Of the 421 rivers in the Philippines, 50 are considered by the Department of Environment and Natural Resources (DENR) as "biologically dead". Recent studies show that 13 percent of surface water bodies in the Philippines have poor water quality, 40 percent have a fair quality and 47 percent have a good water quality[2]. 58 percent of the groundwater is contaminated resulting in pollution of waterways and sub-soils. Due to the deterioration of water quality, many water bodies are now un-fit for their intended uses, such as public water supply, food production, or recreation.

The annual economic losses caused by water pollution are estimated at PHP 67 billion (USD 1.3 billion)[3]. These include PHP 3 billion for health, PHP 17 billion for fisheries production, and PHP 47 for tourism. With a GDP off USD 300 billion per year this represents ca. 0.5 percent of GDP. An example for this is the "Boracay Island" issue that emerged in April 2018 and which included a government order to close the island for tourism activities until proper treatment and disposal of wastewater is put in place.

The main sources of water pollution include: untreated domestic (also called 'municipal') wastewater discharges (33 percent), industrial sources (27 percent), agriculture and livestock (29 percent), and non-point sources such as agricultural farms (11 percent). Pollution is classified as either 'point sources' with emissions of harmful substances directly into a particular water body, or 'non-point sources', with pollutants delivered indirectly to surface water bodies from scattered or non-identifiable sources.

The pollution of Philippine waters comes for a significant part from untreated domestic and industrial wastewater. Only about five percent of households are connected to sewerage networks and treatment facilities[4]. In Metro Manila alone, approximately 2,000 cubic meters of solvent wastes, 22,000 tons of heavy metals, infectious wastes, biological sludge, lubricants, and intractable wastes, as well as 25 million cubic meters of acid/alkaline liquid wastes are improperly disposed of annually[5].

To address the water pollution challenge, the Clean Water Act was enacted in 2004 to focus on the issues of wastewater and septage management. This resulted in the preparation in 2010 of the National Sewerage and Septage Management Program (NSSMP). To address the issue, the DENR further established designating Water Quality Management Areas (WQMAs) that are prioritized for immediate rehabilitation and protection from pollution sources (see Figure 2.1).

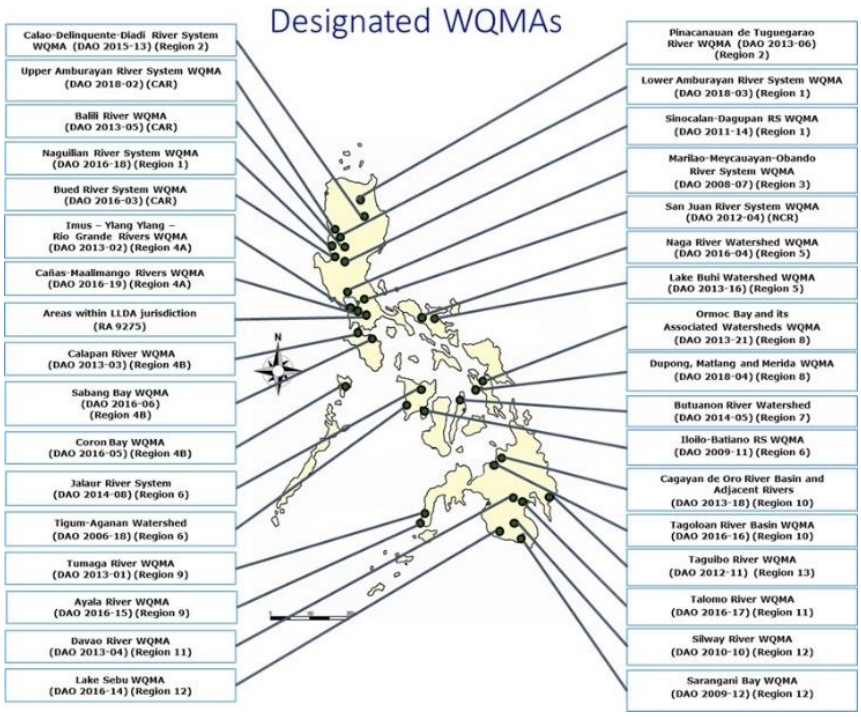
[2] Greenpeace, 2007. State of the water resources in the Philippines.

[3] WSP, 2015. Water Supply and Sanitation in the Philippines Turning Finance into Services for the Future.

[4] NEDA, 2017. Philippines Development Plan 2017 - 2022

[5] UNIDO, 1999. Industrial Policy and the Environment in the Philippines, a paper prepared for the Government of the Philippines. UNIDO consultants Paul Hesp and Richard S. Stevenson (ed.). UNIDO

Figure 2.1 Water Quality Management Areas in the Philippines.



However, urban and industrial wastewater collection and treatment in the Philippines continues to pose a great challenge. According to the Philippine Sustainable Sanitation Roadmap (2010) prepared by the National Economic and Development Agency (NEDA) and the Department of Health (DOH), only 10 percent of the collected wastewater is treated prior to disposal. Despite having multiple organizations focused on wastewater management, there is still significant lack of wastewater collection and treatment facilities because of low investments in the required infrastructure.

While Local Government Units (LGUs) recognize the need to develop wastewater treatment, they are constrained by high investment and operating costs. Citizens unaware of the benefits of proper wastewater treatment are largely unwilling to pay for sanitation and wastewater treatment services. Also, the limited availability of space for sewer lines and wastewater treatment facilities, especially in densely populated, low-income areas, result in sewage being disposed of indiscriminately. In addition, most of the government budget available for water services is directed towards the provision of water supply services (97 percent), leading to a lack of financing available for sewerage and sanitation[6].

[6] World Bank, 2003. Philippines Environment Monitor.

3 URBAN AND INDUSTRIAL WASTEWATER MANAGEMENT

36 percent of the total population, 27 million people, have no access to "improved" sanitation.

Only 10 percent of wastewater is treated and only 5 percent of the total population is connected to a sewer network. The vast majority uses flush toilets connected to septic tanks.

Water and wastewater services in the largest urban areas (>400,000) are mostly operated by national private operators. Others are serviced by city water districts, including through contracting private service providers.

There are 370 Special Economic Zones hosting 3,398 companies. Each Special Economic Zone needs to operate a centralized wastewater treatment facility within the industrial park.

3.1 URBAN WASTEWATER

Urban wastewater collection and treatment in the Philippines continues to pose great challenges. In the Philippines, only 10 percent of wastewater is treated[7] and only 5 percent of the total population is connected to a sewer network. The vast majority of Philippine's population uses a flush toilet connected to a septic tank. Since sludge treatment and disposal facilities are rare, a large part of domestic wastewater is discharged without treatment[8]. In fact, 84 percent of the urban population discharges wastewater to septic tanks and only about 10 percent of the septage is treated, most of which is in Metro Manila. In 2015, 36 percent of the total population (ca. 27 million people) had no access to "improved" sanitation[9].

Domestic effluents are generated from activities such as bathing, laundry, cleaning, cooking, washing, and other kitchen activities. This contains a large amount of organic waste with suspended solids and coliforms. Calculations made based on available data show that half the organic waste is from the domestic sector (see Annex 1). Domestic wastewater discharges contribute highest to the Biological Oxygen Demand (BOD) load in surface waters. This is due to the fact that 90 percent of domestic sewage is discharged into surface waters without going through a sewage treatment system.

[7] NEDA and Department of Health (DOH), 2010. Philippine Sustainable Sanitation Roadmap.
[8] Claudio, L. 2015. Wastewater management in the Philippines. http://www.wipo.int/edocs/mdocs/mdocs/en/wipo_ip_mnl_15/wipo_ip_mnl_15_t4.pdf
[9] WHO/UNICEF, 2015. Progress on sanitation and drinking water - 2015 update and MDG assessment, JMP - WSS

Despite having multiple organizations focused on wastewater management, there is still significant lack of sanitation facilities because of low investments in sewerage networks and treatment facilities[10]. However, there are several private and public entities that manage domestic wastewater. The Metropolitan Waterworks and Sewerage System (MWSS) and its two concessionaires, Manila Water Company, Inc. (MWCI) and Maynilad Water Services, Inc. (MWSI) operate sewage and septage treatment plants within Metro Manila, while the Local Water Utilities Administration (LWUA) manage the domestic wastewater of all other areas outside Metro Manila, including through using private service providers.

Outside Metro Manila, aside from the City of Baguio and a few special locations (Boracay, Clark, Subic), there are no sewerage systems in any of the urban centers. 84 percent of urban households, discharge wastewater to septic tanks that are serviced by unregulated private companies operating septic tank de-sludging services. There are only a few formal septage management services operated by either the LGUs or Water Districts.

Regarding septage management, septic tanks are considered to be the most prevalent means of sanitation in the Philippines for many years to come. Hence, there is the need to accelerate septage management programs across the country, especially for low-density and small urban areas, to ensure that septic tanks operate efficiently and septage is disposed of safely. For densely populated and larger urban areas a rapid transition to centralized wastewater collection and treatment is needed.

Regarding septic management, promising starts for effective septage management programs have commenced in Metro Manila and several cities in the regions (Dumaguete, Baliuag, San Fernando). However, viability of operations depends on the septage collection and treatment service being utilized widely. To enhance septic operations, local governments need to pass ordinances requiring regular septic tank emptying, proper disposal of septage and retrofitting of poorly designed or constructed tanks. Innovative solutions for re-use of treated sludge will also be needed to make the program more attractive to local governments and Water Districts[11].

The amount of BOD annually being discharged into the water bodies of Metro Manila has been estimated to be 430,000 tons per year. An overview of BOD generated in different regions in the Philippines is given in Annex 1. The three major river systems of Metro Manila (San Juan, Marikina and Pasig Rivers) were declared biologically dead in 2000, with reported BOD concentrations of 68, 18.2 and 10.7 mg/L, respectively. The conditions of the three river systems highlighted the need for improved sewerage services in Metro Manila.

Some progress has been made as wastewater treatment in Metro Manila has gradually expanded. The Metropolitan Waterworks and Sewerage System (MWSS) has jurisdiction, supervision, and control of all waterworks and sewerage systems in Metro Manila. In 1997, MWSS awarded two long-

[10] Asian Development Bank, 2013. Philippines Water Supply and Sanitation Sector Assessment, Strategy, and Road Map

[11] World Bank, 2013. EAST ASIA AND THE PACIFIC REGION URBAN SANITATION REVIEW. Philippines Country Study.

term concession contracts, to Manila Water Company Inc. (or Manila Water) for East Manila and the Maynilad Water Services Inc. (or Maynilad) for West Manila. Under the concession agreements, the companies collect and own revenues from water tariffs and in return pay for the operating costs and investments in water and wastewater services.

Maynilad maintains and operates 20 wastewater treatment plants that process wastewater and sludge collected from customers. It also maintains and operates 19 pump stations, 12 lift stations, and over 500 km of sewer lines to enable the efficient collection and conveyance of wastewater from the customers to the treatment facilities to the receiving bodies of water. Manila Water, on the other hand, has 36 operating sewage treatment facilities with a corresponding 23 percent sewerage coverage in the entire East Zone. In attempting to further accelerate the expansion of sewerage coverage, Manila Water uses combined sewer-drainage systems in which existing drainage infrastructure is utilized to convey wastewater. The main advantage of this system is that the construction of extensive (separate) sewer networks is not required.

3.2 INDUSTRIAL WASTEWATER

For the past several years, there has been a constant increase of industrial activities in the Philippines. As of 2012, there were 219,184 businesses in the Philippines, of which 86 percent were engaged in the services sector, 12.9 percent in the industrial sector and 1.1 percent in the agricultural sector. Some of the business in the industrial sector are located in industrial parks or special economic zones located across the Philippines. The Philippines Economic Zone Authority (PEZA) is tasked to facilitate the operations of the businesses within the declared special economic zones. As of October 2017, there are 370 operating special economic zones in the Philippines; 261 Information Technology Parks, 74 Manufacturing Economic Zones, 22 Agro-Industrial Economic Zones, 20 Tourism Economic Zones and 2 Medical-Tourism Centers. Four of these are owned by PEZA while the remaining are privately-owned. The economic zones that are owned and operated by PEZA are Baguio Economic Zone, Pampanga Economic Zone, Cavite Economic Zone and Mactan Economic Zone.

A total of 3,398 companies are located in the Philippine economic zones. Table 3.1 shows the list of the economic zones that have the highest number of companies. The table also shows the estimated domestic wastewater generated by the employees working in the economic zones. PEZA is planning to develop 36 more publicly-owned economic zones. PEZA is also developing a new National Economic Zone Map, which would show available areas in the country for economic zone development as an easy reference for investors interested in expanding operations or setting up their business in the Philippines.

Wastewater produced by industries is not limited to process wastewater, as industries also produce domestic wastewater from employees (see Table 3.1). Ideally, the process wastewater and other non-domestic wastewater are pre-treated by industries before discharging the effluent into the sewerage system of the industrial park. The centralized wastewater

treatment facility (CWTF) within the industrial park shall further treat the effluent from industries before discharging it into bodies of water or reuse for landscaping, irrigation or other purposes. In case the industry is not located within an industrial park, the effluent must already comply with the Philippine Effluent Standards, DAO 2016-08. Recent regulations on nutrients have been a challenge for CWTF, operators as existing treatment systems are not designed to remove nutrients such as nitrates and phosphates to the levels required.

Table 3.1 Major economic zones with corresponding estimated 'employee use' wastewater volume

Economic Zone	Location	Number of Locators (as of Oct 2017)	Number of employees (as of Nov 2017)	Estimated Wastewater Volume ('domestic wastewater') (m^3/day)[12]
Calamba Premiere International Park	Batino, Parian and Barandal, Calamba City, Laguna	78	18,092	1,030
Camelray Industrial Park	Canlubang, Calamba City, Laguna	35	14,234	810
Camelray Industrial Park II	Punta & Tulo, Calamba City, Laguna	61	17,404	990
Cavite Economic Zone	Rosario, Cavite	325	68,882	3,915
Cebu Light Industrial Park	Basak, Lapu-lapu City, Mactan, Cebu	24	12,415	705
First Cavite Industrial Estate	Langkaan, Dasmariñas, Cavite	99	14,778	840
Laguna Technopark	Sta. Rosa and Biñan City, Laguna	165	101,052	5,745
Light Industry & Science Park I	Diezmo, Cabuyao, Laguna	49	19,401	1,105
Mactan Economic Zone	Lapu-Lapu City, Mactan, Cebu	131	57,721	3,280
Mactan Economic Zone II	Basak, Lapu-lapu City, Mactan, Cebu	50	11,894	675

Many industrial parks operate their own CWTF[13], including First Philippine Industrial Park in Batangas, Gateway Business Park in Cavite, Cebu Light Industrial Park in Lapu-Lapu, and Laguna Technopark in Laguna among many others. As said, facilities within industrial parks, however, are still required to comply with pre-treatment effluent standards established by the industrial park before discharge into the CWTF of the park.

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With respect to industrial wastewater, individual companies have obligations to manage their wastewater either as stand-alone entities or as part of an industrial park. There has been some difficulty in industrial wastewater management since proper treatment of wastewater is assigned to individual industries that have to develop their own expertise to comply with effluent standards set either by the special economic zone they are operating in or with general effluent standards.

The volume of wastewater generated by an industry highly depends on its technical level of process and on its production rate. Industries that are

[12] Estimated wastewater generation rate: 56 litres/day/person. Chap. 17 of Philippine Sanitation Code
[13] Information on presence of wastewater treatment facilities in industrial parks taken from websites of respective parks.

known to generate large amount of wastewater are food and dairy manufacturing, pulp and paper products and textile products[14]. Data on the volume of wastewater generated by the industries are very limited in the Philippines. While individual companies do collect and report their wastewater volume data as required by the regulations, there is no national database collating all these data.

Despite limited available data, the range, or the average volume of wastewater generated by selected industries were estimated (see Table 3.2).

Table 3.2 Wastewater generation rate per industry (indicate values – depending on the size of operation)

Industry	Wastewater volume from industrial use ('process wastewater') (m^3/day)	Industry	Wastewater volume from industrial use ('process wastewater') (m^3/day)
Poultry processing plant	1,750	Manufacture of ethanol	3,100
Meat and meat products	75 - 380	Sugarcane milling	100,000
Mining	67,500	Manufacture of beverages	13,000
Manufacture of pharmaceutical	50 - 200	Packaging	60
Manufacture of milk	960	Food processing	500
		Pineapple Processing Plant	6,540

The quality and characteristics of wastewater from each industry differ depending on the nature of the activity of the industry. Table 3.3 presents indicative values of wastewater quality from different industries. Similar to data on the volume of industrial wastewater generated, data on the quality of (untreated) industrial wastewater is lacking in the Philippines.

Table 3.3 Typical wastewater quality of some industries in the Philippines

Industry	BOD (mg/L)	COD (mg/L)	TSS (mg/L)	Temp deg C	pH
Sugarcane milling	2,000-3,500	6,000	800 – 1,000	-	6.5 - 8.0
Manufacture of ethanol	60,000	110,000	6,000	48-50	4 - 4.5
Canning of fish products	30,000	45,000	10,700	25	6.5 -7.5
Manufacture of beverages	900	1,500	250	25	11 - 12
Meat processing	1,000 – 1,500	2,000	250	-	7
Copper Cathode	-	-	43	30.4	8.15
Swine Farm	2,000- 4,200	4,000 – 5,429	1,600 – 5,380		
Bottling Services	400	1,647.05	90	32.2	8.35
Manufacturing of Desiccated Coconut	6,000- 10,000	17,000-20,000	2,000 – 4,000	-	5.0-6.3
Pineapple Processing Plant	10,200	20,000	585	40-50	4.5-6.5

Individual industrial facilities, outside of special economic zones, need to acquire a wastewater discharge permit and are responsible for the quality of their discharge to surface waters.

[14] World Bank, 2003. Philippine Environment Monitor

In the Manila Bay Area alone, 5,228 out of 10,168 industries were served with Notices of Violation (NOV) for failure to acquire permits to discharge treated wastewater[15]. The Manila Bay Area includes the National Capital Region (NCR), Central Luzon Region (R III), and the Calabarzon (R IV-A). However, the recently developed Manila Bay nutrient reduction strategies is designed to provide an important impulse to address pollution in the Manila Bay watershed area (see Box 3.1).

Box 3.1 Manila Bay area – nutrient reduction strategies[16]

Over the last six years, DENR, UNEP GPA and PEMSEA with the support of GEF, have supported the development of nutrient reduction strategies through application of quantitative source-impact modelling and best practices in Manila Bay watershed. The main outcomes of this initiative are:

- an improved decision support system on nutrient issues in Manila Bay watershed as part of integrated approach to overall water quality;
- agreement with government agencies and relevant stakeholders in Manila Bay watershed on nutrient reduction strategies to be implemented, including their effective insertion into integrated national water quality planning for the Bay area; and
- application and implementation of ecosystem nutrient health report card in Laguna de Bay, Manila, including as part of overall nutrient reduction strategies for Manila Bay watershed.

Generally, the treatment of industrial wastewater must be designed for the particular quality of wastewater generated by each specific industry and be capable of meeting the required effluent quality. Some of the wastewater treatment technologies used by industries in the Philippines, include:

- Sequence Batch Reactor (SBR): Conventional activated sludge system that is operated by batches. It consists of a cycle of five stages, all happening in one tank; fill, react, settle, draw, idle.

- Extended Aeration System: An aerobic process wherein the sewage goes straightly to the aeration tank / lagoon for longer aeration time.

- Membrane Bio Reactor: A combination of conventional biological treatment process and membrane filtration.

A number of industrial parks in the country operate CWTFs. As indicated above, some CTWF require individual industrial operators within the Industrial Park to comply with pre-treatment effluent standards established by the industrial park before discharge into the CWTF of the park.

Industrial parks with existing centralized wastewater treatment plants also are required to upgrade their treatment plants particularly to make their nutrient removal capabilities compliant with the new standards set in DAO 2016-08 (Table 3.4).

[15] Manila Bay Coordinating Office, 2018. 1st Stakeholder's Consultation Meeting on Operational Plan for Manila Bay Coastal Strategy

[16] PEMSEA, 2018. Development of Nutrient Reduction Strategies through Application of Quantitative Source-Impact Modelling and Best Practices in the Manila Bay Watershed.

There is no information available regarding the current level of compliance of the industrial parks to the General Effluent Standards, although industrial parks are required to submit self-monitoring reports to the Environmental Management Bureau which should prove that they are compliant with the national effluent standards.

Table 3.4 DAO 2016-08 Class C Standards for nutrients

Parameter	Class C Standards
Nitrate as NO_3-N (mg/L)	7
Phosphate (mg/L)	0.5
Ammonia as NH_3-N (mg/L)	0.05

Industrial wastewater, treated or untreated, generally is discharged to the rivers and other bodies of water. Prior to disposal, the industrial wastewater must meet the national standards, however, this is not observed at all times. Disposal of inadequately treated industrial wastewater causes the increase of pollutants in the rivers. According to The Department of Environment and Natural Resources (DENR) – Environmental Management Bureau (EMB), 15 percent of the organic pollution in the rivers is caused by industrial wastewater.

The majority of the manufacturing industries in the Philippines are located in the National Capital Region (30 percent), Region 4A - Calabarzon (17 percent) and Region 3 - Central Luzon (11 percent)[17]. From the monitoring conducted by the EMB, rivers of the mentioned regions had "unsatisfactory ratings" for their water quality criteria. Rivers that were monitored by the EMB in these regions that were also designated as WQMA are the San Juan River (NCR), Marilao-Meycauayan-Obando Rivers (Region 3) and Imus-Ylang Ylang-Rio Grande Rivers (Region 4A). All these rivers were observed to have high BOD compared to the set criterion of 7 mg/L[18].

The Marilao-Meycauayan-Obando River was included in the "World's Worst Polluted Places" according to the Blacksmith Institute and considered to be a biologically dead river. The river was known to contain high concentrations of mercury and other heavy metals. The river system is extremely polluted due to untreated wastes from tanneries, gold and precious metals refineries, small scale lead recycling facilities and numerous municipal dumpsites along the river. Some efforts have been undertaken to address the situation, but major progress still remains to be made.

[17] Philippines Statistics Authority, 2012. Census of Philippines Business and Industry 2012.
[18] Manila Bay Area Atlas, 2015. 2nd Edition.

4 EXPERIENCES WITH RESOURCE RECOVERY FROM WASTEWATER

Important experiences exist and expertise is available in the Philippines with regard to re-using wastewater, producing bio-energy and recovering nutrients for fertilizers from organic waste and wastewater.

A few companies in the food-beverage and pulp-paper sectors have established water re-use schemes within their operations. Methane-based bio-energy generation from organic materials is commonly known and practiced in some industries and farms. Nutrient recovery from wastewater is practiced by some wastewater service providers.

Though some experiences and limited capacities exist, resource recovery from wastewater is not a common practice in the Philippines to date.

4.1 WATER RE-USE

Treated wastewater can be re-used for industrial, agricultural and urban uses. Within industrial facilities, the re-use of wastewater is common practice in large industrial/economic zones. With an average cost of water[19] in the Philippines at PHP 669.26 per 30 m^3, water re-use has a potential to safe the costs of (additional) water supply, especially for large water users.

«Wastewater is a valuable resource in the circular economy and its safe management could be an efficient investment in the health of humans and ecosystems. »

Nonita Caguioa, DENR Assistant Secretary for Staff Bureaus[1].

There are various applications of wastewater reuse by industries in the Philippines. Wastewater reuse for cleaning pipes or drainage canals is used in several industries. For example, the Mactan Ecozone facility (Mactan, Cebu)[20] treats 83 percent of its wastewater (1,161 m^3/day) and re-uses this water for cleaning toilets, watering plants, cleaning drainage canals and pipes, and for extinguishing fires.

Other industries, especially those that use large volumes of water such as ethanol manufacturing and paper milling, reuse their wastewater as process water and for watering gardens and ponds. At San Carlos BioPower Inc. (SCBI), San Carlos City, Negros Occidental, for example, wastewater is re-used as part of the cooling tower make-up and as process water[21]. A part of the effluent (1,788 m^3/day) is collected and run through an oil/water separator for removal of oil and grease and transferred to a lagoon for cooling and sedimentation. Another part of the effluent (350 m^3/day) is re-used as process water after removal of suspended solids. Another example is United Pulp and Paper Corporation (UPPC) (Brgy. Iba Este, Calumpit,

[19] LWUA, 2017
[20] Japan International Cooperation Agency (JICA), 2008. Special Economic Zones Environment Management Project.
[21] San Carlos BioPower Inc

Bulacan), which reuses its wastewater for watering gardens and lawns, for koi and tilapia fish-ponds, cleaning the facility and cleaning waste paper, which is used as raw material. The company invested PHP 500 million to construct the facility with a capacity of 11,000m^3/day.[22]

«Treated wastewater can act as a drought-resistant source of water especially for agriculture and industry, source of nutrients for agriculture, soil conditioner and source of energy or heat. »

Nonita Caguioa, DENR Assistant Secretary for Staff Bureaus[1]. »

Little information is available on localized / decentralized use of wastewater in agriculture in the Philippines. Some studies have indicated an improvement in farmers' productivity and income due to water saved[23]. The total area irrigated with treated wastewater is estimated to be 1,904 ha and the total surface area on which wastewater is applied as liquid soil conditioner to be 1,424 ha. The major crops irrigated with treated wastewater are sugarcane, banana, pineapple, assorted vegetables, maize, cassava, mango and coconut[24].

The use of domestic or municipal wastewater in backyard gardening, ornamental plants, and landscape grasses is also known but no figures or values are available for these uses.

4.2 BIO-ENERGY

Some industries in the Philippines use industrial effluent to produce biogas, which they use to power their own operations. Distilleries produce high volumes of wastewater and slops to use as raw material for bio-fuel production. Some have installed sophisticated wastewater treatment facilities for production of methane-rich biogas, which the facility uses to power their own operations.

The livestock and agro-industrial sectors present the largest opportunity for methane capture and reuse[25]. There are two sources of methane emissions from these industries, wastewater and solid organic wastes. Capturing methane from livestock and agro-industrial wastes for combustion is a proven and effective Green House Gases (GHG) abatement strategy. With the re-use of methane as bio-gas, electricity costs of the industry can also be reduced. Because bio-gas has no market-determined monetary value yet, the actual cost savings can be determined only by the cost of energy reduced. Average cost of energy in the Philippines ranges from PHP 8 - 10 per kWh[20].

The livestock sector in the Philippines is dominated by the swine industry both in terms of volume and value of production. In 2012, the UNFCCC registered a Programme of Activity (PoA) for pig farms under the "Methane Recovery from Waste Management Project", which allows farms across the Philippines to generate carbon credits (see Box 4.1). This is an added financial incentive for pig farms to invest in wastewater treatment facilities

[22] Philippine Star, 2008. A paper mill that recycles everything.
[23] Raul Alamban, 2005. Environmental assessment of farm household wastewater for vegetable production in Maria Paz, Tanauan City, Batangas
[24] Teresita, M., Sandoval, S., Marcelino Rivera, M., 2012. Wastewater production, treatment and use in the Philippines.
http://www.ais.unwater.org/ais/pluginfile.php/501/mod_page/content/87/reports_philippines.pdf
[25] Methane to Markets, 2009. Resource Assessment for Livestock and Agro-industrial Wastes-Philippines.

that better dispose of pig manure and capture methane to generate electricity. As of June 2017, the Department of Energy awarded 9 Biogas Projects with the potential of generating an additional 52.5 MW of electricity[26].

Alcohol distilleries also produce high volumes of wastewater and slops which can be a source of methane gas that can be converted to bio-gas. Some distilleries such as Asian Alcohol (Pulapandan, Negros Occidental) [27] use slops as a raw material for bio-fuel production. For the Lucio Tan Group, who acquired Asian Alcohol in 1991 and invested in a wastewater treatment plant, it was one of its major projects with a capital expenditure (CAPEX) of PHP 120 million at completion in 1997.

Box 4.1 Methane recovery from pig farms

Marcela Farms Inc. (Bohol) and Biotech Farms Inc. (South Cotabato) were assisted by the Landbank with their animal waste-to-energy technologies. The said farms produced a total of 4,506 MWh of energy that is equivalent to around PHP 27 million of power savings and generated a total volume of 27,487 carbon credits or Certified Emission Reductions (CERs), which amount to additional gross revenue of PHP 7.4 million for the companies.

Facilities such as Del Monte Philippines, Inc. in Cagayan de Oro installed sophisticated wastewater treatment facilities for production of methane-rich biogas, which the facility uses to power their own operations. The facility treats 13,000 m^3/day, with the anaerobic effluent achieving 93 percent Chemical Oxygen Demand (COD) removal, and final effluent achieving a further 83 percent removal. The facility produces methane-rich biogas, which is fed into two 1.4MW generators[28].

Further opportunities exist in using the wastewater effluent of ethanol plants, with extremely high COD and BOD. Moreover, avoiding the methane emissions from the traditional wastewater lagoons could contribute significantly to GHG emission reductions in the Philippines. Carbon finance provides the opportunity and/or incentive for improving existing systems and/or adopting new technologies that are more effective in preventing water pollution while also compelling the plant owners to address methane emissions.

Based on the Philippines Power Development Plan 2017 -2040, the country's power rates are among the highest in the region (ca. PHP 8.72 per kWh)[29]. Due to the new Tax Reform for Acceleration and Inclusion (TRAIN), energy prices are projected to increase during the 2018 – 2020 period in the Philippines as various taxes will have to be included in the prices. However, Manila Electric Co. (Meralco), Philippines' largest power distributor, recently reduced prices to PHP 8.7227 per kWh (USD 0.156) from PHP 9.2487 per

[26] Department of Energy, 2017.
[27] Asian Alcohol
[28] Industrial Water World. Case Study: Del Monte Philippines Harvests Energy from Food Process Water
[29] Department of Energy 2016. Philippines Power Development Plan 2016 – 2040.

kWh[30]. For energy production spot market sales, prices were at PHP 4.7333 per kWh in April 2018[31].

4.3 NUTRIENT RECOVERY

In the big cities of the Philippines, sewage sludge, green waste and organic waste from households or the catering industry, the food processing industry or the agricultural sector are recovered by companies that specialize in the treatment of organic waste. Treatment is either achieved through controlled composting or anaerobic digestion in biogas plants. The compost produced is used as fertilizer for agriculture and the methane generated by fermentation is recovered using the same procedures as those for landfill biogas. An example of urban wastewater – nutrient recovery is the Manila Water and Maynilad activities of delivering biosolids to farmers in Pampanga to use as organic soil conditioner to rehabilitate lahar-affected areas. Another way treated wastewater is used is as liquid fertilizer.

Box 4.2 Absolut Distillers, Lian, Batangas32

The company produces liquid fertilizer for sugarcane farmers. It has acquired a registration as a fertilizer manufacturer and distributor of liquid fertilizer. An estimated 150 sugarcane farmers and four sugarcane plantations use the liquid fertilizer produced by Absolut Distillers. Use of the liquid fertilizer resulted in 60 percent increase in yield and reduced cost of fertilizer requirements with an annual savings of PHP 23,272,970 (USD 541,231). Absolut Distillers installed larger lagoons retrofitted with High-Density Poly-Ethylene liners, a reed-bed system and a Sequential Batch Reactor (SBR) to treat, equalize, aerate, and clarify wastewater. Treated effluent was distributed as liquid fertilizer to their sugarcane farms using trucks

Within the Philippines, a few applications of nutrient recovery from industrial organic waste and/or wastewater exists. However, industry players have not yet gone to a scale to harness and recover organic waste to its full potential. Earlier experiences show however that it is possible to recover nutrients in a profitable manner. A first product that is 'recovered' is 'biosolids', a resource that is sourced from treated septage and processed sludge. Some industries, such as the food and beverage industry, source this wastewater effluent with trucks to farms. The high-organic content of the wastewater effluent has proven to be useful in the production of crops and to reduce the total costs of fertilizer used.

A few examples of agricultural reuse of wastewater from alcohol manufacturing facilities are presented in Box 4.2 – 4.4. These facilities are known to consume high amounts of water for their processes and generate large amount of wastewater. As said, the reuse of wastewater as liquid fertilizer can help reduce the cost of fertilizers that are used by the farmers. Effluent with high nutrient content is processed before discharge since there

[30] The Manila Times 2018 (10 Jan 2018). Meralco cuts power rates in January http://www.manilatimes.net/meralco-cuts-power-rates-january/373413/

[31] Meralco, 2018. Computation of the generation charge for April 2018. https://meralcomain.s3-ap-southeast-1.amazonaws.com/documents/pdf_listing/2018-04/042018_generation.pdf?null

[32] Tan Tee, G. 2009. "The CDM Project of Absolute Chemicals, Inc.: The First in the Philippine Manufacturing Industry." Presentation during the 2009 East Asian Seas Congress. Manila. (23-26 November 2009).

are policies governing safe reuse of wastewater for agricultural purposes. Furthermore, manufacture and distribution of fertilizers must be registered with the Fertilizer and Pesticide Authority.

Box 4.3 San Carlos BioPower Inc. (SCBI), San Carlos City, Negros Occidental33

The company treats its process wastewater for agricultural reuse and fertilization with up to 1,500 m^3 of water reused for irrigation. Wastewater goes through an anaerobic digester (capacity: 300 m^3/day), lined lagoon (capacity: 16,000 m^3) for storage and spent wash evaporator (capacity: 600 m^3 per day) for reduction of spent wash volume. A 20-ha pond with a storage of 200,000 m^3 of treated wastewater is used as a buffer. 300 m^3 per day of effluent goes from the wastewater pump house directly to a field for reuse as fertilizer.

Box 4.4 Busco Sugar Milling Co., Inc. Brgy. Butong, Quezon, Bukidnon 34

The sugar mill uses a "Zero Discharge Program" or a "Close-Loop System" to recycle and re-use its wastewater. The wastewater is used to irrigate ca. 400 ha of land with nitrogen and phosphorous rich water that reduces fertilizer application significantly. The facility operates a common wastewater treatment plant with capacity of 100,000 m3 and employs primary and secondary treatment. The wastewater has a BOD of 50mg per liter and the re-used effluent contained an average nitrogen content of 2.5 mg per liter and a phosphorous content of 3.8mg per liter.

The safe use of treated wastewater in agriculture can lead to a reduction of fertilizer costs. Table 4.5 presents an overview of the most common fertilizers used in the Philippines. The prices vary from PHP 500 – 1500 / 50 Kg bag. (ca. PHP 10 – 30 / kg) (ca. USD 0.19 – 0.57/Kg) depending on the type of fertilizer and the region.

Table 4.5 Average Prices of Different Types of Fertilizer Grades in the Philippines[35]

FERTILIZER	UREA	AMMOSUL	COMPLETE	AMMOPHOS	MOP	DAP
GRADE	(46-0-0)	(21-0-0)	(14-14-14)	(16-20-0)	(0-0-60)	(18-46-0)
Price / 50 kg (PHP)	850-1,000	500-550	1,000-1,300	800-900	950-1,000	1,300 – 1,500

[33] San Carlos BioPower Inc.
[34] Wocat SLM Technologies
[35] Philippines Statistics Authority, 2018. Updates on fertilizer prices. https://psa.gov.ph/content/updates-fertilizer-prices-0

5 INSTITUTIONAL SETTING

A wide range of institutions address water and wastewater management issues in the Philippines making the institutional setting complicated with possible overlaps in responsibilities.

A broad set of regulations, decrees, acts, orders and codes are in place that regulate wastewater management and aspects of resource recovery. A new effluent standard provides a major opportunity for new and upgrading existing wastewater facilities.

The 2017 – 2022 development strategy for the Philippines clearly defines institutional reforms in the water sector as a priority to guide and promote investments in water supply and sanitation.

5.1 NEW DEVELOPMENT STRATEGY

The new development strategy for the Philippines (2017 – 2022) puts an important focus on water resources management[36]. It states: "The primary strategy for the water resources sector is to address its fragmented structure through the creation of an apex body and the formulation of masterplans that will foster coordinated efforts across the country. Such an apex body will institutionalize a science-based river basin approach that integrates the principles of integrated water resource management". The intention is that "the National Water Resources Board and the National Economic and Development Authority (NEDA) will strengthen coordination and linkages with partner institutions (i.e., LGUs, national government agencies, government-owned and controlled corporations, nongovernment organizations, private investors, and academia) in all aspects across the different subsectors toward achieving adequate access and sustainable water resources management".

The new strategy also indicates that: "Institutional reforms will be pursued to encourage and guide investments in Water Supply and Sanitation Sector (WSSS). The creation of an independent economic regulatory body for the WSSS subsector will be pursued for a more transparent and consistent regulation. A unified financing framework with a definite scope and streamlined process will be established to consolidate and make more accessible all available financial resources to support the WSSS projects of all water service providers. Further, a WSSS master plan will be prepared to guide the concerned implementing agencies to attain universal access in the sector". And… "To ensure water security in water-critical areas and in Metro Manila, … sewerage and sanitation infrastructure will be expanded"

[36] NEDA, 2017. Philippine Development Plan 2017 – 2022.

5.2 INSTITUTIONAL FRAMEWORK

A wide range of institutions address water and wastewater management issues in the Philippines (see Annex 2). The existing institutional set-up in the Philippines is thus quite complicated and poses problems, conflicts of interests and possible overlapping of responsibilities that hinder effective water resources and services management.

«Fragmentation among water-related agencies is evident in three areas of concern: water supply and distribution, economic and resource regulation, and planning and policy formulation. »

The Department of Environment and Natural Resources (DENR) – Environmental Management Bureau (EMB) has the mandate to protect and conserve the country's bodies of water. They enforce the water quality guidelines and the effluent standards and ensure compliance by industries with the environmental rules and regulations. DENR approves discharge permits and Environmental Compliance Certificate (ECC) that are applied for by industries. It further provides specific environmental criteria and data for the prioritization of sanitation, sewerage, septage management and a combination of different systems and projects.

Thus, the agencies that are most focused on wastewater treatment and discharge are the Department of Environment and Natural Resources (DENR) – Environmental Management Bureau (EMB) and the Laguna Lake Development Authority (LLDA), as they issue discharge permits and ensure the compliance of industries. The Philippine Economic Zone Authority (PEZA) assists DENR in monitoring the effluent of its locators. The Department of Agriculture (DA) – Bureau of Soil and Water Management (BSWM) and the Bureau of Agriculture and Fisheries Standards (BAFS) formulate guidelines for the re-use of wastewater and its by-products (e.g. sludge, slops, etc.) for irrigation and other agricultural uses. In particular, BSWM focuses more on the re-use of wastewater for agricultural purposes and BAFS provides standards for fertilizer and soil conditioner manufacturing.

Private companies, mostly in residential areas and industrial parks, need to have their own wastewater systems installed and, in a certain way, have to regulate themselves and report to DENR-EMB. Local governments have a clear responsibility for the provision of sanitation facilities within their jurisdiction, but few local governments or Water Districts have implemented sewerage or effective septage management schemes as there are only weak incentives for the local governments to meet their responsibilities with regard to sanitation. In some situation, LGUs have opted to contract a private operator to manage their water (and wastewater / de-sludging) system.

The institutional fragmentation of the sector is well recognized. Many professionals agree that a reform of the sector would include nominating a single lead agency for urban sanitation, establishing a single regulator for the sector, an amalgamation of the many local service providers and a further reform of tariffs. Also, there is a need to further use the river-basin, water quality management areas (WQMAs) and improving centralized monitoring of sector performance. At present, these reforms are at a very early stage of either consideration or implementation and much work remains to be done.

5.3 POLICIES, LAWS AND REGULATIONS

The Philippine Clean Water Act (RA 9275) (2004) and the Implementing Rules and Regulations of Philippine Clean Water Act of 2004 (DAO 2005-10) are the main regulations for wastewater discharges in the Philippines. The Philippine Clean Water Act of 2004 aims to protect the country's water bodies from pollution from household activities, commercial enterprises and industrial establishments. Key features of the act include the water quality and wastewater management systems. The DAO 2005-10 is focused on:

- designation and management of Water Quality Management Areas (WQMAs);
- development of a National Sewerage and Septage Management Plan (NSSMP) to address national issues on sanitation and treatment and disposal of domestic wastewater;
- provision of water supply and sewerage services to highly-urbanized cities (HUCs); and
- implementation of wastewater charge system in all management areas through the collection of wastewater discharge fees[37].

Of particular importance is the recent DENR Administrative Order 'DAO 2016-08' (Water Quality Guidelines and General Effluent Standards (GES)). This order specifies the effluent parameters that will be monitored for each industry together with the new effluent standards that the industry must comply with at all times regardless of the volume of wastewater produced. It is more stringent and has 16 additional parameters including nutrient requirements (see Table 5.2). A grace- period of max. 5 years can be given by DENR if a Compliance Action Plan and periodic reports of steps taken towards implementation of the plan within the grace period are submitted.

Table 5.2 New standards for nutrient emission from Wastewater Treatment Plant (WWTP) effluent (DAO 2016-08 Class C Standards)

Parameter	Class C Standards
Nitrate as NO_3-N (mg/L)	7
Phosphate (mg/L)	0.5
Ammonia as NH_3-N (mg/L)	0.05

PEZA Memorandum Circular 2009-19: "Guidelines on Wastewater Management" provides guidelines on the wastewater management within Special Economic Zones. The guidelines are to assist the locators in managing their wastewater in compliance with the Philippine Clean Water Act of 2004 and DAO 2005-10. It requires all economic zones to install, operate, and maintain a centralized wastewater treatment facility that caters to the locator enterprises within a specific economic zone. An accredited Pollution Control Officer (PCO) or Environmental Management Officer must supervise the operation of the CWTF and monitor effluent from locator enterprises.

[37] Note: industries discharging wastewater to the environment must apply for a discharge permit to DENR and pay the corresponding charges. Only wastewater that complies with the national standards are allowed to be discharged in the water bodies. The industries are also required to submit a self-monitoring report to the EMB or LLDA to report on the quantity and quality of waste discharged daily or periodically (DAO 2003-27).

- Guidelines for the re-use of wastewater for agricultural and aquaculture purposes are within the Department of Agriculture Administrative Order 2007-26: "Guidelines on the Procedures and Technical Requirements for the Issuance of a Certification Allowing the Safe Re-Use of Wastewater for Purposes of Irrigation and other Agricultural Uses". Prior to re-using wastewater, the user must first secure certification from the Department of Agriculture.

The agricultural re-use of sludge, biosolids and biochar is regulated through the Department of Agriculture - Bureau of Agriculture and Fisheries Standards (BAFS): Philippine National Standard on Organic Soil Amendments (PNS/BAFS 183:2016). These guidelines aim to ensure the consistent quality of organic fertilizers, compost, and soil conditioners in the market. They provide specifications on allowable levels of pathogens, heavy metals, raw materials and restrictions of use of input materials.

Furthermore, there are a number of Presidential Decrees, Acts and Administrative orders that are directly relevant to wastewater (and sludge) management. A short overview of all relevant ones is given in Box 5.1 and Box 5.2.

Box 5.1 Presidential Decrees and Acts relevant to wastewater and sludge management in the Philippines

- Commonwealth Act 383, Anti-Dumping Law (1938): Prohibits dumping of refuse, waste matter or other substances into rivers;
- Presidential Decree 984, Pollution Control Law (1976): Provides guidelines for the control of water pollution from industrial sources and sets penalties for violations, also requires all polluters to secure permits;
- Republic Act No. 9003, Ecological Solid Waste Management Act of 2000: Calls for the institutionalization of a national program that will manage the transfer, transport, processing, and disposal of solid waste in the country (Section 40 criteria for siting landfills to ensure they do not affect aquifers, groundwater reservoirs or watersheds);
- Presidential Decree No. 856, Sanitation Code of the Philippines: Covers solid and liquid waste disposal, prescribes standards for sewage collection and refuse and excreta disposal and assigns to cities and municipalities the responsibilities to provide for efficient and proper disposal, and to handle nuisance and offensive trades and occupations.

While a range of rules and regulation is in place, one has to keep in mind that full enforcement of these is hampered by a lack of investment. Also, there is a shortage of funds for the regulatory agencies and a slow development of necessary implementing mechanisms.

Box 5.2 A selection of Administrative Orders and Codes relevant to wastewater management in the Philippines

- DENR Administrative Order No. 90-34, Revised Water Usage and Classification/ Water Quality Criteria: Section 68 classification of water bodies according to their best usage; Section 69 parameters and criteria for water quality required for each type of classification;
- DENR Administrative Order No. 90-35, Revised Effluent Regulations of 1990 – Prescribes the standards for discharge of effluents to the different classifications of water bodies;
- DENR Administrative Order No. 94-26A, Philippine National Standards for Drinking Water: Provides for the different parameters and value for drinking water quality and defines guidelines for assessing water quality for drinking water;
- DENR Administrative Order No. 97-39, Chemical Control Order for Mercury and Mercury Compounds: Regulates importation, manufacture, distribution and use of mercury and mercury compounds and the storage, transport, and disposal of their wastes;
- DENR Administrative Order No. 200018, Chemical Control Order for Cyanide and Cyanide Compound – Identifies requirements and procedures pertaining to the importation, manufacture, distribution and use of cyanide and cyanide compounds and the storage, transport, distribution, and use of cyanide and cyanide compounds and the storage, transport, and disposal of their wastes;
- DENR Administrative Order No. 98-58, Priority Chemical List: Identifies existing and new chemicals with potentially pose unreasonable risk to public health, workplace, and the environment;
- Department of Health Sanitation Code: 1995 - Rules and Regulations of Chapter XVII- Sewage collection and disposal, Excreta disposal and drainage / 2004 - Collection, Handling, Transport, Treatment and Disposal of Domestic Sludge and Septage;
- Department of Agriculture Administrative Order No. 2007- 26: Guidelines on the Procedures and Technical Requirements for the Issuance of a Certification Allowing the Safe Reuse of Wastewater for Purposes of Irrigation and other Agricultural uses.
- DENR Administrative Order No. 2005-10: Implementing Rules and Regulations of the Philippine Clean Water Act of 2004 (RA 9275 – Section 13)
- DENR Administrative Order 2016-08-WQG (Water Quality Guidelines) and General Effluent Standards (GES) approved on May 24, 2016 and took effect on June 15, 2016.

6 NATIONAL CAPACITIES ON WASTEWATER SERVICES

In general, there is sufficient capacity in the Philippines to design and build a 'traditional' wastewater treatment facility. However, there are some limitations in capacity, especially outside Metro Manila, in terms of designing, building and operating advanced wastewater treatment facilities and the application of modern resource recovery technologies.

6.1 CONTRACTORS, SERVICE PROVIDERS AND CONSULTANTS

There are several local and international engineering companies in the Philippines that offer consultancy and design of wastewater treatment plants. Table 6.1 shows some of the WWTP design consultants in the Philippines.

Table 6.1 International and local wastewater treatment plant design consultants

International	Local
Fluor Daniel Inc.	LCI Envi Corporation
Arup	JGC Philippines
Arcadis Philippines	Pacific Spectrum Env. Research & Consultancy Inc.
SGS Philippines	Woodfields Consultants, Inc
GHD	

There are also several leading local and international engineering firms operating in the Philippines that offer water and wastewater engineering services. Most of them maintain offices within the Metro Manila area where the demand for these services is high. An overview is presented in Table 6.2. In general, there is sufficient quality capacity in the Philippines to design and build a 'traditional' wastewater treatment facility. However, there is limited capacity in terms of designing, building and operating advanced wastewater treatment facilities and modern resource recovery technologies.

Table 6.1 Engineering, Procurement and Contract (EPC) providers for wastewater services

Service Providers	Type of Service	Technology
Ecosystem Technology Inc. (ESTI)	Design and Build Operation and Maintenance	Sequence Batch Reactor (SBR), Membrane Bio Reactor (MBR) Sequence Bio Reactor (Patented)
Bauer International Philippines, Inc.	Engineering & Consultancy Turnkey Construction Start-Up and Commissioning Supply & Service Contracts	Sequential Batch Reactor (SBR) Reverse Osmosis Nanofiltration and Ultra filtration
RNM Dynamics	Wastewater Treatment Design Supplies and Engineering Services Plant Design, Installation, Test and commissioning	Membrane Bio Reactors (MBR) Sequential Batch Reactor (SBR) Packaged Sewage Treatment Plant (STP)
Fluid Technologies and Environmental Management Inc.	Design and Build Operation and Maintenance	Portable Wastewater Treatment Facility
Global Water Engineering	Process Consulting and Assistance Technical Consulting and Assistance	Upflow Anaerobic Sludge Blanket Digesters Fixed film bioreactor with suspended biomass Membrane Bioreactor, SBR
Bongar Envirosystems Technologies Corporation	Process Design and Construction Build and Supply	Sequential Batch Reactor (SBR) Extended Aeration Continuous Flow System
EEI Corporation	Construction companies for various facilities, industrial plants, water distribution stations, flood control systems	
SDIC Environmental Technologies, Inc	Full service environmental engineering firm focused on wastewater and sewage for discharge or reuse	Various
Green Innovations	Water conservation, treatment, and reuse. WWTP for resorts, public markets, factories, and other industrial facilities	Various

6.2 TRAINING PROVIDERS AND NETWORKS

There are several relevant network organizations in the Philippines, including:

- Council of Engineering Consultants of the Philippines (CECOPHIL)
- Council of Filipino Consultants Inc. (COFIC)
- Philippines Water Works Association (PWWA)
- Pollution Control Association of the Philippines Inc. (PCAPI)

Furthermore, there are several universities and colleges in the Philippines that have programs at Bachelor and/or Master of Science in Environmental Engineering (EE), Sanitary Engineering (SE) or Environmental & Sanitary

Engineering (EnSE) (see Table 6.3). Environmental and Sanitary Engineering education offered by the different private and State Universities & Colleges include planning, design, management, construction, operation, maintenance in the fields of water supply engineering, solid waste management, sewage and wastewater engineering, environmental management and engineering, plumbing and public health engineering. Each year between 100 and 200 students graduate Environmental and Sanitary Engineering in the Philippines.

Table 6.3 Environmental and Sanitary Engineering education in the Philippines.

Metro Manila		**Region IV –A (Calabarzon)**	
De la Salle University	BS EnSE, MSc EE	Batangas State Univ.	BS EnSE
Mapua University	BS EnSE, MS & PhD EE	Univ. of North. Phils Vigan	BS SE
University of the Phils	MSc & PhD EE	Saint Louis College	BS EnSE
National University	BSc EnSE, MSc SE	Univ. of the Cordilleras	BS EnSE
Techn. Inst. of the Phils	BS EnSE	Saint Paul University	BS EnSE
		University of Baguio	BS EnSE
Region V (Bicol Region)		**Region IX (Zamboanga Peninsula)**	
Partido State University	BSc SE	Western Mindanao State University	BSc SE

BSc: Bachelor of Science; MSc: Master of Science; EE: Environmental Engineering; SE: Sanitary Engineering; EnSE: Environmental & Sanitary Engineering.

The Pollution Control Association of the Philippines Inc. (PCAPI) together with the Philippine Institute of Chemical Engineering (PIChE) and the Environmental Management Bureau (EMB) of the DENR are providing training on wastewater treatment to enhance the capabilities of Pollution Control Officers, Chemical and Environmental Engineers in-charge of designing and operating wastewater treatment facilities. The National Engineering Center of the University of the Philippines (Diliman Campus) also conducts training on wastewater treatment process focusing on the biological process.

7 WASTEWATER TARIFFS AND INFRASTRUCTURE FINANCING

Water tariffs are regulated by the National Water Resources Board (NWRB) and are based on a utility's maximum rate of return of 12 percent. Tariffs vary widely between services operators. Commercial users pay a base fee with additional costs for treatment of highly polluted wastewater.

The investment requirement for water supply is estimated to be USD 838 million per year between 2015 and 2025. For universal coverage of sanitation services by 2028, the total investment requirement is estimated to be USD 619 million per year from 2015 - 2028.

Most investment in the water sector have been through national government funds, international partners and private sector participation. Private investment companies in the Philippines have a growing interest to invest in the water sector.

7.1 WATER AND WASTEWATER TARIFFS

The tariff for small water and wastewater utilities in the Philippines is regulated by the NWRB. In order to introduce cost recovery tariffs and effective regulation, the NWRB issued a primer on tariff setting and regulation in 2005[38] and an updated version in 2008[39]. The document provides the basic guidelines for determining the allowable tariff. Furthermore, the document gives guidance on tariff structures and water rate adjustments. Local water services operators are allowed a maximum Rate of Return of 12 percent. However, for LGU- operated systems, tariff levels and structures vary widely. The water tariff is composed of 5 elements (see Box 7.1).

In water districts, an average tariff is normally charged for the first 10m³ and increasing tariffs for additional consumption. The NWRB found an average tariff of USD 0.41/m³ within a sample of 18 water districts in 2004[40]. At the end of 2006, the national average tariff for 30 m³ was USD 0.36/m³. Since many connections outside metro Manila are not metered, it is difficult to charge tariffs depending on consumption. Where LGUs provide Level I or II services, they usually charge no or very low tariffs, although connection fees are common. The costs of providing the service are usually met by local governments.

[38] NWRB, 2005. Primer on Tariff setting and regulation. http://www.nwrb.gov.ph/images/Site_image/Primer_on_Tariff_Setting_&_Regulation.pdf
[39] NWRB, 2008. Tariff model for small water utilities. http://www.nwrb.gov.ph/images/Downloads/Primer_on_Tariff_Setting__Regulation_2008.pdf
[40] NWRB, 2005. Primer on Tariff setting and regulation. http://www.nwrb.gov.ph/images/Site_image/Primer_on_Tariff_Setting_&_Regulation.pdf

Box 7.1 Water tariff structure including charges for wastewater management41

Basic charge: This covers the cost of operating, maintaining, improving and expanding the distribution network, as well as the facilities responsible for bringing potable water to the end user. The Basic Charge is based on the latest approved tariff schedule.
Currency Exchange Rate Adjustment: PHP 1 / m^3
Foreign Currency Different Adjustment (FCDA): This is a percentage of the Basic Charge which accounts for fluctuations of the Philippine Peso against other countries' currencies subject to periodic review and adjustment.
Environmental Charge: This is for the mitigation of environmental impacts in the course of water and wastewater operation. It is 20 percent of the Basic Charge applicable to all customers.
Sewer Charge: 0 percent of the Basic Charge is added for Residential and Semi-Business customers with a sewer line connection. 30 percent of Basic Charge is charged for Commercial and Industrial customers.
Maintenance Service Charge: Water meter maintenance fee. The charge changes depending on the size of the water meter. The minimum charge is PHP 1.50 for a 13mm-sized meter.
Value Added Tax: A value added tax of 12 percent is added to the bill on top of all fees.
Note: other charges may apply such as connection fees and unscheduled desludging of septic tanks.

In 2018, Manila water residential customers consuming 30 m^3/month pay PHP 623 (USD 0.39/m^3), while those consuming 20 cubic meters per month pay PHP 306 (USD 0.29/m^3). The monthly water bill for residential customers consuming 10 cubic meters per month is PHP 139 (USD 0.26/m^3) and PHP 82 (USD 0.15/m^3) for low-income residential customers[42]. In addition, a 2.46 percent Foreign Currency Differential Adjustment applies. All customers further have to pay the 20 percent environmental charge and businesses pay an additional 30 percent sewerage charge. On top of this VAT of 12 percent is added[43]. Water prices for industrial uses thus are typically PHP 44-58/m3 (ca. USD 0.70/m3).

Operators of centralized wastewater treatment facilities impose various modalities of wastewater treatment charges. In general, the wastewater treatment is lodged in the water consumption billing. Wastewater tariffs varies, depending on the actual operation of the treatment facility. Typical cost includes personnel, chemical treatment, sludge disposal, and maintenance fees.

For industrial water users who are discharging wastewater to the receiving bodies of water, a discharge permit must be secured from the EMB or LLDA, depending on the location of the discharge area. A discharge permit fee must be paid upon application. Aside from this, the government imposes the 'polluters pay principle' where a corresponding wastewater discharge fee is collected from individual discharges based on volume and the organic

[41] NWRB, 2005. Primer on Tariff setting and regulation. http://www.nwrb.gov.ph/images/Site_image/Primer_on_Tariff_Setting_&_Regulation.pdf
[42] Manila Water, 2017. News release on new tariffs. https://www.manilawater.com/corporate/agos/2017-12-15/mwss-approves-new-rates-effective-january-1--2018
[43] Manila Water, 2017. Notice to the Manila Water Customers and the Public. New water rates for the East Zone Jan. 2018.

loading (i.e., kg BOD per year). In case the industry reuses its wastewater without discharge into any water body or land, only the discharge permit fee will be paid[44]. Fees range from PHP 2000 for 0-discharge to PHP 3,900 for above 150m^3/day with an addition of PHP 5/kg of BOD/TSS. This implies a maximum cost that can be avoided by moving to zero-discharge industrial wastewater effluent of USD 0.25/m^3 plus PHP 5 for every kg of BOD removed.

7.2 NATIONAL FINANCING

To achieve government targets for 2025 for water supply, the additional population requiring access is estimated at 2.75 million per year with a total investment requirement of USD 838 million per year for the period 2015 - 2025. For sanitation to achieve universal coverage by 2028, the additional population requiring access annually is estimated at 3.0 million with a total investment requirement of USD 619 million per year[45]. Currently, NEDA is preparing a Water Supply and Sanitation Masterplan and a Unified Financing Framework to accelerate financing in the sector. There is an overall subsidy in place for the construction of wastewater facilities of 50 percent of the CAPEX provided as grant by the Philippine government. A number of national banks provide financing of water and wastewater infrastructure.

The Development Bank of the Philippines operates a Green Financing Program (GFP) that aims to provide technical and financial assistance to strategic sectors, industries and LGUs in adopting environment-friendly processes and technologies and incorporating climate change adaptation and mitigation and disaster risk reduction measures. Private Corporations and LGUs can avail of this program for the CAPEX of pollution and waste management projects such as constructing their wastewater treatment plant. The amount of a loan can be up to 80 - 90 percent of the total project CAPEX and the interest rate depends on the prevailing market rate (fixed or variable). Repayment terms can be up to 15 years inclusive of a 5 years grace period based on the project cash flow.[46]

The Landbank of the Philippines has been a leading financier of water and wastewater activities throughout the Philippines. The World Bank Group – International Bank of Reconstruction and Development (IBRD) has been lending to the Landbank of the Philippines, which then on-lends to water utilities to co-finance wastewater treatment. It also has a lending stream called the CLEECP Program wherein private sector companies, LGUs, national government agencies and government owned corporations can ask for financial assistance in installing energy efficient systems using renewable energy. One of the eligible projects is the installation or energy efficient modernization of biomass cogeneration facilities from the methane from piggeries, poultries or food and beverage processing industries. The amount of loan is based on the investment requirement, but may not exceed PHP 200 million. Mid 2017, the Landbank financed 17 biogas projects for PHP 264 million (USD 5 million) to generate 16,800 MW of power.

[44] DAO 2005-10
[45] WSP, 2015. Water Supply and Sanitation in the Philippines Turning Finance into Services for the Future.
[46] Development Bank of the Philippines, 2017. Green Financing Program.

The Bank of the Philippine Islands (BPI), Banco De Oro (BDO) Unibank Inc. and China Banking Corporation (CBC) work with the International Finance Corporation (IFC) and offer loans to industries that support sustainable energy investment using the Sustainable Energy Finance (SEF) Program. The objective of this program is to give financial assistance to small- and medium-sized firms in pursuing their clean energy and energy efficiency projects. Industries can avail of this program in constructing or upgrading their wastewater facilities to capture biogas as a renewable energy source.

There is a growing interest from private investors in the Philippines to be further involved in the expansion of water and wastewater services across the country. For example, most recently Marcoasia Corp (owned by Lucio Tan) through its subsidiary - New Earth Water System, Inc. (NEWS) - acquired a permit directly from the NWRB to develop and upgrade water and wastewater systems in Iloilo City. Other Philippine investment companies, such as Ayala Corporation, MetroPac Water Investments Corporation and San Miguel Corporation, are also interested to further invest in the water sector in the Philippines.

7.3 INTERNATIONAL FINANCING

International finance of the water sector has mostly been done through concessionary loans and grants from the Philippine's closest development partners including the Asian Development Bank (ADB), World Bank, The Japan International Cooperation Agency (JICA) and Japan Bank of International Cooperation (JBIC), and USAID[47].

Some of the thrusts of the ADB Country Operations Business Plan (2018-2020)[48] include a component on enhanced access of population to sustainable and climate-resilient water, sanitation, and waste management facilities and services. Under this programme, a number of projects focused on water supply are envisaged, including a few to focus on Mindanao and Manila. Recently, the ADB has established a new technical support loan including support to the water and wastewater sector in the Philippines. The loan (USD-libor+.75 percent, 25 years, 5-year grace period) contains a component of USD 28 million for consulting services in the water sector[49]. The main objective of this component is Technical Assistance to prepare up to five flood protection and urban water projects including identification, complete feasibility studies, detailed design, and project documents ready for tendering.

The IBRD has worked through the Landbank of the Philippines as indicated above. It also has implemented carbon credit purchase, which can be applied to projects that recover biogas. Furthermore, the World Bank has a Country Assistance Program that assists in achieving the objectives of inclusive growth such as reducing GHG emissions in key sectors. It seems, however, that the World Bank is currently not in the position to lend money

[47] DEVEX, 2016. Top development aid donors to the Philippines 2015.
https://www.devex.com/news/top-development-aid-donors-to-the-philippines-2015-89091
[48] ADB, 2017. Country Operations Business Plan 2018 - 2020
[49] ADB, 2017. Philippines Loan Agreement 3589-PHI

to the water and wastewater sector due to the lack of sovereign guarantees for these programs[50].

JICA and JBIC are known to finance infrastructure projects that are environmentally friendly, such as wastewater treatment facilities. Currently, a number of projects are implemented in Metro Manila, Cebu, and other districts and regions of the Philippines[51]. Apart from this, biofuel projects can also be funded by JICA.

The United States Agency for International Development (USAID) in its Philippine Country Assistance Strategy prioritizes environment and energy. USAID has indicated an interest to fund wastewater management and water demand management to help alleviate water shortages[52]. With competitive private sector lending now in place in the Philippines, USAID plans to mobilize financing for water utilities by engaging the private sector on public-private partnerships and help the utilities increase access to Philippine government funds. USAID's sanitation initiatives previously focused primarily on low-cost wastewater treatment and are now shifting to look at better options for sewerage and septage management.

[50] IBRD, 2017 December. Christopher C. Ancheta pers. com.
[51] JICA, 2018. JICA Philippines Project List
https://www.jica.go.jp/philippine/english/activities/c8h0vm00004cez31-att/index_01.pdf
[52] USAID, 2017. USAID/Philippines Environment Project 2017-2021 Redacted Concept Paper As of January 25, 2017
www.usaid.gov/sites/default/files/documents/1861/Concept_Note_Environment_PAD_redacted.pdf

8

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

The Philippines has enjoyed an abundance of water. Yet projected water availability and demand shows significant future water shortages for many urban areas throughout the country. Major surface water bodies and groundwater resources face significant pollution leading to economic losses of ca. 0.5 percent of GDP. The main sources of pollution are: untreated domestic wastewater discharges (33 percent), agriculture and livestock (29 percent), industrial sources (27 percent) and non-point sources such as agricultural farms (11 percent). There is a growing consensus that action needs to be taken urgently.

Only 10 percent of wastewater is treated and only 5 percent of the total population is connected to a sewer network. It is expected that septic tanks will continue to be the most prevalent means of sanitation in the Philippines for many years to come. Water and wastewater services in the largest urban areas are mostly operated by national private operators. Others are serviced through public city water districts. Each of the Special Economic Zones in the Philippines needs to operate a centralized wastewater treatment facility.

Important experiences exist and expertise is available in the Philippines with regard to wastewater treatment and resource recovery. This includes re-using wastewater, producing bio-energy from organic waste and recovering nutrients from wastewater for fertilizers. A few companies in the food-beverage and pulp-paper sectors have established water re-use schemes within their operations. Likewise, some companies operate digesters to produce bio-gas from solid organic waste and wastewater. However, resource recovery from wastewater is not a common practice in the Philippines to date.

Local governments have the responsibility to set-up adequate sanitation systems. A broad set of regulations, decrees, acts, orders and codes are in place that regulate wastewater management and aspects of resource recovery. A new effluent standard existing since 2016 provides a major opportunity for new and upgrading existing wastewater facilities and including resource recovery. However, few local governments or Water Districts have implemented sewerage or effective septage management schemes as they have limited capacity and weak incentives to comply with existing obligations and standards.

The enforcement of existing regulations is hampered by the limited (financial) capacity of relevant agencies and implementing mechanisms. Also, as a wide range of institutions address water and wastewater management issues in the Philippines. The 2017 – 2022 development strategy for the Philippines clearly defines institutional reforms in the water sector as a priority to guide and promote investments in water supply and sanitation.

The investment requirement for water supply is estimated to be USD 838 million per year for the period 2015 - 2025. To move towards universal

coverage of sanitation services during the period 2015 - 2028, the total investment required is USD 619 million per year. Limited national financing is available compared to the financial resources required to achieve full coverage of wastewater collection and treatment in the Philippines.

International financing of the water sector has mostly been done through concessionary loans and grants from Philippine's closest development partners including the Asian Development Bank, World Bank, JICA/JBIC, and USAID. There is a need to further diversify financing mechanisms for wastewater treatment and resource recovery in the Philippines, including through the involvement of national and international private sector financing.

Finally, resource recovery from wastewater provides a significant opportunity in the Philippines. Overcoming some of the institutional barriers, operational shortcomings and financial constraints would be critical to expand wastewater treatment and reduce pollution. Capitalizing on the new technologies to recover valuable resources from wastewater provides a new opportunity and can contribute to improving the financial viability of the sector.

8.2 RECOMMENDATIONS

Expanding and upgrading wastewater collection and treatment and implementing resource recovery has great potential in the Philippines. Concerted action is required by government to promote, support and incentivize the use of advanced wastewater treatment and resource recovery technologies.

For municipalities and industries located in areas with (future) water scarcity, more effort should be focused on wastewater re-use in particular for applications in industrial and agriculture settings. This requires a better cooperation between municipalities and their utilities and industrial establishments and agriculture producers for the off-take of treated wastewater for re-use.

Methane-based bio-energy generation from combined wastewater and organic waste could significantly reduce wastewater utility's operating costs by reducing its power purchases. To capitalize on the opportunity to generate bio-energy from wastewater and organic waste, a more rapid transition from septic tank systems towards centralized wastewater collection and treatment needs to be put in place, especially for the larger, densely populated urban areas. Also, municipalities, industrial zones and utilities need to invest in further (pre-)feasibility studies to accelerate the production of bio-energy and energy-efficiency in relation to wastewater and organic waste treatment.

Nutrient recovery from wastewater is practiced by some of the main wastewater service providers and some industries. There is further opportunity to initiate pilot schemes for the production of high-quality fertilizer from wastewater. Cooperation between utilities, research centers

and technology providers needs to be established to test the use of advanced technologies in this regard.

To foster further expansion of wastewater collection and treatment, further reform of the sector needs to be accelerated, including through nominating a single lead agency for urban sanitation, establishing a single regulator for the sector, and amalgamating many local service providers in smaller municipalities.

While there is sufficient capacity in the Philippines to design and build 'traditional' wastewater systems, new capacities for designing, building and operating advanced wastewater treatment and resource recovery is required. In engineering educations and professional updating, more attention needs to be given to advanced wastewater treatment technologies and resource recovery approaches.

Further guidance and promotion of investments in wastewater systems is urgently required. There is an opportunity to use available government financing more effectively, in particular to prepare (pre)feasibility studies. To attract additional national private financing and foreign direct investments in the sector, further tariff reforms will be needed to allow utilities a more attractive rate of return. Such reforms will need to go hand-in-hand with improvements in utility performance and service delivery. Outcome based financing could be a valid pathway for attracting additional financing to achieve agreed upon targets.

There is an opportunity to attract additional 'green' financing related to renewable (bio) energy to the wastewater sector. The existing programs with a number of national banks in the Philippines for financing water, wastewater and septic management need to continue and expand. In addition, the growing interest of national and foreign private companies to invest in the water sector needs to be harnessed to co-finance wastewater treatment and resource recovery systems at a larger scale.

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