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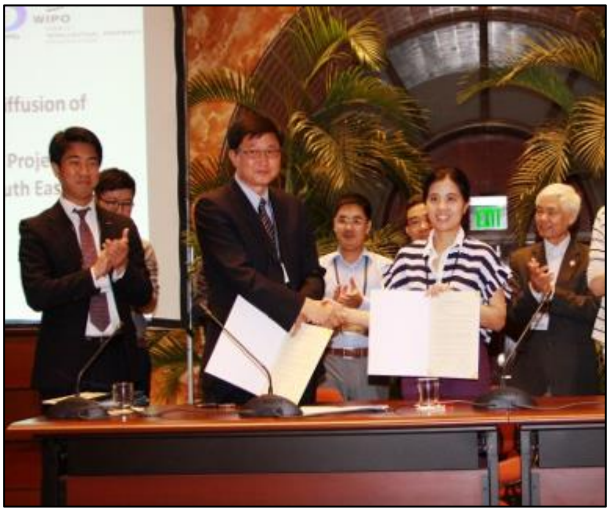
Report of a Pilot Project

Facilitating the Transfer and Diffusion of Clean Technology:
Opportunities in Wastewater Treatment in South East Asia



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Section 1:

Introduction

Global Challenges Program
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Water is the heart of our environment and closely relates to the development of cities and rural areas alike. Increased urbanization, new production and consumption methods in industrialized and developing countries, and competing demands from different sectors create new challenges for the management of the water cycle, and for the protection of water resources. This presents both a public health and environmental challenge, particularly for fast growing urban areas. Given that freshwater accounts for just three percent of this planet's water supply, and that according to UN-Water over 700 million people have no safe access to it, wastewater treatment technologies are among the major tasks we face going into the future.

For these reasons, wastewater treatment has been chosen as the technological area for a pilot project under WIPO GREEN (www.wipo.int/green). The project itself was enabled thanks to the financial support the Government of Japan offers WIPO as part of the country's long term commitment under the Japan Funds-in-Trust Program.

This report summarizes the results of this WIPO GREEN pilot project on wastewater treatment in South East Asia. The project demonstrated how the WIPO GREEN network can contribute to bridging the gap between potential technology providers and seekers in the field of wastewater treatment in the region. Several country studies in South East Asia already compiled green technology needs in this area, and they indicated that the highest industrial wastewater treatment needs relate to municipal water recycling, as well as processing in the food, feed and fiber industries.

WIPO GREEN was launched in late 2013 by the World Intellectual Property Organization (WIPO) together with 35 Partner organizations throughout the globe (now counting 69 Partners; see below for a list). It is a marketplace that promotes the innovation and diffusion of green technologies. It does this by connecting technology and service providers with those seeking innovative solutions and, thus, catalyzes mutually beneficial commercial transactions. As the United Nations (UN) agency dedicated to promoting innovation and creativity, WIPO has a mandate, embedded in WIPO's Development Agenda, to promulgate practical intellectual property tools that drive forward solutions to environmental challenges. The availability of intellectual property rights as options contributes to increases in investments in innovation and technology. Moreover, intellectual property rights may support the transfer and diffusion of innovation as they allow for more structured relationships underpinning commercial transactions. WIPO GREEN encourages the exchange, sale and licensing of technologies and their associated rights on a voluntary basis. Nevertheless, not all technologies and products listed in the WIPO GREEN online database are patent protected. Some are built on local innovation, and any transfer would center around know-how or trade secrets.

Today, WIPO GREEN is a stable network and growing gateway to green technology solutions, thus contributing to a more open market. This adds transparency in the marketplace and, in turn, leads to greater efficiency. By bringing together the public and private sectors, sound partnerships can be created which are critical to achieving synergies and fostering the transfer of technologies. The database comprises technology providers and seekers from industry; small and medium-sized entities and multinationals; public and private research institutions and universities. It is also involved with associations, banks and other finance mechanisms, relevant agencies of the United Nations, most notably the Climate Technology Centre and Network (CTCN), and others from around the world. In addition, WIPO GREEN builds on and reinforces existing WIPO programs, while lending support to the initiatives of other organizations, including those within the United Nations (e.g., United Nations Development Program [UNDP], United Nations Environmental Program [UNEP], United Nations Framework Convention on Climate Change [UNFCCC], UN Global Compact, United Nations Industrial Development Organization [UNIDO]), the Climate Technology Program hosted at *info*Dev within the World Bank Group, and the Asian Development Bank (ADB). In turn, many institutions lend the power of their networks to the work and objectives of WIPO GREEN.

The WIPO GREEN Pilot Project on Wastewater Treatment in South East Asia entails an analysis of specific needs in a well-defined area of technology. A comprehensive understanding of needs is essential for an effective deployment of green technology. This phase of the project was carried out by several consultants to WIPO who identified wastewater treatment technology needs in Indonesia (Section 2), the Philippines (Section 3) and Viet Nam (Section 4). They investigated, identified, and described precise technology needs for wastewater technologies in consultation with relevant stakeholders in all three countries, with a view to facilitating the identification of valid solutions to those needs. The consultants identified gaps between technology seekers in Indonesia, the Philippines and Viet Nam, and technology providers within multiple dimensions: information gaps, technology gaps, purchasing power gaps, as well as gaps between the IP system and other relevant legal and administrative systems. In this way, the project also promoted WIPO GREEN as a matchmaking and networking tool for WIPO GREEN partners. It is believed that a networking environment under the auspices of WIPO GREEN would eventually benefit other developing countries in addressing their technology needs.

Seekers of technological solutions and prospective suppliers of technology were subsequently invited to a matchmaking event and regional seminar known as the “Manila event”, titled *Accelerating the Transfer of Clean Technology: Experiences from South East Asia - A Regional Seminar and Matchmaking event on Wastewater Management Needs and Technologies* (see Annex for the full program). The event was hosted by the ADB in Manila and organized by WIPO in cooperation with the ADB, CTCN, and the Intellectual Property Office of the Philippines (IPOPHL). The event included technology seekers from Indonesia, the Philippines and Viet Nam, and technology providers from Japan, Korea, Malaysia, the Philippines, and Singapore. Over 100 participants took part, including technology seekers and providers, municipal and national governmental representatives, environmental policy makers, regulators, lawyers, technology transfer professionals, wastewater technology experts, and climate finance experts.

The Manila event (with the important matchmaking component) was organized with the belief that sustained deployment and uptake of technologies occurs when parties freely enter into a contract on mutually agreed terms. Although agreements that originate through the use of WIPO GREEN are the responsibility of the contracting parties, the network of credible institutions and experts brought to bear under WIPO GREEN should eventually lead to better transactions. A particular challenge was to make the potential licensees aware of available technologies, and support them in making best use of such offers. Before a technical solution can be provided, the specific reasons behind the problem must be identified. That analysis requires a thorough review of the situation, which is so often difficult anywhere in the world. Similarly, potential licensees worldwide often lack knowledge about technical specificities of the problem that would allow them to sufficiently express their needs, and to choose the right technology.

One immediate outcome of the Manila event was a total of 16 letters of intent that were signed before the event closed. These were between technology providers and seekers, and aimed at exploring a business transaction; nine of these were between Korean companies and various technology seekers from Indonesia and Viet Nam; five were between a company from Malaysia and Indonesian technology seekers; and two were between a company from Malaysia and technology seekers from the Philippines. It is hoped that these initial intents to negotiate transactions will lead to a mutually beneficial arrangement, and that their implementation will improve the wastewater management and environment in these three countries.

WIPO GREEN Partners[1]

African Agricultural Technology Foundation (Kenya)
Asia IP Exchange / Hong Kong Trade Development Council (Hong Kong, China)
Asian Development Bank
Asia-Pacific Industrial Property Center-Japan Institute for Promoting Invention and Innovation (Japan)
Association of University Technology Managers (USA)
Brazilian Forum of Innovation and Technology Transfer Managers (Brazil)
CambridgeIP (UK)
China Technology Exchange (China)
CleanTek Market (Australia)
Climate Technology Centre and Network, UNEP/CTCN
Climate-KIC (Switzerland)
Crosstaff Solutions (Canada)
Danish Patent and Trademark Office (Denmark)
EcoMachines Incubator (UK)
Environmental Law Institute / Eco-Patent Commons (USA)
General Electric (USA)
Ghana Bamboo Bikes Initiative (Ghana)
GIVEWATTS (Sweden)
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infoDev / The World Bank
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Japan Patents Attorneys Association (Japan)
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Kenya Climate Innovation Center (Kenya)
Korea Technology Finance Corporation (Republic of Korea)
League of Arab States
Licensing Executives Society International
Magnefico GmbH (Switzerland)
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NEUW Ventures (Switzerland)
Office Marocain de la Propriété Industrielle et Commerciale (Maroc)
Patent Agents Association, India
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Sathguru Management Consultants (India)
SEED Initiative
Siemens (Germany)
Singapore-ETH Centre for Global Environmental Sustainability (Singapore)
Solben (Mexico)
South-South Global Assets and Technology Exchange (China)

[1] As of June, 2016. For more details, please visit www.ow.ly/BGyOT

Strathmore University / Center for Intellectual Property and Information Technology Law (Kenya)
Team E-Kansai (Japan)
TechnologieAllianz (Germany)
Technology Development Foundation of Turkey (Turkey)
Teijin Limited (Japan)
The Innovation Hub (South Africa)
United Nations Environment Program
United Nations Global Compact
United Nations Industrial Development Organization
United Nations Office for South-South Cooperation
Villgro Innovations Foundation (India)
VisionEdge Technologies (Singapore)
Waseda Environmental Institute (Japan)
World Business Council for Sustainable Development

Section 2:

Indonesia Country Report:
Wastewater Management in Indonesia—Opportunities and Challenges

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Summary

This project report aims to identify and assess the technologies needed to improve wastewater treatment in Indonesia.

The objective is to identify and assess at least 15 wastewater treatment technology needs and technology seekers from Indonesia. The report also briefly reviews the legal frameworks that govern Indonesia's wastewater treatment, its technologies and relevant intellectual property issues.

Indonesia has three types of regulations governing wastewater treatment. The first type is environmental-related regulations.

The key aspect of these regulations is that technologies developed or introduced are required to maintain wastewater discharge below the allowable threshold. The second is technology-related regulation.

The key point of these regulations is that technologies are required to meet Indonesian National Standards (SNI). The last type of regulation covers technology transfer and intellectual property rights. Technologies developed or introduced in Indonesia are required to follow the Indonesia's laws on technology transfer and intellectual property.

15 technology seekers were interviewed for the preparation of the report. The list is comprehensive, consisting of organizations and companies working in palm oil, rubber, pulp and paper and other relevant sectors, and in urban areas.

The coverage of technology seekers is diverse, incorporating three major islands of Indonesia, Sumatra, Java and Kalimantan.

The interviews revealed five important points.

Technological needs. Many technology seekers need innovative technologies that can both help address their wastewater issues and provide useful outputs or by-products.

Wastewater technology seekers, on the other hand, require support in almost all technical fields, including design aspects, alternative energy production, energy conservation and waste management.

Sustainability. Almost all seekers need technological solutions immediately, but the solutions need to be usable over the long-term.

Geographical spread. Although the technology might be used only in seekers' areas, it is also needed in other parts of the country. Thus, if a new or adjusted technology is successful, similar companies and organizations in Indonesia might adopt the technology.

Intellectual property rights. Many seekers need help in buying products and technologies. They require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.

Capacity, infrastructure and financing. Some seekers have knowledge and experience in wastewater management; others do not. Many seekers are connected to transport infrastructure, but only a few have access to a reliable supply of electricity. Some organizations require financial support.

In emerging economies, accelerated development in the industrial, mining and agricultural sectors and in urban areas has led to serious water pollution caused by the discharge of untreated wastewater from these industries and households.

In Indonesia, pollution is reducing the amount of available clean water by 15-35% per capita annually.[1]

[1] http://www.wepa-db.net/policies/state/indonesia/indonesia.htm.

In Indonesia, several factors contribute to the degradation of water quality, such as domestic solid waste and wastewater, and wastewater from small and large-scale agricultural, textile, pulp and paper, petrochemical, mining, and oil and gas activities.

With regard to household or domestic waste and wastewater treatments, only 42.8% of more than 51 million households have such treatments and 56.15% dispose of their domestic waste and wastewater directly into natural watercourses.[2] As a result of this pollution, the water from six major rivers in West Java is unsafe to drink.

Water bodies located near mining areas are contaminated by heavy metals such as mercury (Hg). The Water Environment Partnership in Asia (WEPA) found that of 16 sampling points near mining areas show a significant level of mercury (Hg) concentration, with the highest level of dissolved mercury in one mining area reaching 2.78 Hg/l.[3]

In the agricultural sector, the expansion of oil palm plantations and the palm oil industry have resulted in a significant increase in wastewater. Palm oil processing is water-intensive,[4] and if wastewater is not treated, it contributes to the worsening levels of water pollution. Water pollution affects humans, other species and the overall built environment and already fragile natural ecosystems. It can impact fisheries, agricultural production and many other economic activities. Fortunately, technology has the potential to mitigate this problem.

There is a need, however, to understand what is considered appropriate, affordable and optimal wastewater treatment technology. Users of such technology, such as municipal governments, palm oil companies, mining companies, hotel managers, and affected stakeholders need to be interviewed to understand exactly what they need to help them improve wastewater treatment. An analysis of these needs is imperative because wastewater treatment technologies cannot be directly transferred installed and used if they are found unsuitable for the Indonesian context.

It is believed that WIPO GREEN can provide a useful platform to accelerate the innovation and diffusion of wastewater treatment technologies. This report acts as a needs assessment for wastewater technologies in Indonesia and will be of use not only to technology users, but also to wider communities in the country.

The assessment outlines specific relevant wastewater treatment technologies and potential technology users, mainly from a technical standpoint. The assessment also includes a brief review of the legal framework governing wastewater treatment, its technology and related intellectual property issues. Such a review is crucial to determine whether a particular wastewater treatment technology can be developed or introduced in Indonesia.

The report also attempts to delineate some economic and financing components of the technology so that it can give a clearer idea of whether a particular technology is feasible and affordable for technology users in Indonesia.

1. Introduction and methodology

This report covers relevant wastewater technological needs in urban areas and in industrial and natural resource sectors. It is based on interviews and discussions with selected government officials, technology users and seekers, researchers and NGOs working on wastewater issues or wastewater treatment technology and its needs.

To strengthen the report, a literature review and an analysis of relevant data were conducted, relying on government regulations, documents from government, technology users and seekers, research organizations, relevant companies and organizations.

The review focused on wastewater treatment technology, and a survey of existing and projected wastewater and water pollution challenges.

[2] *Ibid*.
[3] *Ibid*.
[4] http://www.esi.nagoya-u.ac.jp/h/isets07/Contents/Session05/1003Hayashi.pdf.

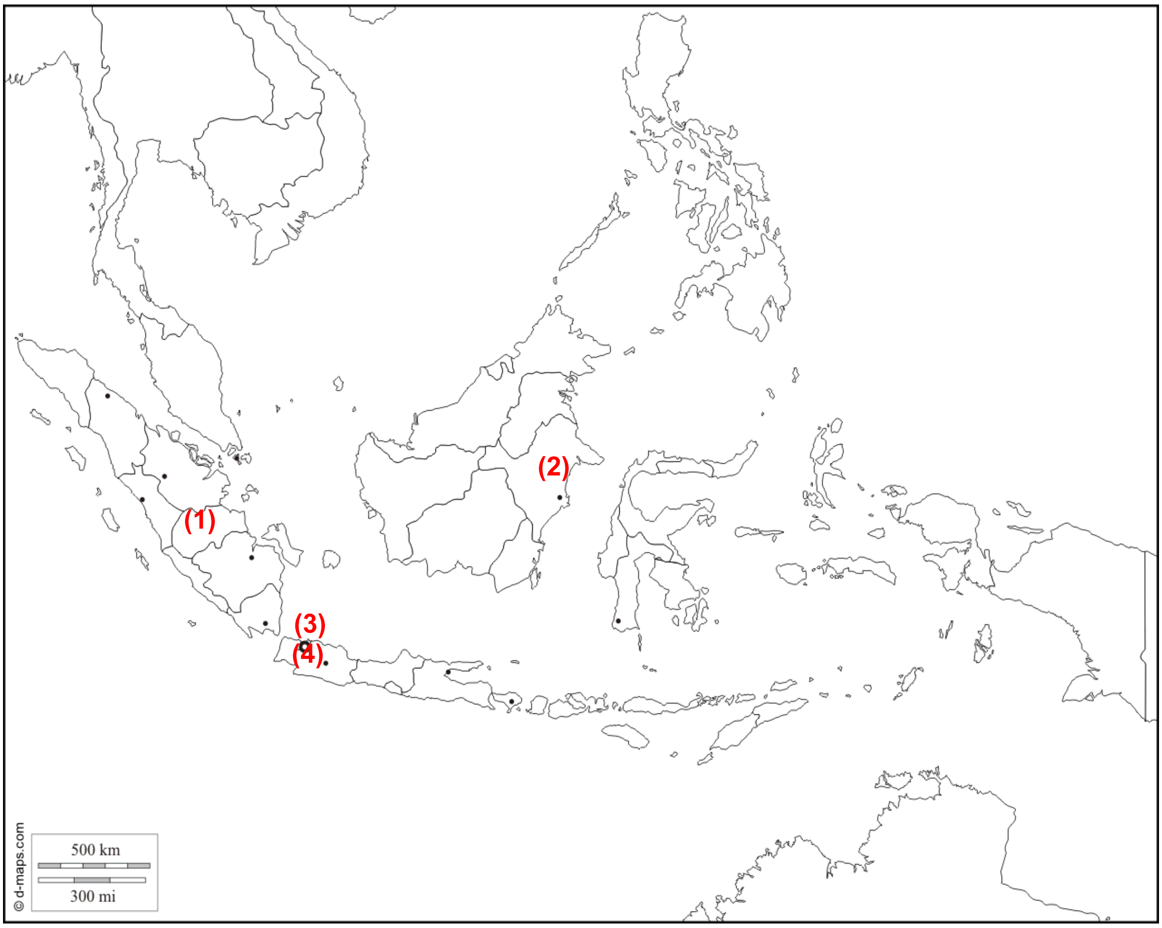
The draft findings were presented in a regional seminar organized in Manila in April 2015.[5] The seminar was jointly organized by WIPO, the Asian Development Bank (ADB), the Climate Technology Centre and Network (CTCN) and the Intellectual Property Office of the Philippines with the support of the Japan Patent Office.

This report does not intend to provide an exhaustive analysis of all technological needs for wastewater treatment; instead, it aims to offer anecdotal evidence and an overview of issues related to the technological needs of wastewater treatment in Indonesia, focusing on urban areas and the industrial and natural resources sectors. To cover all angles, technology seekers from the private sector, research institutions and governments were interviewed.

After the executive summary, Section 4 details the legal framework of wastewater treatment and its technology in Indonesia, providing a general overview of legal requirements, the limitations of technology development and the transfer and application of wastewater treatment. There is also a sub-section on intellectual property rights. Section 5 gives details of the interviews conducted, including descriptions of the interviewees and their needs and corresponding technologies.

This is the most important section of the report. Section 2.5 provides recommendations and next steps, including for technology seekers and providers in the context of Indonesia. The sectors incorporated into these interviews are, in addition to urban areas, the interviews dealt with industry, natural resources and other r relevant subjects. This list of interviewees is a representative geographic spread covering Indonesia's most significant industries. The regions covered are illustrated in Figure 1.

Figure 1: Location of interviews



Legend: (1) Jambi; (2) Balikpapan, East Kalimantan; (3) Purwakarta, West Java; (4) Bandung, West Java
Source of map: http://d-maps.com/carte.php?num_car=15293&lang=en

[5] Facilitating the Transfer and Diffusion of Clean Technology: Opportunities from a Pilot Project on Wastewater Treatment in South East Asia.

2. Wastewater management in Indonesia

Wastewater treatment in Indonesia is regulated under two regulatory frameworks. The first is for environmental management. The second is for technology, regulated under public works. It is also important to identify regulations and policies related to intellectual property rights in technology transfer relating to wastewater treatment.

2.1 Environmental regulations

An umbrella regulation for any environmental protection and management is Law No. 32 of 2009 on Environmental Protection and Management.

Under this law, the Government of Indonesia is empowered to manage the country's environment, require businesses and development activities to carry out an environmental impact assessment or devise environmental management and monitoring plans and secure an environmental permit as a prerequisite for obtaining licenses for businesses and/or development activities.[6]

Another important stipulation is that the country acknowledges the "polluter pays" principle, which includes requiring polluters to mitigate any environmental damage resulting from their activities,[7] and adopting stronger administrative sanctions[8] and criminal punishment[9] for defaulters.

Accordingly, businesses and/or development activities must meet certain environmental standards to be legally eligible to operate in Indonesia. These standards include the maintenance of wastewater quality disposed of by their respective businesses and activities.

The environmental law lays out the details of wastewater quality and management standards and requirements. It also strengthens standards and requirements in various national, sectoral and local regulations and policies. The following regulations, among others, relate to wastewater management:

- Government Regulation (GR) No. 19 of 1999 on Control over Marine Contamination and/or Damage;
- GR No. 27 of 1999 on Environmental Impact Assessment;
- GR No. 82 of 2001 on Water Quality Management and Water Pollution Control;
- GR No. 16 of 2005 on Development of the Drinking Water Supply System;
- Minister of the Environment Regulation (MoER) No. 11 of 2006 on Types of Businesses and/or Activities that Require Environmental Impact Assessment;
- MoER No. 12 of 2006 on Requirements and Procedures in Obtaining Permits for Wastewater Discharge into the Sea;
- MoER No. 1 of 2010 on the Governance of Water Pollution Control; and
- MoER No. 5 of 2014 on Wastewater Quality Standards

MoER No. 5 of 2014 is an important regulation in that it sets out the minimum quality standards for wastewater discharge from businesses and developmental activities in forty-six sectors/industries. Prior to the issuance of this regulation, wastewater quality standards for different sectors/industries were regulated under separate laws.

The new regulation codified these myriad rules into one guideline that can be referred to by all stakeholders.

Since Indonesia has embraced a decentralized system of governance, it is also crucial to note regulatory changes take place at provincial and district/city levels.

These include regulations and policies on wastewater quality and management standards as stipulated in Governor of Jakarta Regulation No. 69 of 2013 on Wastewater Quality Standards for Developmental Activities and Businesses and Governor of East Java Regulation No. 73 of 2013 on Industry and Other Types of Business.

[6] See articles 22-40 of Law No. 32 of 2009.
[7] See articles 53-55 of Law No. 32 of 2009.
[8] See articles 76-82 of Law No. 32 of 2009.
[9] See articles 97-120 of Law No. 32 of 2009.

Provincial and local regulations can be effective if stringently enforced by the respective governments. In some cases, patrons of businesses and development activities who do not meet the required standards of treatment for wastewater, especially those whose untreated wastewater pollutes their surroundings, might be penalized.

An example is Hermina Depok Hospital, in which the hospital director received a one-year jail sentence because wastewater from the hospital was assessed to be above the allowed contamination limit and judged to be polluting the Ciliwung River.[10]

The obligation to fulfill certain wastewater quality standards has increased the need for wastewater treatment technologies. When untreated wastewater falls below the permissible quality standards, relevant businesses and/or developmental activities must endeavor to meet such standards by seeking the means to treat their wastewater with appropriate technologies.

The technical aspects of wastewater treatment are mostly governed by regulation of the ministry of public works. These include Minister for Public Works Regulation (MoPWR) No. 16 of 2008 on National Policy and Strategy in Developing Household Wastewater Treatment System and MoPWR No. 14 of 2010 on Minimum Standard of Service in Public Works and Spatial Planning.

At a higher level, the use or selection of wastewater treatment technology must comply with GR No. 102 of 2000 on National Standardization. Under this regulation, wastewater technology providers are encouraged to meet the standards defined by the National Standardization Agency. Some regulations relating to wastewater treatment technology and the National Standards are listed below:

- SNI 6989.1 to SNI 6989.80 – Water and wastewater (test methods/sampling methods/chemical contents determination methods)
- SNI-03-1733-2004 – Codes for housing design in urban areas
- SNI-03-2398-2002 – Codes for planning of septic tank with absorption systems
- SNI-03-2399-2002 – Codes for the design of public bathrooms and toilets
- SNI-19-6410-2000 – Methods for piling up soils for absorption area in private sewage disposal treatment
- SNI-03-6379-2000 – Specification and methods for installation of trap seal primer valves
- SNI-03-6368-2000 – Specification of concrete pipes for wastewater channel, rainwater channel and culvert pipes
- SNI-19-6409-2000 – Sampling methods of uncompacted wastes from trucks
- SNI-19-6466-2000 – Methods for field evaluation of private sewage disposal absorption systems

2.2 Issues related to technology transfer and intellectual property

The laws governing technology transfer in Indonesia include Law No. 25 of 2007 on Investment and Law No. 14 of 2001 on Patents. Law No. 25 provides two possible schemes for technology transfer. Firstly, a transfer can be in the form of technical assistance.[11]

Secondly, a transfer can be done by “inheriting” technologies used by foreign investors through various means, such as by agreement, after the expiry of the foreign companies’ permits, or through expropriation in accordance with the applicable law.

Regarding patents, Law No. 14 stipulates that patent holders might make use of their own patents, or grant a license to other persons based on a license agreement in which they can set out the profit-sharing arrangement.[12]

Licensing can be considered to be one of the many ways of transferring technology, as the licensee can receive and make use of the technologies needed to produce the licensed products. In summary, these laws and regulations have the following implications for wastewater treatment technologies developed in or introduced to Indonesia:

[10] Case No. 370/Pid.B/2005/PN.CBN.
[11] See article 10(4) of Law No. 25 of 2007.
[12] See article 69(1) of Law No. 14 of 2001.

- technologies are required to produce wastewater discharge that does not exceed the allowable threshold;
- technologies are required to meet the Indonesian National Standards (SNI); and
- technologies are required to follow Indonesia's rules of technology transfer or patents as applied in Indonesia. Section 5:

3. Wastewater management needs

The interviews and assessments were conducted in urban areas, industrial and natural resource-related sectors. The interviewees were selected because these sectors contribute significantly to wastewater discharge and are considered to be major polluters in Indonesia.

If these interviewees or technology seekers could obtain appropriate wastewater treatment technologies, it would lead to better environmental management in their respective areas. The table below provides details of wastewater technology needs from the different seekers interviewed.

Details include the explanation of the needs, corresponding technologies and issues related to intellectual property rights or technology transfer. The details also touch on financial related issues, especially if seekers see these as important.

3.1 PT Pandega Citra Kelola (Agung Podomoro Land Group), Balikpapan Plaza: wastewater from food court/kitchen and toilets

The technology needs that are displayed on the table above are described below.

Balikpapan Plaza was built in 1992 and is one of the commercial centers in East Kalimantan. The managers of the buildings face continuous challenges from wastewater contaminated by cooking oil and fat issuing from its food courts.

There is also the problem of human sewage from its toilets.

Technological needs: It emerged from the interview that the plaza is seeking help to improve its wastewater system so that it uses no additional chemical inputs and is energy- and cost-efficient. The plaza also needs a recycled water system to be installed. It currently uses a sewage treatment plant (STP) with a capacity of 2 x 250 cubic meters per day from two buildings. The technological aspects of the needs encompass all technical fields, particularly alternative energy production, energy conservation and waste management.

Timeline: The plaza needs immediate technological solutions that can address the issues for a period of approximately 25 years.

Location: The plaza needs to introduce the technology in the premises of the plaza in Balikpapan city, East Kalimantan. If this is successful, the plaza can recommend that other malls or department stores under the same group should adopt the technology.

Intellectual property rights: The plaza might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. This might require help in the management of intellectual property. The management of the plaza might require other technology transfer support, including project development, technical assistance and consultancy.

Other relevant issues: The infrastructure in and around the plaza is relatively good and the plaza has sufficient energy support. It does not require financial support (having access to debt financing) but the management lacks capacity and experience in wastewater treatment or management. The management also considers that there is insufficient regulatory incentive to actively seek technologies. Nevertheless, such a shopping center presents a good opportunity for investment since the retail market in Indonesia is huge and growing.

Table 1: Wastewater Management Needs
All Needs are uploaded on WIPO GREEN (www.wipo.int/green)

Description of the need	Name of seeker	Estimated Project Value	Type of technology transfer required	Need for finance
Treatment of wastewater contaminated by cooking oil and fat issuing from food courts.	PT Pandega Citra Kelola (Agung Podomoro Land Group), Balikpapan Plaza (Shopping Center)	It currently uses a sewage treatment plant (STP) with a capacity of 2 x 250 cubic meters per day from two buildings.	Project development, technical assistance and consultancy	No
The wastewater issues faced are the high level of BOD and COD contaminants and the relatively strong smell of wastewater produced by its activities. The need is for a technology that is space-efficient, low-cost, and preferably produces liquid fertilizer as output. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.	Koperasi Tahu Tempe, Balikpapan	To date, the cooperative has 60 members (tofu and tempeh small producers). The total capacity is up to 10 tons per day. The volume of the wastewater discharge is yet to be calculated. If successfully implemented in this SME, applied wastewater technology could be transferred to other SMES.	Project development, technical assistance and consultancy	N/A
Treatment of polluted wastewater resulting from cleaning the wood chips	PT Kutai Chip Mill (KCM, part of PT Pacific Fiber Indonesia), Balikpapan	The chip mill has a current daily capacity of 180 cubic meters.	Licensing, technology patenting, project development, technical assistance and consultancy.	No
Treatment of solids that block the sewage treatment pipeline (e.g. plastics), the high concentration of BOD and COD contaminants, and the high level of E. Coli.	Dinas Kebersihan Pemerintah Kota, Balikpapan	IPLT, a city sludge treatment plant, is one of the three wastewater treatment plants owned and administered by the city of Balikpapan.	Patenting and licensing, project development, technical assistance and consultancy.	Yes (grant)
Treatment of fats and oils from kitchen activities, human waste from toilets discharged into septic tanks and untreated laundry waste.	Grand Senyiur Hotel, Balikpapan	Gran Senyiur Hotel is a five-star hotel. It is a 10-storey building located on the crest of Pasir Ridge Hill. If the project is successful, it could serve as a good model for many five-star hotels across Indonesia. Resort areas such in Bali, Jogjakarta and many others might adopt a similar model.	Technology transfer support, including project development, technical assistance and consultancy.	No
Management of landfill site with leachate that contains heavy metals, high levels of BOD and COD contaminants.	Dinas Kebersihan Pemerintah Kota, Balikpapan	The landfill is the final destination for almost all solid waste disposed of in Balikpapan city. The city produces 350 tons of solid waste per day and 250 tons of this is transported to the landfill.	Technology transfer support, including project development, technical assistance (training on intellectual property rights and patenting) and consultancy.	Yes (grant)

Description of the need	Name of seeker	Estimated Project Value	Type of technology transfer required	Need for finance
Treatment of high levels of organic contaminants and detergents. Although the plant has access to a lagoon with an aeration system, it lacks pumping capacity and electricity (only having three pumping vehicles with a capacity of 4,000 liters).	Dinas Kebersihan Pemerintah Kota, Jambi	The city sludge treatment plant (IPLT) has a treatment capacity of 80 cubic meters. 5-hectare area.	Purchase of technology including technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting and negotiation) and consultancy. The plant might need support in the forms of improved system management.	Yes (grant). One advantage it has is that it is fully supported by the government of Jambi city, especially if new regulations might be required to support any transformation.
Treatment of high level of organic materials resulting from rubber processing activities and the use of storage tanks.	PT Djambi Waras, part of Kirana Megatara Group, a company that processes, produces and exports rubber	An area of roughly 1 kilometer around the plant is permeated by strong odors emanating from the plant.	The company might need help in buying products and tech acquisitions, incl. bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other tech transfer support, including project development, technical assistance (training on IP management, patenting, licensing and negotiation) and consultancy.	Yes (grants and financial guarantees to obtain debt financing)
Treatment of high level of organic materials (POME) resulting from palm oil mill activities and the use of storage tanks. POME thrown in the lagoon usually releases high levels of methane.	PT Perkebunan Nusantara (PTPN) VI, Sumatra	PTPN VI is located in two provinces in Sumatra: Jambi and West Sumatra. It has five mills, one with a capacity of 30 tons, two with a capacity of 45 tons, and two with a capacity of 60 tons per hour. If a new or adapted technology is successful, many palm oil mills owned by the government and private concerns might adopt it as part of a sustainable palm oil platform.	Assistance in buying products, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.	Yes (grants and access to public financing under a public-private scheme)
Treatment of high level of POME resulting from mill activities and the use of storage tanks. As with PTPN VI, POME discharged into the lagoon releases a high level of methane.	PT Brahma Binabakti (PT BBB), Jambi Province	The operation consists of an oil palm plantation with a palm oil mill (60 tons/h) and supporting facilities (warehouses, workshop and employee housing). In addition, PT BBB has an established plasma project of 6,126 hectares. If a new or adjusted technology is successful, many palm oil mills operated by RSPO members and others might adopt it as part of a sustainable platform.	Buying products, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.	Yes (loan or investment to support the acquisition of sustainable POME treatment technology)
Treatment of high level of organic and fiber materials and the use of storage tanks.	PT Sadajiwa Niaga, a trading company, a distributor and wholesaler of beef cattle, beef, beef carcasses, meat products, frozen meat and other related products.	The company has approximately 5,000 head of cattle, originating from Australia. If new or adjusted technology is successful, many abattoirs, for instance those with centralized cattle ranches, might adopt it.	The company might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. The management of the abattoir might require other tech transfer support, (project development, technical assistance, training on IP management, patenting, licensing and negotiation).	Yes (loan, guarantee or investment that can support technology acquisition or adoption)

Description of the need	Name of seeker	Estimated Project Value	Type of technology transfer required	Need for finance
Treatment of high level of organic and fiber materials and the use of storage tanks.	PT Sadajiwa Niaga (PTPN VI). The abattoir is located in the middle of an oil palm plantation.	PTPN VI has approximately 2,000 head of cattle, originating from Australia. Eventually, PTPN plans to source local cattle.	The company might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. The management of the abattoir might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.	Yes (grants)
Treatment of key pollutants include numerous chemicals, such as lead, cadmium, chromium and pesticides.	Coordinating Team for Water Resource Management in the Citarum River Basin (TKPSDA)	TKPSDA has a mandate to help the Ministry of Public Works manage the river basin, which covers approximately 13,000 square kilometers, coming into contact with 9 million people. The river provides as much as 80% of surface water to Jakarta's water supply authority, irrigates farms that supply 5% of Indonesia's rice, and is a source of water for upwards of 2,000 factories.	TKPSDA might need help in buying products, including bacteria that can rapidly degrade or decompose contaminants, and purchasing technologies. TKPSDA might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.	Yes (grants). Technical teams from government and research institutions and universities are willing to lend their support.
Treatment of high level of organic materials resulting from rubber processing activities and the ineffective system of "sludge active".	PTPN VI. The rubber processing plant is located in the middle of a rubber plantation.	In the surrounding area of the processing plant (around 1 km), there was relatively strong smell resulting from the processing activities of the plant. If a new or adjusted technology is successful, other rubber plantations owned by the government and other concerns might adopt the model.	PTPN VI could need help to purchase products and acquire technology, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.	Yes (grants)
Treatment of high level of contaminants from oil (i.e. petroleum and lubricants). There is also an issue of run-off water infiltrating a washing tank.	PT Trakindo Utama, the authorized dealer of Caterpillar equipment in Indonesia. The branch office in Balikpapan city, East Kalimantan, services heavy equipment.	The current capacity of its wastewater treatment plant is 10 cubic meters per day.	Purchasing products and acquiring technology, including bacteria that can rapidly degrade or decompose contaminants. The management of the branch might require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.	No

3.2 Koperasi Tahu Tempe in Balikpapan: wastewater from tofu and tempeh production

The Balikpapan of tofu and tempeh production cooperative affords some insight into the challenges faced by SMEs and factories across Indonesia.

The wastewater issues faced by this cooperative are the high level of BOD and COD contaminants and the relatively strong smell of wastewater produced by its activities. To date, the cooperative has 60 members (tofu and tempeh small producers).
The total capacity is up to 10 tons per day. The volume of the wastewater discharge is yet to be calculated.

Technological needs: We discovered that the cooperative is likely to require wastewater treatment technology that is space-efficient, low-cost, and preferably produces liquid fertilizer as output. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The cooperative needs immediate technological solutions that can address the issues for approximately 25 years.

Location: The cooperative needs to introduce the technology at its production location/factory. If this is successful, it will serve as a good model to be adopted by small and medium enterprises (SMEs) across Indonesia. To this end, the model of this cooperative can be developed further and shared with different levels of government.

Intellectual property rights: The cooperative might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. This could require help in intellectual property management. The management of the cooperative might require other technology transfer support, including project development, technical assistance and consultancy.

Other relevant issues: The cooperative has basic infrastructure that includes spacious aeration ponds and good road access. Nevertheless, electricity supply is unreliable, with regular brownouts and black outs. The cooperative has insufficient capacity and experience in wastewater treatment or management. Also, it has limited access to financing and would require support. If successfully implemented in this SME, applied wastewater technology could be transferred to other SMES. Current system for wastewater management is in Figure 2.

3.3 PT Kutai Chip Mill (KCM) in Balikpapan: organic wastewater from milling activities

PT Kutai Chip Mill (KCM, part of PT Pacific Fiber Indonesia) is a company that processes, produces and exports wood chips as pulp and paper materials from East Kalimantan.

The main issue faced by this company is polluted wastewater resulting from cleaning the wood chips. The chip mill has a current daily capacity of 180 cubic meters.

Technological needs: The company seeks water recycling technology. The technological aspects of the needs encompass all technical fields, particularly alternative energy production, energy conservation and waste management.

Timeline: The company needs technological solutions by 2016 to address the issue for approximately 25 years.

Location: Although many chip mills in Indonesia have installed or developed wastewater treatment plants, it is clear that new and applicable technologies are needed for water recycling in the coming years. If this is successful, many chip mills in the same group and/or across Indonesia could adopt the technology as part of a clean manufacturing industry platform.

Intellectual property rights: The company might need help in licensing, technology patenting, project development, technical assistance and consultancy.

Figure 2: Current wastewater treatment in tofu and tempeh production[13]

O**ther relevant issues:** The company has sufficient electricity support and good road access. The company has sufficient capacity and experience in wastewater treatment or management. It is also financially sound. If successfully implemented in this company, applied wastewater technology could be linked to other chip mills in the same group, at least. PT Kutai Chip Mill is in Figure 3.

3.4 Dinas Kebersihan Pemerintah Kota Balikpapan: wastewater from city sludge treatment plant

IPLT, a city sludge treatment plant, is located in Manggar, Balikpapan. It is one of the three wastewater treatment plants owned and administered by the city of Balikpapan.

The other two are Instalasi Pengolah Air Lindi, a leachate wastewater treatment plant and IPAL, a wastewater treatment plant.

The main wastewater issues the plant faces are solids that block the sewage treatment pipeline (e.g. plastics, the high concentration of BOD and COD contaminants, and the high level of E. Coli. These issues could be common to plants managed by city governments across Indonesia.

Technological needs: It emerged from the interview that the city sludge treatment plant needs low-cost waste treatment technology that makes optimal use of available infrastructure, in particular the existing ponds.
The plant also requires technology that can process human excreta into alternative energy resources and produce liquid organic fertilizer with a low-cost but rapid process.

The technological aspects of the needs encompass all technical fields, particularly design, alternative energy production, energy conservation and waste management.

Timeline: The plant needs immediate technological solutions that can address the issues for approximately 25 years.

[13] All photos are courtesy Rudy Abdul Rahman.

Location: The plant needs the technology introduced within its area. If this is successful, it could serve as a good model for many main cities across Indonesia. To this end, the model of this plant should be developed further and shared with different levels of government.

Intellectual property rights: The city sludge treatment plant might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. This plant might require help patenting and licensing. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management and patenting) and consultancy.

Other relevant issues: The plant has sufficient water supply through its existing ponds and good road access. It is supported by provincial regulations. Nonetheless, it experiences unreliable electricity supply in the form of regular brownouts and blackouts. The management and staff of the plant might require training for operating and maintaining new technologies. Also, the plant has limited financing capacity and might require a grant to support further development and/or introduction of wastewater treatment technology. If successful, the wastewater technology used in this plant could be transferred to similar facilities in Jambi, West Java or other main cities across Indonesia. City sludge treatment in Balikpapan is in Figure 4.

Figure 3: PT Kutai Chip Mill

Figure 4: City Sludge Treatment-Balikpapan

3.5 Grand Senyiur Hotel: wastewater from toilets, kitchen and laundry

Gran Senyiur Hotel is a five-star hotel in Balikpapan. It is a 10-storey building located on the crest of Pasir Ridge Hill, overlooking the city of Balikpapan and the open sea, in the heart of the city's business district.

The main wastewater issues faced by the hotel are fats and oils from kitchen activities, human waste from toilets discharged into septic tanks and untreated laundry waste.

Most laundry water is dumped into waterways, while some wastes from the kitchen contain solids that are processed in a private treatment facility.

The actual total volume of wastewater resulting from hotel activities is yet to be calculated. The general issues faced by this hotel are likely to be common to hotels across Indonesia.

Technological needs: It emerged from the interview that the hotel seeks to overhaul its wastewater treatment system. The hotel wants a system that is low cost, with no additional chemical inputs, energy-efficient, integrated and consistent with global standards. The technological aspects of the need encompass all technical fields, particularly alternative energy production, energy conservation and waste management.

Timeline: The hotel seeks immediate technological solutions that can address the issue for approximately 25 years.

Location: The hotel wishes to install the technology within its premises. If this is successful, it could serve as a good model for many five-star hotels across Indonesia. Resort areas such in Bali, Jogjakarta and many others might adopt a similar model.

Intellectual property rights: The hotel might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. As with previous technology seekers, the hotel might require help with intellectual property management. The hotel management might require other technology transfer support, including project development, technical assistance and consultancy.

Other relevant issues: The hotel has sufficient electricity support and good road access. It has no issues regarding financial support. The management and staff of the hotel might require capacity-building, since they are inexperienced in wastewater management. If successful, any applied wastewater technology could be transferred to other hotels in Bali, Java, Sumatra and Kalimantan. Wastewater treatment of the Gran Senyiur Hotel is in Figure 5.

3.6 Dinas Kebersihan Pemerintah Kota Balikpapan: wastewater/leachate from city solid waste landfill

The city solid waste landfill is the final destination for almost all solid waste disposed of in Balikpapan city. The city produces 350 tons of solid waste per day and 250 tons of this are transported to the landfill.[14]

Figure 5: Wastewater treatment from kitchen and laundry of the Gran Senyiur Hotel

[14] http://ppsp.nawasis.info/dokumen/perencanaan/sanitasi/pokja/bp/kota.balikpapan/BAB%20III-1.pdf.

The main wastewater issue faced by the landfill site is leachate that contains heavy metals, high levels of BOD and COD contaminants. The issues faced by this landfill are probably common to the landfills managed by many other city governments across Indonesia.

Technological needs: It emerged from the interview that the landfill might be seeking space-saving, low-cost and energy-efficient wastewater treatment technology. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The landfill needs immediate technological solutions that can address the issues for approximately 25 years.

Location: The landfill would apply the technology within its boundaries. If this is successful, it could serve as a good model for many main cities across Indonesia. To this end, the model applied in this plant could be developed further and shared with different levels of government.

Intellectual property rights: The landfill might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. This landfill might require help with intellectual property right management. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights and patenting) and consultancy.

Other relevant issues: The landfill has sufficient aeration ponds and good road access. It is supported by provincial regulation. As with most city sludge treatment plants in the country, it also experiences unreliable electricity support, including regular brownouts and blackouts. The management and staff of the landfill might require capacity-building for operating and maintaining technology. Also, the landfill has limited financing capacity and might require grants for further developing and/or introducing wastewater treatment technology. There is a need, for instance, to investigate fiscal incentives to trigger local policy change. If successful, any wastewater technology applied to this landfill could be transferred to similar facilities in Jambi, West Java or other main cities across Indonesia. Solid waste landfill in Balikpapan is in Figure 6.

Figure 6: Solid waste landfill in Balikpapan

3.7 Dinas Kebersihan Pemerintah Kota Jambi: wastewater from city sludge treatment plant

The city sludge treatment plant (IPLT) is located in Talang Bakung, Jambi city. The plant has a treatment capacity of 80 cubic meters.

It has operated since 1996, but has not functioned efficiently enough to serve all communities in Jambi city.[15] City sludge treatment in Jambi city is in Figure 7.

The main wastewater issues faced by the plant are high levels of organic contaminants and detergents, and although it has access to a lagoon with aeration system, the plant lacks pumping capacity and electricity (only having three pumping vehicles with a capacity of 4,000 liters).

The issues faced by this plant might be common to plants managed by many city governments across Indonesia.

Technological needs: It emerged from the interview that the plant is likely to seek low-cost wastewater treatment technology that makes optimal use of available infrastructure, such as the existing ponds. This technology should be compact and have useful outputs such as solid and liquid organic fertilizers, sources for biogas and electricity. The technology should also be equipped with a reliable support system. The technological aspects of the needs cover all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The plant needs immediate and long-term technological solutions.

Figure 7: City sludge treatment plant in Jambi city

[15] http://sosekling.pu.go.id/downloadpdf/upload/files/tibin_7_2014.pdf.

Location: The plant needs to introduce suitable technology within its 5-hectare area, located in a suburb of Jambi city. If this is successful, it could serve as a good model for many main cities across Indonesia. As in Balikpapan, the model of this plant can be developed further to be shared with different levels of government.

Intellectual property rights: The plant might need help in purchasing appropriate technology, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting and negotiation) and consultancy. The plant might need support in the forms of improved system management.

Other relevant issues: The plant has sufficient space (5 hectares) within the current facilities, comprising three pumping vehicles with a capacity of 4000 liters, three aeration ponds, one security post, one office plus accommodation, one warehouse, fences surrounding the compound and green areas. It is supported by provincial regulations. However, the management and staff might require capacity-building since they lack experience and basic scientific and technical knowledge of wastewater treatment. Also, the plant has limited financing capacity and might require a grant to support further development and/or introduction of wastewater treatment technology. One advantage it has is that it is fully supported by the government of Jambi city, especially if new regulations might be required to support any transformation. If successful, any applied wastewater technology could be transferred to similar facilities in East Kalimantan, West Java or other main cities across Indonesia (particularly since the plant has a relationship with the Ministry of Public Works).

3.8 PT Djambi Waras: wastewater from rubber processing plant

PT Djambi Waras, part of Kirana Megatara Group, is a company that processes, produces and exports rubber. It was founded in 1970 and has products ranging from SIR (Standard Indonesian Rubber) 10, SIR 20 and SIR 20CV (Constant Viscosity).[16].

The rubber is sourced from farmers and traders in Jambi, Lampung and Bangka.[17]

The main wastewater issues faced by this company are the high level of organic materials resulting from rubber processing activities and the use of storage tanks. An area of roughly 1 kilometer around the plant is permeated by strong odors emanating from the plant.

Technological needs: It emerged from the interview that the company is seeking new and appropriate technology that is compact and has useful outputs such as solid and liquid organic fertilizers, sources for biogas and electricity. The technology should also be equipped with a reliable support system. The technological aspects of the requirement encompass all technical fields; particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The company needs immediate technological solutions that can be used to address the issues in the longer term.

Location: The processing plant is located in a suburb of Jambi city. If a new or adapted technology is successful, many rubber processing plants in the same group and/or across Indonesia might adopt it as part of a clean manufacturing industry platform.

Intellectual property rights: The company might need help in buying products and technology acquisition, including bacteria that can degrade or decompose contaminants rapidly. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.

Other relevant issues: The company has good road access. It also has sufficient knowledge, capacity and experience in wastewater treatment or management. Nevertheless it faces financial issues and thus might require grants and financial guarantees to obtain debt financing. If successful,

[16] http://www.kiranamegatara.com/id/anak-perusahaan/pabrik-karet-remah.
[17] *Ibid*.

wastewater technology applied in this company could be transferred to other rubber processing plants in the same group, at least.

3.9 PT Perkebunan Nusantara VI: wastewater from POME (palm oil mill effluents)

PT Perkebunan Nusantara (PTPN) VI is a state-owned company involved in the production of palm oil, which constitutes 95% of its business.[18] PTPN VI is located in two provinces in Sumatra: Jambi and West Sumatra.[19] It has five mills, one with a capacity of 30 tons, two with a capacity of 45 tons, and two with a capacity of 60 tons per hour. The main wastewater issues it faces are the high level of organic materials (POME) resulting from palm oil mill activities and the use of storage tanks. POME thrown in the lagoon usually releases high levels of methane. There was an attempt to conduct a feasibility study on using and transforming the POME into electricity sources. The capacity or volume of POME is yet to be calculated.

Technological needs: It emerged from the interview that PTPN VI is seeking a new and appropriate technology to process and transforms its POME into electricity or liquid fertilizer. The technology should be compact and equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: PTPN VI needs immediate technological solutions that can be used to address the issues in the long term.

Location: The processing plant is located in the middle of a palm oil plantation owned by PTPN VI. If a new or adapted technology is successful, many palm oil mills owned by the government and private concerns might adopt it as part of a sustainable palm oil platform.

Intellectual property rights: PTPN VI might require assistance in buying products, including bacteria that can rapidly degrade or de-compose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.

Other relevant issues: PTPN VI has good road access. It also has sufficient knowledge, capacity and experience in wastewater treatment and management. Nevertheless it faces financial constraints and might require grants and access to public financing under a public-private scheme. If successfully applied in this company wastewater technology could be transferred to other palm oil mills operated by state-owned companies. PTPN VI is in Figure 8.

3.10 PT Brahma Bina Bakti: wastewater from POME (palm oil mill effluents)

PT Brahma Binabakti (PT BBB) is an oil palm grower established in 1988, with a land bank of 6,220 hectares, located in Jambi Province.[20]

The operation consists of an oil palm plantation with a palm oil mill (60 tons per hour) and supporting facilities such as the warehouse, the workshop and employee housing.[21]

In addition, PT BBB has an established plasma project of 6,126 hectares (planted) and in production.[22] PT BBB has a mission to be a green plantation for better quality of life by implementing the Roundtable on Sustainable Palm Oil (RSPO) principles and criteria.[23]

The main wastewater issues faced by PT BBB are the high level of POME resulting from mill activities and the use of storage tanks. As with PTPN VI, POME discharged into the lagoon releases a high level of methane. The capacity or volume of POME is yet to be calculated.

[18] http://ptpn6.com/berita-sekilas-perusahaan.html.
[19] *Ibid*.
[20] http://www.rspo.org/members/2042/PT.-Brahma-Binabakti.
[21] *Ibid*.
[22] *Ibid*.
[23] *Ibid*.

Figure 8: PTPN VI

Technological needs: It emerged from the interview that PT BBB seeks a new and appropriate technology that can process and transform its POME to electricity or biogas and solid and liquid fertilizer.

The technology should be equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: PT BBB needs immediate technological solutions that can be used to address these issues in the long term.

Location: The mill is located in a suburb of Jambi city. If a new or adjusted technology is successful, many palm oil mills operated by RSPO members and others might adopt it as part of a sustainable palm oil platform.

Intellectual property rights: PT BBB might need help in buying products, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.

Other relevant issues: PT BBB has good road access, no known land tenure issues and close proximity to electricity transmission. It also has sufficient knowledge, capacity and experience in wastewater treatment or management. Nevertheless, it might require a financing scheme (loan or investment) to support the acquisition of sustainable POME treatment technology. If successfully implemented in this company, wastewater technology could be transferred to other palm oil mills operated by RSPO members, at least.

3.11 PT Sadajiwa Niaga Indonesia: wastewater from a cattle abattoir

PT Sadajiwa Niaga Indonesia is a trading company, a distributor and wholesaler of beef cattle, beef, beef carcasses, meat products, frozen meat and other related products.

The company has approximately 5,000 head of cattle, originating from Australia. The main wastewater issues it faces are the high level of organic and fiber materials and the use of storage tanks.

Technological needs: It emerged from the interview that the company seeks new and appropriate technology that is compact and can produce useful outputs such as electricity, biogas, and solid and liquid fertilizers. The technology should be equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The company needs immediate technological solutions that can be used to address these issues in the long term.

Location: The abattoir is located in a sparsely populated area. If new or adjusted technology is successful, many abattoirs, for instance those with centralized cattle ranches, might adopt it. Intellectual property rights: The company might need help in purchasing bacteria that can rapidly degrade or decompose contaminants. The management of the abattoir might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.

Other relevant issues: The company has good road access and the ranches are in good condition. Electricity is unreliable. Nevertheless, it lacks knowledge, capacity and experience in wastewater treatment or management. It might also require a financing scheme (loan, guarantee or investment) that can support technology acquisition or adoption. If successfully implemented in this company, wastewater technology could be transferred to other abattoirs. PT Sadajiwa Niaga Indonesia is in Figure 9.

3.12 PTPN VI: wastewater from a cattle abattoir

The background of PTPN VI is explained in Sub-section 3.2.9. PTPN VI has approximately 2,000 head of cattle, originating from Australia.

Eventually, PTPN plans to source local cattle. The main wastewater issues faced by the abattoir are the high level of organic and fiber materials and the use of storage tanks. PTPN VI Cattle is in Figure 10.

Technological needs: It emerged from the interview that PTPN VI is looking for a new and appropriate technology that is compact and can produce useful outputs such as electricity, biogas, and solid and liquid fertilizers. The technology should be equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: PTPN VI needs immediate technological solutions that can be used to address these issues in the long term.

Location: The abattoir is located in the middle of an oil palm plantation and owned by PTPN VI. If new or adjusted technology is successful, many government-owned abattoirs across Indonesia might adopt the model.

Intellectual property rights: PTPN VI might need help in buying products, including bacteria that can rapidly degrade or decompose contaminants. The management of the abattoir might require other

Figure 9: PT Sadajiwa Niaga Indonesia

Figure 10: PTPN VI – Cattle

technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.

Other relevant issues: PTPN VI has good road access and its ranches are in good condition, but electricity is not reliable. The company has sufficient knowledge, capacity and experience in wastewater treatment or management. Nevertheless, it might require grants to enable technology transfer. If successfully applied in this company, wastewater technology could be transferred to other abattoirs operated by state-owned companies.

3.13 TKPSDA Wilayah Sungai Citarum: wastewater from activities in the vicinity the river basin

The Coordinating Team for Water Resource Management in the Citarum River Basin (TKPSDA) has a mandate to help the Ministry of Public Works manage the river basin, which covers approximately 13,000 square kilometers, coming into contact with 9 million people.[24]

The river provides as much as 80% of surface water to Jakarta's water supply authority, irrigates farms that supply 5% of Indonesia's rice, and is a source of water for upwards of 2,000 factories.[25] The river is now considered to be one of the worst-polluted in the world.[26] Key pollutants include numerous chemicals, such as lead, cadmium, chromium and pesticides.[27]

It emerged from the interview that the main issues TKPSDA faces are wastewater effluent from various industries, cattle ranches, agricultural activities, and domestic/household activities. In addition, the environmental carrying capacity of the river is rapidly diminishing.

Technological needs: TKPSDA is looking for new and appropriate technology that can help cleanse the river. The technological aspects of the needs encompass all technical fields, particularly administrative, regulatory and design aspects, alternative energy production, energy conservation and waste management.

Timeline: TKPSDA needs immediate technological solutions provided the technology can help cleanse the river.

Location: The technology needed would be deployed in several locations along the river or its tributaries. If such new or adjusted technology is successful, many river management bodies in Indonesia might adopt the model.

Intellectual property rights: TKPSDA might need help in buying products, including bacteria that can rapidly degrade or decompose contaminants, and purchasing technologies. TKPSDA might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.

Other relevant issues: According to TKPSDA, the river has sufficient electricity but a few areas are too far from the main transmission system and are difficult to access. Although it has sufficient knowledge, capacity and experience in wastewater treatment or management, TKPSDA believes that its staff needs to discover the most efficient and effective way to address wastewater issues, and understand the economic, social and cultural characteristics of communities living along the river. TKPSDA stated that governor of West Java had made the cleansing of the river one of his priorities. Technical teams from government and research institutions and universities are willing to lend their support. All levels of governments are also willing to explore new regulations to support sound programs and interventions. Nevertheless, TKPSDA might require grants to support the technology transfer. If successful, the wastewater technology can be transferred to other river management bodies operated by the Indonesian government. Citarum river basin is in Figure 11.

[24] http://www.worstpolluted.org/files/FileUpload/files/2013/Citarum%20River.pdf.
[25] *Ibid*.
[26] *Ibid*.
[27] *Ibid*.

Figure 11: Citarum river basin

3.14 PTPN VI: wastewater from a rubber processing plant

The background of PTPN VI is explained in sub-section 3.2.9. The main wastewater issues faced by this company are the high level of organic materials resulting from rubber processing activities and the ineffective system of “sludge active”.

In the surrounding area of the processing plant (around 1 km), there was relatively strong smell resulting from the processing activities of the plant.

Technological needs: It emerged from the interview that PTPN VI seeks a new and appropriate technology that is compactly built and has useful outputs such as solid and liquid organic fertilizers, sources for biogas and electricity. The technology should also be equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: PTPN VI needs immediate technological solutions that can be used to address the issues in the long term.

Location: The rubber processing plant is located in the middle of a rubber plantation and is owned by PTPN VI. If a new or adjusted technology is successful, other rubber plantations owned by the government and other concerns might adopt the model.

Intellectual property rights: PTPN VI would need help to purchase products and acquire technology, including bacteria that can rapidly degrade or decompose contaminants. The management of the plant might require other technology transfer support, including project development, technical assistance (training on intellectual property rights management, patenting, licensing and negotiation) and consultancy.

Other relevant issues: PTPN VI has good road access and its ranches are in good condition, but electricity is unreliable. The company has sufficient knowledge, capacity and experience in wastewater treatment or management. It might nevertheless require grants to facilitate technology transfer. If wastewater technology is successfully implemented in this company, the technology could be transferred to other abattoirs operated by state-owned companies, at least. Rubber wastewater treatment plant is in Figure 12.

Figure 12: PTPN VI – rubber wastewater treatment

3.15 PT Trakindo: wastewater from mechanic and heavy equipment services

PT Trakindo Utama is the authorized dealer of Caterpillar equipment in Indonesia.[28] Current wastewater treatment of PT Trakindo Utama is shown in Figure 13. The branch office in Balikpapan city, East Kalimantan, services heavy equipment.

The current capacity of its wastewater treatment plant is 10 cubic meters per day. The main wastewater issue faced by the company is the high level of contaminants from oil (i.e. petroleum and lubricants). There is also an issue of run-off water infiltrating a washing tank.

Technological needs: It emerged from the interview that the company wants to improve its system without additional chemical inputs while ensuring low costs and a high level of energy efficiency. The technology should also be equipped with a reliable support system. The technological aspects of the needs encompass all technical fields, particularly design aspects, alternative energy production, energy conservation and waste management.

Timeline: The company needs immediate technological solutions that can address the issues for approximately 25 years.

Location: The company is located in Balikpapan city. If new or improved technology is successful, many other companies that service heavy equipment could adopt the model.

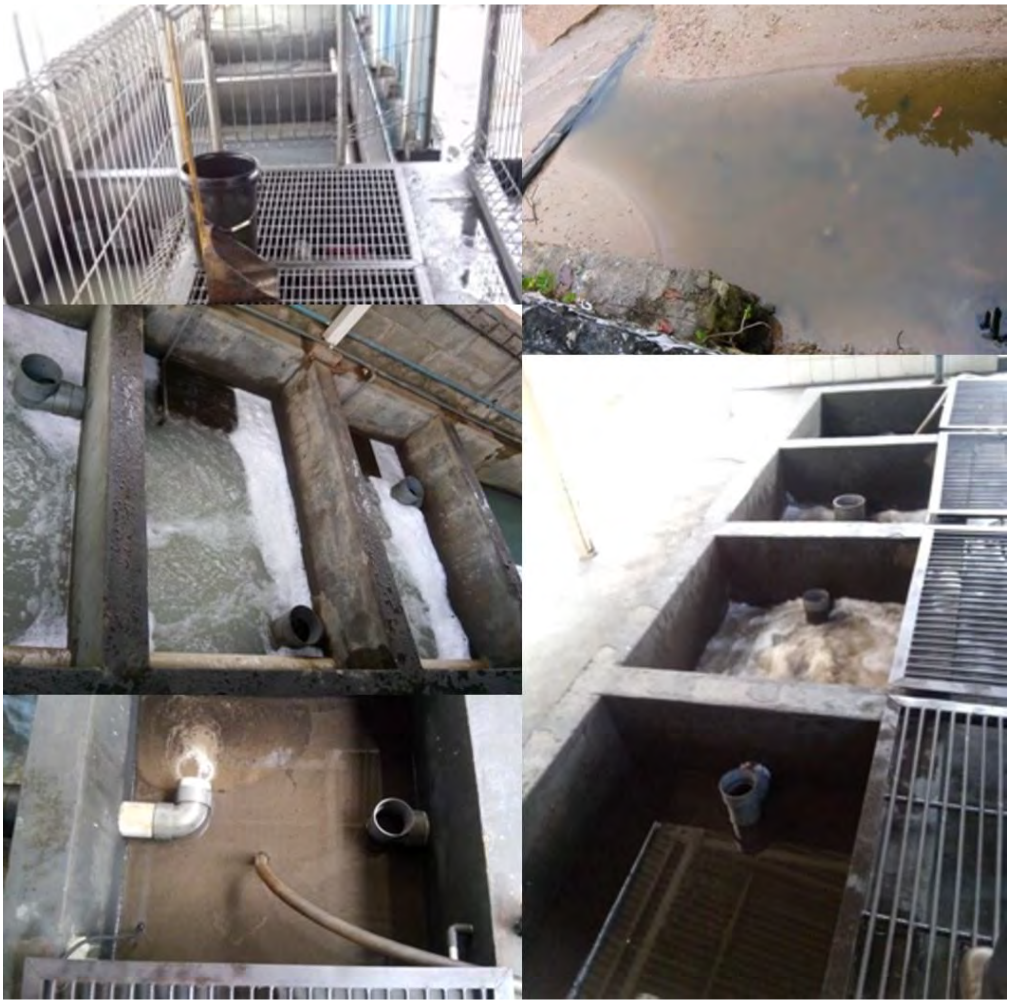
Intellectual property rights: The company might need help in purchasing products and acquiring technology, including bacteria that can rapidly degrade or decompose contaminants. The management of the branch might require other technology transfer support, including project

[28] http://www.trakindo.co.id/website/pages/the-company/about-trakindo.php.

development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.

Other relevant issues: The company has good road access and sufficient electricity support. Nevertheless, it lacks sufficient knowledge, capacity and experience in wastewater treatment or management. It requires no financial support, but requires support in addressing regulatory standards for wastewater treatment, effluent standards and disposal. If successfully applied this company, wastewater technology can be linked to other heavy equipment servicing, at least within the group.

Figure 13: PT Trakindo Utama



4 Recommendations

When it comes to the development, introduction and/or transfer of technology for wastewater treatment, both technological providers and seeker have to operate within existing regulatory and legal frameworks, which include the following requirements.

The technologies are required to produce wastewater discharge that does not exceed the allowable threshold.

The technologies are required to meet the Indonesian National Standards.
From the interviews/surveys conducted for this report, it is clear that to support technology seekers, the following aspects need to be taken into account:

Technological needs: many technology seekers are looking for new and/or appropriate technology that can not only help address their wastewater issues but also provide useful outputs or by-products.

Such dual objectives are very important to technology seekers. In general, the seekers require support in almost all technical fields, but especially design alternative energy production, energy conservation and waste management.

Timeline: Almost all seekers need immediate technological solutions that can be used over the long term.

Location and additional values: Even though the technology might be used only in seeker's area, many seekers see the need for the technology to be replicated elsewhere. This means if such a new or adapted technology is successful, many similar companies and organizations in Indonesia might adopt the technology.

Section 3:

Philippines Country Report:
Wastewater Management Needs and Solutions for the Philippines

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Summary

This project report aims to identify and assess the needs and existing technologies to improve wastewater treatment in the Philippines. In addition, the report provides information on the related environmental policy and technology transfer frameworks.

At the completion of the project in April 2015, a workshop based on the project's findings took place in Manila. Over 90 key stakeholders participated in the workshop; in addition to seekers and providers of technological solutions, key institutions in climate finance, technology transfer, wastewater management expertise, intellectual property management, technology assessment, legal support and environmental policy participated in the event.

The success of the event and subsequent discussions with the participants demonstrated the need for additional events that bring together technology seekers and providers with the involvement of institutions with key roles in technology transfer.

Also, it became apparent that the participants would benefit from a seminar of this nature which would extend to an add-on event on how to structure various types of deals based on the finance model (equity, debt, grant, or public sector procurement). Participants stressed the importance of trusted negotiators in brokering deals, and many welcomed the various intermediaries and service providers at the event.

Based on discussions with various stakeholders, it became apparent that there are also significant needs for capacity building in urban centers as well as financing in the form of grants or other sources to expedite the adoption of appropriate technology solutions. Events such as the WIPO GREEN Manila workshop can add tremendous value to the local stakeholders; however, a more systematic review of technology providers would be desirable.

1. Introduction and methodology

The analysis and findings of this report are based on a combination of secondary desk research, interviews with industry experts, and interviews with local representatives and stakeholders.

The initial outreach also included emailing professional networks on social media such as the Water and Wastewater treatment groups on LinkedIn, and academic alumni groups such as the Philippines London Business School Alumni. The Intellectual Property Office of the Philippines offered invaluable support, especially in engaging the academic sector, through their patent officers' network. A country visit took place in the months of November and December 2014.

After the initial phase of analyzing the wastewater needs of a variety of industries, it became apparent that the strongest response and willingness to adopt new 'green' technologies came from academic institutions and municipalities. As a consequence, the report's focus shifted into further understanding those needs and potential solutions.

1.2 Wastewater management in the Philippines

There is a significant need for the introduction of low cost, low tech wastewater treatment facilities in urban areas in the Philippines. In the Philippines only 10% of wastewater is treated while 58% of the groundwater is contaminated. Only 5% of the population is connected to sewer network. (WHO study). According to UNIDO, 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 in Metro Manila alone.

Data from the Environmental Management Bureau (EMB), Philippines shows that out of the 127 freshwater bodies sampled, only 47% were found to have good water quality. However, 40% of those sampled were found to have only fair water quality, while 13% showed poor water quality.

The Water Environment Partnership in Asia (WEPA) states that the discharge of domestic and industrial wastewater and agricultural runoff has caused extensive pollution of the receiving water-bodies in the 'form of raw sewage, detergents, fertilizer, heavy metals, chemical products, oils, and even solid waste'. It has also been calculated by WEPA that "the adverse impact of water pollution costs the Filipino economy an estimated Php67 Billion annually (more than US$1.3 Billion)." [1]

A report from the Asian Development Bank estimated that only one third of Philippine's river systems are considered suitable for public water supply. It is estimated that in 2025, water availability will be marginal in most major cities and only 42% (8 out of the 19) of major river basins, compared to 51% in the late 1990s, would meet the required standards.

Since the country's waste water situation is predominantly caused by water pollution, the level of effluent treatment and adherence to local discharge standards are of paramount importance. The dominant level of effluent treatment in the municipal sector is primary, which allows for significant improvement to discharge quality.

The industrial sector uses secondary effluent treatment; based on discussions with relevant stakeholders so far it is clear that tertiary levels of treatment are rare, only implemented by very large industrial players. There is no reliable data about the amount of recycled or treated wastewater for and from agricultural activities so far.

Financing for wastewater treatment projects is usually obtained from government sources, grants and other local funding mechanisms, such as the Philippine Water Revolving Fund. To partly fill the financing gap, the fund – backed by USAID, JICA and the Philippines Department of Finance - was introduced in 2008 as a unique mechanism to blend limited public donor funds with commercial lending in local currency from private banks.

To overcome the immaturity of the local water sector and the lack of funds liquidity due to the perceived high sector risk a credit rating system for borrowers in the water sector was established and a guarantee system was set up to lower the risk for the banks.

Under this system, the LGUGC (Local Government Unit Guarantee Corporation) guarantees 85% of loans from commercial banks, with a counter-guarantee from USAID's Development Credit Authority.

Also, in parallel to the loans from commercial banks, the Development Bank of the Philippines (DBP) provided in the past co-funding for subsidized loans for wastewater treatment projects.

External development agencies that work on water supply and sanitation in the Philippines include the Asian Development Bank, Germany's KfW Development Bank, Japan's JICA, USAID, IFC and the World Bank.

In the case of waste-to-energy plants, a carbon financing mechanism has been used in the past from the World Bank. However, as the carbon trading market has slowed down considerably it is possible that such deals are not economically feasible any more.

The industrial sector's wastewater treatment plants are often financed by companies' funds, as in the case of Roxol Bioenergy Corporation's construction of a wastewater treatment and energy recovery system which was financed by its parent company

1.3 Environmental regulations

Even though ''Integrated Water Resource Management'' and ''River Basin Management'' approaches are mentioned in Viet Namese legal documents, such as the Law on Water Resources (1998, amended in 2012), the Law on the Environment (2005), and River Basin Commissions have been established for the three principal river basins in Viet Nam, these approaches are yet to be implemented.

[1] http://www.wepa-db.net/pdf/0710philippines/6_MWSS.pdf

The country has a comprehensive and well-developed wastewater treatment policy framework following the entry into force of the Philippine Clean Water Act of 2004. The current legislation is based on the 'polluter pays' principle and has introduced innovative and forward thinking instruments such as effluent-trading mechanisms to combat water pollution. However, adherence to effluent treatment and discharge standards is reportedly very low, especially in areas outside the major city centers.

The Philippine Clean Water Act of 2004 (Republic Act No. 9275) aims to protect the country's water bodies from pollution from land-based sources (industries and commercial establishments, agriculture and community/household activities).

The Clean Water Act prohibits the following:

- Discharging or depositing any water pollutant into the water body, or such which will impede natural flow in the water body
- Discharging, injecting or allowing to enter into the soil, anything that would pollute groundwater
- Operating facilities that discharge regulated water pollutants without the valid required permits
- Unauthorized transportation of wastewater or discharging into waters of sewage sludge or solid waste
- Transport, dumping or discharge of prohibited chemicals, substances or pollutants listed under Toxic Chemicals, Hazardous and Nuclear Wastes Control Act (Republic. Act No. 6969)
- Discharging regulated water pollutants without the valid required discharge permit pursuant to this Act
- Refusal or failure to submit reports and/or designate pollution control officers whenever required by the (Department of Environment and Natural Resources) DENR in accordance with the Act's requirements
- Operation of facilities that discharge or allow to seep, willfully or through grave negligence, prohibited chemicals, substances, or pollutants listed under R.A. No. 6969, into water bodies
- Undertaking activities or development and expansion of projects, or operating wastewater treatment/sewerage facilities in violation of P.D.1586

All operators of facilities that discharge wastewater are required to have a permit to discharge from the DENR and pay a wastewater charge to the local authority. In addition, they are required to employ sanitary engineers.

The Clean Water Act allows also for fiscal and non-fiscal incentives to be given to Local Government Units (LGUs), water districts, enterprise, private entities and individuals who develop and undertake outstanding and innovative projects in water quality management. However the criteria for the evaluation of such projects are not clearly articulated.

The Supreme Court Decision mandates the Local Water Utilities Authority (LWUA) in coordination with the DENR "to provide, install, operate and maintain sewerage and sanitation facilities and the efficient and safe collection, treatment and disposal of sewage in the provinces of Laguna, Cavite, Bulacan, Pampanga and Bataan where needed at the earliest possible time".

Violations of the legal requirements stemming from the Clean Water Act incur fines and penalties based on the recommendation of the Pollution Adjudication Board (PAB). The PAB has the authority to impose penalties on any company or individual who commits prohibited acts based on the broad guidelines stipulated in the Clean Water Act.

The Philippine Department of Environment and Natural Resources (DENR) is the lead ministry for implementing water sector legislation. DENR is the primary government agency responsible for the implementation and enforcement of the Act. It is responsible for the preparation of the integrated water quality management framework and the 10-year management plans for each water management area.

However many other government organizations, local government units, non-government organizations and the private sector are also involved in the decision making process.

Other government bodies that play a significant role in wastewater management are:

- The National Water Resources Board (NWRB) is responsible for water resources management. NWRB has limited technical capacity and a lack of financial means to execute the required functions; as a result, compliance is very low, although the legislative framework is adequate to safeguard the country's water resources.
- The Department of Public Works and Highways provides sewerage and sanitation facilities, and the efficient and safe collection, treatment and disposal of sewage within their area of jurisdiction
- The Department of Agriculture is responsible for setting and enforcing guidelines for the re-use of wastewater for irrigation and other agricultural uses and for the prevention, control and abatement of pollution from agricultural and aquaculture activities
- The Department of Science and Technology is responsible for the evaluation and development of pollution prevention and other relevant technologies
- The Department of Education, Commission on Higher Education, Department of Interior and Local Government, and the Philippine Information Agency are jointly responsible for the design and implementation of public education and information programs relating to safe water and wastewater treatment

Wastewater management is based on watershed, river basin regions or other regions as deemed appropriate by the relevant government departments and the designation of similar areas by the DENR and NWRB. The DENR and NWRB designate the areas that have similar hydrological, hydrogeological, meteorological or geographic conditions and decide on the management of water pollution based on these parameters.

A complex system of different and cross-sectoral bodies exists to manage water quality issues at the local level. Such bodies include local governments' representatives, representatives of relevant national government agencies, non-government organizations, the local water utility, local industries and other relevant stakeholders.

In the Philippines, there is a professional group mandated by law (R.A. 1364) to deal with wastewater treatment, the Sanitary Engineers. They are responsible for all activities relating to the design, management and operation of wastewater treatment plants as well as the investigation of any polluting activities.

1.4 Issues related to innovation and intellectual property rights

Research has shown that in the case of climate change innovation, a prerequisite for technology transfer or increased innovation is the presence of ambitious climate change policies and stringent standards.[2] Due to the similar nature of the technological innovation and the sector discussed, it can be safely inferred that the research findings could be applied to the wastewater treatment as well. Singapore and Israel are examples of how strong policy frameworks, increased penalties and fines, as well as correct pricing of clean water have a positive impact on innovation in the water sector.

From that perspective, the Philippines have a less than favorable outlook for innovation in the water sector. Although the required policy framework exists, the lack of enforcement and inappropriate water pricing do not create the necessary drivers for new and innovative technologies to develop.

Furthermore, the country's technological transfer legislative framework is also relatively new, as the Philippine Technology Transfer Act was enacted in 2009. The act is providing the framework and support system for the ownership, management, use, and commercialization of intellectual property generated from research and development funded by government and for other purposes.

The main hubs of innovation so far have been academic institutions. In an attempt to replicate the innovation hubs in other countries, the legislators are hoping to significantly boost innovation in academic environments and enable the commercialization of new technologies and eventually start-

[2] 'Promoting the International Transfer of Low-Carbon Technologies: Evidence and Policy Challenges
Report for the Commissariat général à la stratégie et à la prospective', French Center for Policy Planning, October 2013

up spin offs. Although so far there has been limited technology transfer and commercialization, probably due to insufficient awareness of the policy framework, more activity is expected in the future.

2. Wastewater management needs

2.1 Overview

The Philippines has experienced strong economic growth in the past decade driven by growth in the professional services sector. Other important sectors of the Philippine industry include mining, food processing, textiles and garments, and electronics and automobile parts. Most industries are concentrated in the urban areas around Metro Manila, while Metro Cebu is also becoming attractive for foreign and local investors.

Data on the total volume of wastewater generated and treated by the municipal and industrial sectors is not readily available. However, it has been reported that the estimated total annual volume of wastewater produced from both municipal and major food processing industries is approximately 7,465million cubic meters. [3]

It would be meaningless at this point in time to estimate a breakdown of wastewater produced and discharged by different industries due to the lack of data. Based on the composition of the country's GDP it is assumed that the sectors with the most pressing needs for wastewater treatment technologies (including those that could facilitate water re-use for agriculture) are:

- Oil and gas production
- Energy generation
- Mining
- Food processing
- Sugar Millers
- Commercial/Municipal

From the list above, the sector that is mostly supported by intergovernmental initiatives in the adoption of sustainable 'green' technologies is the commercial/municipal sector. The reason for that is that recently governments, development banks, non-for profit organizations and think tanks have turned their attention to the environmental consequences of the rapid development of cities and the large investment deficit in environmental infrastructure.

The Asian Development Bank (ADB) reports that the investment deficit in Asian cities environmental infrastructure spending is in the region of US$100 billion per annum, when up to 80% of gross domestic product comes from the same urban areas.

Government and private initiatives aim to increase the adoption of wastewater treatment technologies, strongly supported by organizations such as United States Agency for International Development (USAID).

In 2014, DENR issued a memorandum requiring all new commercial establishments such as malls, hospitals, universities, and residential buildings to install adequate sewage treatment facilities as a condition to the granting of environmental compliance certificates (ECC)'s and permits to operate. Also, all existing commercial properties where required to have adequate wastewater treatment facilities as a condition of the renewal of their permits.

USAID established the Local Initiatives for Affordable Wastewater Treatment (LINAW) project to assist local authorities with the implementation of the new legislation and as a result it introduced low-cost technologies and solutions, such as the Decentralized Wastewater Treatment Systems (DEWATS) to help. The project was quite successful as it helped develop onsite, offsite and decentralized wastewater treatment facilities across the Philippines.

[3] 'Wastewater production, treatment and use in the Philippines' Engr. Gerardo Mogol, Engr. Teresita S.Sandoval, Engr Marcelino Rivera Jn.

In 2007, the Cities Development Initiative for Asia was founded as a partnership between the Asian Development Bank (ADB) and the German Federal Ministry for Economic Cooperation and Development (BMZ). The cities of Cebu and Cagayan de Oro are already participating in the Cities Development Initiative for Asia seeking ‘green’ technology solutions and financing. Alongside those municipalities many academic institutions are seeking to build wastewater facilities and collaborate with both established technology players and new technology providers to showcase their solutions.

In the course of the project many different industries were approached either through their associations or through direct contact with industry owners to document their specific wastewater treatment needs, but very limited responses were received in the required timeframe, with the exception of the broader wastewater treatment needs from the City of Iloilo and the surrounding area.

As a result the technological needs of the City of Iloilo (Aerial photo of the city of Iloilo, Figure 1), Table 1 lists them with focus on universities and hospitals in the region. The following consulting, technological and funding needs for the provisions of wastewater treatment were identified during the course of the project.

2.2 City of Iloilo

The City of Iloilo (Figure 1) is the capital city of the province of Iloilo on Panay Island. At the time of the 2010 census, it had a population of 424,619 people with an annual growth rate of 1.8% and 93,200 households. There are a considerable number of villages – 180 – in the five districts. The city is a large urban center with 13000 registered businesses, amongst them eight hospitals, 9 shopping malls, two fuel oil depots and 29 universities/colleges. In the broader district are also located coal fired and diesel power plants with a combined capacity of more than 200 megawatts. The city is not served by a centralized sewerage system: the majority of the residents and businesses rely on on-site treatment through septic

Figure 1: The City of Iloilo: Wastewater Management needs

Table 1: Wastewater Management needs

	Title of the technology need	Area of application	Remarks
1	Low cost technologies to treat light load wastewater at: Academic Institutions, Hospitals, Malls and other commercial properties at the City of Iloilo http://ow.ly/DjBX302eviJ	City of Iloilo, Environment Department	At the 2010 census, city had a population of 424,619 people with an annual growth rate of 1.8% and 93,200 households. There are a considerable number of villages – 180 – in the five districts. The city is a large urban center with 13000 registered businesses, amongst them eight hospitals, 9 shopping malls, two fuel oil depots and 29 universities/colleges. In the broader district are also located coal fired and diesel power plants with a combined capacity of more than 200 megawatts.
2	Improvement of Wastewater treatment Facilities http://ow.ly/2swv302evqq	University of the Philippines Visayas	The University of the Philippines Visayas (UPV) is based in the Iloilo area. It has three campuses in Miagao, Iloilo City, and Tacloban—with Miagao being the main campus with 4,000 students. The Iloilo City and Tacloban campuses have 2,000 and 1,000 students respectively.
3	Upgrade of centralized water treatment facilities to treat light chemical waste http://ow.ly/nc90302evKi	University of the Philippines Visayas	The University of the Philippines Visayas (UPV) is based in the Iloilo area. It has three campuses in Miagao, Iloilo City, and Tacloban—with Miagao being the main campus with 4,000 students. The Iloilo City and Tacloban campuses have 2,000 and 1,000 students respectively.
4	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/XYzY302evR3	University of the Philippines Visayas	The University of the Philippines Visayas (UPV) is based in the Iloilo area. It has three campuses in Miagao, Iloilo City, and Tacloban—with Miagao being the main campus with 4,000 students. The Iloilo City and Tacloban campuses have 2,000 and 1,000 students respectively.
5	Low cost, low tech solution for onsite wastewater treatment of commercial waste	University of the Philippines Visayas	The University of the Philippines Visayas (UPV) is based in the Iloilo area. It has three campuses in Miagao, Iloilo City, and Tacloban with Miagao being the main campus with 4,000 students. The Iloilo City and Tacloban campuses have 2,000 and 1,000 students respectively.
6	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/evVV302ew0H	City of Iloilo/University of the West Visayas, College of Agriculture and Forestry Campus	The main campus has over 500 staff and approximately 7,000 students. A new low cost 'green' technology solution is required to treat the effluent discharged. Ideally, the technology provider should train the existing staff and work closely with the engineers of the Environment Department of the City of Iloilo.
7	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/Mrbb302ew4J	City of Iloilo/University of the West Visayas, La Paz Campus	A new low cost 'green' technology solution is required to treat the effluent discharged. Ideally, the technology provider should train the existing staff and work closely with the engineers of the Environment Department of the City of Iloilo. Funding will be required for the completion of the project.
8	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/mD9R302ewbn	City of Iloilo/University of the West Visayas, Calinog Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.no wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.
9	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/A44B302ewjO	City of Iloilo/University of the West Visayas, Janiunay Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.
10	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/uq2m302ewpP	City of Iloilo/University of the West Visayas, Lambunao Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.

	Title of the technology need	Area of application	Remarks
11	Low cost, low tech solution for onsite wastewater treatment of commercial waste http://ow.ly/VWwg302ewvW	City of Iloilo/University of the West Visayas, Pototan Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.
12	Low cost, low tech solution for onsite wastewater treatment of commercial waste	City of Iloilo/University of the West Visayas, Negros Occidental Extension Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.
13	Low cost, low tech solution for onsite wastewater treatment of domestic type waste http://ow.ly/iKK6302ewAJ	City of Iloilo/University of the West Visayas, Negros Occidental Extension Campus	No wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.
14	Green' low cost energy wastewater treatment is required for onsite treatment of hospital waste http://ow.ly/E3H0302ewFK	Don Bonito Hospital, West Visayas	The hospital requires the introduction of low cost technology that can treat its effluent on site before it is discharged. The effluent has similar characteristic to domestic wastewater with the addition of pathogens and possibly low concentration of heavy metals.

The Need:

The LINAW initiative helped hospitals build their own on-site treatment plants. The program so far made it possible to avoid no less than 2 million liters of untreated wastewater from entering Iloilo River daily. The LINAW Program provided the city officials with insights that were integrated into their planning criteria.

Unfortunately, although USAID introduced a variety of low cost technologies, there has so far been only limited technology transfer to local engineers. There is an increasing need for local knowledge to address the spiraling demand for low energy cleantech technologies in the city.

In recent years, the stricter implementation of the Discharge Permit by the National Government has increased dramatically the demand for waste and wastewater treatment technical services.

Establishments and institutions which were required to put up on-site treatment (usually those discharging 30 cm. and above) were forced to resort to desludging as often as possible in order to stay compliant. This is no longer an economically viable solution.

The City of Iloilo is looking to establish a technical center to provide technical services to local stakeholders, such as hotels, schools, commercial centers, etc., that need it urgently. The technology providers that could work closely with the center should be able to offer a technology that can be easily replicated, one that offers low energy consumption and that can adapt to a variety of small to medium effluent load demand.

In the past, there have been many efforts to link one of the engineering schools with NGOs and consultants for capacity building. Several universities have been identified as potential partners for the planned technical center and funding for the treatment projects could be obtained from Land Bank and potentially two more undisclosed banks.

The City is also responsible for technical support to the numerous commercial and other premises that require wastewater treatment facilities. It is the hub for any wastewater treatment initiatives that take place in the province and is keen to have access to knowledge and expertise in a timely and efficient manner.

In summary the technology providers that would work with the city at the technology center should be able to offer low tech solutions for predominantly the following categories of wastewater:

- Commercial – lightly polluted waste from malls, academic institutions, schools, etc.
- Hospital – waste that could potentially include pathogens and low concentrations of heavy metals

2.3 University of the Philippines Visayas

The University of the Philippines Visayas (UPV) is based in the Iloilo area. It has three campuses in Miagao, Iloilo City, and Tacloban—with Miagao being the main campus with 4,000 students. The Iloilo City and Tacloban campuses have 2,000 and 1,000 students respectively.

Out of the three campuses only the one in Miagao has a basic wastewater treatment facility. The other two campuses discharge their untreated effluent directly into the environment.

The needs:

- Miagao campus: The University has a basic existing water treatment facility in the Miagao campus. There is no wastewater treatment facility for the chemical waste and the sanitary waste of the academic buildings however, the university has a waste stabilization pond but only treats sewage from the housing area. This facility consists of a collector well, pump house, storage basin, sand filter, clear well, reservoir, and pumping station; the water distribution is done by gravity.
- There is no problem regarding supply of electricity and accessibility of different treatment units. There is a need for the refurbishment of the existing treatment facilities like the concreting of storage basin, reduction of water pressure due to the high elevation of the water reservoir and repair of control units. In addition to the wastewater treatment need needed by the Miagao campus, it also requires the construction of proper solid waste disposal or waste recycling/reuse facility. Currently, there is no segregation of solid waste and the disposal of the commingled waste is by modified landfill.
- Iloilo City campus: The University has no wastewater treatment facility for the Iloilo City campus. Due to the strict regulations, there is an urgent need for a wastewater treatment facility to be established as soon as possible. The university is keen to work with technology providers that offer innovative solutions.
- Tacloban campus: Similarly to the Iloilo City campus, the campus at Tacloban has no wastewater treatment facilities. The university is keen to work with technology providers that offer innovative solutions.

2.4 University of West Visayas

The University of West Visayas is based in the Iloilo province in the Western Visayas region of the Philippines. The main campus is based in La Paz, Iloilo City and accommodates over 500 staff and approximately 7,000 students. There are six more campuses ranging in size.

Currently, there are no adequate wastewater treatment facilities on any of the sites. Similarly to the situation at the University of the Philippines Visayas, low cost, low tech solutions are required to address the ever increasing problem. The university works very closely with the City of Iloilo to find the best technical solution. Funding will be possibly required as well.

The needs:

La Paz, Iloilo City: The main campus has over 500 staff and approximately 7,000 students. A new low cost ‘green’ technology solution is required to treat the effluent discharged. Ideally, the technology provider should train the existing staff and work closely with the engineers of the Environment Department of the City of Iloilo.

Funding will be required for the completion of the project. There is enough space to accommodate an anaerobic baffle reactor, planted gravel filter and other technologies that would not require electricity. A pond system would not be feasible. The facility could potentially need to accommodate 300-350 cubic meters per day.

The following campuses have no wastewater facilities in place and depend on septic tanks for wastewater management purposes. Low cost, low tech wastewater treatment technologies are required for all of them.

- College of Agriculture and Forestry Campus, Lambunao, Iloilo
- WVSU, Calinog Campus
- WVSU, Janiuay Campus
- WVSU, Lambunao Campus
- WVSU, Pototan Campus
- WVSU, Himamaylan City, Negros Occidental Extension Campus

2.5 Don Bonito Hospital, West Visayas

Don Bonito Hospital is located at the city of Iloilo. It has a capacity of 300 beds and 700 staff. Currently the hospital is using septic tanks for wastewater treatment purposes, the effluent produced is domestic waste, pathogens and toxic chemicals, pharmaceuticals and other metabolites. In most cases, hospital wastewater has a BOD of 300-400 mg/l.

The need:

The hospital requires the introduction of low cost technology that can treat its effluent on site before it is discharged. The effluent has similar characteristic to domestic wastewater with the addition of pathogens and possibly low concentration of heavy metals. There is limited space on site, but a combination of baffle reactor and sequencing batch reactor would be ideal. It is expected that approximately 200-250 cubic meters of effluent discharge will take place per day.

For reference purposes it must be pointed out that on average, to design and build a wastewater treatment facility for an establishment discharging 200 cubic meters of wastewater per day will cost US$150,000.

Financing for wastewater treatment projects is usually obtained from government sources, grants and other local funding mechanisms, such as the Philippine Water Revolving Fund. To partly fill the financing gap, the fund – backed by USAID, JICA and the Philippines Department of Finance - was introduced in 2008 as a unique mechanism to blend limited public donor funds with commercial lending in local currency from private banks. To overcome the immaturity of the local water

3. Potentially suitable water management technologies

The nature of the needs identified allow for the use of innovative, ‘green’ secondary treatment technologies that would offer lower energy consumption and environmentally friendly effluent treatment. A few organizations with relevant technologies have been identified and presented below. The technologies’ list is not limited and there were suitable technologies during the project.

3.1 BioGill

BioGill (http://www.biogill.com/) is a Sydney, Australia based company that supplies BioGill units to integrators, specialist wastewater treatment system designers and installers. BioGill has currently clients in Australia, Canada, China, Fiji, India, Mexico, Samoa, the Philippines, USA, Japan and Vietnam.

BioGill’s technology treats grey water, sewage and many different industrial wastewater streams such as effluents from breweries, wineries and food manufacturing. BioGill provides above-ground bioreactors for wastewater treatment and water recycling purposes which results in lower energy consumption and cost.

The technology can be used as a secondary treatment to treat effluent from municipalities, resorts and commercial building, breweries and food production units. The company has already established presence in the Philippines, as the technology has already been used by a local water authority to treat 50000lt of effluent per day.

The company has developed a network of installers and designers outside Australia, in places such as New Zealand, India, Fiji and Canada. BioGill treatment cores contain no filters, thus minimizing fouling and the cost of cleaning and replacing the filters.

Conventional secondary treatment technologies, in most cases, rely on pumping oxygen to biomass; the process accounts for up to 50% of energy costs as traditional wastewater treatment plants. BioGill reverses the process by growing the biomass in air and pumping the wastewater to the biomass. The attached biomass grows as biofilm in air, with an infinite supply of oxygen.

Because BioGill bioreactors are placed above ground oxygen is more freely available and a result the growth of a much more diverse ecosystem than that of conventional plants is facilitated. This diverse biomass which includes a variety of fungus is much more effective than bacterial biomass in removing nutrients from the liquid stream.

The company claims that the BioGill system can deliver savings of +40% on the overall build, energy use savings of +50%, as well as maintenance and repair savings of +50%. BioGill's technology could be used for the largest university campuses and the company could potentially be a partner and contributor to the City of Iloilo technology center.

3.2 Biocleaner

Biocleaner (http://biocleaner.com/) is a California headquartered privately owned company with operations in many regions. In Asia, the company has clients in China, Indonesia, Korea, Philippines and other countries.

It uses natural microbes to treat wastewater. The microbes are in a patented immobilized state in the form of media. Immobilized state means that the microbes are dormant or hibernating. When the microbes have oxygen and nutrients available, they activate and start multiplying. It is the newly produced microbes that will occupy the entire tank and treat the wastewater to high standards.

The media is located along the bottom horizontal tube of the Biocleaner. The effluent's pH ideally must be between 4.0-9.0 and the effluent temperature not lower than 15 Celsius. Biocleaner has an existing client base in the commercial sector in the Philippines, where its technology can reduce BOD from 2000ppm to 5ppm at flowrates of 4400gallons per day.

The technology could be very useful for retrofitting existing facilities that produce not highly polluted effluent such as universities, schools and commercial establishments as well as upgrading existing septic tanks.

3.3 BioKube

Biokube (http://www.biokube.com/) is a Danish privately owned company with strong Asian network. BioKube's technology offers the ability to build wastewater treatment systems with a capacity of up to 5000 lt per day by using standard smaller modules. The modules are factory manufactured, delivered ready to install on site in containers and can be quickly erected as a fully operational wastewater treatment system.

One of the benefits of the BioKube modules is that they can be installed in many ways on site ranging from mounted in concrete tanks, installed above ground or delivered fully functional and complete in 20 and 40 foot containers for temporary use and relocated to another location as needed.

Biokube's modular approach could be used for small to medium size needs as it can be efficiently scale up or down. It seems more appropriate for the purposes of the larger campuses and the Don Benito Hospital. In addition, the company could be a partner for the City of Iloilo.

3.4 IHI Enviro Corporation

IHI Enviro Corporation (http://www.ihi.co.jp/ike/en/) was established in 1984 in Tokyo, Japan and provides design, installation, operation and maintenance of water and waste processing facilities.

The company's IC reactor is a high speed anaerobic effluent treatment system featuring a fermentation bio-reactor that generates methane biogas from anaerobic organisms. By utilizing the biomass from wastewater, it is the ideal solution to produce energy through water treatment and could be appropriate for smaller facilities that require low cost wastewater treatment such as the University of the Philippines Visayas and the University of West Visayas requirements.

3.5 KOTEC

The Korea Technology Finance Corporation (KOTEC) is a quasi-government financial institution highly specialized in technology financing. The institution was established with the aim to help create growth engine for the national economy by supplementing financing primarily in the form of credit guarantee through technology appraisal for promising new technology businesses with lack of collateral. It also provides comprehensive services from incubating, consulting, to direct equity-investment.

KOTEC has identified an advanced wastewater treatment process which can provide efficient removal of contaminants (can achieve nutrients removal below T-N 5mg per L) and high effluent quality as well as small footprint. The system has been used to replace existing systems and can be easily expanded as required.

The system could be a suitable solution for the improvement of the wastewater facilities of the University of the Philippines Visayas main campus.

3.6 Teijin Ltd

Teijin (http://www.teijin.com/) is a Japanese publicly listed (3401: JP) company with expertise in the transportation, environment and energy, healthcare and electronics sectors. The company has a very broad network of operations with strong presence in many Asian countries.

Teijin's Multi-Stage Activated Biological Process (MSABP) technology can be used in smaller scale wastewater treatment project as it offers significant advantages. The entire system can easily be transported in a container and assembled onsite. Teijin's MSABP system utilizes special biological carriers packed with high concentrations of microorganisms in multistage aeration tanks.

The microorganisms vary from tank to tank to form a food chain that decomposes even highly concentrated and persistent effluent. The system significantly suppresses the generation of excess sludge, thereby eliminating the need for sludge disposal.

Not only does the technology result in smaller amounts of sludge, consequently requiring lower maintenance, but it also has lower energy requirements than conventional wastewater treatment technologies.

Teijin's MSABP system currently is being used for wastewater treatment in chemical, dyeing and food manufacturing plants in developing countries such as Indonesia and Angola, but also in manufacturing sites in China. Teijin's technical knowhow would be extremely useful for the City of Iloilo technology center project.

3.7 Trident Water & Process Technologies

Trident Water & Process Technologies (http://trident-water.com/index.html) offers water and wastewater treatment solutions primarily for commercial, industrial and municipal applications, combined through strategic partnership with engineering resources and services by the Bacfree Group.

The company offers process and design engineering, operations and operator training, instrumentation and control, and treatability assessments, including piloting and field testing at full scale. The company's services includes: water analysis, process analysis, design-construction-implementation and after sales service, consultation and turn-key water works.

Trident's XCEL-MOBIBCEL compact wastewater treatment packaged plant is a fully pre-assembled biological system for treatment industrial and domestic wastewater. This system is designed in multiple sizes to fit a 20ft or 40ft shipping container with a multitude of different connection sizes and configuration available.

The built-in bioreactor provides high efficiency biodegradation of the dissolved organic matter by oxidation and to biomass that acts as activated sludge. The MOBIBCEL pre-packaged plant could provide a solution to the University of the Philippines Visayas main campus requirements for further wastewater treatment.

4. Recommendations

In the Philippines, only 10% of wastewater is treated while 58% of the groundwater is contaminated and only 5% of the total population is connected to a sewer network. The vast majority uses flush toilets connected to septic tanks. Since sludge treatment and disposal facilities are rare, domestic wastewater is discharged without treatment.

With regard to technology needs most of the technology seekers are looking for appropriate technology that can not only help address their wastewater issues but also provide useful outputs or by-products. Such dual objectives are very important for technology seekers. It is also important for the seekers to have technologies using less energy. In general, the seekers require support in almost all technical fields, but especially in alternative energy production, energy conservation and waste management.

Most of the technology seekers need immediate technological solutions which may be used in the long term. If an adopted technology is successful, many similar companies and organizations in Indonesia might adopt the technology.

In the Philippines in the wastewater management sector consideration should be given to the issues below:

- Cost - borrowing capacity of LGU, investor, developer,
- Health Impact - reduced health risks associated with wastewater management,
- Institutional Framework - can the program be implemented and sustained?
- Self-help Potential - can the community provide the necessary support?
- Water and environmental institutions need to respond to technical and social issues,
- Public approval and willingness to pay is essential for the sustainability of our water/ wastewater management initiatives,
- There is a need for an establishment and operations of Water Quality Management Area (WQMA).

Section 4:

Viet Nam Country Report:

Overview of Wastewater Management in the Urban Sector: Technology Needs

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Summary

This project report aims to identify and assess the technologies needed to improve wastewater treatment in Viet Nam. The objective of this assessment is to identify and assess at least 16 wastewater treatment technology needs and technology seekers from Viet Nam. The report also briefly reviews the legal and regulatory frameworks that govern Viet Nam's wastewater treatment, its technologies and relevant intellectual property issues.

Viet Nam has improved urban sanitation significantly in recent years by investing in the construction of new wastewater treatment systems. However, a large proportion of wastewater continues to be released without treatment, with significant consequences for health and the environment. Viet Nam is in the process of privatizing urban water suppliers. This initiative, combined with increasingly strict environmental standards, creates opportunities to introduce new technologies to improve the treatment of wastewater.

The past 10 years have seen growing investment in urban sanitation, especially wastewater treatment, in both large and medium-sized cities, primarily supported by Official Development Assistance (ODA). This investment has focused largely on the provision of treatment facilities, with limited development of collection systems. In particular, no effective sewage management is practiced anywhere in Viet Nam. All these are areas of need for technology seekers.

With regard to IPR (intellectual property rights) management, levels of awareness and understanding of IP (intellectual property) are low, while rates of IPR infringement are high. However, in this sector, strict regulatory requirements around wastewater incentivize technology users to purchase genuine certified systems rather than risk using cheaper unbranded systems.

For this report, we interviewed 26 technology seekers. Only 16 technology needs were identified as a result of the interviews. The list is comprehensive, consisting of government agencies, regulators and manufacturers working in the wastewater sector, and managers of industrial zones who need better wastewater treatment technologies. The industrial zones constitute a representative geographic spread.

The interviews resulted in the identification of 16 technological needs and revealed the following points:

1. Technological needs. Many technology seekers need innovative technologies that can cope with the demands of urban use, such as shock loading and the ability to process harmful chemicals and compounds. Technologies are needed to treat both ground and surface water.
2. Sustainability. Almost all seekers need technological solutions immediately, but the solutions need to be useable over the long term.
3. Geographic spread. Although the technology may be used only in the seeker's area, it is also needed in other parts of the country. Thus, if such a new or adjusted technology is successful, similar companies and organizations in Viet Nam may adopt the technology.
4. Intellectual property rights. Many seekers need help in buying products and technologies. They could potentially require other technology transfer support, including project development, technical assistance (training on intellectual property rights, patenting, licensing and negotiation) and consultancy.
5. Capacity, infrastructure and financing. Some seekers have knowledge and experience in wastewater management, but others do not. Most seekers are connected to transport and electricity infrastructure. Some organizations require financial support.

This study provides ground-level documentation of such needs and evaluates technologies that could improve industrial wastewater treatment. Successful evaluation could lead to technology transfer at the end of the project.

This study focuses on the wastewater and sludge management needs of urban and industrial areas of Viet Nam. Suburban areas are outside the scope of this study, as they have limited sanitation infrastructure. In industrial areas, the study focuses on centralized wastewater treatment plants, which could provide a sufficiently large market opportunity for technology providers.

1. Introduction and methodology

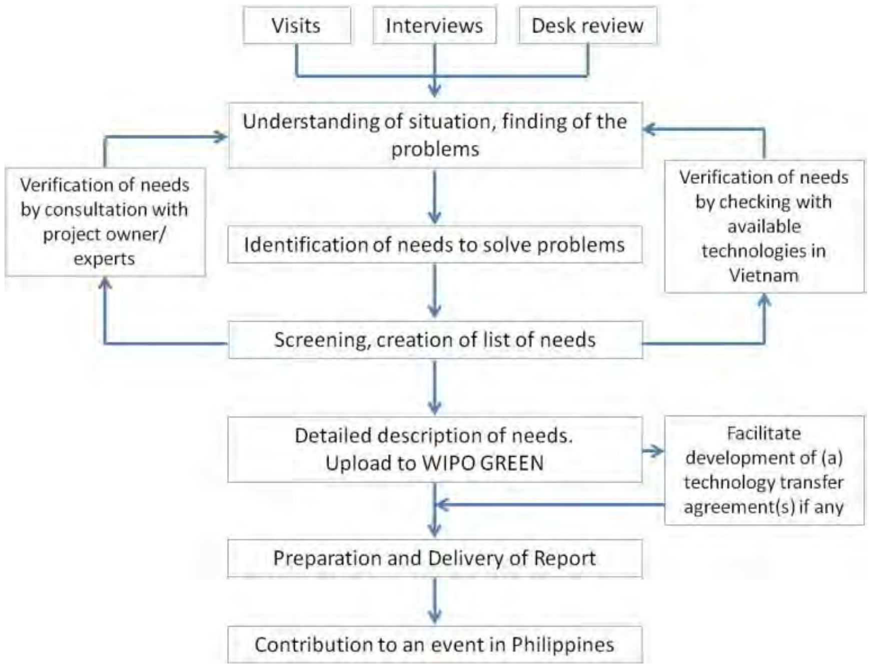
Industrial wastewater treatment, sludge treatment, and urban wastewater treatment were selected as the study focus because several country studies have already established green technology needs in this area. Rapid industrialization and urbanization in the target countries makes the need for technological solutions to water pollution and depletion of water sources particularly urgent.

In order to identify technological needs on the ground, the consultant:

- reviewed the relevant literature on wastewater sector in Viet Nam;
- met key local stakeholders;
- visited wastewater treatment systems; and
- reviewed available relevant technology transfer platforms in consultation with WIPO.

This process resulted in the identification of.16 technology needs. An overview of how the study was conducted is provided in Figure 1.

Figure 1: Methodology



2. Wastewater management in Viet Nam

Since 1998, the Government of Viet Nam has initiated policies and provided investment to improve urban sanitation. This has resulted in significant progress in the development of the wastewater sector. Key achievements in urban wastewater management are as follows (adapted from World Bank report, 2013):

- Provision of wastewater services to the urban poor has been impressive, with open defecation now eliminated.
- Access to toilets is now 94 per cent,1 with 90 per cent of households using septic tanks as a means of on-site treatment.2
- 60 per cent of households dispose of wastewater in a public sewerage system, primarily comprising combined systems.3
- By 2014, some 25 urban wastewater systems had been constructed in Hanoi, Ho Chi Minh

[1] JMP, WHO – United Nations Children's Fund (UNICEF), 2008.
[2] Nguyen V.A., 2012.
[3] Nguyen V.A., 2012.

City and Da Nang and another five systems in provincial towns and cities, with a total design capacity of 650,000 cubic meters per day (m3/day).

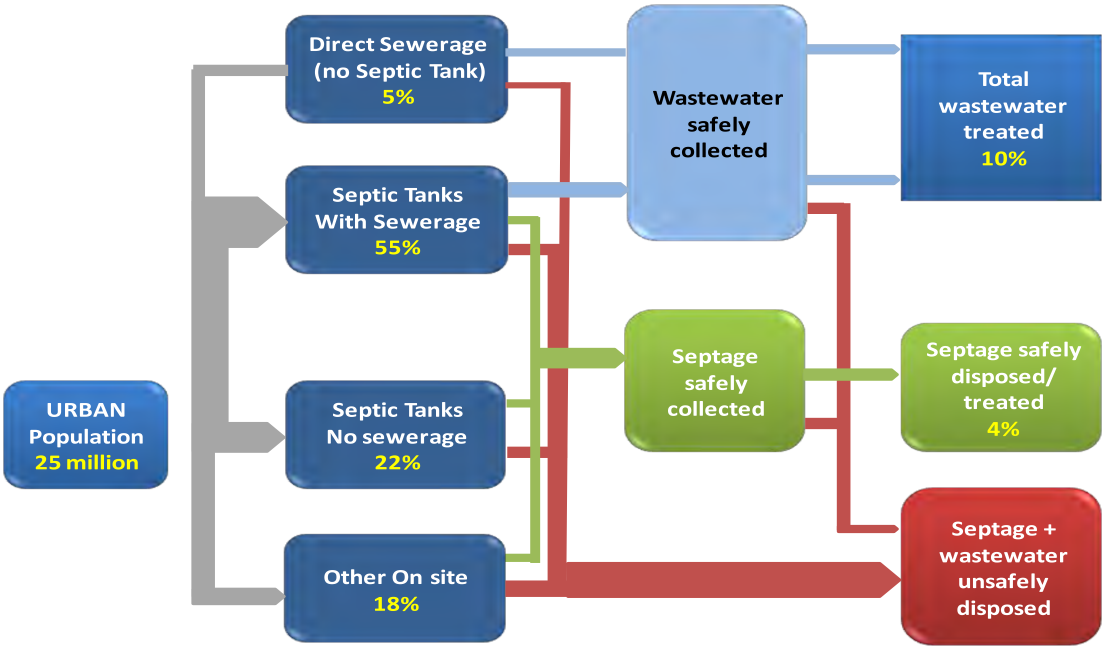
- Currently some 35 new wastewater systems, primarily comprising combined systems, are in the design/construction phase.
- During the past decade annual sanitation sector investment has been 150 million US dollars and 2.1 billion US dollars for drainage and wastewater between 1995 and 2009. This represents 0.45 per cent of GDP annually.4 Most of the funding sources are loans and grants from official development assistance (ODA). A new trend of private sector participation in wastewater sector is emerging.

Despite these impressive initiatives, urban sanitation continues to face critical issues that need to be urgently addressed:

- Although 60 per cent of households dispose of wastewater into a public system, much of this is directed informally to the drainage system and only 10 per cent is treated.
- While 90 per cent of households dispose of wastewater into septic tanks, only 4 per cent of septage is treated. Fecal sludge management is generally poor in most cities.
- The focus of wastewater expenditure to date has been in constructing treatment facilities, but this has not always been accompanied by appropriate collection systems.
- Despite wastewater tariffs in the order of 10 per cent of water tariffs being charged, cost recovery of the capital and operations and maintenance (O&M) costs of the wastewater systems is generally low.
- Institutional arrangements do not encourage efficient system operation, with the wastewater enterprises having limited autonomy to manage operations and undertake system development.
- Financing needs are still very high, estimated at 8.3 billion US dollars to provide sewerage to the estimated 2025 urban population of 36 million. This needs to be addressed in the context of the estimated economic losses resulting from poor sanitation of 780 million US dollars per year, or 1.3 per cent of GDP (WSP, 2007).

The current sector performance is illustrated in Figure 2.

Figure 2: Status of urban wastewater management in Viet Nam



Source: World Bank, 2013.

[4] Grontmij – Water and Sanitation Program (WSP), 2012.

2.1 Integrated water resource management and river basin management principles

Even though ''Integrated Water Resource Management'' and ''River Basin Management'' approaches are mentioned in legal documents in Viet Nam, such as the Law on Water Resources (1998, amended in 2012), the Law on the Environment (2005), and River Basin Commissions have been established for the three principal river basins in Viet Nam, these approaches are yet to be implemented.

2.2 Institutional arrangements and ownership

Most urban wastewater enterprises are public utilities. Some companies are in the process of privatization. The wastewater companies often do not own the wastewater system assets (which belong to the city's authority), but operate the system under the mechanism of a ''work order from the city authority'' and are paid directly from the city budget based on the volume and quality of works/services carried out. The same policy is applied for solid waste management service in cities. For urban water supply, most provincial water supply companies are in the process of privatization, where Government owns 51% or more shares, and the company can set the water price to ensure full cost recovery. City authorities regulate the water price to ensure the correct balance between public welfare and sufficient returns to private enterprises. Cost recovery is not yet being implemented in urban wastewater service. The wastewater tariff is gradually being increased, aiming at recovery of operational and maintenance expenditure. The rest is covered by the city budget. It is worth noting that the cost recovery principle is clearly stated in Decree No. 88/2007, replacing Decree No. 80/2014, but this should be undertaken and implemented by local decision-makers. Cost recovery is also impacted by operational and maintenance expenses, which are a function of the level of technology selected.

2.3 Effluent standards

Regulations controlling effluent standards have undergone significant change since the first standard was issued in 1995 (TCVN [Viet Nam National Standards] 5945:1995) with six revisions between 2000 and 2011. Different effluent standards have been set up for domestic wastewater and for wastewater from different industries. There is a tendency in provinces to set up environmental regulations and effluent standards which should be stricter than national standards, based on the receiving capacity of the local environment.

2.4 Wastewater treatment plant technology selection

Despite the low concentration of influent BOD (biochemical oxygen demand) and other constituents measured in the flow to the 13 municipal Wastewater Treatment Plants (WWTPs) currently being served by combined sewer systems in existing urban centers, eight of these are now operating based on conventional activated sludge treatment solutions. Note that the average influent BOD for these 13 WWTPs is 67.5 mg/l (Table 1). Twenty-five of the WWTPs currently under design or construction will be based on similar technology. The lack of household connections, partial treatment/decomposition of organic matter in septic tanks and the drainage canals, infiltration of groundwater and collection of rainwater runoff all contribute to the dilution of the collected sewage in these combined systems. Given the low organic loading at these treatment facilities, lower-cost appropriate technologies could be adopted which would allow for upgrading as the influent strength increases over time. Planners in Viet Nam do to currently give high priority to facilities which emphasize low power consumption, resource recovery from sludge or reuse of treated wastewater. This approach was recently mentioned in a new National Decree, No. 80/2014, on wastewater management.

2.5 House connections

The connection of households to public sewerage systems is an essential part of ensuring that most of the organic loading is conveyed to the treatment facility, regardless of whether the wastewater is collected by a combined or separate sewerage system. However, in Viet Nam, house connections are not mandated for combined sewerage systems (CSS) and are generally only employed where soil percolation is low, such that discharge to the drain is the only means of disposal from the vicinity of the household. Most connections to combined systems are from the septic tank, where some pre-treatment is effected, which is one of the contributing factors for the low influent organic loading received at downstream WWTPs from combined systems.

In separate sewerage systems (SSS), all households within the sewerage service area must have connections as these constitute the only source of flow to the system. Generally, direct household connections to the SSS-based systems are mandated by local authorities and the septic tanks are decommissioned. This has resulted in higher concentrations of influent BOD experienced for SSS-based systems in the cities of Da Lat and Buon Ma Thuot (Table 2).

Table 1: Key Performance Indicators of Viet Nam Urban Wastewater Sector

Population and Growth Rates	Year		
	2000	2005	2014
Population (million) (GSO, 2010)	77.6	82.2	90.5
Population, total annual growth rate (%) (GSO, 2014)			1.1
Urban share (GSO, 2014)	18.7	22.5	33.1
Urban annual growth rate (%) (GSO, 2010)			3.5
Rural share (GSO, 2014)	81.3	77.5	66.9
Rural annual growth rate (%) (GSO, 2010)			0.3

MDG Targets	Value	Note
MDG water supply target coverage (%) by 2015 (WHO – UNICEF, 2010)	79	Baseline 1990: 58%
MDG sanitation target coverage (%) by 2015 (WHO – UNICEF, 2010)	68	Baseline 1990: 36%
Infant mortality (per 1000 live births) by 2015 (WHO – UNICEF, 2010)	15	Baseline 1990: 44.4%. 2009: 16

Current Sector Performance	Value	Note
Urban sanitation coverage access to toilet (%)	91-94	94%: JMP, WHO – UNICEF, 2008; 91%: WB - Hydroconseil & PEM, 2008
Urban sewerage connections (%)[1]	60	Nguyen V. A. *et al.*, 2012
WWT volume treated by 2014 (MLD)	550	Urban wastewater only
Installed capacity of WWT by 2014 (MLD)	650	Urban wastewater only
Urban wastewater treated (%)	10	Based on volume of wastewater treated vs. volume of urban water supplied (MOC-WB, 2013)
Proportion of systems that are combined waste water and drainage systems (%)	92	
Proportion of systems that are separate wastewater and drainage systems (%)	8	Central Buon Ma Thuot and Da Lat, new areas in other cities
Urban proportion of septage treated (%)	4.3	Estimated by study team
Urban water supply coverage, JMP access (%)(WHO – UNICEF, 2010)	99	73% in 2011 (JICA, 2011); 80% in 2012 (Nguyen V. A. *et al.*, 2012)
Share of urban population with 24/7 water supply (%) (VWSA, 2006)	60	
Share of urban water supply samples meeting water quality standards (%) (JICA, 2011)	59	

Financial Performance	Value	Note
Per capita GDP, 2014 (USD) (GSO, 2014)	2,028	401.5 in 2000
Total annual water investments (USD million) (Nguyen V.A. *et al.*, 2012)	88.4	USD 1,238 million over period 1991 – 2005.
Total annual investment in environmental protection (USD million) (Grontmij – WSP, 2012)	400	ODA: USD 2,100 million over period 1995 – 2009 or USD 150 million per year. Government budget for Environmental protection: USD 250 million per year
Sanitation sector investments as percentage of GDP (%) (adapted from Grontmij – WSP, 2012)	0.45	Including 0.2% from ODA and 0.25% from Gov. EP budget
Representative WSS Tariffs (VND per m^3)	4,000	
Representative WWT Tariffs (VND per m^3)	400	
Desludging fee (VND) (Nguyen V. A. *et al.*, 2012)	700,000	
Non-Revenue Water (%) (VWSA, 2014)	27	In 2000: 40%
Typical CAPEX costs/capita of septage management (2010 US dollar prices) (adapted from Nguyen V. A. *et al.*, 2012)	0.2	Calculated for Hai Phong city case

[1] Percentage of urban population connected to combined or separate sewerage network, with/without wastewater treatment. This number includes households with on-site sanitation facilities. In cities in Viet Nam, most septic tanks treat black wastewater where the effluent is discharged into combined drainage mixed with untreated grey wastewater and storm water.

2.6 Septage management

There is currently no effective sewage management being practiced anywhere in Viet Nam, with scheduled emptying of sewage from septic tanks being practiced only in one city (Hai Phong). Some cities provide treatment of sewage at wastewater treatment plants or at solid waste dumping sites. Poor design and operation of most household septic tanks plus uncontrolled fecal sludge emptying, transportation and dumping, mostly by private service providers, are common in cities in Viet Nam, contributing to a growing environmental problem.

2.7 Sources of funding and private sector participation[5]

The past 10 years have seen growing investment in urban sanitation and especially wastewater treatment in both large and medium-sized cities, primarily supported by ODA. This investment has focused largely on the provision of treatment facilities, with limited development of collection systems, and its effectiveness is yet to be established. An appropriate strategic or programmatic approach that would lead to better targeting of investment to address the particular environmental and public health deficiencies, followed by proper investment planning, is needed.

Appropriate policies and incentives are not yet in place to encourage private sector participation in the wastewater sector from both financial and operational perspectives. In particular, inadequate tariffs and the lack of an effective regulatory system are principal barriers to private sector entry. To date, there are few examples of municipal wastewater projects with private sector participation initiated in Viet Nam.[6] However this trend seems becoming more and more attractive in the past few years, thanks to newly issued policies, such as the Investment Law of 2014, encouraging private sector participation in infrastructure development.

As at October 2014, there were 209 out of 300 planned Industrial Zones (IZs) in operation in Viet Nam, occupying 47,300 hectares. The average coverage ratio of IZs is 65%. Average industrial production value per leased hectare is USD 1.6 million/ha/year. The IZs employ 1.6 million people directly and 1.8 million indirectly.

Centralized effluent wastewater treatment plants (CETPs) exist in 150 IZs (nearly 80% of total IZs). Furthermore, 20 other IZs are constructing their CETPs. Only 10% of IZs built before the enactment of Environmental Protection Law (1994) are not equipped with CETPs. In some provinces, thanks to enforcement efforts, 100% of IZs have CETPs.

CETPs are often operated by the IZ owner or IZ daughter company. The CETP operator charges industrial factory investors or tenants at the IZ for each cubic meter of wastewater transported and treated based on a prior agreement. Most tenants should have their own local wastewater treatment station for preliminary treatment to meet the agreed requirements of the CETP operator. The CETP operator supervises this agreement to make sure that its CETP is not overloaded or overwhelmed by heavy loads of wastewater from tenants. In return, the CETP operator is answerable to local and central environmental protection authorities for treated wastewater from CETP being discharged into the environment.

Besides IZs, there are thousands of industrial clusters, individual industries and 3,300 handicraft villages.

[5] Text in this section is extracted from World Bank & Australian AID. 2014. Vietnam Urban Wastewater Review. ACS7712v1. http://ow.ly/QNWmh.
[6] Currently the Build and Transfer projects in Da Nang and Hanoi have included an element of private sector participation. Operation of wastewater systems by private sector is being initiated in Hanoi, Da Nang, Ho Chi Minh and Nha Trang.

2.8 Public awareness and behavior change[7]

The benefits of public awareness tend to be ignored by most urban wastewater companies. Sanitation investments tend to be top-down and subsidized, with limited participation by the communities. This results in inadequate understanding by the community of the environmental and public health advantages of a well-designed and operated wastewater system. The outcome is less willingness to pay to achieve cost recovery and a reluctance to connect to the wastewater system.

2.9 Environmental regulations

As stipulated by the Environmental Protection Law, the Polluter-Pay-Principle is applied in industrial wastewater management. Following that, the industry should be fully in charge of its generated wastewater, which should be treated adequately before it is discharged into the environment. For newly-established IZs, it is compulsory to build and operate the CETP together with the IZ infrastructure such as road, drainage, power supply, water supply, communication, etc. before land in the IZ is leased to the tenants.

A number of supporting policies for financing, technology selection, monitoring & evaluation of CETP operation are being issued and improved by the Government of Viet Nam. Besides, understanding that industrialization is an important strategy for promoting socio-economic development, most provinces are competing to develop IZs and attract investors. However, having had costly prior experiences, some provinces now try to favor specific industries. “Dirty industries” such as leather, paper and pulp, textile with dyeing, electroplating, seafood processing, etc. are excluded from some IZs. Some IZs have a clear “green policy”. This is a very good opportunity for environmental industries to find customers.

All companies must undertake an Environmental Impact Assessment (EIA) before their investment projects receive government approval. An EIA report is also required for the construction of a CETP. The EIA report should include quantitative and qualitative estimates of pollution loads during construction and operational phases of the industry, planned environmental protection measures, such as wastewater treatment, emission gas treatment, solid waste and hazardous waste management solutions. Risk management and an environment monitoring program should be also included in the EIA report.
During the construction and operational phases, the monitoring and evaluation activities are often carried out by central and local environmental protection agencies to verify if the company is complying with the action it proposed in its approved EIA report.

The recent Decree No. 38/2015/ND-CP on waste management issued by the Government of Viet Nam requires all CETPs at IZs and all individual factories having wastewater treatment plants with a capacity of more than 1,000 m^3/day to install Automatic Wastewater Monitoring Stations (AMS) which should able to monitor wastewater and transmit data to the local environmental protection authorities. This is one of the strict control measures on industrial wastewater management to avoid illegal dumping of untreated wastewater into water bodies.

As for effluent standard for CETPs and for industries, that is, Class A, B, QCVN 40:2011/BTNMT, Class A is applied where industrial wastewater discharges effluent into water bodies used for domestic purposes. Class B is applied to other water sources. Special effluent standards have been developed for selected industries such as steel, paper and pulp, sugarcane, petroleum, etc.

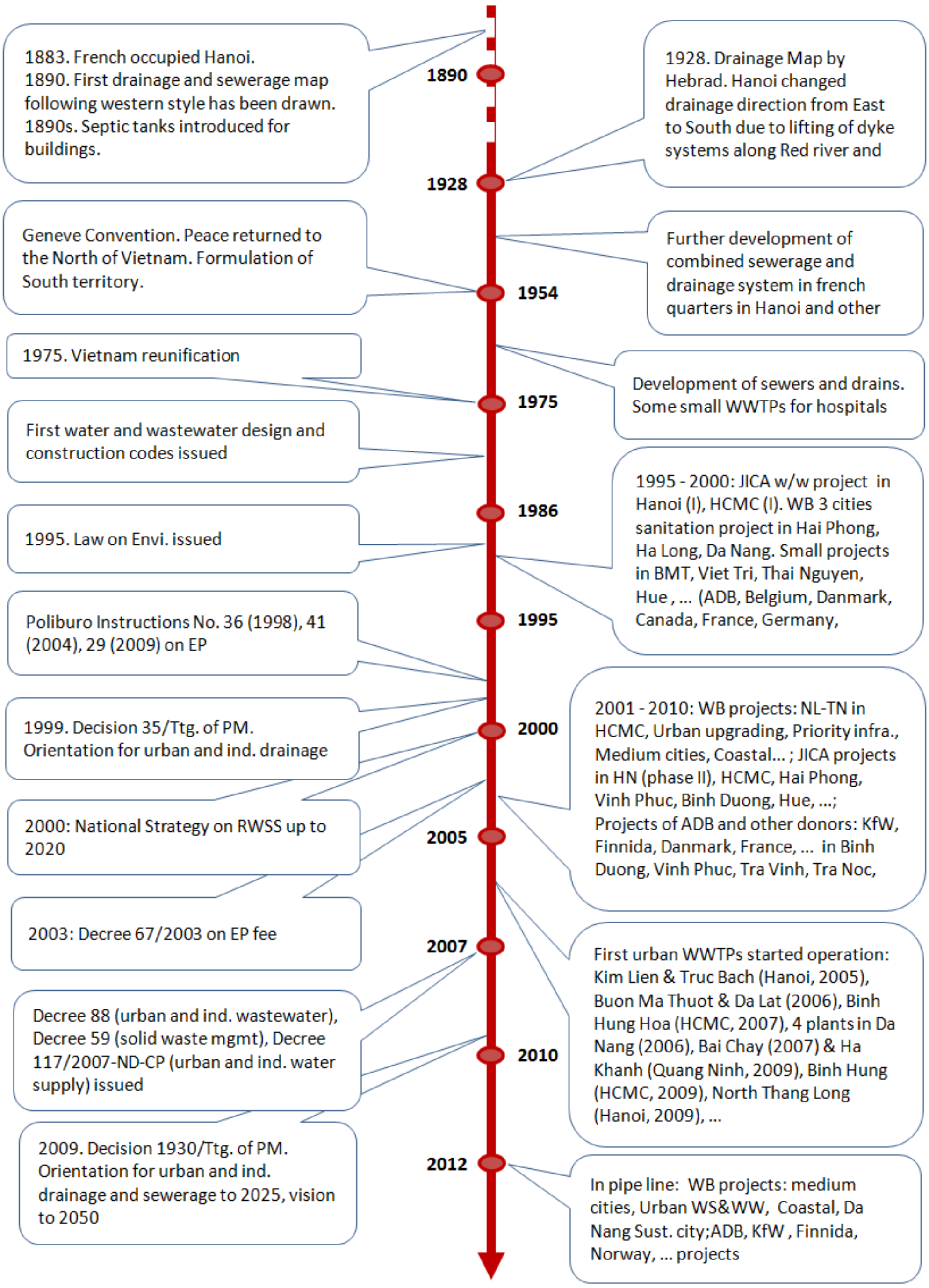
One major challenge is the control of incoming flows and efficient operation and maintenance (O&M) of CETPs, so that investors/tenants do not discharge their untreated wastewater into CETPs and maintain proper operation of the CETPs.

Besides IZs, there are thousands of industrial clusters and 3,300 handicraft villages. These industrial enterprises are the under management of local authorities, which do not have sufficient power to undertake environmental protection activities. Poor technology and unclear benefits are among the key challenges industrial clusters and handicraft villages face in applying environmental protection

[7] Text in this section is extracted from World Bank & Australian AID. 2014. Vietnam Urban Wastewater Review. ACS7712v1. http://ow.ly/QNWmh.

measures. Figure 3 illustrates the historical development of sanitation in Viet Nam. There have been significant developments in establishing the legal framework for environmental protection, urban and rural infrastructure development and in sanitation/wastewater management. The first environment protection law was issued in 1995 and amended in 2005. An environmental protection fee for urban and industrial wastewater discharges was introduced in 2003. Important decrees on urban and industrial water supply, wastewater management, and solid waste management were issued in 2007. The third National Target Program on Rural Water Supply and Sanitation (NTP3) implemented during the 2011-2015 period focused more on sanitation improvement. Effluent standards for different types of wastewater are being established. However, further efforts are still required in order to make wastewater-related legislation more practical and efficient.

Figure 3: Timeline of Viet Nam Wastewater Sector Development



Source: World Bank, 2013.

Decree No. 88 of 2007 is an important development in the urban and industrial wastewater sector, addressing a number of key constraints that reduce the effectiveness of the sector. The decree is now being amended with the aim of providing more comprehensive regulation. Some of the areas to be addressed include the development of standards for the quality of wastewater discharged into the urban sewerage and drainage system; legislation by the local authority mandating regulations on urban wastewater management; establishment of policies for mobilizing resources for urban sanitation investment; clarification of the ownership of urban wastewater systems; and development of a methodology for wastewater tariff-setting for urban and industrial wastewaters aiming at gradual O&M cost recovery.

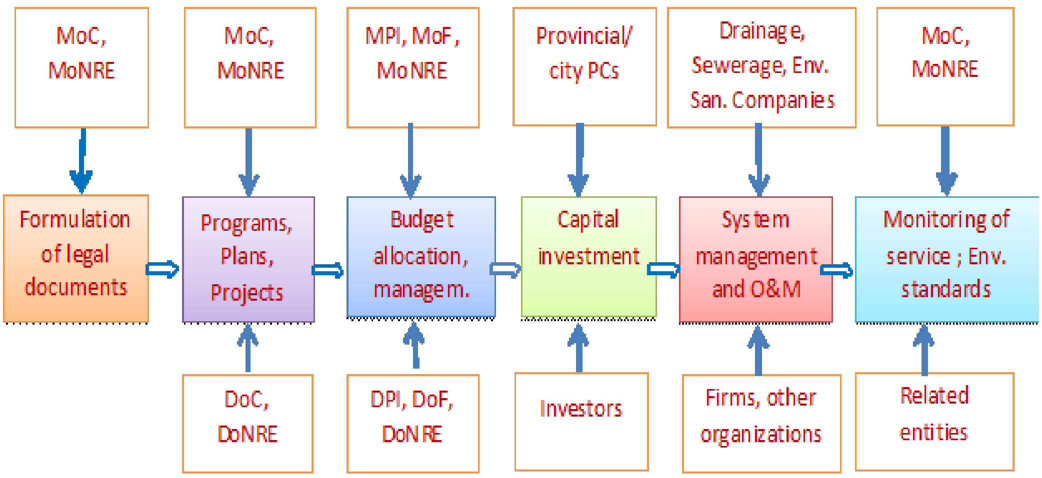
Decree No. 25/2013/ND-CP was issued on March 2013, replacing Decree No. 67. Furthermore, in May 2013 Circular No. 63/2013-TTLT was issued to provide guidelines for the implementation of Decree No. 25. This decree has distinguished the environmental protection (EP) fee from the wastewater fee. The EP is to be collected from industrial users and from households discharging wastewater into the environment. For domestic wastewater, the wastewater system operator and the households who are not connected to a piped water system have to pay an EP fee which should not exceed 10 per cent of the local water tariff. Since 10 per cent of the water tariff is far below the wastewater tariff which should follow the principle of recovery of wastewater system O&M costs, this rule may not encourage the connection of households to the wastewater network.

Decree No. 80/2014/ND-CP has replaced Decree No. 88, and now refers to a “tariff for wastewater collection and treatment services” instead of a wastewater fee. This tariff is to be collected from all users of wastewater services.

An overview of the management responsibilities of ministries and agencies involved in drainage and sewerage management in urban areas in Viet Nam is presented below (Figure 4). Although ‘’integrated water resource management’’, and ‘’river basin management’’ approaches are mentioned in the legal instruments, such as the Law on Water Resources (1998, amended in 2012), the Law on the Environment (2005), and River Basin Commissions have been established for the three principal river basins in Viet Nam, the existing institutional structure in Viet Nam does not allow these approaches to be implemented.

Recent Circular No. 35/2015-TT-BTNMT, issued in June 2015, has confirmed Government efforts in strengthening environmental protection in industrial areas. Each IZ should have completely built engineering infrastructure together with environmental protection facilities before it can become operational. In order to control treated wastewater flow from CETPs, automatic monitoring stations (AMS) should be established, connected and able to transmit the current status of CETP to the local environmental protection agency.

Figure 4: Matrix of state management of wastewater in urban areas



Source: Adapted from Grontmij, WSP 2012

2.10 Issues related to technology transfer and intellectual property

An Intellectual Property Law[8] was enacted in 2005 and amended in 2009. The number of new patents registered in Viet Nam is increasing annually. Viet Nam suffers from high rates of IPR infringements and enforcement can be difficult. In the wastewater sector, strict regulatory requirements around effluent wastewater have encouraged project managers to purchase genuine systems from certified, branded technology owners rather than low-quality and less reliable products.

"Technology transfer" is often mentioned in contracts for the installation of wastewater treatment systems. This is normally understood in terms of requirements for training in operation and maintenance by the designer, installation contractor or equipment supplier for the staff of project owner/plant operator during the hand-over process.

3. Wastewater management needs

A total of 16 wastewater technology needs have been identified by this study. These are listed in Table 2 and described in subsequent sections.

3.1 Appropriate wastewater treatment technology dealing with low C/N ratio in the incoming wastewater flow

Rationale: A combined sewerage system is the most common type of wastewater collection system in cities in Viet Nam. Infiltration of groundwater, pre-treatment of black water in septic tanks before connection to city drainage and sewerage network, etc. result in low BOD wastewater flows (60-80 mg/l) entering the municipal wastewater treatment plant. Meanwhile, concentration of ammonium and total nitrogen in wastewater is still fairly high (30 – 50 mg/l). Therefore, C/N ratio seems less sufficient for biological treatment. For example, during its start-up period, Yen So wastewater treatment plant, using SBR technology, had to add sugar to the treatment plant to maintain a sufficient C/N ratio. Appropriate technologies are needed to allow users to meet effluent standards at reasonable cost.

Areas of application: Hanoi, Ho Chi Minh City, Hai Phong, Da Nang, and other cities.

Possible types of technology transfer: All types

Experience from attempting to solve the problem, challenges and successes: Yen So wastewater treatment plant, 200,000 m^3/day, has had to use sugar to increase carbon concentration during the start-up period. A high energy consumption rate is required for intensive aeration in the oxidation reactor and for high return flow rate from the toxic tank back to the anoxic tank. Most plants face the problem of not meeting the effluent standard.

Existing support, potential joint venture/collaboration: Most investment projects for municipal wastewater treatment plants are owned by the government and paid for by the government budget or ODA. Wastewater tariffs cover only part of the operational expenditure. The rest is subsidized by the municipal budget.

Existing physical infrastructure and limitations: a wastewater collection network is under development. Not all households are connected to the sewerage and drainage network. Other infrastructure such as electricity, roads, etc. is acceptable. Combined sewerage and drainage system is in Figure 5 and 6.

Regulatory aspects: There are policies to encourage wastewater collection and treatment.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

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[8] http://www.wipo.int/wipolex/en/details.jsp?id=12011.

Table 2: List of identified technology needs in Viet Nam wastewater market

No.	Title of technology need	Area of application	Remarks
1	Appropriate wastewater treatment technology dealing with low C/N ratio in incoming wastewater flow http://ow.ly/BDvg301AX0u	Hanoi and other cities in Viet Nam	Viet Nam Water Supply and Sewerage Association (VWSA) as representative body for provincial sewerage and drainage companies Contact: Dr. Nguyen V. A., Head of Science & Technology Department, VWSA vietanhctn@gmail.com
2	Appropriate technology for treatment of sludge generated from combined sewerage and drainage system http://ow.ly/7kzY301AX2Z	Large cities: Hanoi (2 projects), Ho Chi Minh city (2 projects)	Hanoi Sewerage and Drainage Company Hanoi Wastewater Project Management Unit HCMC Sewerage and Drainage Company Ho Chi Minh City Wastewater Project Management Unit
3	Adequate fecal sludge treatment technology http://ow.ly/EgdU301AX6L	Gia Lam Urban Environment Enterprise; Hanoi Urban Environment Company; other Solid Waste Management Companies	Gia Lam Urban Environment Enterprise: Mr. Nguyen Nam, Director
4	Removal of organic matter from surface water http://ow.ly/9Ewz301AXam	Hai Phong water supply company Other water companies in Viet Nam	Hai Phong Water Supply Company Mr. Vu Hong Duong, Director General
5	Equipment to control incoming wastewater flow features http://ow.ly/ZYjj301AXdt	Operators of CETPs	Sonadezi Environment Service Company Viglacera Infrastructure Company Other CETP operators
6	Technology for decentralized wastewater treatment with small foot-print reactor and shallow reaction zone http://ow.ly/wkX1301AXhH	Investors for urban developments, apartments, hotels, resorts and hospitals	IESE as Consulting organization. Contact: Assoc. Prof. Nguyen V. A, Director
7	Technology for flow rate and concentration equalization allowing stable incoming wastewater features at wastewater treatment plants http://ow.ly/v5Vk301AXkc	Operators of CETPs	Sonadezi Environment Service Company Viglacera Infrastructure Company Other CETP operators
8	Technology to improve treatment performance of existing biological CETPs receiving non-degradable substances in incoming flows http://ow.ly/5Tla301AXmT	CETPs at Industrial Zones with industries like printing ink, traditional medicine materials, cosmetics, paper and pulp, textile, etc.	Sao Thai Dzuong Co. (Consulting firm for WWTP: NUCETECH-E Co. Director: Mr. Doan Dzuy Dong) Tien Son IZ CETP, Viglacera Infrastructure Co. Sonadezi Co. (visited CETP Giang Dien) Representing consulting organization: IESE

9	Technology for co-treatment of iron, manganese, ammonium and arsenic in groundwater http://ow.ly/Q1s9301AXrt	Hanoi Water Company Other water companies in Red River Delta	Hanoi Water Company, R&D Department. Contact: Ms. Hong (Consulting organization – representative: IESE)
10	Technology for co-treatment of high range of iron, manganese and ammonium in groundwater http://ow.ly/SUZM301AXv9	Bac Ninh Water Company Hanoi Water Company Other Water companies	Bac Ninh Water Company. Contact: Mr. Hiep, Director (Consulting organization – representative: IESE)
11	Technology (know-how) for quick start-up of biologically-based wastewater treatment plant http://ow.ly/cQYH301AXzt	Different urban and industrial wastewater treatment plants across the country	Consulting firm: IESE
12	Energy-efficient technology for sludge dewatering from water treatment plants http://ow.ly/uElu301AXGo	Most water treatment plants in Viet Nam, especially large-capacity plants such as Thu Duc, Tan Hiep (HCMC), Song Da, North Thang Long (Hanoi), An Dzuong (Hai Phong)	Sai Gon Water Company (SAWACO) Song Da Water Company Hanoi Water Company Hai Phong Water Company Consulting firm: IESE
13	Technology for pre-treatment of organic fractions of municipal waste, industrial waste and agro-waste before their co-treatment with sewage sludge in anaerobic digester for biogas recovery http://ow.ly/G2WY301AXKb	Wastewater and solid waste treatment centers in urban and industrial areas across the country	Hanoi Sewerage and Drainage Company Consulting firm: IESE
14	Technology for treatment of digested sludge after anaerobic digester for resource recovery http://ow.ly/bReZ301AXNl	Wastewater and solid waste treatment centers in urban and industrial areas across the country	Hanoi Sewerage and Drainage Company Consulting firm: IESE
15	Technology for treatment of pig farm wastewater rich in organics and nitrogen (ammonium) http://ow.ly/TSsN301AXQ8	Thousands of pig farms across the country	Consulting firm: IESE
16	Technology to enhance nitrification, or removal of ammonium, in wastewater treatment systems by applying natural treatment processes http://ow.ly/uUZo301AXTa	Urban areas potentially applying natural wastewater treatment processes such as cities in central and southern Viet Nam	Thanh Hoa Urban upgrading Project Management Unit Buon Ma Thuot Wastewater Treatment Plant Da Nang Wastewater Company Consulting firm: IESE

Figure 5: A combined sewerage and drainage system is common in urban areas

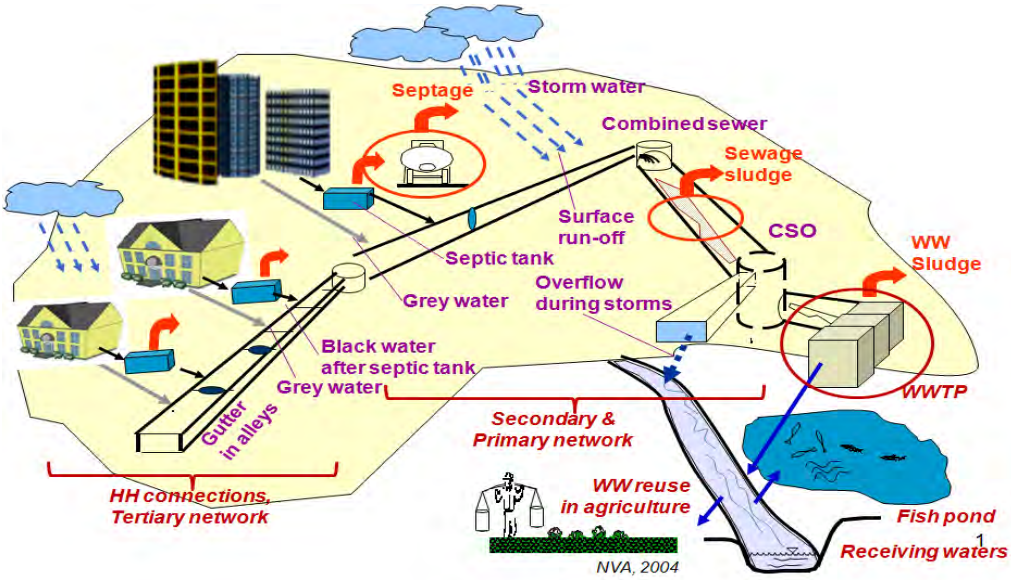

Figure 6: An open drainage canal is part of a combined sewerage and drainage system which has low organics and a low C/N ratio in wastewater coming into the wastewater treatment plant

3.2 Appropriate technology for treatment of sludge generated from a combined sewerage and drainage system

Rationale: Sludge generated from combined sewerage and drainage systems often has a low VS/TS ratio. Sludge from combined sewerage and drainage systems produce high volumes and high levels of inorganic content is in Figure 7. The only technology for dealing with sludge from municipal wastewater treatment plants is dewatering by mechanical processes (filter press, centrifuge, etc.) and dumping. While biogas recovery from anaerobic digestion processes is a promising technology, some suitable pre-treatment processes and suitable anaerobic digestion technology are required to enhance treatment process efficiency and to make anaerobic digestion competitive versus the conventional dumping method.

Areas of application: Hanoi, Ho Chi Minh City and other cities

Possible types of technology transfer: All types.

Experience from attempting to solve the problem: Challenges and successes

Existing support, potential joint venture/collaboration: Most investment projects for municipal wastewater treatment plants are owned by the government and paid for by the government budget or ODA. Wastewater tariffs cover only part of the operational expenditure. The rest is subsidized by the municipal budget.

Existing physical infrastructure and limitations: A wastewater collection network is under development. Not all households are connected to the sewerage and drainage network. Other infrastructure such as electricity, roads, etc. is acceptable.

Regulatory aspects: There are policies to encourage wastewater collection and treatment.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 7: Sludge from combined sewerage and drainage systems produce high volumes and high levels of inorganic content.

3.3 Appropriate fecal sludge treatment technology

Rationale: Fecal sludge generated from septic tanks needs adequate treatment for stabilization, dewatering, and removal of pathogens. Stabilization ponds or sludge drying beds are not suitable in most cases due to land scarcity in urban areas. Composting struggles to find a market due to the poor quality of composted fertilizer. Dewatering technology and equipment allowing fecal sludge stabilization in a small foot-print treatment station would be a useful technology in big and medium cities in Viet Nam.

There is no deadline, but there is an urgent need in Hanoi and Da Nang (2015-2016 plan).

Areas of application: large and medium-sized cities: Hanoi, Ho Chi Minh City, Da Nang, Hai Phong, Ha Long, etc.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem: Challenges and successes

- A stabilization pond is used in Hai Phong.
- A sludge drying bed is used in Nam Dinh and Ha Long.
- Because of land scarcity in other urban areas, these options are not suitable. Composting is used in Hanoi, Hai Phong, Ho Chi Minh City and Da Lat, but there is the challenge of being unable to sell poor quality composted fertilizer.
- Sludge thickening is used in Da Nang and thickened sludge is just dumped at landfill.
- Co-treatment with wastewater is used in Buon Ma Thuot and Da Lat, contributing to an overload of ammonium in incoming wastewater flows and making treatment processes more difficult. Coordination among stakeholders is also a challenge.

Existing support, potential joint venture/collaboration: The municipal budget can be an important source of finance. Waste management companies would consider investing if there is evidence of benefits. Some grants or loans can be found, as fecal sludge management is a hot topic in donors' sanitation improvement programs.

Existing physical infrastructure and limitations: The most feasible location for fecal sludge treatment is in an existing landfill site or a wastewater treatment plant site. Typical fecal sludge treatment technologies are in Figure 8.

Regulatory aspects: There are policies to encourage wastewater, solid waste and sludge collection and treatment.

Estimate of project value: Project value depends on the size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 8: Sludge treatment systems

Sludge drying bed

Co-treatment with wastewater at wastewater treatment plant

Sludge stabilization pond

Sludge drying and composting fecal sludge treatment technologies applied in Viet Namese cities

3.4 Removal of organic matter from surface water

Rationale: Coagulation – Flocculation – Sedimentation – Rapid sand filtration is a conventional water treatment technology applied in most surface water treatment plants in Viet Nam, including in Hai Phong. Because of increasing pollution by wastewater from industries, agro-activities and fast-growing urban areas, surface water sources in Hai Phong are being polluted by excessive organic matter. Conventional treatment processes can remove 30-50% of organics. Powered activated carbon and granular activated carbon are not suitable in terms of cost. Biological carbon filtration (BCF) pre-treatment does not yield good results. An inexpensive technology for retrofitting/upgrading existing treatment plant is needed.

Areas of application: Hai Phong city, Ho Chi Minh City, Da Nang, etc.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, Challenges and successes: Conventional treatment process can remove 30-50% of organics. Powered activated carbon, granular activated carbon seems not suitable in terms of costs. Biological carbon filtration (BCF) pre-treatment does not yield good results. Pollution by organic matters is a challenge for a number of water treatment plants using surface water sources is shown in Figure 9.

Existing support, potential joint venture/collaboration: Company can invest.

Existing physical infrastructure and limitations: Physical infrastructure is acceptable.

Regulatory aspects: Government requirement for adequate treated water quality and increasing awareness among customers are important driving forces for the company to invest in new technology.
Estimate of project value: Project value depends on size and concrete input data of each case. This technology need can find a market in a number of cities.

Figure 9: Pollution by organic matters is a challenge for a number of water treatment plants using surface water sources

3.5 Equipment to control incoming wastewater at centralized effluent treatment plants of industrial zones

Rationale: Factories in centralized IZs are often required to install their own on-site wastewater pre-treatment systems, before wastewater is discharged into a CETP. Operators of CETPs require factories to treat their own wastewater so that the incoming flow of wastewater into the CETP does not exceed certain concentration limits to avoid hampering the biological treatment processes in the CETP. However, many factories do not follow these agreements and CETPs are facing the problem of shock loading with polluted water. CETP failures can lead to system damage, exceeding effluent standard limits and possible fines. On-line monitoring of wastewater flows discharged from factories seems expensive. Adequate control measures are needed. (Automated responsive action associated with recorded changing patterns of incoming flows is optional).

Areas of application: There are 290 IZs in Viet Nam, of which two thirds are equipped with CETPs; others have to build CETPs and all need strict control of incoming flows.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Random sampling at connection point of industries/factories to CETP collection network and special controls of “blacklist” industries are the most common measures. Some CETPs can install on-line measurements for flow rate, pH, NH_4, TDS, conductivity, COD at central collection lines or, in most cases, in CETP inlet only. A balancing tank is often installed at inlets before wastewater is pumped to treatment facilities. Automated responsive action associated with recorded changing patterns of incoming flows is often not applied.

Existing support, potential joint venture/collaboration: The CETP operator/IZ owner can invest in this crucial work.

Existing physical infrastructure and limitations: Infrastructure such as electricity, roads, wastewater collection and treatment are acceptable.

Regulatory aspects: Wastewater collection and treatment at IZs, and effluent quality from CETP are compulsory to meet standards.

Estimate of project value: Project value depends on size and concrete input data of each case. This technology need can find a market in a number of IZs. Wastewater receiving/balancing tank at CETP in IZ is in Figure 10.

Figure 10: Wastewater receiving/balancing tank at CETP in IZ

3.6 Technology for the decentralized wastewater treatment with small foot-print reactor and shallow reaction zone

Rationale: Because of limited space, a number of decentralized wastewater treatment stations built for hospitals, hotels, apartments and commercial centers in urban areas and resorts have to be installed in the basement or ground floor of the building. Limited footprint and limited ceiling height (around 2.4-2.8 m) are challenges for efficient physico-chemical and biological processes. Appropriate technologies are needed for domestic wastewater treatment aiming at effluent standards QCVN 14:2008/BTNMT, Classes A&B. Packaged wastewater treatment station installed in a basement of a building is in Figure 11.
Areas of application: Hanoi, Ho Chi Minh City, other cities (investors for urban developments, apartments, hotels, resorts, hospitals, etc.).

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: AO, A2O process is often applied. Tanks are often made from reinforced concrete, or, in some cases, pre-fabricated fiberglass. Limited footprint, and limited ceiling height (around 2.4-2.8 m) are challenges for efficient physico-chemical and biological processes. Conventional aeration solutions for toxic reactors are not efficient, consuming high levels of energy in shallow tanks. Shallow secondary clarifiers have low solids/liquid separation efficiency.

Existing support, potential joint venture/collaboration: Owners of building are project owner, so budget is coming from their own source. In case of hospitals, budget can come from state, provincial or private sources.

Existing physical infrastructure and limitations: Infrastructure is acceptable.

Regulatory aspects: There are policies to encourage wastewater collection and treatment. Effluent quality standard is Class A or B, QCVN 14:2008/BTNMT.

Estimate of project value: Project value depends on size and concrete input data of each case. This technology need can find a market in a number of cities. For reference, 500-2,000 US dollars per m^3 capacity per day is average unit capital expenditure for packaged wastewater treatment plants.

Figure 11: Packaged wastewater treatment station installed in a basement of a building

3.7 Technology for flow rate and concentration equalization allowing stable incoming wastewater is found at wastewater treatment plants

Rationale: Factories in centralized IZ are often required to install their own on-site wastewater pre-treatment systems, before wastewater is discharged into a CETP. Operators of CETPs require factories to treat their own wastewater so that the incoming flow of wastewater into CETP does not exceed certain concentration limits to avoid hampering biological treatment processes in the CETP. However, many factories do not follow these agreements and CETPs are facing the problem of shock loading with polluted water. CETP failures can lead to system damage, exceeding effluent standard limits and possible fines. On-line monitoring of wastewater flows discharged from factories seems expensive. Adequate control measures are needed. (Automated responsive action associated with recorded changing patterns of incoming flows is optional).

Areas of application: There are 290 IZs in Viet Nam, two thirds of which are equipped with CETPs; others have to build CETPs and all need equalization of incoming flows to allow for the stable operation of CETPs.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: A balancing tank is often installed at the inlet of CETPs, after the screen, grit chamber, and oil/grease chamber, before wastewater is pumped to treatment facilities. This is often a single- or double-chamber rectangular concrete tank, with or without aeration. The tank is often designed with effective volume allowing 4-8 hours retention of average hourly flow. The experience of a number of CETPs in Viet Nam has shown that this conventional balancing/equalization tank design is not sufficient to provide stable flow and concentration of substances in wastewater fed into treatment processes. The problem is more significant at CETPs treating wastewater flows with high hourly peak factors, discharged from industries at the end of the shift or during operational failures.

Existing support, potential joint venture/collaboration: CETP operator/IZ owner can invest in this crucial work.

Existing physical infrastructure and limitations: Infrastructure such as electricity, roads, wastewater collection and treatment are acceptable. Incoming wastewater at CETP is in Figure 12.

Regulatory aspects: Wastewater collection and treatment at IZs and effluent quality from CETP are compulsory to meet standards.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of IZs.

Figure 12: Incoming wastewater at CETP

3.8 Technology to improve treatment performance of existing biological CETPs receiving non-degradable substances in incoming flows

Rationale: Existing CETP at IZs often face the problem of non-degradable or slow-degrading substances appearing in incoming wastewater flows. These substances can be generated from the production lines of industries such as printing, traditional medicine, cosmetics, paper and pulp, textile, etc. Unstable pre-treatment performance at localized wastewater treatment systems from these industries creates high loads of slow- or non- degradable organics in incoming flows to the CETPs. While the primary treatment step at CETPs often consists of chemically enhanced clarification, these organic substances enter biological treatment processes and pass through them. Technologies are needed to remove non-degradable substances before, during or after biological treatment. Yellow incoming wastewater from traditional medicine factory is in Figure 13.

Areas of application: There are 290 IZs in Viet Nam, two thirds of which are equipped with CETPs; other have to build CETPs. A number of CETPs have to receive wastewater from industries not anticipated in the design stage of the IZ. Unexpected high loads of non-biodegradable substances in incoming flows are creating problems for the built CETPs. Upgrading of the CETPs to meet effluent standards is crucial.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Non-biodegradable substances can be generated from production lines of such industries as printing ink, traditional medicine materials, cosmetics, paper and pulp, textile, etc. Unstable pre-treatment performance at localized wastewater treatment systems in the above-mentioned industries create high loads of slow- or non-degradable organics in incoming flows to the CETPs.

Primary treatment step at CETPs often consist of chemically enhanced clarification, so those organic substances enter biological treatment processes and pass through them.

Advanced oxidation using ozone, perozone, Fenton’s reagent, etc. is often expensive, especially when it is applied at a centralized wastewater treatment plant and not at a localized pre-treatment facility at the individual production lines of individual industries.

Existing support, potential joint venture/collaboration: CETP operators/IZ owners could invest in this crucial work.

Existing physical infrastructure and limitations: Infrastructure such as electricity, roads, wastewater collection and treatment are acceptable.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of industrial zones.

Figure 13: Yellow incoming wastewater from traditional medicine factory

3.9 Technology for the co-treatment of iron, manganese, ammonium and arsenic in groundwater

Rationale: Conventional centralized water treatment plants in the Red River Delta treating groundwater often have the following technology line: production well – Aeration – contact chamber for iron oxidation (with or without line and alum addition) – rapid sand filtration – chlorine disinfection. This technology can remove iron efficiently. If manganese is present in groundwater, additional aeration, pH raising and green sand are often applied. However, in the last decade, ammonium and arsenic have been found in a number of production wells in this region. Upgrading of existing water treatment plants is needed where cost-effective technologies are required. Conventional groundwater treatment plant is in Figure 14.

Areas of application: Hanoi, other cities in the Red River Delta.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Conventional technology line for iron removal: production well – aeration - contact chamber for iron oxidation (with or without alum addition) – rapid sand filtration – chlorine disinfection.

In case of presence of manganese: additional aeration, pH raising, application of green sand.

Ammonium removal solutions were tried: biological nitrification followed by sand filtration seems difficult to control; break-point chlorination and ion exchange seem expensive for large and medium-sized treatment plants. Arsenic removal takes place as a co-oxidation/co-adsorption process during iron and manganese removal. No arsenic removal study for a large-scale project has been conducted.

Existing support, potential joint venture/collaboration: Water companies may be interested in investing.

Existing physical infrastructure and limitations: Physical infrastructure is acceptable.

Regulatory aspects: Government requirement for adequately treated water quality and increasing awareness from customers are important driving forces for companies to invest in new technology.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 14: Groundwater treatment plant using conventional technology cannot remove iron, manganese, arsenic and ammonia at the same time

3.10 Technology for the co-treatment of high levels of iron, manganese and ammonium in groundwater

Rationale: Some production wells in the Red River Delta suffer from elevated concentrations of iron, manganese and ammonium. For example, in Bac Ninh Province, iron concentration in raw groundwater can be > 40 mg/l, manganese > 7 mg/l, and ammonium > 10 mg/l. Such a high level of contaminants requires upgrading of the existing treatment plant, which was designed for iron removal only. Cost-effective technologies are required.

Areas of application: Bac Ninh, Hanoi, other cities in the Red River Delta.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: The conventional technology line for iron removal is as follows: production well – aeration – contact chamber for iron oxidation (with or without line and alum addition) – rapid sand filtration – chlorine disinfection. Contamination by iron, manganese and ammonia is becoming a more common problem in the Red River Delta (northern Viet Nam) is in Figure 15.

In case of presence of manganese: additional aeration, pH raising, application of green sand. Ammonium removal solutions were tried: biological nitrification followed by sand filtration seems difficult to control; break-point chlorination and ion exchange seem expensive for large and medium-side treatment plants.

Existing support, potential joint venture/collaboration: Water companies would be interested in investing.

Existing physical infrastructure and limitations: Physical infrastructure is acceptable.

Regulatory aspects: Government mandates for adequately treated water quality and increasing awareness among customers are important driving forces for companies to invest in new technology.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 15: Contamination by iron, manganese and ammonia is becoming a more common problem in the Red River Delta (northern Viet Nam)

3.11 Technology (know-how) for the quick start-up of biologically based wastewater treatment plant

Rationale: It often takes at least 3 to 6 months for a microbial community (sludge) to farm. There is a need to rapidly increase sludge concentration in biological reactors at the commissioning/start-up period of newly built wastewater treatment plants, or during re-starting after temporary closure of plants. Technology to reduce start-up times for biologically-based wastewater treatment plants could benefit contractors and project owners.

Areas of application: There are 290 IZs in Viet Nam, two-thirds of which are equipped with CETPs. The rest need to build CETPs. New and existing CTEPs urgently need better start-up technology to decrease the amount of time they take to become operational.
There will be a number of municipal wastewater treatment plants coming into operation in Viet Namese cities. There is also potential in decentralized wastewater treatment plants for industries, commercial centers, new urban developments, etc.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Common methods to reduce start-up time currently used are:

- bringing sludge from nearby wastewater treatment plants (not always feasible); and
- adding a commercial seeding microbial community (such as Aquaclean, made in USA, which is quite expensive, especially for large- or medium-scale wastewater treatment plants.

Existing support, potential joint venture/collaboration: Contractors can invest in this crucial work since time-saving is their benefit. CETP operators can invest to avoid fines from local authorities when their CETP fails and effluent standards are not met.

Existing physical infrastructure and limitations: Infrastructure such as electricity, road, wastewater collection and treatment are acceptable.

Regulatory aspects: Effluent from wastewater treatment plants is required to meet standards.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need could find a big market in Viet Nam. The biological wastewater treatment process is in Figure 16.

Figure 16: The biological wastewater treatment process requires certain start-up period

3.12 Energy-efficient technology for dewatering sludge at water treatment plants

Rationale: In water treatment plants, sludge is generated mainly from treatment processes such as filter backwashing and from clarifiers in a main treatment line. Conventional methods for sludge treatment consist in sludge thickening in a gravity thickener, followed by dewatering in sludge-drying beds, or mechanical dewatering in machines such as centrifuges, filter presses, belt presses, etc. Sludge-drying beds require large spaces, while mechanical dewatering consumes expensive chemicals and electricity. While treated water from sludge treatment processes can be sent back to the main treatment line, energy-efficient sludge dewatering technology is needed in most water treatment plants treating both ground and surface waters. Sludge-drying beds are the most common technology for sludge dewatering at water treatment plants is in Figure 17.

Areas of application: Most water treatment plants in Viet Nam, especially large-capacity plants such as Thu Duc, Tan Hiep (HCMC), Song Da, North Thang Long (Hanoi) and An Dzuong (Hai Phong).

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Conventional methods for sludge treatment are sludge-thickening in a gravity thickener, followed by dewatering in sludge-drying beds, or mechanical dewatering in machines such as centrifuges, filter presses, belt presses, etc. Sludge-drying beds require large space, while mechanical dewatering consumes expensive chemical enhancement and electricity. Energy-efficient sludge dewatering technology is needed in most water treatment plants treating both ground and surface waters.

Existing support, potential joint venture/collaboration: Company can invest.

Existing physical infrastructure and limitations: Physical infrastructure is acceptable.

Regulatory aspects: Government requirements for adequately treated water quality and waste management, coupled with increasing awareness among customers, are important driving forces for companies to invest in new technology.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 17: Sludge-drying beds are the most common technology for sludge dewatering at water treatment plants

3.13 Technology for pre-treatment of organic fractions of municipal waste, industrial waste and agro-waste before their co-treatment with sewage sludge in anaerobic digester for biogas recovery

Rationale: The efficiency and stability of anaerobic digestion depends very much on the composition of the feed material. Even though anaerobic co-digestion of organic fractions of municipal, industrial, and agricultural wastes has a promising future, a big challenge to be overcome is to pre-treat those waste fractions to convert them into easily degradable substrates before they can be fed into digesters. The various materials, forms, sizes, shapes, and characteristics of different wastes make their pre-treatment processes, such as separation, sorting, chopping, maceration, etc. difficult. Anaerobic digestion of organic waste is a new field in Viet Nam and experience is very limited.

Areas of application: Wastewater and solid waste treatment centers in Hanoi, Ho Chi Minh city, urban and industrial areas across the country of Viet Nam.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: A major challenge is to pre-treat organic fractions of municipal, industrial, and agricultural wastes to convert them into easily degradable substrates before they can be fed into the anaerobic digesters. The various materials, forms, sizes, shapes, and characteristics of different wastes make their pre-treatment processes, such as separation, sorting, chopping, maceration, etc. difficult. Anaerobic digestion of organic waste is a new field in Viet Nam and experience is very limited. Efficient pre-treatment would enhance sludge stabilization and biogas recovery (Figure 18)

Existing support, potential joint venture/collaboration: Most investment projects for municipal wastewater treatment plants are owned by the government or paid for by the government budget or ODA. Wastewater tariffs cover only part of the operational expenditure. The rest is subsidized by the municipal budget.

Existing physical infrastructure and limitations: Infrastructure is acceptable.

Regulatory aspects: Government has policies to encourage wastewater collection and treatment and resource recovery from waste.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in a number of cities.

Figure 18: Efficient pre-treatment would enhance sludge stabilization and biogas recovery

3.14 Technology for the treatment of digested sludge after anaerobic digester for resource recovery

Rationale: One of main challenges for anaerobic digestion of sludge is the requirement to undertake follow-up treatment of the liquid and solid phases of digested sludge after it has been through the digester. The solid phase can be used for making compost fertilizer or fuel. Sludge from the liquid phase can be used as a nutrient source for fertilizer. Energy consumption is the main challenge for solid-phase treatment. High concentrations of organics, colloids, N and P in the liquid phase are the main challenges for efficient physico-chemical and biological treatment processes. Mechanical sludge dewatering is an energy-consuming technology is shown in Figure 19.

Areas of application: Wastewater and solid waste treatment centers in Hanoi, Ho Chi Minh City, urban and industrial areas across the country.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: One of the main challenges for anaerobic digestion of sludge is the requirement to undertake follow-up treatment of the liquid and solid phases of digested sludge after it has been through the digester. The solid phase can be used for making compost fertilizer or fuel. Sludge from the liquid phase can be used as a nutrient source for fertilizer. Energy consumption is a major challenge for solid-phase treatment.

High concentration of organics, colloids, N, P in the liquid phase is a major challenge for efficient physico-chemical and biological treatment processes that should meet effluent standards. Return of the liquid phase to main wastewater treatment lines increases nutrient loads, which are already high compared to carbonaceous substances in wastewater flows from combined sewerage and drainage collection systems.

Existing support, potential joint venture/collaboration: Most investment projects for municipal wastewater treatment plants are owned by the government or paid for by the government budget or ODA. Wastewater tariffs cover only part of the operational expenditure. The rest is subsidized by the municipal budget.

Existing physical infrastructure and limitations: Infrastructure is acceptable.

Regulatory aspects: Government has policies to encourage wastewater collection and treatment and resource recovery from waste.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need could find a market in a number of cities.

Figure 19: Mechanical sludge dewatering is an energy-consuming technology

3.15 Technology for the treatment of pig farm wastewater rich in organics and nitrogen (ammonium)

Rationale: In Viet Nam there are thousands of pig farms with 1,000-10,000 pigs. Approximately half of them are equipped with biogas digesters and biogas is harvested for farm energy needs such as cooking, heating and electricity generation. Some farms have waste stabilization (with or without macrophytes – aquatic plants) as a post-treatment step. The rest discharge biogas digester effluent directly into the environment. In both cases, wastewater still does not meet effluent standards, especially in terms of organics, and nitrogen parameters. There is a need for cost-effective technology for post-treatment after anaerobic digestion or a full package of solutions for wastewater treatment and resource recovery. High levels of organics, ammonium and color are key challenges in pig farm wastewater treatment (Figure 20)

Areas of application: Thousands of pig farms across the country.

Possible types of technology transfer: All types.

Experience from attempting to solve the problem, challenges and successes: Biogas digesters are the most common technology for pig farm wastewater treatment. Some farms have waste stabilization (with or without macrophytes) as a post-treatment step. The rest discharge biogas digester effluent directly into the environment. In both cases, wastewater still does not meet effluent standards, especially in terms of organics, and nitrogen parameters. Cost-effective criteria are an important challenge.

Existing support, potential joint venture/collaboration: Pig farm owners could invest.

Existing physical infrastructure and limitations: Physical infrastructure is acceptable.

Regulatory aspects: The key driving forces for the adoption of this technology are government requirements for pollution control, increasing public awareness and the need to protect pigs from diseases.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need can find a market in thousands of farms.

Figure 20: High levels of organics, ammonium and color are key challenges in pig farm wastewater treatment

3.16 Technology to enhance nitrification, or removal of ammonium, in wastewater treatment systems by applying natural treatment processes

Rationale: The average total nitrogen concentration in wastewater coming into municipal wastewater treatment plants is within the range of 40-50 mg/l, while ammonium concentration is within the range of 20-40 mg/l (as N). Required total nitrogen in treated wastewater is 20 mg/l (Class A) or 40 mg/l (Class B), while required ammonium for Class A is 5 mg/l and 10 mg/l for Class B. Natural wastewater treatment processes such as waste stabilization ponds, constructed wetland, trickling rock filter or filtering with other natural filter media, etc. are often recommended for developing countries like Viet Nam, thanks to their simplicity, reliability, high buffer capacity and robustness. However, these systems are not very efficient at removing nitrification or ammonium. Enhancement solutions are needed to maximize the benefits and overcome the limitations of these treatment systems. Enhancing nitrogen removal in wastewater treatment plants using trickling filter and waste stabilization pond technology is in Figure 21.

Areas of application: Urban areas, including cities in central and southern Viet Nam, could potentially apply natural wastewater treatment processes. Concrete examples include Thanh Hoa Urban Upgrading Project Management Unit; Buon Ma Thuot Wastewater Treatment Plant and Da Nang Wastewater Company.

Possible types of technology transfer: All types.

Existing support, potential joint venture/collaboration: Most investment projects for municipal wastewater treatment plants are owned and paid (on ODA loans) by the government. Wastewater tariffs cover only part of the operational expenditure. The rest is subsidized by the municipal budget.

Existing physical infrastructure and limitations: The wastewater collection network is under development. Not all households are connected to the sewerage and drainage network. Other infrastructure such as electricity, roads, etc. is acceptable.

Regulatory aspects: There are policies to encourage wastewater collection and treatment.

Estimate of project value: Project value depends on size and concrete input data for each case. This technology need could find a market in a number of cities.

Figure 21: Filter and waste stabilization pond technology:

4. Conclusions

One of the challenges faced during this study was the breadth of the topic, although criteria for the selection of technology needs were fairly flexible. For a developing country like Viet Nam, where wastewater technology is still rather new, it was challenging to identify technological needs. By contrast, water supply technology has existed in Viet Nam for more than 40 years. It might have been easier to define technology needs in this field, where technology seekers know exactly what they need to improve the situation or to solve their problems.

The specific problems faced are outlined below.

- Stakeholders interviewed had only limited awareness of the role and importance of intellectual property.
- It was occasionally difficult to convince interviewees to state their technology needs to unknown people. Most stakeholders also lack the funds to purchase new technology.
- Another challenge for analyzing, identifying and describing technology needs was the limited operational data from wastewater systems in general. This also limited the current study, where some technology needs were provided without detailed information.
- It is important to clarify “technology need” in the form of process, equipment, facility, or system. This point also links to the issues raised above.
- Cost-efficiency is the crucial criterion in technology selection.

Viet Nam is undergoing a period of rapid economic development. The country’s current relative lack of technological sophistication is a legacy of its turbulent recent past. However, there is increasing pressure from government and the public to improve water quality and institute new technological solutions. This project is welcome as part of this process of change.

Resources and further reading

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Nguyen, VA., Lan, H.T., Dan P.H., Hoa, L.T., Nhung, B.T., Hutton, G. Economic assessment of sanitation interventions in Viet Nam. World Bank, Water and Sanitation Program, (2012). (www.wsp.org).

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Annex:

Program of the Regional Seminar

E

REGIONAL SEMINAR

WIPO/IP/MNL/15/INF/1
ORIGINAL: ENGLISH
DATE: APRIL 22, 2015

Facilitating the Transfer and Diffusion of Clean Technology:

Opportunities from a Pilot Project on Wastewater Treatment in South East Asia

organized by
the World Intellectual Property Organization (WIPO)

in cooperation with
the Asian Development Bank (ADB)

the Intellectual Property Office of the Philippines (IPOPHL)

and
the Climate Technology Centre and Network (CTCN)

with the support of
the Japan Patent Office (JPO)

Manila, April 23 and 24, 2015

PROGRAM

prepared by the Secretariat

Thursday, April 23, 2015

8.30 – 9.00	Registration and networking at the Marketplace	
9.00 – 9.45	**Welcome Remarks and Objectives of the Regional Seminar**	
	Speakers:	Mr. Allan B. Gepty, Deputy Director General & Officer in Charge, Intellectual Property Office of the Philippines, (IPOPHL), Manila
		Mr. Junichiro Suzuki, Second Secretary, Embassy of Japan, Manila
		His Excellency Truong Trieu Duong, Ambassador of Vietnam, Manila
		Mr. Mushtaq Ahmed Memon, Program Officer International Environmental Technology Centre UNEP, also representing the Climate Technology Centre and Network (CTCN), Osaka, Japan
		Mr. Yongping Zhai, Technical Advisor (Energy), Asian Development Bank (ADB), Manila
		Mr. Anatole Krattiger, Director, Global Challenges Division, World Intellectual Property Organization (WIPO), Geneva, Switzerland
		Ms. Mary Ann Lucille L. Sering, Secretary, Climate Change Commission, Manila
9.45 – 10.30	**Formal Opening of the Marketplace, Coffee and Networking**	
10.30 – 11.30	**High-Level Discussion on the Importance of Wastewater Management in the Context of Low-carbon Technologies and Climate Change**	
	Moderated by Mr. Anatole Krattiger, WIPO	
	Speakers:	Mr. Michael Rattinger, Climate Change Specialist, ADB
		Mr. Yorimasa Suwa, Japan Intellectual Property Association (JIPA) and the Japan Institute of Promoting Invention and Innovation (JIPII), Tokyo
		Ms. Ruby Raterta, Senior Science Researcher, Department of Science and Technology, DOST, Manila
		Mr. Mushtaq Ahmed Memon, UNEP (CTCN)
	Panel discussion.	

11.30 – 12.30	**Current State of Play: Wastewater Management in Indonesia, Philippines and Viet Nam**	
	Moderated by	Ms. Yesim Baykal, Senior Program Officer, Global Challenges Division, WIPO
	Speakers:	Mr. Rudy Abdul Rahman, Associate Expert, Pelangi Indonesia, Jakarta
		Mr. Vieth-Anh Nguyen, Consultant, Hanoi
		Mr. Javier Coloma Brotons, Urban Development Specialist, ADB, Manila
		Mr. Lormelyn E. Claudio, Regional Director, Environmental Management Bureau, Department of Environment and Natural Resources
	Panel discussion.	
12.30 – 14.00	Lunch hosted by ADB	
14.00 – 15.45	**Roundtable Introducing Technology Needs**	
	Moderated by Ms. Yesim Baykal, WIPO	
	Three Panels, each introducing technology seekers and specific needs: • Indonesia • Philippines • Vietnam	
	Each Panel will discuss challenges (including technological, regulatory, and financial) and potential synergies.	
15.45 – 16.00	Coffee and Networking at the Marketplace	
16.00 – 18.00	**Matchmaking Session and Marketplace**	
	Rooms for small group meetings will be made available	
18.00 – 20.00	Reception hosted by WIPO	

Friday, April 24, 2015

Principal Elements of Technology Transfer

9.00 – 10.30 **Part 1: Intellectual Property as one Tool in Technology Transfer**

Moderated by Gunawan Suryomucito, ROUSE, Jakarta, and Public Interest Intellectual Property Attorneys (PIIPA), USA

Speakers: Mr. Anatole Krattiger, WIPO

Ms. Winelma Garcia, Intellectual Property Rights Specialist, IPOPHL, Manila

Ms. Patricia A. O. Bunye, Licensing Executives Society International (LESI), Senior Partner, Cruz Marcelo & Tenefrancia, Manila

Panel discussion.

10.30 – 11.00 Coffee and networking at the Marketplace

11.00 – 12.30 **Part 2: Technological Solutions**

Moderated by Jiwan Acharya, ADB, Manila

Speakers: Mr. Kingsley Kalusha, Consultant, United Nations Office for South-South Cooperation (UNOSSC), New York, United States of America

Ms. Jingmin Huang, Senior Urban Development Specialist, ADB, Manila

Alex Yan, China Beijing Environment Exchange, Beijing

Presentations by Tech Providers

Panel discussion.

12.30 – 13.30 Lunch

13.30 – 14.45 **Part 3: Technology Assessment and Business Plan Development**

Moderated by Ms. Patricia Bunye, LESI & Cruz Marcelo & Tenefrancia

Speakers: Mr. Yanis Boudjouher, IPEx Director and Co-founder, IPEx Cleantech Asia, Singapore

Mr. Ramanan Suryanarayan of DNV GL Singapore

Mr. Wanghee You, KOTEC, Busan, Korea

Mr. Mushtaq Ahmed Memon, UNEP (CTN)

Panel discussion.

14.45 – 16.00	**Part 4: Financing**	
	Moderated by Mr. Yanis Boudjouher, IPEx Cleantech Asia	
	Speakers:	Mr. Nagaraja Rao, Asia Regional Coordinator, Climate Technology Initiative-Private Financing Advisory Network (CTI PFAN). Bangalore, India
		Ms. Natalie Bertsch, Financial Sector Specialist, ADB, Manila
	Panel discussion.	
16.00 – 16.45	**Lessons Learned, Possible Strategy for Regionalization and Collaboration, and Next Steps**	
16.45 – 17.00	**Closing Remarks**	
	Speakers:	Ms. Carmen G. Peralta, Bureau Director, IPOPHL, Manila
		Mr. Jiwan Acharya, Senior Climate Change Specialist, ADB, Manila
		Mr. Anatole Krattiger, WIPO
17.00 – 18.00	Coffee and Networking at the Exhibition Space	

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