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Waste & Recycling

Sustainable Resource Utilization via Circular Economy

Taiwan's recycling goal has changed from the conventional end-of-pipe treatment to the current source reduction, gradually heading toward the goal of zero waste. Through the implementation of *2018-2020 Resource Recycling and Reuse Plans* (資源回收再利用推動計畫), the EPA hopes to build a circular economy and achieve sustainability, including maximizing resource utilization and minimizing the impacts on the environment.

Launched in 1997, the EPA's *Four-in-one Resource Recycling Plan* (資源回收四合一計畫) has combined four forces, including communities, recycling enterprises, local sanitation crews, and the Recycling Fund, with government authorities. It aims to establish recycling channels participated by all citizens and completely solve garbage treatment problems with a proper treatment rate of over 99%.

However, rapid economic development and drastic increase of the types and quantity of industrial wastes has led to more complicated treatment methods and higher costs. The conventional end-of-pipe treatment can no

longer meet modern needs. In order to achieve a circular economy of zero waste, the EPA is currently implementing the following measures:

Strengthening industrial waste reutilization management

The EPA announced the *Management Regulations for Reuse of Common Industrial Waste* (共通性事業廢棄物再利用管理辦法) on 8 January 2018. Eight industrial wastes -- food waste, waste cooking oil, waste iron, waste paper, waste glass, waste plastic, waste single metal (copper, zinc, aluminum, and tin), and waste cement telecommunication

lines -- are listed for control and management under the EPA.

Subsequently, an announcement on 9 January 2018 mandated tracking of reused coal ash, waste casting sand, and electric arc furnace slag. Each competent authority should conduct environmental monitoring if their reuses are potentially affecting the environment.

On 27 November 2018, the amended *Industries Required to Submit Online Reports of Waste Production, Storage, Clearance, Treatment, Reuse, Export, and Import* (應以網路傳輸方式申報廢棄物之產出、貯存、清除、處理、

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再利用、輸出及輸入情形之事業) and *Industries Required to Submit Industrial Waste Clearance Plans* (應檢具事業廢棄物清理計畫書之事業) were both announced. The revisions are specifically to include evaluation for industrial waste clearance plans for the purpose of reuse.

Resource Recycling and Reuse

(1) Implementation of 2018-2020 Resource Recycling and Reuse Plan

Besides incorporating the concept of circular economy, the *Resource Recycling and Reuse Plan* launched in 2018, promotes strategies based on life cycles of various materials. Under the strategies covering production, consumption, waste management, and reused material markets, the EPA has formulated cross-departmental action strategies, measures, and key performance indexes and determined that plastic, metals, construction waste, and food waste would be the first to implement upon.

As it carries out the plan, the EPA hopes to build a circular economy and achieve sustainability, maximizing resource utilization and minimizing environmental impacts. Recycling and reuse of waste plastic and construction waste were the targets set in 2018, and the project's accomplishments were reviewed by members of the Resource Recycling and Reuse Promotion Committee of the EPA.

(2) "Cradle-to-cradle (C2C)" design concepts and circular economy evaluation

To encourage companies to prioritize product design from the beginning and enhance public awareness of C2C design concepts and understanding of circular economy, the EPA continued to invite corporations to participate in the C2C Platform in 2018. To date, the platform has 94 members. In 2018, nine meetings were organized with group discussions to increase exchanges among members and promote the platform.

Evaluation for circular economy of waste resources had been conducted in 2018 on reuse institutes to further encourage and promote reuse. After the evaluation, nine of 74 enterprises that signed up were awarded with two stars, and 15 with one star. Enterprises with excellent performances are used as examples to encourage and guide each industry to commit to circular economy. Moreover, the EPA hopes that the evaluation will become an index on the promotion of circular economy by various industries.

(3) Promoting recycling and treatment of waste solar panels

In response to future treatment of waste photoelectricity modules, the EPA has planned out a semi-automatic recycling mechanism and mandated enterprises to fulfill their extended producer responsibilities (EPRs). A joint recycling, clearance, and treatment organization is to be established by enterprises.

Before the revisions, waste recycling, clearance, and treatment fees collected by the Bureau of Energy of the Ministry of Economic

Affairs and fees specially applied by the EPA were used on recycling, clearance, and treatment of waste solar panels. After the revisions, the EPA has become in charge of collecting the relevant fees, which are managed under the Recycling Fund.

Strengthening functions of Recycling Fund

1. Perfecting management of recycling and treatment channels

The EPA has actively encouraged authorities in charge to conduct recycling plans, open up recycling channels, and increase recycling results.

(1) Authorities in charge of recycling have been supplied with needed equipment and facilities. In 2019, it is expected to subsidize purchase of 11 loaders, construction of one and renovation of three recycling and storage sites, and replacement of 192 hybrid recycling vehicles.

(2) The *Neighborhood Recycling Station Plan* (村里資源回收站計畫) prescribes the setting up of 1,400 stations in 2019. As many as 1,299 had been set up by February 2019 to strengthen the recycling system.

(3) The *Circular Economy and Recycling Force Plan* (循環經濟資收大軍計畫) prescribes the hiring of 2,982 people every month in average in 2019 to help sort recycled wastes. The EPA will also try to prevent self-employed recyclers from being financially affected by price changes in the recycling market.

(4) The *Recycling Care Program*

(資收關懷計畫), newly launched in 2019, focuses on self-employed recyclers that are also medium-low income households. For wastes required to be recycled, subsidies of NT\$5/kg or NT\$20/set (or unit) are provided. Among them, the subsidy for waste paper container will be raised from NT\$5/kg to NT\$10/kg beginning 1 July 2019.

- (5) Annual performance evaluation is conducted on competent authorities, where exchanges on innovative recycling methods in different areas are also carried out to raise recycling efficiency.

To set up a comprehensive system of recycling and treatment channels, 614 recyclers and 92 treatment enterprises had obtained registration licenses as of the end of February. Among those, 226 recyclers and 75 treatment enterprises have been subsidized. The EPA has finished helping subsidize enterprises to set up closed-circuit television, measuring equipment and systems. The monitoring efficiency has also been raised through monitoring operations of both subsidized enterprises and inspecting and certifying organizations. Measuring and weighing data can now be uploaded to an online system without manually keying in the data, largely cutting down costs and raising efficiency.

The EPA has been publicly asking for innovative and research projects on recycling and treatment in order to encourage enterprises to develop recycling and treatment technology, attract talents, and create reuse channels. Fifteen applications were approved in 2018, and 17 in 2019.

2. Monitoring responsible enterprises to practice recyclable waste management

A total of 23,714 responsible enterprises (35,096 per company/time) had been listed under control as of the end of May 2019 with 804,676 pieces of registered data of operation evaluated and put into the system. Responsible enterprises can pay fees in banks, post offices, and convenience stores. To provide a convenient way to pay fee, or they can set up a link on the reporting system via the e-bill website and pay directly online.

During January and May 2019, an accounting firm was commissioned to audit 757 recycling and treatment enterprises that have larger amount of reported recycling, clearance, and treatment fees. The audited fees amounted to approximately NT\$2.816 billion. The rate of enterprises accurately reporting fees is 99.19%.

3. Promoting recycling to increase effectiveness

There were 1.407 million metric tons of recyclable waste in 2018 and 119,000 metric tons in January 2019. The EPA actively helps Southeast Asian countries develop business opportunities for recycling industry-needed technology and equipment by assisting them with evaluations and skill-building projects and exchanging recycling and reuse technology. A toll-free phone number is in place to assist anyone in need. The resource recycling system had adopted its website with responsive website design (RWD) and issued e-newsletters to intensify online promotion with interactive videos, images, texts, and social networks. Until the end of May 2019, civil organizations had been sponsored to hold 52 recycling and treatment promotion activities, with a total of 82,110 participants.

Future prospect

The EPA believes the future policies of circular economy should aim for resource sustainability. With recycling, reuse, and innovation as the guidelines, the EPA has been adopting the idea of materials' life cycles and circular utilization and gradually heading toward the final goal of zero-waste. In addition to the conventional 3Rs (reduce, recycle, and reuse), another 3Rs -- recovery of energy, land reclamation, and redesign -- have also been introduced to build a circular economy.

Air

Online Uploading Required for Trial Operation Plans

After reviewing the *Regulations on Trial Operations and Assessments for Public and Private Premises*, the EPA added a new stipulation requiring public and private premises to upload their trial operation plans on a designated website for the general public.

The *Air Pollution Control Act* was amended on 1 August 2018 to include stipulations on the information transparency of trial operation plans. Therefore, the *Regulations on Trial Operations and Assessments for Public and Private Premises* will also be updated correspondingly to maintain regulation consistency.

According to the current regulations, public and private premises are required to submit trial operation plans and other related documents before resuming the operation of pollution sources or business if it meets the following circumstances:

- 1.The premise is ordered by the competent authority to suspend

the operation of pollution source, suspend work or business pursuant.

- 2.The premise is ordered to make improvements by the competent authority but voluntarily suspends work or business.

Additionally, to ensure that stationary pollution sources comply with the emission standards prior to the resumption of operation, the regulations also include clear stipulations on the assessment procedure and standards of trial operation plans.

However, to respond to the current emission control status and management system, adjustments are to be made to the regulations.

Other revisions to the regulations include:

- 1.Public opinions shall be included for reference in the assessment process of trial operation plans.
- 2.During the meeting for the assessment of trial operation plans, the minutes of the meeting shall be published on the designated website.
- 3.In response to the changes in the *Air Pollution Control Act*, the regulations will be renamed as the *Regulations on Trial Operations and Assessments for Public and Private Premises Prior to Operation Resumption*.

Chemicals

Three Toxic Chemicals Added to Align with the Stockholm Convention

In response to the new items added to the Stockholm Convention, the EPA announced on 6 March 2019 short-chain chlorinated paraffins (SCCPs) would be listed as Class 1 toxic chemical substances. The EPA also relisted decabromobiphenyl ether from currently listed control chemical substances as a Class 1 and Class 2 toxic chemical substance. In addition, the EPA now bans all uses of hexachloro-1,3-butadiene in order to keep up with the latest international control trends.

The EPA explained that SCCPs, decabromobiphenyl ether, and hexachloro-1,3-butadiene are three persistent organic pollutants (POPs). POPs are substances that are slow to decompose in nature or have a long metabolic half-life inside a living organism, therefore posing dangers to human health and the ecosystem. The three substances have been put on Annex A (elimination) of the Stockholm Convention. Through the Convention, the United Nations (UN) requires signatory nations to ban the use or restrict the production of POPs unless the

substance obtains a registration from the UN to be used for special purposes.

The EPA stated that SCCPs are primarily used as an additive and a plasticizer to manufacture conveyor belts in the natural and synthetic rubber industry. Decabromobiphenyl ether is widely used in brominated flame retardant to inhibit burning of organic compounds and often used to manufacture electronics, clothes, and furniture in order to lower products' flammability. Hexachloro-1, 3-butadiene is

commonly found in solvents used in making elastic objects as well as heat-transferring liquids.

The EPA has already initiated an investigation into the domestic industrial uses of the abovementioned substances. SCCPs are the byproducts of chlorinated paraffin manufacturing and are primarily used in research, experiments, and education. Decabromobiphenyl ether has already been gradually eliminated internationally. As such, Taiwan is also reducing the usage of this substance. The investigation into

hexachloro-1,3-butadiene has found it to have no other purposes beyond research, experimentation and education. Given this, the tightened control on hexachloro-1,3-butadiene will only have a marginal effect on Taiwan's

industries.

The EPA emphasized that, after the announcement, enterprises transporting, manufacturing, importing, selling, using, storing, or handling the three substances

should apply for approval and operate according to relevant regulations. The purpose is to track the flow of these chemical substances.

Waste

Banning Personal Care Products Containing Synthetic Polymers

Since the *Manufacturing, Import, and Sale Restrictions for Cosmetics and Personal Care Products Containing Microbeads* (限制含塑膠微粒之化粧品與個人清潔用品製造、輸入及販賣) was announced on 3 August 2017, it has made a positive difference in reducing the use of microbead-containing products.

However, after the ban of microbeads, some companies reformulated their products by using different artificial polymers, which remain insoluble in water. Therefore, to ensure products are eco-friendly, the EPA has made amendments to the restrictions by adopting some of Sweden's rules governing microbeads in cosmetic

products. The main points of the amendments are as follows:

1. Synthetic polymers, such as solid synthetic wax, have been included in the category of microplastics. Also, the definition of naturally occurring polymers has been added.

2. The manufacturing and import of personal care and cosmetic products containing synthetic polymers will be banned starting from 1 September 2019. The ban on the sale of products containing synthetic polymers will enter into force on 1 March 2020.

Water

Comprehensive Water Quality Improvement Measures

The EPA has been striving to promote water quality-improving measures, which fall under three aspects: revisions to water pollution prevention regulations and collections of control fees, improvement of water body quality, and reduction of livestock wastewater pollution. The River Pollution Index (RPI) has dropped from 3.9 in 2001 to 2.54 in 2018, indicating a gradual improvement of river water quality.

Revising water pollution-related regulations and collecting control fees

1. Revising water pollution control regulations

In 2018, announcements were made on revisions of the *Water Pollution Control Act* (水污染防治法), the *Water Pollution Control Act Enforcement Rules* (水污染防治法施行細則), and the *Water Pollution Control Measure Plan and Regulations to Manage Permit Application and Evaluation* (水污

染防治措施計畫及許可申請審查管理辦法). Revisions of the *Water Pollution Prevention Permit Application Fee Standards* (水污染防治各項許可申請收費標準), the *Regulations to Establish a Water Pollution Control Fee Review Board* (水污染防治費費率審議委員會設置辦法), and the *Regulations Concerning Water Pollution Control Fee Collection* (水污染防治費收費辦法) were also announced. The EPA later announced other amended relevant sub-laws and

standards in 2019.

2. Water pollution fee collection and utilization

Since the collection of water pollution control fees on 1 May 2015, targets of the first phase were sewage of enterprises and industrial zones that exclude livestock industry. The second phase targeted livestock enterprises and took effect on 1 January 2017. The third phase began on 1 January 2019 and

included sewage specifically from other designated zones or venues. The EPA carried out eight collection operation periods between 1 May 2015 and 26 March 2019, with collected fees totaling NT\$1.18524 billion for various water pollution control measures. The EPA has been appropriated with 40% of the total fee, and the local governments 60%.

Improving water body quality

Based on analysis of the average annual RPI, the amount decreased from 3.9 in 2001 to 2.54 in 2018, showing an improving trend. However, average RPI in 14 monitoring stations still indicated severe pollution in 2018, meaning active improvement of water quality is still needed.

1.Reducing household wastewater pollution

- (1) The EPA continues to coordinate with the Construction and Planning Agency of the Ministry of the Interior and other competent authorities. For rivers that are severely polluted with larger amounts of household wastewater pollution, public sewage system construction and households' connection to public sewage will be pushed forward as priority operations.
- (2) For the watershed ranges of severely polluted rivers that have yet to connect to public sewage or have public sewage constructed, subsidies have been provided for projects like wastewater interception or onsite purification and treatment. As of the end of 2018, improvement projects had been completed at 116 sites with a total capacity

of 880,000 metric tons of household wastewater intercepted and treated every day. The EPA aims to effectively reduce pollution loads caused by household wastewater within a short period.

2.Reducing enterprise wastewater pollution

- (1) Based on the current *Water Pollution Control Act* local governments are urged to actively investigate and punish major violations such as rerouting discharge or unpermitted discharge. Illegal gains will be pursued as well in order to effectively deter enterprises from breaking laws or thinking they could escape undetected.
- (2) Concerning irrigation ditches selected by the Council of Agriculture as with high pollution trends, total quantity control and reduction measures targeting heavy metals have continued to be implemented on enterprise wastewater in irrigation sources. As of the end of April 2019, a total of ten cooperation meetings across agricultural and conservation agencies had been convened to preserve water quality of irrigation sources. As for regions densely populated with enterprises or with major pollution hotspots, the joint force of the EPA's Environmental Police Unit, the environmental police of the National Police Agency, and regional competent authorities, has increased efforts to stop environmental pollution.
- (3) To improve river quality and reach goals set for water body quality standards, the EPA

placed all surface water bodies under priority remediation by selecting key monitoring stations and integrating central and regional resources. Water bodies are sorted based on levels of pollution and whether heavy metal standards are exceeded. Local governments are supervised and reviewed for formulating improvement measures and proposing practices and goals each year. In order to control pollution sources such as wastewater generated by households, enterprises, and livestock operations, measures and goals are formulated based on indicative pollution items from key monitoring stations.

- (4) The EPA continues to supervise and assist local governments in the implementation of total control or tightening of the *Effluent Standards* (放流水標準) to protect severely polluted rivers or water bodies in need of special protection. The following are the results:

A. In 2018, the EPA announced that four total control zones were designated for water pollution control and the effluent standards were strengthened. By 2018, there were total control zones for water pollution control in six municipalities, counties, and cities, and seven regions. Tighter effluent standards were put in place in four municipalities, counties, and cities, and five regions.

- i. The *Total Control Regulations for Wastewater Copper Discharge in Nankan Stream Watershed in Taoyuan City* (control on copper) was announced on 5 January 2018.
- ii. The *Total Control Regulations for*

⬇️ *Tighter Effluent Standards were put in place in four municipalities, counties, and cities, and five regions.*

Control methods	County/City	Control targets	Control items	Announcement date
Designated total control zones	Taoyuan City	Hsinchie Stream and Puhsin Stream	6 heavy metals	03 February 2016
		Nankan Stream	Copper	05 January 2018
	Taichung City	Janchuoyuan Ditch	6 heavy metals	23 December 2016
	Changhwa County	Dongsi Second and Third Ditches	6 heavy metals	17 May 2016
		Dongsi Second and Third Ditches and Babou Ditch (expanded control areas)	6 heavy metals	25 September 2018
	Miaoli County	Fongli Stream	6 heavy metals	03 May 2018
	Hsinchu City	Hsiangshan Irrigation Region	6 heavy metals	09 August 2018
Tightened effluent standards	New Taipei City	Taliaokung Stream and its branches	Copper	22 February 2017
		Daan Ditch and branches	True colorimetry and copper	22 February 2017
	Hsinchu City	Keya Stream and its branches; Sansing Stream and its branches	Copper	13 October 2017
	Hsinchu County	Chiedong Stream	Copper	07 December 2017
	Tainan City	Sanye Stream	Copper	30 August 2018

Wastewater Discharge in Fangli Stream Watershed in Miaoli County (control on six heavy metals: copper, zinc, nickel, total chromium, hexavalent chromium, and cadmium) was announced on 3 May 2018.

iii. The *Total Control Regulations for Wastewater Discharge in Hsiangshan Irrigation Region in Hsinchu City* (control on six heavy metals: copper, zinc, nickel, total chromium, hexavalent chromium, and cadmium) was announced on 9 August 2018.

iv. The *Total Control Regulations for Wastewater Discharge in Dongsi Second and Third Ditches and Babou Ditch in Changhwa County* (control on six heavy metals: copper, zinc, nickel, total chromium, hexavalent chromium, and cadmium) was revised and announced on 25 September 2018.

v. The *Tightened Effluent Standards*

in Sanye Stream Watershed in Tainan City (control on copper) was announced on 30 August 2018.

B. River water quality has been greatly improved with three major moves. First, in line with the *Irrigation-Use Water Protection Plan* (灌溉用水保護方案) formulated and implemented by the Council of Agriculture (COA), the EPA promoted the *Total Control for Farmland Water Bodies in Need of Special Protection*. As there are larger areas of farmlands with heavy metal pollution in Taoyuan City, Taichung City, and Changhwa County, they have been chosen as demonstration counties/cities. Total control zones for heavy metal discharge in farmland water bodies in need of special protection are designated in the three municipalities/counties, where total control of heavy metal discharge is implemented.

Second, the EPA strengthened inspection of rerouting and illegal discharge, joining forces with prosecutors and police. Third, the COA, the Industrial Development Bureau and the Ministry of Economic Affairs, jointly promoted the *Water Quality Protection Plan for Agricultural Irrigation*, banning direct wastewater discharge into irrigation ditches and assisting enterprises in phased rerouting of wastewater channels. In 2018, the percentage of heavy metal readings in Hsinchie Stream, Pushin Stream, Laujie Stream, and Nankan Stream meeting the irrigation water quality standards reached 99%. The percentage of satisfactory heavy metal readings in Janchuoyuan Ditch in Taichung City and Dongsi Second and Third Ditches in Changhwa County reached 100%. This shows total heavy metal control measures are

extremely effective in improving the water quality of irrigation water sources.

3. Cutting livestock wastewater pollution

(1) By working with agricultural authorities and local governments, the EPA continues to promote reduction of livestock wastewater pollution. Liquid and fiber digestate made from livestock manure via anaerobic fermentation is used as farmland fertilizers. From 2016 to 29 April 2019, liquid and sludge digestate from 535

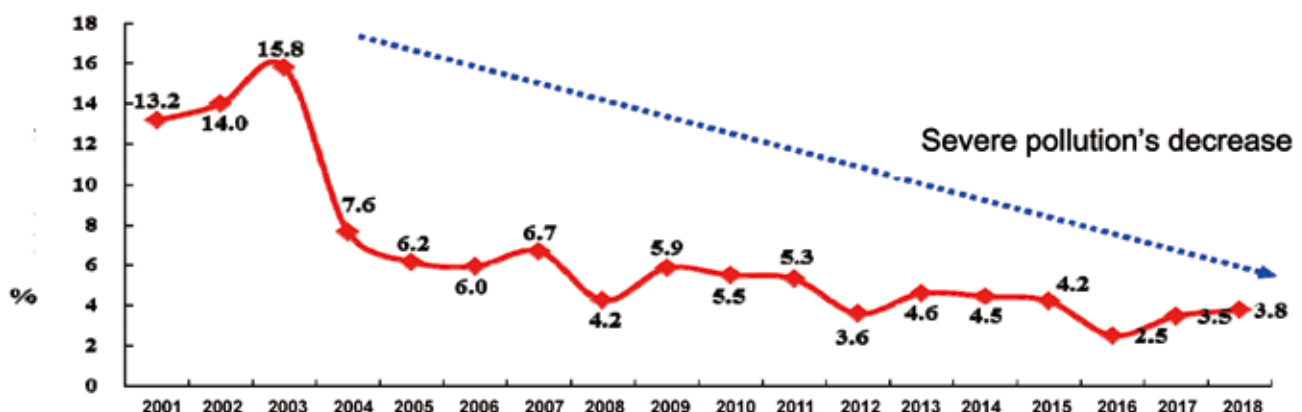
livestock farms were used to irrigate 1,541 hectares of farmland. Annual irrigation amounts have reached 1.83 million metric tons. Organic pollutants have been reduced by 10,874 metric tons per year, equivalent to the pollution reduced by 198 gravel oxidation treatment facilities with daily wastewater treatment capacity of 10,000 metric tons. The annual amount of nitrogen irrigated has reached 616 metric tons.

(2) For regions heavy with livestock operations, local governments and livestock and energy

enterprises are subsidized to set up treatment centers for centralized livestock manure reutilization. The centers collect livestock wastewater for anaerobic fermentation and reutilization of liquid and sludge digestate, greatly ameliorating pollution incidents in those regions.

(3) For small animal farms (with 20 to 199 heads of livestock), enterprises are encouraged to submit wastewater management plans, set up complete wastewater treatment facilities, and carry out manure reutilization.

📉 For water quality of 50 major rivers, the percentage of lengths with severe pollution dropped from 13.2% in 2001 to 3.8% in 2018, showing a trend of long-term reduction.



Percentage of Severely Polluted River-lengths in 50 Major Rivers

Water

Taiwan's First Water Resource Recycling Center Launched

On 29 April, reporters visited Taiwan's first water resource recycling center in Fongshan, Kaohsiung and learned about the importance of water recycling and reutilization in periods of water shortage. The center currently is able to provide 25,000 metric tons of water every day and is expected to expand capacity to 45,000 metric tons in the future.

The EPA mentioned that even after treating wastewater to reach the effluent standards allowed for discharge into rivers, the center does not discharge it into rivers.

Instead, it further turns it into cleaner water via quick quartz sand filtration, ultrafiltration (UF), and reverse osmosis (RO), which are then provided to factories inside

the industrial zones. After the piping was finished, the current daily 25,000-metric ton capacity is expected to increase up to 45,000 metric tons. Since the construction

was completed in August 2018, there has been a total of 11.87 million metric tons of renewable water provided to China Steel Corporation and C.S. Aluminum Corporation for cooling uses.

Lower river levels during the dry season also worsen river pollution conditions. If wastewater is purified, recycled, and reused in the manufacturing processes, use of clean river water can be cut. The more clean water that stays in rivers, the more livelihoods rivers can support.

To encourage treatment and reuse of wastewater, in recent years the EPA also amended water pollution control measures and managing regulations for testing and reporting. Industrial wastewater or sewage is to be treated until it conforms to the standards allowed for reuse. In some cases, certain control regulations are relaxed, for example for uses of industrial wastewater or sewage recycled for production processes, tower rinsing or other pollution prevention equipment. Also included are uses to prevent reverse flows back

into facilities used for wastewater or sewage treatment and pretreatment.

Wastewater treatment and reuse is one measure to alleviate future water shortages. For example, the water resource recycling center in Fongshan acts as a small reservoir in the city and provides a stable water supply for industries. It greatly reduces the dependence of businesses on rivers and reservoirs and in turn increases the base flow of rivers while improving water quality.

Air

Regulations Governing Stationary Source Pollution-Monitoring Equipment Amended

To strengthen the management of the continuous emission monitoring system (CEMS) for public and private premises, the EPA announced amendments to the *Management Regulations Governing Stationary Source Air Pollutant Continuous Automated Monitoring Facilities* on 12 April 2019. The purpose of the amendments is to increase the quality and reliability of monitoring data and reinforce audit capability and efficiency. The amendments include added regulations on the storage and audit of data from the data acquisition handling system (DAHS), and an extended time for retention of monitoring data.

The main points of the amendments are as follows:

1. Tracking records of signals from the DAHS and any related monitoring programs required to be archived shall be included in confirmation reports for audits conducted by competent environmental authorities.
2. The retention time for documents from monitoring facilities has been extended to six years, including: routine calibration and testing records, maintenance and repair records, original monitoring data, recorded values, history of use and quality control records of calibration gases and equipment.
3. The amendments have specified the submission time and required documents for reports regarding replacement, change of monitoring location or removal of monitoring facilities and internet transmission facilities. Also, to improve emission control on public and private premises, any changes to their monitoring facilities and internet transmission facilities are to be reported through the newly added procedures.
4. Online transmission has been adopted for monitoring equipment installation and document reporting, with the official enforcement date to be announced in the future.
5. To improve the precision of monitoring data, stipulations on test audit procedures and specifications for signal variations have been added for review purposes.
6. Testing procedures and specifications for NO₂/NO converter efficiency were included to strengthen the quality of monitoring data for NO_x emissions. Also, the EPA has formulated new specifications for relative accuracy test audits, relative accuracy audits, and cylinder gas audits for stationary sources with lower emissions.
7. Transmission sampling lines are required to be equipped with heating elements. In addition, reinforced regulations have been made for the following

procedures: zero and span drift checks, test audits, calibration gases and equipment. Revisions were also made to several calculation formulas, and proper time will be given to make adjustments.

8. To strengthen the general management system for stationary sources of pollution and to ensure the implementation of emission monitoring and reporting, regulations on penalties and punishments have

been adjusted.

The amendments listed above are only the first stage of the EPA's plan and mainly focus on the content that is deemed important by different fields and is feasible for immediate implementation. The EPA has already started working on further revisions which include: raising the percentage of effective quarterly monitoring hours, increasing the data transmission frequency of monitoring data status

codes and original data generated every minute, and altering data calculation principles and online transmission formats. However, the revisions above will require public and private premises to replace their monitoring and internet transmission facilities. Therefore, all related systems and programs for the updated facilities will be in need of adjustment and review by local environmental bureaus.

Environmental Monitoring

Enhancing Environmental Monitoring Capacity

Detailed and correct environmental monitoring information is the key foundation of promotion of various environmental policies as well as the reference for strategy formulation. Enhancement of environmental monitoring capacity, currently implemented by the EPA, is a major part of the policy, "Sustainable Earth." The actual measures fall under three categories: promoting the Internet of things (IoT) of environmental quality sensors, strengthening air and water body quality monitoring information service, and expanding open data service for environmental information integration.

Policy of enhancement of environmental monitoring capacity is detailed below.

1. Promoting environmental quality sensing IoT

(1) The EPA aims to, from 2017 to 2020, install 10,200 air quality sensing spots and 1,000 water quality sensors, establish a platform and system for sensor testing certification, and integrate systems of monitoring stations and sensing spots. Other tasks include setting up a smart environmental monitoring data center and a common application service and integration platform, and enhance the smart operation system for new-generation environmental law enforcement. The EPA hopes to achieve environmental protection

optimization via IoT.

To date, a total of 700 sensors have been installed for the air quality IoT in Taichung City, Guanin Industrial Area in Taoyuan City, Yingge District in New Taipei City, Dalinpu community in Kaohsiung, etc. In 2018, 13 city/county environmental bureaus were asked to cooperate with the EPA on sensor installation, and by the end of 2018, 2,600 sensors had been installed. The EPA will also cooperate with 15 city/county environmental bureaus to install sensors in over 4,000 spots by the end of 2019. Moreover, the EPA has been planning and setting up a center for certifying and testing sensing devices in the environmental IoT. The part for testing PM_{2.5} sensing had been finished in 2018. It was announced on 10 April that the Industrial

Technology Research Institute is commissioned to conduct function testing and certification for air quality sensing device.

In March 2019, the EPA approved cooperation projects from 2019 to 2020 to install 4,000 air sensors jointly with local governments. Yilan County, Keelung City, New Taipei City, Taoyuan City, Hsinchu County, Miaoli County, Chunghwa County, Yunlin County, Chiayi County and City, Tainan City, Kaohsiung City, and Pingtung County have been asked to proceed with sensor installation according to set plans.

(2) Establishing an environmental monitoring data center

The EPA has finished setting up the infrastructure for the environmental monitoring data center. It included managing multiple types of sensing equipment, supporting multiple

communication protocols, and establishing program interface, all for future application and development. Until now, data of the EPA's 700 sensing devices has been collected, and that of 77 monitoring stations (both national and regional) continues to be transferred. It is hoped that all information will be integrated in the IoT platform to enable each application system to, with subscription, display data in real time and develop innovative applications across different fields. The service, "Smart Environmental Management: Smart Law Enforcement Application via Environmental IoT", was one of the EPA's achievements in innovative environmental IoT applications. It even received from the Commuter Association the 2018 Smart City Innovative Application Award.

2.Strengthening air and water body quality monitoring information service

The EPA has been maintaining its 77 air quality monitoring stations to ensure normal operations and conducting manual PM2.5 monitoring in 31 stations. Monitoring data has over 96% of availability rate after going through quality control and is displayed online in real time. Every day there are three forecasts of air quality index for the coming three days, and a warning mechanism is in place from September to May to remind the public to take precaution against offshore pollutants (dust and smog from China). On the other hand, national air quality monitoring resources, such as stack emissions of pollution sources as well as air quality monitoring in industrial

areas, are integrated to disclose information for public supervision.

Water quality monitoring for water bodies like rivers, seas, reservoirs, groundwater, beaches, etc., continued in 2018. Some 90,000 pieces of regular monitoring information were added to water quality monitoring network for public inquiry and also put on the EPA's Open Data Platform and Environmental Info Push App for value-added applications. For better information service concerning water-related recreational activities, water quality monitoring was conducted three times at eight beaches during August 2018, with newsletters issued, so that the public can

watch out for safety and health.

3.Expanding open data service for environmental information integration

(1) Integrating environmental resource information

The EPA conducted the "Environmental Resource Database Integration Plan", developing diverse service by combining environmental information on atmosphere, water, earth, forests, and ecosystems. The Plan received the 2016 Cloud IoT Innovation Award, presented by Vice President Chen Chien-Jen, for its excellent application in the government category. With joint efforts of both the central and

In 2018 ●3,000 sensors installed in 14 cities/counties ●120 districts ●44 industrial parks and technology parks ●30,000 factories on control list	
2020 Mature promotion period	
2019 Fully built period	
2018 Cooperative period	
2017 Basic construction period	●To install 4,000 more air sensors ●12 cities/counties asked to cooperate with the EPA for installation and submitted applications for review ●13 cities/counties cooperated with the EPA on 2,600 sensors installation ●Cooperated installation completed in Yilan County, Keelung City, New Taipei City, Taoyuan City, Hsinchu City and County, Miaoli County, Yunlin County, Chiayi County, Tainan City, Kaohsiung City and Pingtung County ●700 sensors installed for the air quality IoT in Taichung City, Guanin Industrial Area in Taoyuan City, Yingge District in New Taipei City, Dalinpu community in Kaohsiung

Four stages of installation of air quality sensors in Taiwan

local governments, 2,184 pieces of information were exchanged and shared across different fields through data exchange systems between 2014 and September 2018. Air quality impacts were studied and analyzed by using both environmental resource information and that in other institutes, like traffic data, to increase applications. Also, the EPA has expanded common sensing information platforms by setting up the i-Environment website to provide integrated micro-information on the environment and taking in civilian-monitored real-time micro-information on air quality. These social media and platforms established by civilian makers include the multi-source Location Aware Sensing System, focusing on public welfare, as well as data collected from air boxes and open databases in municipalities, counties and cities. The public can now access local environmental information with ease. Since July 2018, all information mentioned above has been combined with the EPA's air quality sensing data so that integrated environmental information can be provided.

(2) Improving the Open Data platform for environmental information

In accordance with the Open Data

policy, 1,313 types of information had been disclosed by September 2018, with more than 300,000 views, citations, and downloads every day on average and over 52 cases of civilian applications. Moreover, the EPA expedites environmental information availability, improves quality of open data, and puts cloud application models of information service in practice.

On the other hand, the EPA strives to increase people's rights to access environmental information by improving information disclosure and transparency. In the Listed Pollution Source Data Search System, information registered by listed pollution sources and concerning penalties is updated continuously. More than 280,000 pieces of information on 70,000 listed enterprises are already disclosed for public inquiry, and violations were added in February 2018, followed by emissions of toxic and chemical substances. Implementation of the Open Data policy will continue with regular rolling reviews of the EPA's disclosed information and categories.

(3) Improving the Environmental Info Push App

The launch of the Environmental

Info Push App is an example of open data application. Real-time monitoring information, historic data, and forecasts can be viewed on charts and images. The App also offers notifications on air quality and sends out warnings. By September 2018, more than 430,000 people have downloaded it, with daily peak usage of 20,000 people as the highest record, millions of views every month, and average rating of over four stars. It has become the necessary environmental information service in users' daily lives.

The EPA kept optimizing its convenient mobile service applications in 2017 and brought forth the Environmental Info Push 2.2, which was chosen as one of 100 innovative products during the 2017 IT Month. The 3.0 version launched in February 2018 added hourly forecasts on air quality index for the coming 12 hours by establishing a forecast model with artificial intelligence algorithms and including meteorological data. This way, users can choose the most suitable hours and modes of transportation when planning outdoor activities. As a result, the EPA was honored with the Golden Graph Award from Taiwan Geographic Information Society in the category of application system.

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