



INTERNATIONAL
TRADE
ADMINISTRATION

2016 Top Markets Report **Environmental Technologies**

A Market Assessment Tool for U.S. Exporters

June 2016



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Executive Summary

The global market for environmental technologies goods and services reached USD 1.05 trillion in 2015. The United States is host to the single largest market and accounted for USD 303.0 billion of the global market. U.S. environmental companies exported USD 51.2 billion worth of goods and services in 2015. The U.S. industry for environmental technologies employed approximately 1.6 million people and had revenues of USD 320.4 billion.¹

The U.S. Environmental Export Initiative (EEI) is a sector-specific effort within NEI/Next that addresses the unique role environmental export promotion plays in advancing the economic, environmental and sustainable development and diplomatic goals of the United States. Led by the International Trade Administration (ITA) and the U.S. Environmental Protection Agency (EPA), the EEI is a government-wide initiative coordinated through the Environmental Trade Working Group (ETWG) of the Trade Promotion Coordinating Committee (TPCC).

The overarching goal of the EEI is to deliver, within the context of finite government resources, targeted trade promotion and policy programs that enhance the international competitiveness of the U.S. environmental technologies industry. Specific objectives include the dissemination of U.S. technical knowledge and expertise to foreign environmental regimes, the identification and removal of trade and competitiveness barriers, and the provision of targeted industry specific export promotion services to U.S. companies. This *Top Markets Report* supports the efforts of the EEI by identifying and ranking export markets where focusing finite government resources will have the greatest impact in terms of increasing commercial opportunity for U.S. companies.

Before a government strategy to address the opportunities and challenges to environmental technology exports can be developed, a common definition of the environmental technology industry must be established. From an industry perspective, environmental technologies are defined as all industrial goods and services that:

1. Foster environmental protection and physical resource efficiency in industrial settings;
2. Generate compliance with environmental regulations;
3. Prevent or mitigate pollution;
4. Manage or reduce waste streams;
5. Remediate contaminated sites;
6. Design, develop and operate environmental infrastructure; and
7. Afford the provision and delivery of environmental resources.

Environmental technologies are generally categorized by the three environmental media they are designed to protect or provide, which are air, water and soil.

Water, Wastewater, and Industrial Water

The water and wastewater treatment subsector includes key segments that include municipal drinking water treatment and delivery, municipal wastewater conveyance and treatment, ground and surface water remediation, industrial process water treatment, and industrial wastewater treatment. U.S. industry revenue in the water and wastewater treatment subsector in 2014 was USD 154.6 billion.² Key industry trends driving growth in 2016 include: zero liquid discharge, reuse and resource recovery; smart water; climate adaptation; and Public Private Partnerships (PPPs).

Air Pollution Control

The air media category deals with air pollution monitoring and control technologies for both stationary and mobile pollution sources. Stationary sources include emissions from thermal energy generation and those from industrial sources, such as boilers, incinerators, smelters and a variety of other emitting industries. U.S. industry revenues for air pollution control in 2014 totaled USD 19.6 billion, including equipment, instruments and attendance services.³

Municipal Solid Waste, Hazardous Waste, Recycling and Resource Recovery

The soil media category includes solid and hazardous waste management, recycling and resource recovery, and soil pollution prevention and remediation technologies. Revenues for the U.S. solid waste and recycling industry equaled USD 96.1 billion in 2014, driven predominantly by waste management services.⁴

Monitoring and Instrumentation

Crosscutting the three media categories is the monitoring and instrumentation subsector, which includes monitors and testing equipment for the air, water and soil; metering technology for water treatment and conveyance; and laboratory equipment and testing services. U.S. industry revenues in 2014 for instruments and information systems totaled USD 6.3 billion, led by instruments for water and wastewater management at USD 2.3 billion, followed by those for air quality at USD 1.3 billion and remediation at USD 1.1 billion.⁵

Environmental Consulting and Engineering

Environmental consulting and engineering also spans all media categories. The industry is underpinned by practitioners who design, develop and operate environmental infrastructure and systems. Environmental projects can be both free-standing and part-and-parcel of larger infrastructure tenders. Environmental Business International's (EBI) survey of the industry reports 2014 revenues of USD 28.9 billion in environmental consulting and engineering.

Understanding Export Promotion Strategies in the Context of Global Market Drivers

Rules Supersede Needs in the Global Market for Environmental Technologies

Environmental technologies develop in settings where the cost of non-compliance with environmental rules exceeds that of compliance, meaning that the environmental regime must be bound by a functional system of enforcement.

Resource Scarcity is an Emerging Driver of Environmental Technologies

Resource scarcity and the corresponding demand for resource efficiency are evolving and important drivers of environmental technology markets.

Export Promotion in Environmental Technologies

The United States hosts a comparatively advanced and sophisticated environmental technologies industry. The U.S. brand itself is highly valued globally, and U.S. environmental products are generally recognized for their excellence in innovation, engineering and durability. Despite the recognized excellence of the U.S. industry, companies face a variety of challenges in the international market:

Business Time Horizons

The time horizon for fostering a business relationship that leads to the sale of an environmental system typically is one to five years. For international markets, this translates into a substantial corporate investment in time and resources to develop a business partnership. It also leads to statistics indicating relatively poor success in U.S. export promotion activities -- the success horizon often exceeds the typical three-year limit for harvesting results from U.S. export programs.

Preferential Procurement Practices and Cost/ Quality Trade-offs

The sophistication of U.S. products coupled with the cost of production in the United States has a corresponding effect on price. The high price differential for U.S. technologies and systems can negate competitiveness in low-income markets.

Tariffs

Tariffs remain a substantial and limiting barrier to trade in environmental technologies.

Standards, Regulation, and Certification

Beyond tariffs, substantial and often insurmountable barriers exist for U.S. companies with respect to differential standards regimes, lack of regulatory compatibility, and failure to provide mutual recognition of product and professional certifications.

Data Gaps and Asymmetrical Market Information

Neither the Harmonized Tariff System (HTS) nor the North American Industrial Classification System (NAICS) accurately addresses the breadth of technologies and services within the industry, and therefore, assessing market size and opportunity is a persistent problem.

U.S. Government Resources and Coordination

ETWG agencies face a variety of challenges in promoting environmental exports, including a lack of the time and resources needed to effectively conduct interagency coordination; different missions, which may subordinate export promotion as a priority; diminishing staff and budget resources for program implementation; and limited mechanisms to transmit market information to industry and individual companies.

The Role for the U.S. Government

Given environmental technologies' market drivers and challenges both the industry and the U.S. government experience, successful export promotion in this sector has four critical components:

1. Policy dialogue and development,
2. Technical assistance for regulatory development and environmental management,
3. Direct promotion and advocacy, and
4. Financial vehicles for project development and export finance.

Top Markets 2016

The top environmental technologies markets in 2016 ranked in order are:

1. China

China is the largest and fastest growing emerging market for environmental technologies. The overall environmental technologies market in China (including goods and services) is valued at USD 60.7 billion (2016). China ranks first overall on the 2016 Top Markets Study (TMS) with a Composite Environmental Technologies Score of 100. China also ranks first across all three media categories, with scores of 47.4, 44.9 and 7.7 for the air pollution control, water, and waste and recycling markets.

2. Mexico

Unprecedented investment in environmental infrastructure has catapulted Mexico to the number two rank in the Environmental Technologies Top Market Study. U.S. environmental technologies exporters' benefit from close commercial ties with Mexico, but lagging Mexican technical capacity in the environmental sector could moderate the implementation of sophisticated projects and attendant opportunities for U.S. business.

3. India

Mounting and persistent pollution problems will lead to steady growth in India's fragmented environmental technologies market. The overall environmental technologies market in India including goods and services is valued at USD 16.3 billion (2016). India ranks third overall on the 2016 Top Markets Study (TMS) with a Composite Environmental Technologies Score of 31.7. India ranks second for water with a score of 16.3, sixth for air pollution control and seventh for waste and recycling markets with a score of 12.8 and 2.7, respectively.

4. Brazil

Brazil's ample market size and growing scope of opportunity for U.S. environmental technology producers is juxtaposed by varying levels of technical capacity, enforcement and finance for environmental project development. Persistent tariff and non-tariff barriers impede U.S. firms' ability to access the Brazilian environmental market.

5. South Korea

Since 2010, South Korea has worked to integrate green growth into its overall industrial development strategy. As a result, the market is making great strides in the implementation of advanced water treatment systems, air pollution control measures, and waste treatment and recycling. With an overall market valued at USD 20.6 billion and the U.S.–Korea FTA (KORUS) in place, Korea is a growing market for U.S. environmental technologies exporters. Domestic competition, however, is highly sophisticated, and understanding how to work within the Chaebol system is necessary.

6. Saudi Arabia

Saudi Arabia has a limited domestic environmental technologies industry and, therefore, imports the balance of the goods and services required to meet its environmental goals. Its preference for imported goods, pronounced water scarcity issues, and vast oil and gas industry make it a top market for U.S. environmental technologies. Recent budgetary tightening resulting from low oil prices, however, could slow implementation of the project pipeline.

7. Indonesia

Indonesia ranks seventh overall on the 2016 Top Markets Study (TMS) with the market for environmental technologies valued at USD 6.3 billion in 2016. Despite years of donor efforts to establish a modern environmental regime, weak technical capacity in the public sector and poor administration of assets guarantee that the application of environmental technologies in Indonesia, for the short-term, will remain the purview of the private sector and donor organizations.

8. Turkey

The overall environmental technologies market in Turkey, including goods and services, is valued at an estimated USD 7.3 billion (2016). Growth in the Turkish market is driven by European Union (EU) mandates and a national effort to provide basic sanitation services. Turkey ranks eighth in the 2016 Top Markets Report overall with a composite environmental technologies score of 22.1. Turkey ranks fourth for air pollution control markets with a score of 17.4. It ranks 24th for water with a score of 2.8 and 11th with a score of 1.82 for waste and recycling.

9. Poland

The overall environmental technologies market in Poland, including goods and services, has an estimated value of USD 7.0 billion (2016). Advanced by European Union (EU) mandates, Poland's environmental technologies market continues to grow. A disparate standards development system based on the precautionary principal, however, can make it difficult for U.S. technology providers to compete.

10. United Arab Emirates

The United Arab Emirates (UAE) environmental technologies market, including goods and services, is valued at USD 5.8 billion (2016). UAE ranks 10th overall on the 2016 Top Markets Study (TMS), with a composite environmental technologies score of 15.8. UAE's high relative score in the water and wastewater segment drive its ranking in this study, as data reporting for both the air pollution monitoring and control market and the waste and recycling market is lacking. There is evidence, however, that UAE is host to a robust air pollution control market and growing waste management market, validating its inclusion in the top 10 priority markets.

Overview and Key Findings

Introduction

The global market for environmental technologies goods and services reached USD 1.05 trillion in 2015. The United States is host to the single largest market and accounted for USD 303.0 billion of the global market. U.S. environmental companies exported USD 51.2 billion worth of goods and services in 2015. The U.S. industry for environmental technologies employed approximately 1.6 million people and had revenues of USD 320.4 billion.⁶

On May 14, 2012, then-Commerce Secretary Bryson and U.S. Environmental Protection Agency (U.S. EPA) Administrator Jackson announced the creation of the U.S. Environmental Export Initiative (EEI). The EEI is now a sector-specific effort within NEI/Next that addresses the unique role environmental export promotion plays in advancing the economic, environmental, sustainable development and diplomatic goals of the United States.

Led by the International Trade Administration (ITA) and the U.S. EPA, the EEI is a government-wide initiative coordinated through the Environmental Trade Working Group (ETWG) of the Trade Promotion Coordinating Committee (TPCC). The initiative leverages U.S. EPA's world-renowned regulatory and scientific expertise on solving challenging environmental problems with ITA and other TPCC agencies' trade policy, promotion and finance capabilities.

The overarching goal of the EEI is to deliver, within the context of finite government resources, targeted trade promotion and policy programs that enhance the international competitiveness of the U.S. environmental technologies industry and, in so doing, help mitigate global pollution problems. Specific objectives include the dissemination of U.S. technical knowledge and expertise to foreign environmental regimes, the identification and removal of trade and competitiveness barriers, and the provision of targeted industry specific export promotion services to U.S. companies.

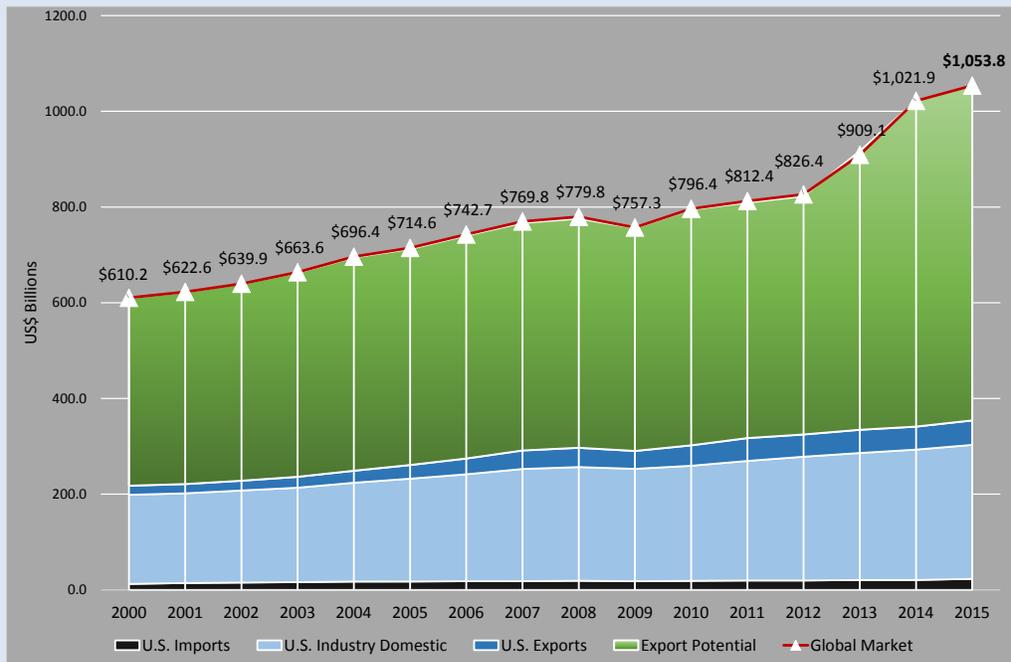
Top Markets: Key Findings and Methodology

This *Top Markets Report* supports the efforts of the EEI by identifying and ranking export markets where focusing finite government resources will have the greatest impact in terms of increasing commercial opportunity for U.S. companies. This study distills market forecasts and quantitative assessments into overall market scores that identify and rank export markets relative to three critical traits: first, markets that are large and growing in absolute terms; second, those that have a defined and increasing need for imported technology and services; and third, those where U.S. exports are lower than predicted, based on markets with similar characteristics -- this last component indicates that policy and trade barriers might exist and thus where U.S. government intervention is most helpful.

Figure 1: Environmental Technologies Top Markets Results

| | Water | Air | Waste | Composite Environmental Technologies Score |
|----|---------------------------|--------------------|------------------|--|
| 1 | China 44.9 | China 47.4 | China 7.7 | China 100.0 |
| 2 | India 16.3 | Mexico 26.2 | Indonesia 4.2 | Mexico 37.1 |
| 3 | United Arab Emirates 15.8 | Korea 18.3 | Pakistan 3.7 | India 31.7 |
| 4 | Oman 15.3 | Turkey 17.4 | Brazil 3.6 | Brazil 29.4 |
| 5 | Saudi Arabia 12.0 | Brazil 15.3 | Thailand 3.3 | Korea 27.3 |
| 6 | Brazil 10.5 | India 12.8 | Saudi Arabia 3.0 | Saudi Arabia 25.9 |
| 7 | Mexico 9.5 | Saudi Arabia 10.9 | India 2.7 | Indonesia 23.4 |
| 8 | Indonesia 9.3 | Indonesia 9.9 | Vietnam 2.1 | Turkey 22.1 |
| 9 | Poland 8.4 | Poland 8.6 | Korea 2.1 | Poland 17.7 |
| 10 | Korea 6.9 | Czech Republic 8.0 | Egypt 1.9 | United Arab Emirates 15.8 |

Figure 2: Global Environmental Technologies Market Overview



The rankings are then filtered further to adjust for mature markets that are relatively frictionless – markets that are large and open to U.S. products and services and that boast relative ease of doing business overall⁷. The final result is a list of large and growing markets where the scope of opportunity is countered by the presence of policy or other barriers; these are the markets where U.S. government policy and promotion activities have the highest potential for impact relative to the U.S. government resources available for policy and promotion activities. These markets and their environmental subsector are scored on a scale from 0 to 100, with 100 being the highest score achievable on the Composite Environmental Technologies Score. Utilizing these scores, the reader can assess the relative contribution of a given markets subsectors to its composite score and can compare both subsectors and composite scores across markets. (See Figure 1 for scores and rankings and the methodology section for a detailed description of this study’s methods).

The next step is a qualitative assessment of opportunities and challenges in the top 10 ranked markets. Industry and market experts collaborated on this effort to define the scope of opportunity for U.S. companies as well as to identify barriers and obstacles that should be addressed by the U.S. government. This

analysis leads to the subsequent identification of programmatic and policy remedies best suited to meet both the challenges and opportunities afforded in these critical markets.

This suite of programs forms a nexus of trade promotion and policy interventions that are mutually reinforcing. By considering both promotion opportunities and policy barriers in this context and developing a holistic response, this study serves as a strategic guide and foundational document to drive interagency coordination for environmental export promotion.

Global Industry Landscape

Understanding Global Environmental Markets

Before a government strategy to address the opportunities and challenges to environmental technology exports can be developed, a common definition of the environmental technology industry must be established. This is particularly important for environmental technologies, since the term could include any permutation of goods and services that might fall under the nebulous category of environmentally friendly or beneficial. In practice, producers of environmental technology have a clear

definition for their sector. From an industry perspective, environmental technologies are defined as all industrial goods and services that:

1. Foster environmental protection and physical resource efficiency in industrial settings;
2. Generate compliance with environmental regulations;
3. Prevent or mitigate pollution;
4. Manage or reduce waste streams;
5. Remediate contaminated sites;
6. Design, develop and operate environmental infrastructure; and
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Environmental technologies are generally categorized by the three environmental media they are designed to protect or provide, which are air, water and soil.

Water, Wastewater, and Industrial Water

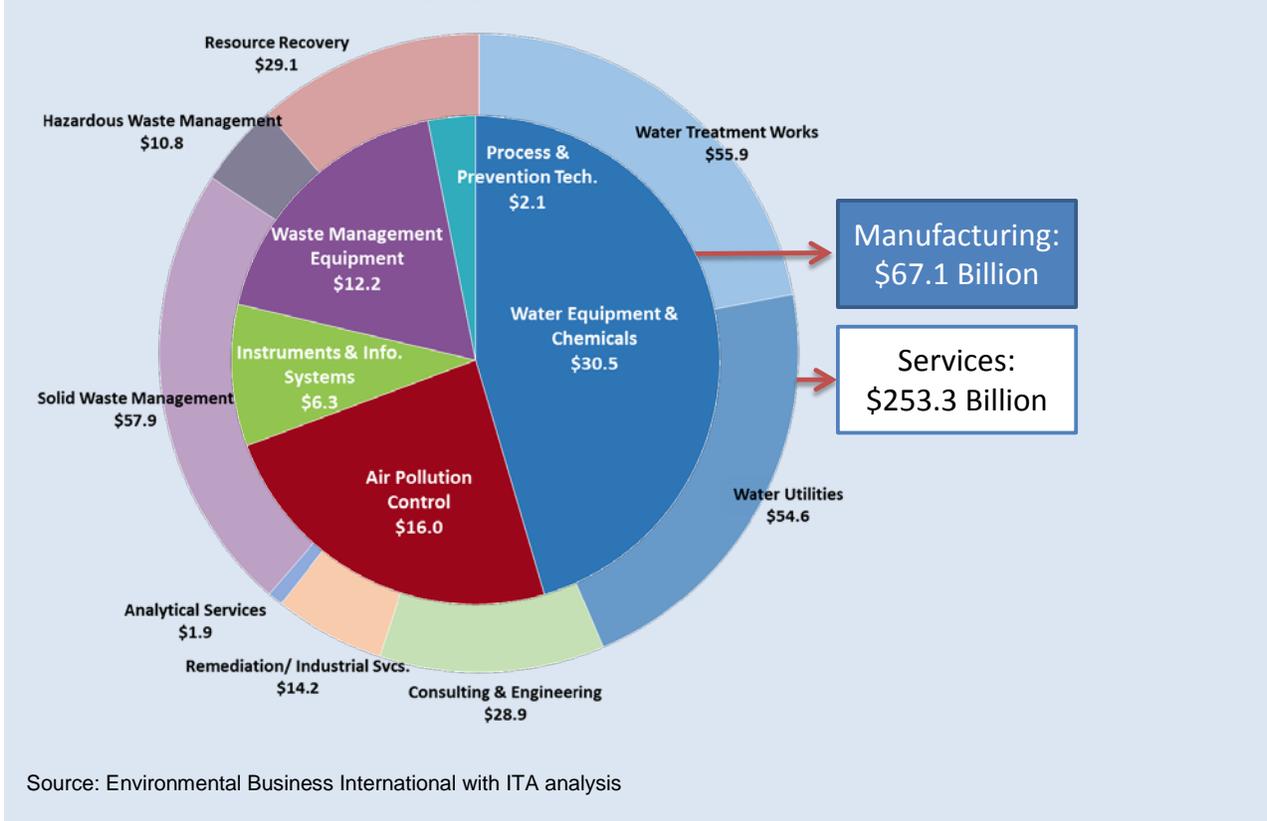
The water media category addresses the water and wastewater treatment subsector with key segments that include municipal drinking water treatment and delivery, municipal wastewater conveyance and treatment, ground and surface water remediation,

industrial process water treatment, and industrial wastewater treatment. U.S. industry revenue in the water and wastewater treatment subsector in 2014 was USD 154.6 billion; this figure includes analytical services, wastewater treatment services, consulting and engineering, equipment and chemicals, instruments and information systems, and utilities.⁸

Municipal drinking water treatment and delivery, municipal wastewater conveyance and treatment, and ground and surface water remediation are distinct from industrial water treatment, since the former deals primarily with public sector clients concerned with provision of water for human consumption and use and the protection of water as an ecological and social resource. The public utility aspect of these markets generally translates into a low degree of market flexibility and innovation due to a relatively greater regulatory burden that is applied in order to protect human health.

Alternatively, industrial process and wastewater (sometimes called “produced water”) speak to water’s value as an economic input for any variety of industries. As an industry segment, industrial water treatment solutions are diverse and sophisticated

Figure 3: U.S. Industry Revenues by Segment



compared to their municipal counterparts and are typically higher on the value chain overall. Generally, the cost and complexity of treatment technologies are positively related to the quality of water needed for the industrial process at hand while correspondingly, the cost and complexity of treatment for industrial wastewater is positively related to the scope of contaminant introduced during the industrial process and the regulatory burden applied to industrial effluents (i.e. water released back into public water bodies).

Key Market Trends and Themes for the Global Water Industry

Zero Liquid Discharge, Reuse and Resource Recovery

Water scarcity, increasing costs of fresh water intake for industrial uses and growing costs to meet stringent effluent discharge regulations are driving a trend toward Zero Liquid Discharge (ZLD). ZLD applies a process-tailored suite of advanced treatment technologies, such as evaporators, brine concentrators and crystallizers, to treat industrial effluent to high degree of purity for reuse. Companies employing ZLD systems produce no effluent and, in doing so, avoid effluent permitting and regulatory costs altogether. ZLD is a rapidly expanding technology suite utilized in industrial settings, in particular for power generation, oil and gas, and chemicals industries.

ZLD also provides companies with extracted organic or mineral solids, which can be reused on site to produce energy or as a manufacturing input or sold on the open market. In the municipal sector, the trend toward resource recovery, where wastewater treatment plants recover and use or sell energy, organic solids, minerals and nutrients, is best understood by many of these facilities referring to themselves as water resource recovery facilities (WRRF) rather than treatment plants. Growing technology areas for WRRFs include nutrient recovery and anaerobic digestion with combined heat and power.

Smart Water

Similar to ZLD and resource recovery, the growing trend toward improved water pricing, efficiency, conservation and loss-reduction is fueling investment in and deployment of smart water technologies.

Smart water technologies include those that automate monitoring and metering; treatment and distribution functions, loss and leakage; and metering and usage. These 'smart' components are a suite of automation and monitoring technologies tied together by a network based human interface and control component.

In utility and industrial settings, smart water is governed by supervisory control and data acquisition (SCADA) systems while the consumer interfaces can take the form of any combination smarter meter and consumption management technologies, including web enabled versions for personal mobile devices.

Climate Adaptation

Climate vulnerability is forcing utilities to fundamentally rethink how they move, treat and store water and wastewater products. Climate change poses three major challenges to water service providers: (1) disruption of service due to infrastructure failures caused by severe weather events, such as hurricanes; (2) combined sewer overflow due to increased frequency and severity of precipitative events, such as flash floods; and (3) water shortages caused by prolonged drought.

Climate related concerns are driving investment in fundamental changes in the configuration of water infrastructure that represent a paradigm shift in how water is managed. These include modular and mobile systems for emergency response; evaporation prevention technologies; water storage systems; groundwater recharge systems; storm water management; smart metering, billing and automated shut-off systems; and a slew of adaptive technologies for treatment processes with increased durability and the ability to treat variable rates of flow and volumes.

Public Private Partnerships (PPPs)

Public Private Partnerships (PPP) in water infrastructure are typically defined as an arrangement between the government and a private entity, often an Engineering, Procurement, and Construction (EPC) firm or private operator, where the private entity invests in partial or whole ownership of capital development and utility service in exchange for a share of tariff revenue and risk. The division of capital, service responsibilities, project and asset risk, and revenue sharing varies greatly among PPPs, and there is no standard model for how PPPs are structured. PPPs can therefore range

from basic operations concessions to Build-Own-Operate models where the private entity is the wholesale owner of the water infrastructure and utility service.

PPP projects and models are growing rapidly in number and complexity globally. Governments turn to PPPs to meeting funding gaps for infrastructure, provide more efficient service to consumers, and to defray project and asset risk. Businesses find PPPs to be lucrative long-term investments where tariff rates are optimized and tariff avoidance is low. The scope of opportunity for PPPs therefore rests in the quality and consistency of the rate payer, the government's ability to incentivize PPP projects through appropriate balancing of risk and financial incentives, and private sector willingness to navigate a sometimes complex contractual system of asset and revenue ownership, operation and transfer in order to maximize profitability.

Air Pollution Control

The air media category deals with air pollution monitoring and control technologies for both stationary and mobile pollution sources. Stationary sources include emissions from thermal energy generation and those from industrial sources, such as boilers, incinerators, smelters and a variety of other emitting industries.

A substantial segment of the industry is comprised of monitoring technologies, including the instrumentation and software required for public applications that monitor ambient air quality for the population at large. This segment also includes industrial and fence-line monitoring systems and software that assess specific industrial sites and applications as well as fence-line monitors for trans-boundary sources. U.S. industry revenues for air pollution control in 2014 totaled USD 19.6 billion, including equipment, instruments and attendance services.⁹

Control technologies are determined by the scale of the emitting industry and scope of the pollutants that are limited by the control technology. Large emitters, like concrete producers and coal-fired power plants, use systems the size of a city block that cost in the millions to produce and run. Smaller operations, such as those attached to medical incinerators, have a substantially lower footprint and cost profile. Mobile sources, including marine diesel engines, non-road

diesel engines and automobile engines, are a primary example of scale driven systems and unit pricing. An example of the scalability of control technologies can be found in passenger vehicles, which have a catalytic converter that does not exceed two feet in length and width.

Key Market Trends and Themes for the Global Air Pollution Control Industry

Emissions Control for Coal-Fired Power Plants

Parts of Asia, especially China and India, are continuing to view coal as a primary power source. A significant percentage (approximately three-quarters) of planned new coal-fired power plants worldwide for the near and medium-term are slated to be installed in one of those two countries. Depending on the stringency of the regulatory environment, if realized, these plans are likely to result in an abundance of both retrofit and new installation opportunities for stationary source emission reduction and control technologies in the next five to 10 years. The types of technologies needed for a given power plant will depend on regulatory requirements. The variety of coal to be burned is also relevant, as pollutant levels differ for different kinds of coal. In addition to demand for more traditional technologies used to limit or control NO_x, SO_x, particulate matter and mercury emissions, state-of-the-art and new and emerging technologies - particularly those designed for multi-pollutant control - are likely to be of great interest. Emerging technologies include non-carbon sorbents for removal of flue gas mercury, as well as non-thermal plasma (NTP) and treated activated coke for multi-pollutant removal.

Municipal Solid Waste, Hazardous Waste, Recycling, and Resource Recovery

The soil media category includes solid and hazardous waste management, recycling and resource recovery, and soil pollution prevention and remediation technologies. Like municipal water treatment, solid waste is subject to a high degree of regulatory burden due to the public policy considerations related to waste management. The types of technologies needed depend on the composition and properties of the waste generated. Revenues for the U.S. solid waste and recycling industry equaled USD 96.1 billion in 2014, driven predominantly by waste management services.¹⁰

The recycling industry is driven by demand from materials markets, and its growth is positively related to the increase of price for raw materials. The hazardous waste management industry, which deals with industrial wastes that require independent treatment and storage technologies due to the potential for contamination, accounted for USD 19.4 billion in revenues during 2014.¹¹

Key Market Trends and Themes for the Global Waste Management and Recycling Industry

Sustainable Materials Management/Circular Economy

Sustainable materials management (SMM) is a systemic approach that emphasizes the productive use and reuse of materials throughout their entire life cycle. Historically, societies have viewed the life cycle of a product as linear and unidirectional, e.g. from production to use to disposal. SMM is an alternative approach that emphasizes employing used materials as a resource, rather than discarding them as waste, in a 'closed loop' or cyclical process. Beginning with materials extraction and following with each stage in a product's life, the product – or more precisely, the materials from which it is made – are viewed as key and valuable inputs for other processes. The goal is to reduce consumption of new materials and generate minimal waste. SMM has gained traction among policymakers and the public as an integrated solution to address environmental concerns. It can also help industries decrease costs associated with the purchase of typically expensive virgin materials, as well as enhance efficiency and reduce materials losses during production. It may be more difficult to implement on a municipal scale, however, as MSW reduction is often labor intensive and can be expensive when compared with the cost of disposal, particularly for areas lacking the necessary infrastructure.

Conversion Technologies

Solid waste conversion technologies include gasification, plasma arc gasification, pyrolysis and thermal depolymerization. These technologies differ from traditional waste incineration processes because they do not involve combustion. Instead, they typically use thermal degradation or electric current to convert the organic fraction of solid waste to liquid fuels, syngas, biogas, heat, electricity and/or chemical products, depending on the inputs and the process. Most of these conversion technologies are proven for homogenous waste streams and are operating

commercially in several locations outside of the United States. There is limited data on their effectiveness for mixed waste or MSW feedstocks, particularly on a larger scale. As population and waste generation rise and disposal becomes more costly, however, interest in and opportunities for conversion technologies are likely to increase.

Monitoring and Instrumentation

Crosscutting the three media categories is the monitoring and instrumentation subsector, which includes monitors and testing equipment for the air, water and soil; metering technology for water treatment and conveyance; and laboratory equipment and testing services. U.S. industry revenues in 2014 for instruments and information systems totaled USD 6.3 billion, led by instruments for water and wastewater management at USD 2.3 billion, followed by those for air quality at USD 1.3 billion and remediation at USD 1.1 billion.¹²

Environmental Consulting and Engineering

Environmental consulting and engineering also spans all media categories. The industry is underpinned by practitioners who design, develop and operate environmental infrastructure and systems. Environmental projects can be both free-standing and part-and-parcel of larger infrastructure tenders.

An example of a free-standing environmental project includes the site assessment, design, engineering, construction and operation of a wastewater treatment facility, whether municipal or industrial. An example of a part-and-parcel project is the site assessment, environmental impact assessment and sustainability design components to building a new hospital.

The project definition and scope variability of this services component to the environmental sector contributes to difficulty in establishing reliable environmental industry figures. Nonetheless, Environmental Business International's (EBI) survey of the industry reports 2014 revenues of USD 28.9 billion in environmental, consulting and engineering.

Though interrelated in terms of their collective impact on ecology, the environmental technology media subsectors and segments generally function as independent markets driven by both regulation and demand from client industries. The implications for an

Figure 4: Challenges and Opportunities Matrix

| | CHALLENGES | OPPORTUNITIES |
|-----------------|---|--|
| MARKET | <ul style="list-style-type: none"> • Preferential Procurement • Differential Standards and Regulatory Models • Availability of Finance • Government Support for Foreign Competitors • Low Technical Sophistication | <ul style="list-style-type: none"> • Unprecedented Growth • Regulatory and Standards Development • Quality & Sophistication of U.S. Products and Services • Recognition of U.S. Brand & Reputation |
| U.S. GOVERNMENT | <ul style="list-style-type: none"> • Industry Specific Data Gaps • Diffuse Number of Programs • Diminishing Resources • Interagency Coordination • Differential Missions • Marketing and Communication | <ul style="list-style-type: none"> • ETTAC – ETWG Policy Development • Web-based & New Media Tools • Partnerships with Key Industry Players • NEINext Platform |

Source: Environmental Technologies Trade Advisory Committee (ETTAC) and ITA analysis

environmental technology export promotion strategy are that these diverse and complex markets must be complemented by a promotion strategy appropriate to their respective market drivers.

Challenges, Barriers, and Opportunities

Understanding Export Promotion Strategies in the Context of Global Market Drivers

Rules Supersede Needs in the Global Market for Environmental Technologies

To establish an effective export promotion strategy for U.S. environmental technologies, one must dispel a common misconception of how environmental markets are established and function. Neither environmental needs, like the lack of potable water, nor conservation philosophies, such as desire to steward natural resources for future generations, translate into a tangible market for environmental technologies.

Instead, environmental technologies markets develop when galvanized by the creation of an environmental protection regime. Specifically, environmental markets develop in settings where the cost of non-compliance with environmental rules exceeds that of compliance, meaning that the environmental regime must be bound by a functional system of enforcement.

In the absence of enforcement, compliance failures negate the implementation and maintenance of environmental protection systems regardless of the scope of environmental challenges in market. A recent example of this is air pollution control in China. The Chinese government articulated its first air pollution control law in 1987 followed by revisions in 1995 and 2000. Despite high legal standards for air pollution mitigation, the absence of an effective enforcement mechanism has led to China’s pervasive and widely reported air pollution problems. Data from the U.S. Embassy in Beijing show that from April 2008 to March 2014, only 25 days qualified as “good” air quality days using U.S. standards.¹³ The implication for export promotion is that needs-based approaches fail to accurately anticipate market opportunity.

While regulatory enforcement is typically the mode of environmental market creation, finance is the means. Environmental technology markets do not catalyze without resources to fund public environmental infrastructure projects and private environmental compliance costs. For this reason, the analysis in this study emphasizes national mechanisms to finance public environmental infrastructure in its assessment of the readiness to implement projects related to stated national environmental goals.

Resource Scarcity is an Emerging Driver of Environmental Technologies

Resource scarcity and the corresponding demand for resource efficiency are evolving and important drivers of environmental technology markets. Since environmental resources, such as water, play an integral role in industrial production, their value as an input creates demand for technology that enables efficient use and reuse. An example of this relationship is the boom in investment and development of water treatment and reuse technologies for the recovery of natural gas through hydraulic fracturing. The productive value of a cubic meter of water in the hydraulic fracturing process is estimated to be about USD 1.54.¹⁴

Comparatively, a cubic meter of water used in agriculture has a productive value of approximately USD 0.13,¹⁵ which demonstrates why investments in water efficiency in natural gas extraction are seen as profit enhancing. Between 2005 and 2012, venture capital firms made an estimated USD 415.1 million in investments for new treatment technologies to promote reuse of produced water and better manage the cost of process water in extractive industries.¹⁶

Similarly, the entire recycling industry is predicated on the price of materials and the relatively lower cost of non-virgin materials as productive inputs. As the price of virgin materials historically has risen with energy and other associated costs and has been compounded by overall scarcity, the demand for recycled materials has grown along with the technologies required to produce them. Over the past year, however, as the global price of oil and other commodities has fallen, so, too, have prices for recycled materials, which has adversely impacted both recyclers and technology providers.

Capital efficiency and industrial hygiene demands also can introduce the need for environmental technologies. An illustrative example is the need for mercury removal technologies in gas combustion power plants since even low levels of mercury present in the natural gas fuel stream can destroy heat exchangers and other essential energy production equipment.

Demand for resource efficiency-driven environmental technologies is expected to increase as resource scarcity is compounded by demographic, social and

ecological trends, including climate change, population growth, urbanization, and per capita income growth and attendant consumption pattern changes.

Export Promotion in Environmental Technologies

The United States hosts a comparatively advanced and sophisticated environmental technologies industry. The U.S. brand itself is highly valued globally, and U.S. environmental products are generally recognized for their excellence in innovation, engineering and durability. This reputation stems from the maturity and independence of the regulatory regime through the United States Environmental Protection Agency (U.S. EPA).

U.S. EPA's application of scientific rigor and its separation from industry interests in its rule making process has lent it a global reputation as the gold standard in environmental protection policy making. Thus, the industry that U.S. EPA helped promulgate receives similar respect for the efficacy of its systems. Global buyers also recognize the U.S. brand for the services associated with U.S. environmental technologies, which emphasize long-term business and engineering relationships over short-term sales opportunities. Despite the recognized excellence of the U.S. industry, companies face a variety of challenges in the international market:

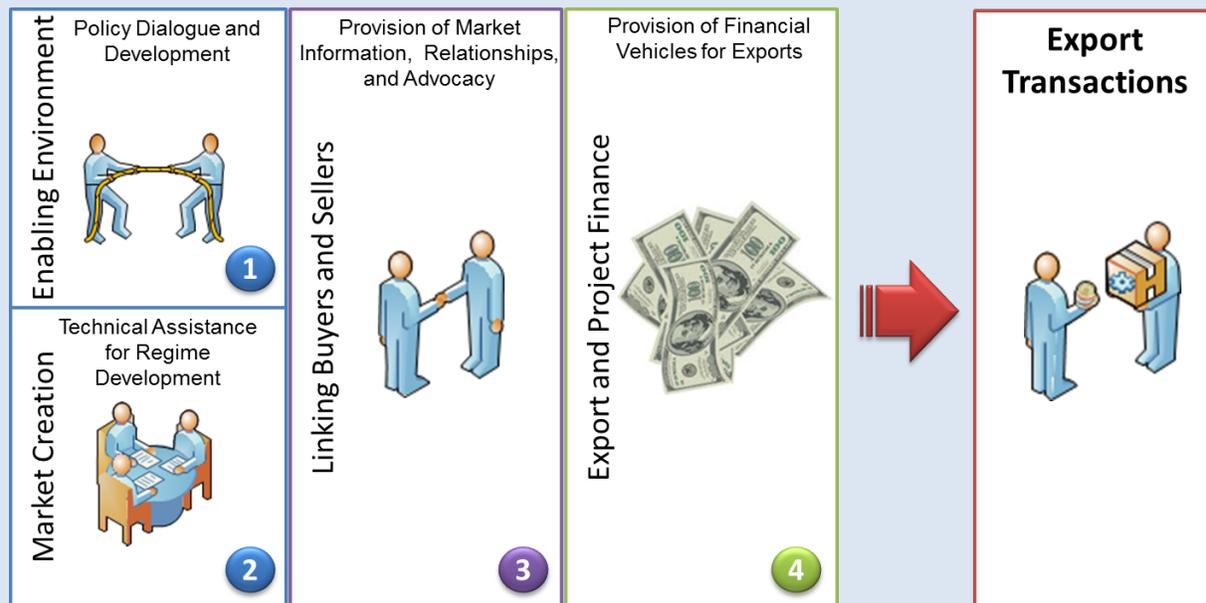
Business Time Horizons

The time horizon for fostering a business relationship that leads to the sale of an environmental system typically is one to five years. For international markets, this translates into a substantial corporate investment in time and resources to develop a business partnership. It also leads to statistics indicating relatively poor success in U.S. export promotion activities and correspondingly a diminished interest within government to support programs for the industry -- the success horizon often exceeds the typical three-year limit for harvesting results from U.S. export programs.

Preferential Procurement Practices and Cost/ Quality Trade-offs

The sophistication of U.S. products coupled with the cost of production in the United States has a corresponding effect on price. The high price differential for U.S. technologies and systems can

Figure 5: Environmental Technologies Export Promotion Process



Source: ITA/Office of Energy and Environmental Industries

negate competitiveness in low-income markets. U.S. products may also be foregone in the short-term for lower-cost and less durable alternatives despite the long-term operational cost competitiveness of U.S. products. Similarly, preferential procurement practices that favor domestic competitors or competitors from aid-donor countries can create an overall environment of unfair competition for U.S. companies.

Tariffs

Tariffs remain a substantial and limiting barrier to trade in environmental technologies. The United States Trade Representative (USTR)¹⁷ reports tariff peaks in environmental technologies among World Trade Organization (WTO) members of 20 percent for air pollution control, waste management and recycling, and monitoring and instrumentation products. Tariffs for water and wastewater products are as high as 21 percent. In many markets, high tariffs compound the price differential for U.S. environmental technologies, making U.S. products prohibitively expensive in many markets or eroding profitability of U.S. goods in export markets.

Standards, Regulation, and Certification

Beyond tariffs, substantial and often insurmountable barriers exist for U.S. companies with respect to different standards regimes, lack of regulatory compatibility, and failure to provide mutual recognition of product and professional certifications.

The United States drives innovation in part through its approach to standards, which emphasizes performance-based measures of conformity where practicable and predicates standards and testing protocols on the principles of science, risk assessment and cost-benefit analysis. This creates conflict in foreign markets that emphasize design-based standards models and utilize the precautionary principle in developing standards and regulation, an approach which eliminates the practicability of performance-based design, stymies innovation and narrows the field of applicable technologies to those developed within the destination market. It also imposes onerous additional fees for testing and conformity assessment to similarly performing technologies and equally rigorous professional certifications.

Data Gaps and Asymmetrical Market Information

Weak trade and market data has plagued the environmental technologies industry for some time. Neither the Harmonized Tariff System (HTS) nor the North American Industrial Classification System (NAICS) accurately address the breadth of technologies and services within the industry, and therefore, assessing market size and opportunity is a persistent problem (see methodology section for how these gaps are addressed in this study).

The U.S. market is large and, until recently, substantial enough to support the business aspirations of many U.S. environmental technology providers. Saturation in the U.S. market, however, coupled with explosive growth in emerging markets, makes international growth inextricably linked with companies' growth. Small and medium-sized enterprises need to identify markets where their technologies are in demand and develop the business relationships that will lead to future sales. The lack of market data makes it difficult to determine where opportunities are the greatest and makes it difficult for individual companies to discern where their specific products are in demand.

U.S. Government Resources and Coordination

ETWG agencies face a variety of challenges in promoting environmental exports. These challenges include a lack of the time and resources to effectively conduct interagency coordination; different missions, which may subordinate export promotion as a priority; diminishing staff and budget resources for program implementation; and limited mechanisms to transmit market information to industry and individual companies.

The Role for U.S. Government

Given environmental technologies' market drivers and challenges both the industry and the U.S. government experience, successful export promotion in this sector has four critical components:

1. Policy dialogue and development,
2. Technical assistance for regulatory development and environmental management,
3. Direct promotion and advocacy, and
4. Financial vehicles for project development and export finance.

Policy Dialogue and Development

The objectives of policy dialogue and development are two-fold: 1) identify and eliminate existing trade barriers, and 2) prevent new barriers from forming in order to generate an enabling environment for environmental technologies exports. This is achieved through bilateral, regional and multilateral fora. Current efforts include elimination of tariffs for environmental goods through plurilateral negotiations to achieve an Environmental Goods Agreement in the World Trade Organization.

Important regional discussions and negotiations include the Transatlantic Trade and Investment Partnership with the European Union, the Trans-Pacific Partnership and Asia Pacific Economic Cooperation discussions in Asia, while key bilateral fora include the U.S.–China Joint Commission on Commerce and Trade Environment Working Group and the U.S.–Brazil Commercial Dialogue.

Technical Assistance for Regulatory Development and Environmental Management

The regulatory nature of the industry means that the U.S. government can be particularly effective in facilitating the creation and expansion of environmental export markets by providing technical assistance that creates opportunities to encourage the development of compatible regulatory approaches and an attendant compatible industrial environment. Technical assistance increases understanding of the efficacy of U.S.-style approaches, particularly the emphasis on solutions underpinned by science. Technical assistance can also yield favorable market results when it facilitates the creation of mechanisms for enforcement as well as knowledge and expertise for the maintenance and management of environmental systems.

The interagency ETWG engages in “soft” technical assistance by providing publicly available resources, such as the U.S. Environmental Solutions Toolkit (URL), which is an online searchable database that marries U.S. EPA scientific and regulatory expertise with a catalogue of technology providers for specific environmental issues. There are also a variety of ‘hard’ technical assistance programs, including the series of memoranda of understanding that U.S. EPA develops with partner governments to provide technical know-how to foreign regulators.

Since failures of environmental systems can harm human health, the risk associated with implementing new technologies is high and can prevent the introduction of new technologies altogether. Similarly, a lack of technological know-how is a formidable barrier to the development and implementation of environmental systems. The U.S. Trade and Development Agency works to address both of these challenges by funding demonstration projects in select emerging markets and educating foreign officials and buyers through reverse trade missions (RTMs).

Direct Promotion and Policy Advocacy

Direct promotion and policy advocacy facilitates company and industry export sales by identifying and advocating for the removal of acute trade barriers and by delineating market opportunities and facilitating subsequent business relationships. ITA, along with other TPCC agencies, provides businesses with market information, trade counseling and opportunities to develop international business relationships.

Provision of Financial Vehicles for Project Development and Export Finance

Finance is a limiting factor to environmental technologies exports, from both the project

development and the export finance perspective. The Overseas Private Investment Corporation helps fill the gap in project development finance by funding and facilitating the development of foreign infrastructure projects. Direct export finance is provided to U.S. companies through the Export-Import Bank of the United States, which provides a suite of export finance and insurance products to facilitate export transactions.

Top Markets in Context

The subsequent chapters of this report provide a market and policy overview of the top 10 global markets where U.S. trade policy and promotion interventions can yield the best results for the U.S. environmental industry. The country analysis is supplemented with an overview of existing ETWG programs that support policy and promotion in these markets and recommendations for additional government programs to address trade obstacles and opportunities in the sector.

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Country Case Studies and Regional Supplements

The following pages include country case studies and regional supplements that summarize U.S. environmental technologies export opportunities in selected markets. The markets represent a range of countries to illustrate a variety of points– not the top markets overall.

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China

China is the largest and fastest growing emerging market for environmental technologies. The overall environmental technologies market in China (including goods and services) is valued at USD 60.7 billion (2016). China ranks first overall on the 2015 Top Markets Study (TMS) with a Composite Environmental Technologies Score of 100. China also ranks first across all three media categories, with scores of 47.4, 44.9, and 7.7 for the air pollution control, water, and waste and recycling markets (see Appendix 1 for global rankings).



The scope, size and expected growth of China's market for environmental technologies is unmatched, but market barriers, particularly those related to protection of intellectual property, continue to make China a challenging market in which to operate.

State of the Environmental Regime

China's environmental regime has improved in recent years with the development of a national legal framework that supports the mitigation of pollution across all three environmental media. Enforcement, however, remains weak to non-existent, since it is delegated to municipal and regional governments whose focus centers on economic development. In 2014, China fundamentally restructured its approach to environmental regulatory enforcement with the introduction of the amended Environmental Protection Law (EPL). The revised EPL took effect on January 1, 2015 and serves as an enabling statute that could yield stronger adherence to environmental rules, if incentives and penalties therein ultimately prove to be greater than the cost of non-compliance.

The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent in the world), substantiates the business perception of improved environmental rules in China. China scored a 3.6 in 2012, a 1.8 point improvement from its 2005 score of just 1.8. Similarly, China scored a 4.11 on the World Economic Forum's 2011 Index for Regulatory Stringency (on a similar scale to that of EBJ-OECD) while China's score in the same survey for enforcement was just above the median at 3.82.

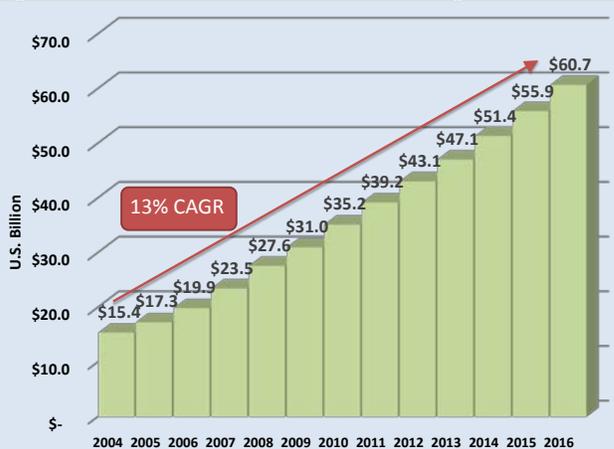
Though the EPL came into effect more than a year ago, many local authorities still have yet to implement or enforce its provisions, and efforts to encourage public interest environmental law suits from non-governmental organizations under the revised law have so far resulted in only 36 court cases across 13 provinces.¹⁸ Although the longer-term effectiveness of the EPL remains to be seen, the legal text highlights improved efforts at monitoring, a path toward legal recourse to address public harm imposed by polluters, authority to halt projects that exceed pollution limits, requirements for key point sources to publicly disclose their primary pollutants, accountability of local officials to higher-level officials and daily fines towards polluters that exceed the cost of compliance.

Market Barriers

Market barriers in China are persistent and prohibitive in many cases. In its most recent charter, the U.S. Department of Commerce's Environmental Technologies Trade Advisory Committee (ETTAC), along with industry experts in the Office of Energy and Environmental Industries (OEEI), identified the following barriers as most problematic for environmental technologies companies attempting to export to, or work in, China:

- 1. Complex intellectual property environment**
Intellectual property rights infringement continues to affect U.S. businesses working in China and complicates operations in the country.
- 2. Technical barriers to utilization of advanced environmental technologies.**

Figure 1: China Environmental Technologies Market



Source: *Environmental Business International*, 2016.

Chinese authorities use a series of reference technologies to identify which environmental solutions should be applied in a given process. The introduction of new or novel technologies and processes often requires the development of a demonstration project at the expense of the company to prove the efficacy of the technology. Since environmental rules are enforced on the municipal and provincial level, it is often necessary to repeat this process in several provinces.

- "Strategic Emerging Industries", State Owned Enterprises, and preferential procurement.** Exporters to China may also face headwinds from State-Owned Enterprises seeking to crowd out competitor technologies and establish a state-sponsored monopoly. This effect should only increase in the future since environmental technologies have been designated as one of the government's seven strategic industries intended to generate growth based on domestic consumption (as opposed to China's export-led policies of the last 30 years.) Furthermore, government tenders often exhibit open or explicit preference for domestic bidders over foreign tenders.
- Local certifications and safety approvals not recognized as exporting market equivalents.** The ETAC reports that many certifications, such as the CMC certificate, are available only for locally produced products. Furthermore, government tenders sometimes demand

special certifications, which are only granted to local products.

5. **Political disincentives to enforce environmental rules.**

Enforcement of environmental rules occurs at the city and provincial levels through local Environmental Protection Bureaus (EPBs). The EPBs answer to the mayor or provincial governor, whose promotion potential as a party official is based primarily on demonstrating economic growth. This dynamic assures that environmental goals are almost always subordinated to economic development goals. The revised Environmental Protection Law (EPL), if fully enforced, may serve as a remedy to systemic weaknesses in enforcement by incentivizing environmental protection in bureaucratic performance measures and penalizing those who fail to enforce the law with demotion, dismissal and potential criminal prosecution.

Market Opportunities

Air Pollution Control

Ambient Air Monitoring

In late 2013, the State Council issued the Airborne Pollution Prevention and Control Action Plan. The state air plan stipulates a 25 percent reduction in particulate matter for the Beijing-Tianjin-Hebei region, a 20 percent reduction for Shanxi and Shandong, and a 10 percent reduction for Inner Mongolia. In 2015, China also amended its national Air Pollution Prevention and Control Law. The revised law took effect on January 1, 2016 and places the onus directly on city and municipal governments to improve local air quality, as they will be subject to oversight by a national-level coordinating body accountable to the State Council. In addition, major emitters are now required to install automated monitoring equipment and to publish their emissions data.¹⁹ With the exception of Beijing, no other cities have sufficient monitoring networks to establish the baseline for reductions or to monitor progress.²⁰ Implementation of the state plan and amended Air Pollution Law will thus require the development of a series of ambient air monitoring networks and should yield opportunities for U.S. air pollution monitoring and instrumentation companies.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

Industrial Air Pollution Reduction

In its Nationally Determined Contribution (NDC) for the December 2015 Paris Climate Agreement, China committed to reach peak carbon emissions by 2030 or earlier. China's NDC also calls explicitly for the control of emissions from key industries, specifically iron and steel, nonferrous metals, building materials and chemicals. The recently-amended Air Pollution Law follows on China's NDC commitments by expanding the list of centrally-controlled pollutants beyond solely NOx and SOx to include particulate matter, Volatile Organic Compounds (VOCs) and greenhouse gases.²¹ If enforced, this emissions reduction effort will require the immediate implementation of control technologies at industrial sites. Industries that will be of the highest interest for the application of control technologies include iron, cement and steel plants; oil refineries; non-ferrous metallurgical plants; coal boilers; and petrochemical plants.

Key Technologies in Demand:

- Wet/dry scrubbers (particularly systems that remove multiple pollutants)
- Carbon injection systems (for reduction in mercury and organics)
- Particulate matter control systems (particularly new bagging systems)
- NOx, mercury, CO2 and particulate matter monitoring and continuous monitoring systems
- Selective catalytic and non-catalytic reduction controls
- Oxygen enrichment, fuel injection and other efficient combustion technologies
- Innovative specialty cements
- Mixing technologies
- Pumping and fluid handling equipment
- Engineering and plant design
- Leak detection equipment
- Alternative fuel technologies used to fire cement kilns

Power Plant Emissions Reduction

The Chinese power generation sector is heavily reliant on coal. China currently accounts for 45 percent of global installed coal-fired capacity and, in the past, has applied few, if any, central measures to reduce particulates and other criteria pollutants, such as sulfur oxides (SOx), nitrogen oxides (NOx) and mercury. Coal-fired power plants generated 67.5 percent of China's energy in 2013,²² significantly contributing to air quality issues in the region. Despite China's commitments under the Paris Climate Agreement to increase the share of non-fossil fuels in primary energy consumption to 20 percent by 2030, coal is expected to remain the dominant fuel in the power sector in coming years.²³ Thus, reducing coal-fired based emissions is a key pillar of China's recent series of air pollution related reforms.

Though China has prohibited the building of new coal-fired power plants around three major cities—Beijing, Shanghai and Guangzhou—coal-fired capacity is increasing closer to the inland coal-producing centers to alleviate air pollution affecting major urban areas along the east coast. In 2015 alone, at least 155 planned coal-fired projects received permits.²⁴ The government is tightening regulations on both new and existing coal-fired power plants, including reducing allowed levels of particulate matter (PM) in certain areas to 5 mg/Nm³.²⁵ The newly amended Air Pollution Law also requires all older coal-fired plants to be retrofitted to meet environmental standards. The Hebei region in particular relies heavily on coal-fired power to fuel the nation's steel industry but has committed nonetheless to a reduction in coal consumption of 40 million tons. Maintaining production while reducing coal consumption will require switching to cleaner burning fuels and administering control technologies. Similarly, the Beijing Air Pollution Control Action Plan stipulates an approach to power generation that includes fuel switching to natural gas.

The Chinese government has also ratified the Minamata Convention on Mercury. The convention is an international and legally binding instrument to reduce mercury use and emissions. The text of the Minamata Convention was adopted by over 150 countries, including China, in January 2013. Given that coal-fired power plants represent a major source of airborne mercury (and other toxins), the

implementation of this instrument will further foster Chinese interest in air pollution control emission control technologies.

Key Technologies in Demand:

- Continuous emissions monitoring systems
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Electrostatic precipitators (wet and dry)

Mobile Source Emissions Control

China's amended Air Law also includes provisions covering emissions from motor vehicles and non-road machinery. Enforcement and compliance with regulations in this area traditionally have been lacking. The amended Air Law shifts responsibility for regulation of air pollutants to local officials, who must be incentivized to push for compliance. If the proper incentives are put into place, the government is now empowered to recall vehicles in violation of regulations and can issue substantial fines to violators.²⁶

In Beijing, on-road vehicles currently account for a significant percentage of pollutant emissions, including 86 percent of carbon monoxide, 57 percent of nitrogen oxide and 31 percent of PM2.5, according to the International Council on Clean Transportation. As part of its progressive program to continue to reduce vehicle emissions, Beijing, in late 2015, proposed more stringent vehicle emission standards (Beijing 6/VI) for light-duty vehicles that are based on California's emissions standards. The new standards are likely to be implemented by early 2017 and should create an important opportunity for U.S. emission technologies on new gasoline vehicles sold in Beijing and, potentially, the surrounding Jing-Jin-Ji capital region.²⁷

Key Technologies in Demand:

- Emissions control technologies for motor vehicles and non-road (diesel) vehicles and machinery

Waste Management and Recycling

Solid Waste and Recycling

Over the next decade, China's municipal solid waste (MSW) generation is expected to increase on pace with

its rapidly growing and urbanizing population and is likely to reach 1.39 million tons per day by 2025.²⁸ Of the MSW that currently is being collected and recorded by municipalities, approximately 82 percent is landfilled, 15 percent is incinerated and 3 percent is composted.²⁹ China outlined its goals for recycling and solid waste in its 12th Five-Year Plan (2011 – 2015), which included comprehensive resource recovery from bulk solid waste such as public associated mineral resources, coal powder, coal gangue, industrial by-product gypsum, refining and chemical waste, tailings, construction waste, as well as straw, livestock wastes and waste wood. The Government of China aimed to achieve a comprehensive utilization rate of 72 percent by the end of the Five-Year Plan period.

Key Technologies in Demand:

- Waste pile design and sampling
- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise

Recycling of Discarded Electronics

In 2011, the Chinese government implemented a series of regulations to guide the domestic processing of discarded electronics and electrical appliances called the *Rules on the Administration of the Recovery and Disposal of Discarded Electronic and Electrical Products (or China WEEE)*. According to the Global E-Waste Monitor report, China generated about 6 million tons of e-waste, or about 37.5 percent of the total generated in Asia in 2014.³⁰ China's current electronic scrap recycling infrastructure is dominated by small-scale collection operations, informal recycling facilities and outdoor recycling markets.

Guided by the Ministry of Environmental Protection and funded by a levy on electronics sold throughout the country, the current recycling infrastructure will be replaced by a large network of sophisticated electronics recycling facilities. In 2011, the Institute for Scrap Recycling Industries (ISRI) estimated that 6 percent of U.S. export sales of scrap equipment were destined for China.

The relatively sudden explosion in Chinese demand for equipment and recycling services presents opportunities to U.S. companies with experience in

providing equipment or services used in the safe and efficient recovery of valuable materials from discarded electronics.

Key Technologies in Demand:

- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise

Hazardous Waste Management

In November 2012, the Chinese government adopted an action plan to address mounting environmental and health issues related to improperly managed hazardous waste (medical, chemical and heavy metal). The Chinese Ministry of Environmental Protection estimates 60 million tons of hazardous waste are generated annually as of 2015. With current disposal capacity at approximately one-third of that amount, there is an urgent need to develop disposal capacity commensurate to the scope and size of waste production. Four billion dollars have been set aside to construct 300 hazardous waste disposal facilities and initiate brown field remediation projects throughout China.

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Water and Wastewater Treatment

The State Council issued its highly anticipated Clean Water Action Plan in April 2015.³¹ The plan sets a series of ambitious targets for 2030, including achieving excellent water quality in seven major water sheds, elimination of “black and odorous” water, and achieving an overall water quality of level-3 or better for 95 percent of point sources in urban areas.³² The action plan delineates 26 detailed requirements and 238 measures³³ to achieve improved water quality and promote water stewardship. Key themes are improved industrial effluent management, municipal of the plan include wastewater treatment, water reuse, enhanced monitoring and new enforcement mechanisms. The Ministry of Environmental Protection estimates that

plan implementation is valued at USD 920 billion over the next five to seven years.³⁴

Municipal Water and Wastewater Treatment and Plant Development

Aggressive construction of water treatment plants continues as China works to improve water quality and enhance access to drinking water and sanitation services. The Ministry of Environmental Protection (MEP) announced in 2014 that it would invest USD 329 billion in addressing water pollution, which will include treating municipal and industrial wastewater.³⁵ In the coming years, China hopes to protect the drinking water sources and improve the water quality in centralized drinking sources. The government hopes to expand and promote the protection and management of important water resources.

In the 2016 to 2017 tender period, the total value of drinking water, wastewater and desalination projects expected to be tendered is USD 543.5 million across 18 projects.³⁶ The marquee opportunity is Guangdong province’s Jieyang Waste Water Treatment Package project, which strings together nine waste water treatment plant projects in a single tender worth an estimated USD 33.3 million.³⁷ Furthermore, the South-to-North Water Diversion Project mandates the construction of 426 wastewater treatment plants along the eastern route to treat heavily polluted surface waters.³⁸ Tightening of national regulations will provide retrofit opportunities for existing plants to move beyond mechanical treatment alone and introduce improved chemical and biological methods.

Key Technologies in Demand:

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

Water Transmission and Storm Systems

The Clean Water Action Plan outlines several major initiatives to reduce non-revenue water, expand

wastewater collection capacity and manage storm water. The plan calls for remediation or replacement of all transmission pipelines in service for more than 50 years with a goal to reduce non-revenue water to 12 percent by 2017 and 10 percent by 2020. Another ambitious goal is to provide universal wastewater collection and treatment capacity. By 2020, the plan calls for collection and treatment levels to reach 85 percent in semi-rural and suburban areas and 95 percent in urban areas. An accelerated goal has been outlined for the Beijing-Tianjin-Hebei region, the Pearl River Delta and the Yangtze River Delta, which are set to achieve 95 percent collection and treatment levels by 2019. Furthermore, cities and provincial capitals with independent planning status must achieve universal collection and treatment by 2017. The plan also requires the elimination of combined sewers and the introduction of distinct storm water systems that include storage and reuse capabilities where feasible as well as the design of storm water drainage systems that contribute to groundwater recharge.

Key Technologies in Demand:

- Engineering, procurement and construction services
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems
- Leak detection equipment
- Trenchless technologies
- Catchment design and construction
- Pipe rehabilitation technologies

Sludge Treatment

China discharges approximately 22 to 30 million tons of untreated sludge annually,³⁹ a growing and persistent environmental challenge. Recent government action has led to the development of technology standards for sludge treatment, a requirement that municipalities install sludge treatment systems and a central government capital development investment of RMB 60 billion (USD 9.6 billion) for sludge treatment facilities. The Clean Water Action Plan calls for enhanced processing of 90 percent of sludge from cities and prefectures, including sludge stabilization, disinfection and resource recovery. Nonetheless, lack of domestic operational expertise and technology for sludge treatment remains a challenge for China that could provide sludge treatment opportunities for U.S. firms.

Key Technologies in Demand:

- Engineering and design
- Sludge disinfection systems
- Sludge dewatering and drying systems
- Anaerobic digestion
- Bio-gas/natural gas recovery
- Nitrogen and phosphorus recovery technologies

Groundwater Monitoring, Pollution Prevention and Remediation

Much of China's groundwater resources have been degraded by pollution, limiting their use as a reliable source for drinking water. The Ministry of Land Resources reports that 57 percent of ground water ranks 'bad' or 'very bad' in quality estimates.⁴⁰ The *National Groundwater Contamination Prevention and Remediation Plan* calls for an RMB 34.7 billion (USD 6.2 billion) investment through 2020. Groundwater protection efforts are focused on monitoring, source control and remediation.

The 12th Five-Year Plan delineates the study of pollution assessment, monitoring and simulation in order to establish a national monitoring system and quality standards. Source control research focuses on hazardous waste storage, landfill contamination, oil and gas extraction, mining, agriculture, and underground piping and disposal systems to establish control techniques and rules. China seeks to address contaminated groundwater by conducting a groundwater pollution remediation pilot study that will inform national approaches to groundwater remediation and lead to subsequent large-scale remediation projects. U.S. Superfund experience in environmental remediation creates a competitive advantage for U.S. companies.

Key Technologies in Demand:

- Monitoring equipment
- Source pollution control technologies
- Sparging
- Bioremediation
- Chemical treatment
- Flushing
- In-situ air stripping
- Multiphase extraction
- Permeable reactive barrier
- Phytoremediation
- Pump and treat

Water efficiency and reuse

China's scarce fresh water resources have made water efficiency and reuse a national priority designed to limit further economic disruptions due to water shortages. The Clean Water Action Plan sets a reuse goal of 20 percent or more in water scarce areas by 2020. The seriousness of the economic impact of water scarcity led the State Council to note in the plan that water conservation is now a performance metric for municipal and provincial governments. The plan explicitly calls for water reuse in coal-mining, metal production, textiles, tannery, pulp and paper, chemical, and petroleum industries.

These priorities will be a boon to membrane, non-revenue water management and industrial water efficiency technologies. It is estimated that water reuse will lead to 30 percent annual growth over the next five years in the membrane technology market.⁴¹ Beijing is following through with plans to emphasize water reuse, with the Miyun Yunxi Zutuan and Changping water reuse projects that are worth an estimated USD 25.9 million and USD 64.8 million, respectively.⁴² Both projects are expected to be tendered during 2016.⁴³

Key Technologies in Demand:

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

Process and Produced Water

The aggressive stance of the Clean Water Action Plan on industrial water treatment and reuse combined with new effluent standards and better enforcement thereof are driving growth in process and produced water treatment. The plan calls for strengthened pollution control, effluent treatment and reuse in many of its water-intensive industries, particularly in petroleum refining, chemical production, pharmaceuticals, chemical fiber manufacturing, non-ferrous metallurgy, textiles, pulp and paper, coking, fertilizer production, food and beverage, tanneries, pesticide production, and electroplating.

The plan also calls for a systematic approach toward ports, industrial clusters and special economic zones, including export processing zones. Those areas will be serviced by central wastewater and solid waste processing facilities with continuous monitoring capabilities, and manufacturers therein will be subject to pre-treatment requirements for industrial effluent. The plan requires the implementation of treatment and monitoring capabilities by the end of 2017, indicating that there may be ambitious efforts on the part of Chinese manufactures to acquire and implement improved monitoring and treatment technologies.

Key Technologies in Demand:

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

Soil Remediation

Weak or non-existent waste management strategies, including the failure to develop sanitary landfills, has led to prevalent soil pollution in China. The Ministry of Environmental Protection and the Ministry of Land Resources report that 16.1 percent of China's soil is polluted⁴⁴ and that of this total, 19.4 percent of arable land is polluted. Much of this contamination is non-organic with the most prevalent pollutants being cadmium, nickel and arsenic. Soil pollution threatens the safety of agricultural products and contributes to groundwater pollution through leaching.

In 2014 and 2015, the central government allocated RMB 130 million (about USD 19.8 million) to support six national pilot projects in the Hunan, Shandong, Hubei, Guizhou, Zhejiang and Guangdong provinces and RMB 2.8 billion (about USD 425.7 million) to support 30 regional pilots focused on remediation of heavy metals in soil. China is expected to release its National Soil Pollution Prevention and Treatment Action Plan in 2016. The expected accompanying budget allocations for remediation also are likely to be supported by the 13th Five Year Plan (2016-2020). In the coming years, a substantial remediation effort should yield opportunities for U.S. providers of remediation technology and services.

Key Technologies in Demand:

- Engineering and design
- Monitoring equipment

Environmental Consulting and Engineering

The new Environmental Protection Law stipulates that all new construction projects must undergo an Environmental Impact Assessment (EIA) before construction permits can be issued.⁴⁵ Similar to the U.S. National Environmental Policy Act (NEPA) if fully implemented, EPL will develop a massive industry for EIAs, an area where U.S. environmental engineering and consulting firms have substantial expertise.

Key Technologies in Demand:

- Environmental impact assessment

ETWG Agency Initiatives and Programs

U.S. – China Environmental Industries Forum (EIF)

The EIF engages U.S. and Chinese officials and businesses in a series of technical and policy-oriented discussions designed to enhance the U.S.-China commercial and environmental partnership. The goal of the EIF is to facilitate the development of a robust environmental protection regime and corresponding environmental technology markets. Themes and topics of focus for 2016 and future EIF events may include air, water, chemicals, soil and waste.

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's environmental regulations, related underlying research and a directory of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. A Mandarin language version of the Toolkit was recently introduced.

The Toolkit is used by U.S. EPA officials and environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns and in fostering U.S.-Chinese partnerships. This includes the U.S.-China Joint Commission on Commerce and Trade, the Air Action Plan of the U.S.-China Strategic and Economic Dialogue's Ten Year Framework on Energy and Environment, the U.S.-China Joint Committee on Environmental Cooperation, and others.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Chinese participants and to foster business relationships between Chinese end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Chinese participants and to introduce Chinese buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Chinese officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

Green Cement Best Practices Guide

The stated goal of the Chinese Ministry of Environmental Protection is to create a *Green Cement Best Practices Guide*. For years, the U.S. government has worked to support green cement efforts in China, including funding the development of the "BEST" tool (Benchmarking Energy Efficiency Standards Tool), which recommends best practices to improve cement kiln combustion efficiency and limit air pollutants. These activities are being leveraged to support the completion of a Chinese Best Practices Guide and are utilized in various bilateral forums to introduce Chinese end users to relevant environmental solutions providers.

Mercury Reduction Engagement

The United States and China are exchanging experiences in tackling various environmental concerns caused by mercury, highlighting existing approaches and required technologies. Improperly handled solid state mercury can contaminate the environment, as can airborne mercury falling back to earth. This engagement is advancing goals related to commitments made during recent international mercury reduction negotiations and supports the Chinese efforts to improve hazardous waste management and remediation practices.

CIEPEC U.S. Pavilion

The China International Environmental Protection Exhibition and Conference (CIEPEC) is the Ministry of Environmental Protection's biennial sponsored trade show and conference. CIEPEC draws officials from all regional Environmental Protection Bureaus (EPBs) and municipalities, providing access to the tendering organizations that are developing water and wastewater treatment plant projects. A U.S. pavilion during CIEPEC provided U.S. companies with an opportunity to promote their participation in specific projects.

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<http://www.solidwaste.com.cn/>

Water China
<http://www.h2o-china.com/>

China City Water
<http://www.chinacitywater.org/>

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Mexico

Unprecedented investment in environmental infrastructure has catapulted Mexico to the number two rank in the Environmental Technologies Top Market Study. U.S. environmental technologies exporters benefit from close commercial ties with Mexico, but lagging Mexican technical capacity in the environmental sector could moderate the implementation of sophisticated projects and attendant opportunities for U.S. business.

| | | | |
|--------------|---|-----------------------|----|
| Overall Rank | 2 | Air Pollution Control | 2 |
| Water | 7 | Waste & Recycling | 13 |

The overall Mexican environmental technologies market, including goods and services, is valued at USD 14.7 billion (2016).⁴⁶ Mexico ranks second overall on the 2016 Top Markets Study (TMS), with a composite environmental technologies score of 37.1. Mexico’s air pollution monitoring and control market is the most prominent environmental technology segment and ranks Mexico second globally, with a score of 26.2. Mexico’s water sector ranks seventh overall, with a score of 9.5. For waste and recycling, Mexico ranked 13th, with a score of 1.4 (see Appendix 1 for global rankings).

State of the Environmental Regime

Mexico’s environmental legal standards are improving thanks to recent legislative efforts, but compliance remains a challenge. This change is reflected through the Environmental Business Journal (EBJ)-OECD’s

Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent). Mexico scored a 4.0 in 2012 on the EBJ-OECD Survey, a 0.7 point improvement from its 2005 score. Mexico’s ranking on the World Economic Forum’s 2011 Index for Regulatory Stringency of 45th globally, with a score of 3.99 (on a similar scale to that of EBJ-OECD), echoes this result, indicating that Mexico’s legal framework is above the median and improving. Mexico’s ranking in the same survey for enforcement, however, lags at 57th globally, with a score of just 3.42, highlighting the need for improved compliance measures.

Mexico’s environmental regime is based upon two fundamental pieces of legislation: the General Law of Equilibrium and Environmental Protection (LGEEPA) and the General Law for Prevention and Integral Management of Wastes (LGPGR). In 2012, President Calderon signed the first General Climate Change Law in Mexico. The Law accelerates implementation of programs for air pollution monitoring and control in particular. Mexico further emphasized its commitment to reduce greenhouse gas emissions in its Nationally Determined Contribution (NDC) under the COP 21 Paris Agreement in December 2015. The NDC calls for reducing GHG emissions by 22 percent and black carbon by 51 percent from business-as-usual levels by 2030.

The Mexican Ministry of Environment and Natural Resources (SEMARNAT) governs and implements environmental regulation and is also responsible for issuing environmental tenders for air pollution monitoring, soil remediation, waste management and projects that fall under the recently promulgated

Figure 1: Mexico Environmental Market



Source: Environmental Business International with OEEI Analysis 2016.

national Climate Change Strategy.

Water tenders are the purview of the National Water Commission (CONAGUA). CONAGUA manages water resources at a federal level and is the only entity authorized to delegate or grant concessions for water use. Municipal governments provide water services to communities through decentralized municipal water utilities known as “*organismos operadores*”.

While these water utilities are tasked by law with developing water service infrastructure, due to subsidized and inadequate water rates, commercial inefficiencies and a lack of technical capacity in many cases, however, CONAGUA has been the de facto developer and financier of water infrastructure projects throughout the country.

Market Barriers

Over the past 20 years, the North American Free Trade Agreement (NAFTA) has removed many barriers to trade with Mexico. The following barriers, however, do persist for environmental technologies companies attempting to export to or work in Mexico:

1. Local partnership is encouraged in public tenders.

While not a formal requirement, local partnership in public tenders is strongly encouraged in Mexico. U.S. companies hoping to develop consortia relationships with Mexican companies should seek assistance through the U.S. Commercial Service to identify appropriate and credible partners for engineering, procurement and construction (EPC) contracts.

2. Value added taxes diminish competitive pricing of U.S. environmental technologies.

While U.S. companies enjoy duty free privileges under NAFTA, a Value Added Tax (VAT) of 16 percent, while imposed on domestic and foreign goods alike, further erodes the price competitiveness of higher quality, and thus more expensive, U.S. environmental technologies.

3. Finding a credible distributor with national reach can be difficult.

The benefits due to acceptance of U.S. products, as well as low tariffs afforded by the NAFTA, are often counter-balanced by

difficulties arising from Mexico’s size and diversity, which can be under-estimated by U.S. exporters. It can be difficult to find a single distributor or agent to cover this vast market, and assistance with locating the appropriate distributor for a given product segment is often required. Mexican companies are extremely price conscious, seek financing options, tend to push for exclusive agreements, and value outstanding service and flexibility.

4. The presumption of conformity is not extended for international standards in Mexico.

Companies exporting to Mexico will need to meet Mexican standards and demonstrate conformity. The cost of accreditation for a single product in Mexico through *Entidad Mexicana de Acreditación* is approximately USD 4,875. Mexico hosts a national NSF International office, which can help ease the accreditation and conformity assessment process. Mexico does not explicitly extend the presumption of conformity, however, and therefore, it is recommended that U.S. companies work with NSF Mexico or another relevant testing and certification organization to determine a cost-effective path toward meeting Mexican standards and certification requirements.

Market Opportunities

In 2015, the Mexican government allocated USD 100 million to SEMARNAT to support federal, state and municipal environmental projects throughout the country. U.S. firms can access the most current lists of funded projects on SEMARNAT’s website.⁴⁷

Air Pollution Control

Air Quality Monitoring

The ambient air quality of many Mexican large metropolitan areas, particularly Mexico City, Guadalajara, Toluca and Monterrey, is poor and can lead to increased incidence of respiratory disease. For example, the concentration of nitrogen dioxide (NO_2) in Mexico City is above the national standard nine days out of 10. Most metropolitan areas in Mexico have air quality monitoring mechanisms and local regulations in place; however, enforcement of these regulations is

often weak as many of the municipalities do not have sufficient technical capability or resources.

Official ambient air monitoring is conducted by the Mexican environmental federal regulator SEMARNAT, which tenders openly to U.S. businesses. Increased opportunities under the Climate Change Strategy's Program for the Strengthening of the Environment of States (*Programa de Fortalecimiento Ambiental de las Entidades Federativas*), which provides funding for projects at the municipal, state and federal level for compliance with environmental rules,⁴⁸ should emerge for monitoring as local governments ramp up their monitoring efforts.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services

Air Pollution Control

In terms of air pollution control approaches, various regulatory plans call for vehicle emissions testing, catalyzer replacement programs and industrial pollutants reduction. Moderate regulatory enforcement, however, has translated into moderate demand for these technologies compared to the overall potential in Mexico's industrial market. While vehicles and other mobile source control measures have long been emphasized, meeting the goal of reducing harmful emissions will require implementation of control technologies for industrial sources.

The Climate Change Law aims to reduce the country's output of carbon dioxide by 51 million tons, forcing Mexican companies to report and reduce their emissions. Furthermore, this law also focused on the reduction of short-lived climate pollutants like black carbon, methane, tropospheric ozone, hydrofluorocarbons (HFCs) and Volatile Organic Compounds (VOCs). Compliance with the General Climate Change Law will require industries to institute improved monitoring and control technologies, opening up a variety of opportunities for in-line and end of pipe industrial monitoring systems.

Technologies and Services in Demand:

- Air pollution control equipment
- Fuel vapor control systems

- Selective Catalytic Reduction
- In-line monitors and software
- Electrostatic precipitators
- Thermal oxidizers
- Catalytic converters
- Scrubbers

Water and Wastewater Treatment

While the population percentages for drinking water and sewage services connection are 89.6 percent and 86 percent, respectively, large gaps still remain in serving rural areas, where both resources and infrastructure is scarce. Lack of access to potable water and sewerage is a fundamental challenge Mexico is seeking to address through the National Water Plan 2014-2018. The government estimates that 9 million Mexicans do not have access to potable water and that 11 million do not have access to sewerage. The overall Mexican municipal water and wastewater market is expected to grow 7 percent annually between 2013 and 2018.

Subsequent projects are to be financed through public private partnerships (PPPs), a model recently adopted through the Public and Private Partnership Law. The new PPP model anticipated USD 950 million of private investment in 2014 to match the CONAGUA's allocation of USD 6 billion,⁴⁹ During the 2015 to 2018 period, CONAGUA's budget for water infrastructure development is USD 4 billion, which will be leveraged to develop 1,200 new potable water treatment plants, the upgrading of wastewater treatment plants, new desalination plants, water pipelines and dams.⁵⁰ U.S. companies interested in developing PPPs should work with CONAGUA, which will remain the tendering agency for these projects.

Municipal Drinking Water Treatment

Drinking water conveyance and distribution are expanding at a steady rate in Mexico. Total mains water consumption is expected to rise from 169,356 million m³ in 2014 to almost 194,546 million m³ by 2018. This is largely due to the continued expansion of the pipeline network and increasing number of households connected to water mains.⁵¹ Water infrastructure projects will continue to grow at a 4.3 percent rate through 2015 following the 2013 Mexican housing market crash, which negatively impacted the construction industry.⁵²

Water treatment facilities are also upgrading to improve coverage. CONAGUA plans to invest USD 200 million in upgrades to existing drinking water plants in the states of Morelos, Puebla, Guerrero, Coahuila, Sinaloa, Tamaulipas, Zacatecas, Mexico City and Veracruz.⁵³ The push for centrally distributed water services is likely to continue, which will discourage the implementation of decentralized systems.

Consumer confidence in the ability of municipalities to deliver safe potable water is low; this has driven double-digit growth in residential treatment options as a backstop to the water quality issues encountered in urban and suburban areas of Mexico.

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Pipes, pumps and valves
- Clarifiers and flocculators
- Sedimentation systems
- UV disinfection
- Ozone disinfection
- Meters and monitoring equipment
- Point-of-use treatment equipment

Municipal Wastewater Treatment and Plant Development

Wastewater treatment continues to lead in Mexico's environmental priorities, as it is the least developed part of Mexico's water sector. Less than 50 percent of wastewater receives treatment,⁵⁴ though Mexico has almost doubled the volume of wastewater being treated in the last decade, indicating that expansion of services is not keeping pace with demand. Mexico's most recent National Water Program, released in 2013, sets treatment goals of 100 percent for municipal waters by 2030, requiring a near USD 500 million public annual investment in wastewater treatment plants.

Currently, over USD 1.7 billion is invested in wastewater infrastructure, USD 1.1 billion in sewers and USD 621 million in treatment plants. Development of new wastewater plants in the states of Puebla, Colima, Yucatan, Quintana Roo, State of Mexico, Nayarit, Guerrero, Colima and Mexico City,⁵⁵ as well as USD 150 million in upgrades to existing wastewater plants in the states of Aguascalientes, Chihuahua, Guanajuato, Jalisco, Nuevo Leon, Oaxaca, Puebla and Mexico City,⁵⁶ is also planned.

Technologies and Services in Demand:

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

Desalination and Water-Efficiency

Mexico is increasingly faced with scarce water supplies, and the heavy reliance of the agricultural sector on these resources is straining an already troubled system.⁵⁷ Unsustainable extraction from ground and surface sources has threatened the stability of the conventional water supply.

Mexico is turning to alternative methods in an effort to protect surface water and aquifer sources while providing fresh water for human consumption and industry. Areas facing significant scarcity challenges include large urban centers in northern and central Mexico and the western Baja Peninsula. Promoting efficient water use by industry and citizens and building complementary efficient local water utilities is a key government priority.

In northern Mexico, authorities are coping with water scarcity through the construction of new reservoirs and costly transport infrastructure, implementation of complex purification technologies, and increases in tariffs to improve supply and encourage conservation. An example of this type of infrastructure expansion can be found within the 2015 to 2016 project pipeline period via the USD 78 million La Laja Dam project, which will create an additional fresh water source for 120,000 residents of the Ixtapa-Zihuatanejo metropolitan area.⁵⁸

Similarly, in several areas of northeast Mexico, the use of sophisticated water purification technologies is needed since the available water requires the elimination of materials such as heavy metals or even arsenic.

In some areas, such as the Baja peninsula, saline conversion has become the only viable drinking water option, thus three large desalination projects are in the project pipeline during 2015 to 2016. The Cozumel

desalination plant will provide 17,280 cubic meters a day (m³/d) of fresh water to residents of Cozumel and is estimated to be worth USD 27.4 million.⁵⁹ In the state of Baja, two desalination projects are slated for the Tijuana municipal area. The collective value of these twin projects is USD 75 million.⁶⁰ Other major desalination projects slated for 2016 include the Planta San Carlos project valued at USD 307 million, the Metates water for mining project valued at USD 86.7 million and the La Paz desalination project valued at USD 41.7 million.

Key Technologies in Demand:

- Water reclamation technologies
- Engineering and construction services
- Water reuse equipment and services (process specific)
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- *Anaerobic digestion*
- Nitrification
- Biological denitrification
- Testing equipment

Groundwater Monitoring and Pollution Prevention

Scarce water supply in Mexico has necessitated comprehensive monitoring of groundwater availability and quality. Of Mexico's 653 subterranean aquifers, more than 100 are overexploited.⁶¹ Overexploited aquifers produce roughly 60 percent of the groundwater that Mexico relies on for agriculture and drinking water. The National Water Plan has emphasized the promotion of geo-hydrological exploration, increasing groundwater monitoring and an integrated ground water management plan. Other projects deemed necessary to the maintenance of groundwater resources are artificial aquifer recharge and evapotranspiration management.

Key Technologies in Demand:

- Environmental engineering and consulting services
- Water quality monitoring equipment
- Monitoring wells
- Site characterization technology
- Groundwater recharge technologies

Waste Management and Recycling

Municipal Solid Waste and Recycling

Municipal waste in Mexico is governed by local and state governments, who apportion part of their budgets for waste collection and disposal. In recent years, there has been a push towards modernizing Mexico's waste infrastructure to better address the roughly 102,850 mt processed a day.⁶² The open sky dumps prevalent in Mexico pose a threat to human health and the environment and have increased public support for the improvement of waste infrastructure.

In 2009, the Government of Mexico developed financial support programs designed to help modernize the country's waste management system and provided grants for upgrades to landfills, closures of open sky dumps, technical landfill studies, municipal waste collection, and the development of state, municipal or inter-municipal waste management plans. SEMARNAT also issues tenders for solid waste management and recycling projects. SEMARNAT received a USD 40 million budget allocation in 2014 to fund local and state-level projects for waste management through the Program for the Prevention and Management of Waste (*Prevención y Gestión Integral de Residuos*).⁶³

In 2014, USD 43 million⁶⁴ was approved for projects in municipal waste development, providing significant opportunities for U.S. businesses. Recycling is also an emerging area of opportunity in Mexico, as municipalities recognize the cost-recovery benefits of the practice. In 2011, the Institute for Scrap Recycling Industries estimated that 18 percent of U.S. export sales of scrap equipment were destined for Mexico.

Key Technologies in Demand:

- Waste handling equipment
- Cranes, crushers and shredders
- Odor control systems
- Bio-gas capture technologies
- Separators
- Protective equipment for separating lines
- Garbage trucks with compactors
- Engineering services
- Waste collection technologies
- Sanitary landfill systems
- Environmental monitoring and analytical equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment

- Collection services, containers and vehicles
- Recycling process expertise
- Waste incinerators

Environmental Engineering and Consulting

As of 2015, while permits exist for environmental impact and the use of natural resources, both of which involve an environmental impact assessment (EIA), environmental audits are not mandatory. The EIA, however, is a required instrument of environmental policy that establishes the legal framework through which federal or state authorities are able to evaluate environmentally threatening activities in order to protect the environment. Under the General Law of Ecological Equilibrium and Environmental Protection (LGEEPA), environmental regulators enforce violations of law through fines, closures, forfeitures, suspension or revocation of permits, and implementation of corrective measures.⁶⁵

Fernando A. Gonzalez, the CEO of the Mexican building materials company, CEMEX S.A.B. de C.V., explained that "Construction is likely to be one of the most dynamic sectors globally in the next fifteen years and is utterly crucial to the evolution of prosperous societies around the world." The construction sector in Mexico specifically is projected to grow at a quick pace, potentially overtaking Brazil in the Latin American construction market by 2030.

Key Technologies in Demand:

- Environmental Impact Assessment

ETWG Agency Initiatives and Programs

WEFTEC International Buyer Program

WEFTEC, the largest water technology exhibition in North America, works with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to exchange relevant technical information and to advance U.S.-Mexican water cooperation through targeted activities at WEFTEC. Business relationships with U.S. water technology providers are facilitated.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S.

Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to exchange relevant technical information on the Mexican market and U.S. environmental technology capabilities. Business relationships with U.S. waste management providers are facilitated.

U.S. Environmental Solutions Toolkit

The Toolkit is an online searchable database that marries U.S. Environmental Protection Agency (U.S. EPA) expertise on solving environmental challenges and developing environmental rules with a catalogue of U.S. technology providers. In 2015, the International Trade Administration and U.S. EPA introduced a Spanish-language version of the Toolkit to expand its usability in Latin America. It serves as a reference tool in bilateral engagements that focus on increasing Mexican capacity to address environmental concerns.

Green Expo

Green Expo is Mexico's preeminent environmental technology show. This event is leveraged through the U.S. Department of Commerce's trade fair certification program to promote the development of U.S.-Mexico business relationships in the environmental sector.

Border 2020

The U.S. Environmental Protection Agency has awarded over USD 1.1 million in grants to fund 25 new environmental projects along the U.S.-Mexico border with Arizona, California, Texas and New Mexico. The projects include improving air monitoring, expanding waste collection and recycling, green infrastructure and improving environmental awareness, and education among area residents. U.S. companies seeking a foothold in the market should consider participating in this program.

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India

Mounting and persistent pollution problems will lead to steady growth in India's fragmented environmental technologies market. The overall environmental technologies market in India, including goods and services, is valued at USD 16.3 billion (2016). India ranks third overall in the 2016 Top Markets Study (TMS), with a Composite Environmental Technologies Score of 31.7. India ranks second for water, with a score of 16.3; sixth for air pollution control; and seventh for waste and recycling markets, with scores of 12.8 and 2.7, respectively.



State of the Environmental Regime

India's complex environmental regulation is hinged on five major pieces of legislation, including the Environment (Protection) Act, 1986; Forest (Conservation) Act, 1980; Wildlife (Protection) Act, 1972; the Water (Prevention and Control of Pollution) Act, 1974; and the Air (Prevention and Control of Pollution) Act, 1981.

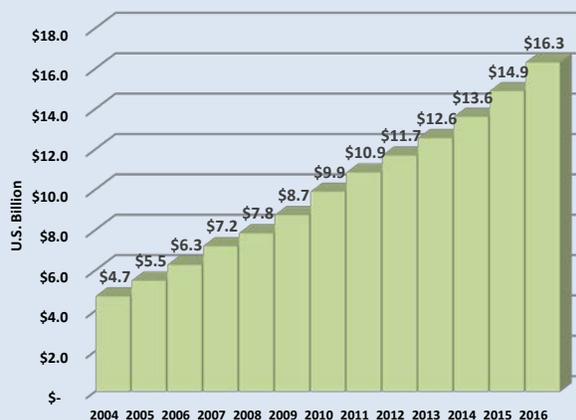
The regime is steadily improving as evidenced by the Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being the most stringent), which scored India a 3.6 in 2012, a 1.2 point improvement from its 2005 score of 2.4. India's ranking on the World Economic Forum's 2011 Index for Regulatory Stringency of 48th globally, with a score of 3.88 (on a similar scale to that of EBJ-OECD), was

consistent with the EBJ-OECD ranking in the same survey for enforcement of 54th globally, with a score of just 3.50, reinforcing the assessment of moderate regulatory stringency coupled with moderate enforcement.

The Ministry of Environment, Forest and Climate Change (MoEFCC) is India's federal agency responsible for implementation and oversight of environmental laws. Enforcement, however, is delegated to the state level through State Pollution Control Boards (SPCBs) or Pollution Control Committees (PCCs) in the seven union territories who ultimately answer to state government heads rather than the federal authority. This delegation of enforcement to state governments has served to decentralize enforcement practices and contributes to fragmentation and incongruent application of rules across provinces, lack of transparency in regulations and practices, poor implementation of regulations, weak regulatory compliance and corrupt practices in some areas. India's environmental laws have proved challenging to enforce because regulators lack the resources to address issues of asymmetric information and assert authority. Government agencies that enforce India's environmental laws have 200 to 300 technical staff, who monitor at least 50,000 plants and factories.

There is also concern among Indian civil society that the Modi government may hinder development of an effective environmental enforcement regime by abolishing environmental approvals for select industries and proposing that government regulators rely on industry to monitor and report its own effluent and emissions.⁶⁶ Since becoming Prime Minister of India on May 26th, 2014, Prime Minister Narendra

Figure 1: India Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis, 2016.

Modi expressed his commitment to economic development and growth. Some experts view this commitment as an attempt to dismantle laws for protecting the environment. On August 29, 2014, Prime Minister Narendra Modi organized a high level committee within the MoEFCC to review and amend important Indian environmental laws: the Environmental (Protection) Act (1986), Forest (Conservation) Act (1980), Wildlife (Protection) Act (1972), the Water (Prevention and Control of Pollution Act) (1974), and the Air (Prevention and Control of Pollution) Act (1981). One of the committee's recommendations is eliminating the role of independent pollution regulators, thereby trusting industries to police themselves. Many experts expressed concern about the process used by the committee and its recommendations, including whether they indicate that the Modi administration is opposed to enhancing environmental protection.⁶⁷

Market Barriers

The following barriers have been identified by the Environmental Technologies Trade Advisory Committee (ETTAC), the U.S. Department of Commerce's Office of Energy and Environmental Industries (OEEI), and the Commercial Service India as the most problematic for environmental technologies companies attempting to export to or work in India:

- 1. High Tariffs**
India has relatively high tariffs for environmental technologies, particularly in the area of monitoring and instrumentation. High import taxes also diminish the price competitiveness of higher quality, and thus pricier, U.S. environmental technologies.
- 2. Fragmentation of the Market Across Regions**
Environmental technology markets in India are highly fragmented across the country, and it is difficult to find a representative or distributor that can truly provide national sales coverage. Companies that succeed in India must expend additional resources to develop export strategies on a region-by-region basis.
- 3. Transparency and Price Sensitivity in Tenders**
Transparency in how tenders are bid is an ongoing issue in India that is further complicated by regional fragmentation. Tenders are also plagued by a lowest bidder mentality with little assessment of cost/quality trade-offs.

4. Corrupt Practices in Tenders

U.S. companies have reported that public tenders are rife with institutional corruption that negates U.S. companies' ability to compete.

5. Rolling Back Environmental Compliance Rules

Poor enforcement of environmental rules has been an ongoing struggle in India. The Modi government proposal of "the concept of utmost good faith" hinges on voluntary disclosure and monitoring of pollution control by Indian businesses. If this proposal becomes law, the market for industrial environmental technology will likely erode, along with the environmental compliance incentives that an active enforcement regime enables.

6. Limited Sophistication of Local Partners

Local partners are tacitly, if not formally, required in tenders, and many national players in the Indian water market are new to the water technology sector and may have no prior experience developing and implementing water projects, creating additional management burdens for U.S. companies entering into joint venture relationships.

Market Opportunities

Air Pollution Control

Air Quality Monitoring

The Central Pollution Control Board is responsible for operating India's 342 monitoring stations under the National Air Quality Monitoring Programme (NAMP). In April 2015, the Indian government launched the country's first Air Quality Index (AQI). The AQI will cover 10 cities initially and eventually will be expanded to more than 60 cities. Each city will have six to seven continuous monitoring stations with AQI display boards, and the data will be made available to the public via an online portal on a daily basis.⁶⁸ The Indian government has sought adoption of science-based air pollution control strategies in Indian cities to establish baseline data on ambient air quality and pollution sources. This information will be used to define cost-effective source reduction opportunities and investments, assist policymakers in evaluating health and economic impacts of various air pollution control approaches, and foster accountability for air quality

improvements.⁶⁹ This initiative will build Indian capacity in assessing and predicting future emissions inventories, developing effective and efficient control strategies, and assessing health benefits of various air pollution control approaches. Particular emphasis has been placed on monitoring and control technologies relevant to coal-fired power plants and petroleum refining operations. India's expanding network of air monitoring stations provides opportunities for relevant U.S. technology providers.

Key Technologies in Demand:

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

Air Pollution Control

Coal is India's primary energy source,⁷⁰ accounting for more than 70 percent of energy generation in the power sector.⁷¹ Most of the country's hard coal, however, is of poor quality, with low to medium heat values and high ash content, contributing to decreased efficiency in power generation and higher local emissions.⁷² With low quality coal and more than 85 percent of India's coal-fired power plants currently employing subcritical technology, the average efficiency for the generating fleet is less than 35 percent.⁷³ The resulting unreliable electricity supply, together with high end-use tariffs, has led energy-intensive consumers, such as the steel, cement, chemicals, sugar, fertilizer and textile industries, to produce a significant portion of their own electricity. Wealthier households also typically employ back-up diesel generators, contributing to worsening local air pollution, particularly from particulate matter.⁷⁴

The government's "Make in India" initiative aims to increase India's manufacturing as a percentage of GDP to 25 percent by 2022.⁷⁵ The program was launched in 2014 and targets a number of key sectors, including mining, oil and gas, power generation, pharmaceuticals, chemicals and construction.

Expansion of infrastructure – including energy infrastructure – to support a build-up of the country's manufacturing base will require increased inputs from energy-intensive, coal consuming sectors such as cement and steel, which are substantial contributors to air pollution. If India is to meet its Nationally Determined Contribution (NDC) commitment under the December 2015 Paris Climate Agreement to reduce the emissions intensity of its economy by 33 to 35 percent as compared with 2005 by 2030, emitting facilities will require emissions control technology.

The government also has identified 17 high polluting industry sectors in need of greater oversight and air pollution control measures. These include aluminum smelting, pharmaceuticals manufacturing, chlor-alkali/caustic soda, cement (200 tons per day (TPD) and above), copper smelting, dyes and dye intermediate, fermentation (distillery), fertilizer, integrated iron and steel, leather processing including tanneries, oil refinery, pesticide formulation and manufacturing, pulp and paper (30 tons per day (TPD) and above), petrochemical, sugar, thermal power plants, and zinc smelting. As the development of new rules for these industries evolves and are enforced, opportunities in control technologies will continue to develop.

Key Technologies in Demand:

- Wet and dry scrubbers
- Bag houses
- Filters
- Flue Gas Desulphurization
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems

Waste Management and Recycling

Solid Waste Management and Recycling

Waste management and recycling is underdeveloped in India. The country generates about 55 million tons of municipal solid waste (MSW) per year,⁷⁶ the vast majority of which remains untreated. Formal and industrial recycling processes are fairly limited, as a widespread informal recycling industry provides income to many of India's poorest households. The government has allocated approximately USD 1.11 billion for solid waste management projects in urban areas,⁷⁷ which is about one-third of the total estimated amount of investment needed to manage the

country's MSW, according to the U.S. Commercial Service in Kolkata.

In June of 2015, the MoEFCC published new draft *Solid Waste Management Rules* for public comment. The draft rules cover waste separation, collection, transportation, processing, storage and disposal, with an emphasis on source reduction. Also included are criteria specified for solid waste treatment facilities, landfills (siting, closure and environmental monitoring), waste-to-energy (WtE), composting and construction and demolition (C&D) waste. Standards are set forward for composition of compost, treated leachates and emissions from MSW incineration, as well. The final version of the rules went into effect in March 2016. If enforced, the new rules should lead to opportunities for U.S. waste management equipment and service companies.

Key Technologies and Services in Demand:

- Waste handling equipment
- Gasification, pyrolysis and incineration technologies
- Waste treatment technologies
- Waste management systems design expertise
- Landfill design and engineering

Recycling of Discarded Electronics

The Indian MoEFCC implemented the *E-Waste Management and Handling Rules* in 2011 and a revision as the *E-Waste (Management) Rules* in 2015. These directives outline responsibilities of electronics producers, discarded electronics collection centers, recyclers and other relevant entities to limit environmental and health issues potentially created by improperly discarded/recycled electronic equipment. The 2011 law seeks to establish a formal electronics recycling framework to promote safe handling of discarded electronics and growth in related economic activities nationally. The 2015 revision expands producers' responsibility under an Extended Producer Responsibility (EPR) program, including setting up Producers Responsibility Organizations (PRO) and e-waste exchange.

According to Environment Minister Prakash Javadekar, the new 2015 rules will place "absolute responsibility" on the producer to manage all aspects of e-waste, from generation to safe disposal.⁷⁸ The increase in Indian demand for equipment and recycling services presents opportunities to U.S. companies with

experience in providing equipment or services used in safely and efficiently recovering valuable materials from discarded electronics.

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Hazardous and Medical Waste Management

Continued economic and industrial development in India has led to increased focus on properly managing resulting hazardous wastes. In 2008, the Indian government implemented the *Hazardous Wastes (Management, Handling and Transboundary Movement) Rules*, outlining the responsibilities of various entities relevant to disposal, collection and treatment of hazardous wastes. Additionally, increased access to healthcare in India has created an estimated USD 80 billion industry in 2012 with an expectation to reach USD 280 billion by 2020,⁷⁹ the wastes of which require effective management.

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Water and Wastewater Treatment

The Indian water and wastewater sector has high ambitions to develop comprehensive public and private water and wastewater treatment and distribution infrastructure. As of January 2016, India has 68 water treatment and transmission, desalination and industrial reuse projects in its tendering pipeline for 2016 with a cumulative estimated value of USD 6.5 billion.⁸⁰ Realizing implementation at this level will require unprecedented levels of investment in public infrastructure as well as new financial vehicles that make water, wastewater and reuse projects profitable endeavors. The Indian Planning Commission's Expert Committee Report on Indian Urban Infrastructure and Services underscores this point, estimating that USD 126 billion of capital investment is required over the next 20 years to meet India's basic potable water and sanitation needs.⁸¹ In real terms, this means that capital expenditure on water and wastewater

infrastructure is poised to grow 83 percent from 2015 to 2020, reaching an annual run rate of USD 16 billion by 2020.⁸²

Municipal Water and Wastewater Treatment and Plant Development

Growth in the municipal water and wastewater treatment sector is being driven by shortfalls in drinking water and sanitation access, growing concerns over surface water pollution and efficiency demands related to overall water scarcity in India, and it will continue to translate into a robust water and wastewater treatment market in India. While 94 percent of Indians have access to clean drinking water, just under 40 percent of the population has access to sanitary wastewater systems,⁸³ a disparity that emphasizes the dire need for wastewater treatment systems in particular. The Government of India estimates installed wastewater treatment capacity currently at less than 20 percent of need.⁸⁴ Plans to introduce wastewater tariffs and combine them with drinking water tariffs, if implemented, will lead to steady and robust infrastructure growth over the next five years. The emphasis on improving wastewater treatment is reflected in the segment's expected growth curve of 15.3 percent CAGR between 2015 and 2020.⁸⁵ Global Water Intelligence estimates that the value of the wastewater treatment segment will reach USD 6.78 billion in 2020, more than doubling its 2015 value of USD 3.3 billion.⁸⁶

Correspondingly, the drinking water treatment and supply segment will grow at a slower clip, reaching USD 9.4 billion in 2020 from a 2015 base of USD 5.5 billion. The Planning Commission estimates that USD 126 billion of capital investment is required over the next 20 years to meet India's basic potable water and sanitation needs.⁸⁷ In the short run, lack of consumer confidence in municipal sources of drinking water will continue to fuel a robust point-of-use water technology market in India.

Major tenders expected for municipal wastewater treatment and water supply projects include the Ahmedabad City 24X7 water supply project in Gujarat estimated to worth USD 364 million, the Kochi water supply project in Kerala worth an estimated USD 300 million, the Malad wastewater treatment plant in Mumbai estimated to be worth USD 296 million, the Bandra series of wastewater treatment plants also in Mumbai worth an estimated USD 289 million, and the

Bangalore water supply extension with an estimated value of USD 271 million.

The Government of India's *Approach to the Twelfth Five-Year Plan* states that currently only 30 percent of total sewage generated is treated before being released into surface waters, creating substantial pollution and public health problems. The Approach sets a goal of zero discharge of untreated sewage into rivers. This goal has been translated into a series of recently announced municipal reuse projects, including the Hyderabad recycling plants in Andhra Pradesh, with an estimated tender value USD 453 million. The project calls for the construction of a series of municipal treatment plants that will supply treated effluent that is currently released into local rivers directly to industrial and agricultural users.

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM), formerly the largest source of financing for municipal water and wastewater projects, has been replaced by the Modi government's Atal Mission for Rejuvenation and Urban Transformation (AMRUT) and, to a lesser extent, the Smart Cities Initiative. AMRUT combined with the Smart Cities Initiative could yield substantial investments in water and wastewater infrastructure depending on the forthcoming project allocation. AMRUT has budgeted USD 7.7 billion across 500 towns and cities while USD 7.4 billion has been budgeted across 100 cities for smart infrastructure initiatives.⁸⁸

In the short-term, the state of Bihar plans to develop a series of 112 water, sewerage and storm water drainage projects for tendering of Public Private Partnership (PPP) finance models.⁸⁹ This plan is confluent with the Modi government's recently announced model for funding the National Mission for Clean Ganga, which seeks to entice investors by relying on a "hybrid annuity-based PPP model" where the central government will finance 40 percent of the capital costs for facility construction followed by a release of remaining funds in annuity-style payments subsequent to commissioning.⁹⁰ Under the national program, this model will be employed for approximately 20 municipalities.⁹¹

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Operations services
- Advanced Filtration
- Membrane filtration

- Waste to energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment

Municipal Water Efficiency

Energy consumption and water loss issues plague Indian municipalities. The Government of India estimates that between 50 to 70 percent of water supply finances go to electricity to pump water, while reported non-revenue water is 30 to 50 percent (with actual non-revenue water likely to be greater than reported). The *National Action Plan for Climate Change* states a goal of improved management that will increase water use efficiency by 20 percent during the Five-Year Plan period. Coupled with other investments in infrastructure and the vast national build-out of water treatment facilities, the demand for water efficiency technologies will rise rapidly in the coming years.

Technologies and Services in Demand:

- Monitoring technology
- Leak resistant transmission systems

Industrial Process and Wastewater Treatment and Reuse

Industrial process and wastewater is a rapidly growing segment of the Indian water market, estimated to reach USD 2 billion of revenues by 2020⁹² and expected to grow 20 to 25 percent per year.⁹³ The market for process water is driven by process demand and influent quality (surface water meets 41 percent of industrial demand),⁹⁴ while the market for wastewater and reuse is driven more by the relative scarcity of water than strict effluent guidelines provided by the government. This point is underscored by the fact that although encouraged in official planning, industrial reuse is not articulated in any state or national regulation.⁹⁵

Weak regulations and enforcement of industrial effluent is expanding the scope of pollutants and increasing treatment complexity and burden on municipalities. Tightened regulations and enforcement are expected during the 12th Five-Year Plan as well as new incentives to induce industrial water reuse. Plans to implement a tariff system for industrial effluent that

penalizes low treatment quality and provides industrial credits for water reuse is a key pillar of the *New National Water Policy*. Consistently, the Modi government has recommended that heavily polluting industries embrace zero liquid discharge to avoid effluent release into surface sources entirely. High water consuming industries, such as power generation, oil and gas refining, petrochemical production, pharmaceuticals, and steel, are already implementing reuse strategies in order to meet locally imposed freshwater limits and overall issues with scarcity.

There are emerging opportunities in the "new industrial cities" for improved wastewater management. The preeminent opportunity is the Delhi-Mumbai Industrial Corridor (DMIC). The DMIC plans to establish seven new industrial cities with forthcoming water and wastewater capital investments estimated to be worth USD 90 billion. DMIC will provide a series of Engineering, Procurement, Construction (EPC) and Build, Own, Operate, Transfer (BOOT) contracts for water supply networks, drainage schemes and effluent treatment plans.⁹⁶

Primary industries that exhibit demand for treatment technologies include power plants, oil and gas extraction and refining, food and beverage, pharmaceuticals, textiles, steel and aluminum production, and mining. These industries favor high-end treatment technologies and those that meet high international standards for quality and technical efficacy.

Technologies and Services in Demand:

- Engineering and construction services
- Water reuse equipment and services (process specific)
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Membrane bioreactor systems

Groundwater Maintenance and Recharge

India is withdrawing groundwater resources at a faster rate than recharge occurs. The Government of India plans in the 12th Five Year Plan phase to introduce a

legal shift of ground water resource ownership from property owners to a federally managed commons. In the short-term, the government plans to rectify shortages by creating a comprehensive groundwater monitoring system and groundwater recharge projects. This will translate into demand for groundwater mapping services to assess current resources, monitoring technology and early phase recharge demonstration projects.

Technologies and Services in Demand:

- Hydrological mapping services
- Monitoring equipment
- Groundwater recharge technology

Environmental Engineering and Consulting

The construction market in India is expected to grow twice fast as China's leading up to 2030, while India's urban population is projected to grow by 165 million by 2030. India is also expected to become the world's third largest construction market by 2021. If bound to requirements for environmental impact assessments, this coming boon of construction activity could correspondingly grow India's environmental engineering and consulting exponentially.

Technologies and Services in Demand:

- Environmental impact assessment

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA) environmental regulations, related underlying research and a list of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. The Toolkit is used by U.S. EPA officials and environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power

plant emissions control with Indian participants and to foster business relationships between Indian end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Indian participants and to introduce Indian buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Indian officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

MDCP Assisted Development of Drinking Water Standards

Through the International Trade Administration's Market Development Cooperation Program (MDCP), the American Water Works Association (AWWA) is implementing a program to help Indian utilities develop and meeting AWWA standards for drinking water treatment.

Market Contacts and Program References

Ministry of Urban Development

<http://www.moud.gov.in>

Central Pollution Control Board

<http://www.cpcb.nic.in/>

Environmental Information System – ENVIS: India

<http://envis.nic.in/>

JICA

<http://www.jica.go.jp/india/english/>

USAID

<http://www.usaid.gov/india>

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Brazil

Brazil's ample market size and growing scope of opportunity for U.S. environmental technology producers is juxtaposed by varying levels of technical capacity, enforcement and finance for environmental project development. Persistent tariff and non-tariff barriers impede U.S. firms' abilities to access the Brazilian environmental market.

| | | | |
|--------------|---|-----------------------|---|
| Overall Rank | 4 | Air Pollution Control | 5 |
| Water | 6 | Waste & Recycling | 4 |

Brazil ranks fourth overall on the 2016 *Top Markets Report* with a composite environmental technologies score of 29.4. The Brazilian environmental technologies market, including goods and services, is valued at U.S. USD 29.6 billion,⁹⁷ making Brazil the largest single market for environmental technologies in Latin America. Brazil ranks fourth, with a score of 3.64, for waste and recycling; fifth for air pollution control markets, with a score of 15.3; and sixth for water, with a score of 10.5 (see Appendix 1 for global rankings).

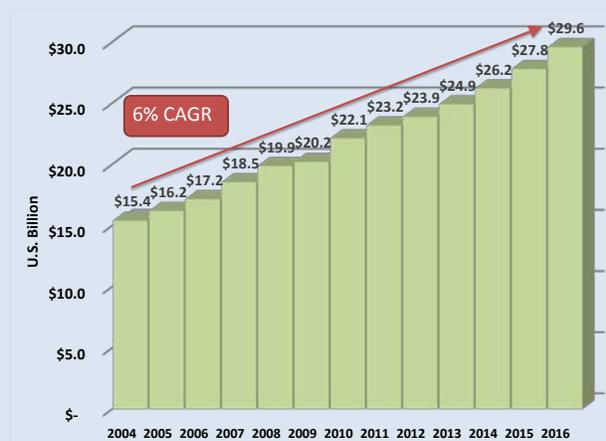
The scale of Brazil's market is due predominantly to its population of 204.3 million⁹⁸ and its growing middle class rather than to strong adherence to environmental laws. As this report will delineate, there is high variability within Brazil in terms of the capacity to implement and finance advanced environmental systems.

State of the Environmental Regime

The Brazilian government has high ambitions in terms of environmental policy development but limited means at this time to fulfill that ambition. Enforcement shortfalls, variable technical capacity to implement environmental rule, and limited public finance for environmental projects continue to hobble market potential.

Nonetheless, recent Brazilian government efforts to improve the environmental regime have made a noticeable impression on the private sector. The Environmental Business Journal-OECD Environmental

Figure 1: Brazil Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis, 2016.

Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent, scored Brazil a 4.1 in 2012, a 1.6 point improvement from its 2005 score of 2.4.

These figures echo the U.S. EPA's assessment of the Brazilian environmental regime, which notes that the scope of environmental laws is improving while enforcement and compliance remain a challenge. The lag effect on enforcement of new rules can also be seen in Brazil's score on the World Economic Forum's 2011 Index for Regulatory Stringency, which scores Brazil quite high on regulatory quality with a score of 5.19 (on a similar scale to that of EBJ-OECD) while Brazil's score in the same survey for enforcement is just 3.94.

Figure 2: ETTAC Illustrative Examples of Market Barriers

| Certification Type | Brazilian Agency | U.S. Product(s) | Reported Costs to U.S. Business | Associated Unnecessary Delays |
|--------------------------------------|------------------|--|---|-------------------------------|
| ISO 17025 | Inmetro | Monitoring and testing instrumentation | \$250,000 | 1 -2 Years |
| Generic New Technology Accreditation | Inmetro | Various | Per Product: \$3,000 \$250 per semester recurring \$1,750 per inspection Laboratory expenses: \$17,500 | - |
| Transmitter Technology Certification | ANATEL | Satellite Transmitter to remotely transmit environmental/metrol ogy data | \$7,500 | 4 – 6 Months |

Source: Environmental Trade Advisory Committee (ETTAC) 2012-2014 Charter

Brazil’s enforcement and implementation woes emanate from the fragmentation of environmental authority among federal, state and municipal entities. As a result, the capacity to adopt advanced environmental solutions varies greatly between states, with generally higher capacity in the southeast of the country in areas such as Rio de Janeiro, São Paulo and Minas Gerais and lower capacity in more rural states.

One issue that affects environmental compliance in Brazil is that environmental authorities conduct investigations *ex post facto*, based upon a direct complaint of contamination or after the closure of an industrial facility. As a result, the incidence of oil spills, gas leakages and inadequate storage of hazardous wastes are frequent and reported widely in the Brazilian media.⁹⁹ Imposing regular monitoring of industrial sites would improve compliance.

Funding gaps for environmental infrastructure are also prevalent in Brazil. While the government has prioritized the provision of sanitation services, including water, wastewater, drainage and waste management services, many of the planned projects have faltered for lack of funding. For example, the Ministry of Cities reports that the average annual investment in sanitation is around USD 4.5 billion, which is a USD 2.5 billion shortfall from the USD 7 billion the Government of Brazil (GOB) estimates is necessary annually to meet the government’s goal of universal access to sanitation services by 2030.¹⁰⁰

Market Barriers

Market barriers in Brazil are persistent and prohibitive for U.S. exporters in many cases. In its most recent charter, the Department of Commerce’s Environmental Technologies Trade Advisory Committee (ETTAC) identified the following barriers as most problematic for U.S. environmental technologies companies attempting to export to or work in Brazil:

1. Tariff escalation tied to local content requirements or disqualification of imported components.

The ETTAC observed minimum local content requirements ranging from 40 percent to 60 percent of a product’s total value; this is applied mostly by government-owned monopolies for fossil fuel production and public procurement sectors, such as municipal water treatment. In the absence of domestic content, much higher tariffs are applied, such as a 22 percent tariff for water pumps. There is evidence that goods that fail to meet local content requirements may be disqualified from competition altogether.

2. Tendering practices favor local competition.

Small Brazilian businesses benefit from preferential treatment in public tenders. Typically, small local businesses are afforded additional points on commercial evaluation, and small business set-asides are commonly

available for public bids below the USD 40,000 threshold per decree 42.063/2009, Act 123/2006. Small local businesses also benefit from tax advantages such as Brazil's "Simple Tax Scheme," which eliminates taxes for companies below a certain annual revenue threshold.

3. Local certifications and safety approvals fail to recognize international equivalents.

Local electrical and safety approvals are applicable to most products which have electrical components and mechanical products. Brazil does not accept certification from equivalent U.S. certification and testing organizations, imposing additional and onerous costs on U.S. businesses for redundant testing and certification.

4. Failure to recognize international standards.

Despite certification from relevant and globally accepted international certification bodies, products that have transmitting and/or receiving devices must obtain approvals from ANATEL (Brazil's National Telecommunications Agency). ETTAC advisors also highlight a Brazilian preference for ISO standards even where other equivalent international certifications exist. Complications with the certification of transmitting and receiving devices handicaps the sale of U.S. continuous monitoring and automated control devices and systems, an area of competitive advantage for U.S. providers.

Market Opportunities

Air Pollution Control

Air Quality Monitoring

Given Brazil's heavy reliance on hydroelectric power and relatively low use of conventional combustion in its electricity sector, air pollution in Brazilian cities primarily originate from industrial and mobile sources.¹⁰¹ Addressing air pollution has become a priority for Brazilian national and local governments and has generated demand for gas emission monitoring technologies, gas analyzers and air pollution control technologies.

CETESB, São Paulo region's environmental agency, is currently expanding its air monitoring program

through the acquisition of 10 new monitoring stations destined for the interior of the state. Imported instruments in demand for these new stations include ozone analyzers, nitrogen oxide analyzers, multi-calibrators, air purifiers, inhalable particle analyzers at particulate matter (PM) 2.5 and 10, wind sensors, humidity and temperature sensors, barometric pressure sensors, and UVA sensors. According to CETESB, the principal industrial sources of air pollution in the region include sugar and alcohol plants, laundries, foundries, oil storage terminals, waste and sewage treatment facilities, aluminum smelters, chlorine and soda plants, glass and paint plants, pulp and paper plants, cement plants, and fertilizer plants.

In 2013, the state of São Paulo established "New Standards for Air Quality," which is similar to the EPA NAAQS (only for the State of São Paulo). CETESB, the São Paulo state environmental agency, published a study called Emission Reduction Plan for Stationary Sources – PREFE, which was released to the public in January 2015. The plan evaluates the ambient air quality and lists the state regions that do not comply with new standards as well as the priority sectors. The PREFE also has a sector program for vapor emission control generated by gas stations as well as a program for the industries in the Santa Gertrudes Ceramic Pole.

São Paulo also recently launched an online self-reporting protocol for companies operating in São Paulo state to report their greenhouse gas (GHG) emissions and climate change mitigation strategies, including benchmarks, targets and timetables. Executives from DOW, Toyota, Unilever and GE expressed their support for the protocol and their general willingness to participate in the reporting mechanism.

Rio de Janeiro region's environmental authority, INEA, has a continuous monitoring network of 21 stations that are supplemented by fence-line monitoring applications at high-emissions industrial sites. Monitors assess criteria pollutants and their precursors, including ozone, nitrogen oxide (NOx), sulfur dioxide (SOx), carbon monoxide, Volatile Organic Compounds (VOCs), hydrofluorocarbons and particulate matter. Additionally, several climate change initiatives, including the September 2011 Climate Decree issued by the Rio de Janeiro State Environmental Secretary, will require improved capabilities to measure and control greenhouse gases.

Legislation related to vehicle emissions and air quality: CONAMA Resolution 18/86 established the Vehicle Air Pollution Control Program (PROCONVE) complemented by other CONAMA resolutions, and Federal Law #8723 of October 2003 defined the emissions limits for light and heavy duty vehicles. As of 2012, Brazil's diesel engines must follow the Euro V emission parameters, corresponding to the Automotive Air Pollution Control Program (PROCONVE P-7).

Resolution ANVS/DC #176 of October 24, 2000 provided reference standards on indoor air quality; CONAMA Resolution #4 of June 15, 1989 established the "National Air Quality Control Program" (PRONAR); CONAMA Resolution #3 of June 28, 1990 defined air quality standards for air pollutant concentrations.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

Water and Wastewater Treatment

Municipal Water and Wastewater Treatment

There are currently 27 state-owned water utilities that serve 76 percent of the population and a number of municipal and private sector utilities that serve about 10 percent of the population. Approximately 86 percent of Brazil's population is served by a water utility, leaving the remainder without access to piped drinking water and sanitation services.

The Brazilian sanitation law and implementation plan, *Plansab*, is attempting to bridge the sanitation gap and sets a formal target of universal sanitation services by 2030. Much needs to be achieved in sewage treatment alone; currently 70 percent of sewage in Brazil is disposed untreated.¹⁰² Correspondingly, *Plansab* has forecasted that investments of USD 57.5 billion in drinking water and USD 86 billion in wastewater transmission and treatment technologies and services are needed to meet the goal of universal access.¹⁰³ The Government of Brazil has provided USD 221 billion of federal funds to municipalities and states governments to develop projects in wastewater treatment and sewerage.

The government has required that states and municipalities develop local plans to implement *Plansab* but has stopped short of penalizing municipalities that failed to do so by the federal deadline.¹⁰⁴ The breach in plan development among municipalities is attributed to a lack of technical capacity to develop and implement such plans. Meeting universal sanitation goals are also put at risk by financial shortfalls for project development. Fifty-nine percent of *Plansab* is financed by the federal government, with the remaining 41 percent of financing left to municipalities and regional governments.¹⁰⁵ Data received from the Brazilian Ministry of Cities show that average annual investments in basic sanitation are around USD 4.5 billion. This is significantly less than the annual spending goal set by the Government of Brazil (GOB) of USD 7 billion, which it estimates is required through the year 2030 in order to reach the GOB's goal of providing basic sanitation services to every citizen.¹⁰⁶

Growth in this area is nonetheless expected to be aggressive, with an estimated Combined Annual Growth Rate (CAGR) from 2010 to 2015 of 12.3¹⁰⁷ percent, with revenues estimated to reach USD 189.3 million in¹⁰⁸ 2015 from a base of USD 94 million in 2010.¹⁰⁹ At the writing of this report, total contract values of concessions and other tenders announced for 2016 are estimated to be worth USD 2.2 billion.¹¹⁰ The National Bank for Economic and Social Development (BNDES) estimates that USD 14 billion will be invested in the water treatment sector between 2015 to 2018.¹¹¹ Investments in infrastructure will include design and construction of wastewater collection systems and treatment facilities as well as upgrades to existing equipment, pumps and asbestos contaminated pipes.

This finance gap in Brazil has led to some creative and fairly successful public private partnerships (PPP) for the provision of municipal services. It has also led to several prominent market failures where planned projects have remained "planned" indefinitely due to failures, again, in technical capacity and shortfalls in available private sector finance.

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Operations services
- Pipes, valves and pumps
- Headworks
- Aerators and sedimentation technology

- Smart water technologies
- Advanced filtration
- Membrane filtration
- Waste to energy technology
- Biological treatment
- Anaerobic digestion
- Nitrification/denitrification
- Integrated Fixed Film Activated Sludge
- Thickeners and dewatering devices
- Sludge dryers and incinerators
- Monitoring equipment
- Testing equipment

Municipal Water Efficiency and Smart Water

Water loss issues are compounded by drought, water scarcity problems in arid regions and increased demand for affordable potable water sources in urban areas. Water lost in transmission or stolen is a serious issue for Brazilian municipalities, with non-revenue water in urban areas estimated at 40 percent.¹¹²

These issues have converged to increase demand among Brazil's state water companies for systems and technologies that address non-revenue water and those that enhance water efficiency, such as smart water software and monitoring equipment. Drought and water scarcity in the São Paulo region is compounding the need for greater efficiency and conservation of water resources. As of early 2015, São Paulo's Cantarieria reservoir was only 5.1 percent full. The local utility, SABESP is implementing market-based control measures, including providing discounts for water savings and surcharges for overuse. SABESP is also seeking technology based solutions to this shortage by identifying best practices in water reuse.¹¹³ The drought is also driving interest in desalination technology; both Rio de Janeiro and São Paulo have expressed interest in developing desalination capacity to bridge the gap in freshwater demand.¹¹⁴

Technologies and Services in Demand:

- Water efficiency and reuse engineered solutions
- Water efficiency and reuse system training and maintenance services
- Smart water systems and software
- Energy efficient physical treatment
- Leak detection equipment and software
- Water loss prevention solutions
- Advanced metering technology and software
- Intelligent valves
- Rainwater collection systems
- Advanced filtration

- Membrane filtration
- Reverse osmosis
- UV disinfection

Process Water, Industrial Wastewater Treatment and Water Reuse

As Brazil's industrial base continues to grow and to become more sophisticated, there is increasing demand for water treatment to quality levels specific to the industrial process as well as that for water reuse and efficiency as industrial water consumers pay the highest rate per cubic meter for freshwater.¹¹⁵ Key client industries include aerospace, electronics, oil and gas, petrochemicals, mining, metallurgy, textiles, sugar and ethanol, food and beverage, automotive, pharmaceuticals, and pulp and paper.

Process water has an expected CAGR of 6.2 percent from 2010 to 2015¹¹⁶ with estimated revenue of USD 305.6 million in 2016.¹¹⁷ Industrial effluent laws in Brazil impose high tariffs on companies for effluent disposal in water bodies, making on-site tertiary treatment cost effective for compliant industrial facilities. From a base of USD 317.4 million in 2010 and an estimated CAGR of 9.4 percent,¹¹⁸ the industrial wastewater market is estimated to reach annual revenues of USD 544.0 million in 2016. For example, water treatment in the pharmaceutical sector is expected to grow at 9.8 percent annually between 2014 and 2018 and is expected to reach USD 38.9 million by 2018.¹¹⁹

Water scarcity and adduction costs make desalination and water reuse attractive, particularly in water-intensive extractive sectors. For instance, an average large mining project in Brazil demands approximately USD 800 million in water technology and infrastructure.¹²⁰ Correspondingly, the capital market for water in mining was estimated at USD 4.5 billion in 2015.¹²¹ Brazil is expected to be the fastest global market for offshore water treatment in the oil and gas sector with a combined annual growth rate of 8.5 percent.¹²² Global Water Intelligence estimates that capital expenditures on offshore systems for sulfate removal reached USD 190 million in 2015.¹²³

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Water efficiency and reuse engineered solutions
- Water efficiency and reuse system training and maintenance services

- Smart water systems and software
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Ozone disinfection
- Anaerobic digestion
- Aerators and sedimentation technology
- Incinerators and dryers
- Chemical sludge treatment
- Sludge collection systems
- Thickeners and dewatering devices

Waste Management and Recycling

Brazil's needs in terms of improved waste management are vast. According to the Brazilian Association of Urban Cleaning (ABRELPE), solid waste generation in Brazil is estimated at 62 million metric tons per year. Approximately 90 percent of solid waste is collected, with 37 percent destined for unsanitary landfills, posing a substantial threat to human health and the environment.

In 2010, Brazil finalized its *National Solid Waste Policy (Law 12,305)*, a measure intended to reduce national waste production and improve solid waste management practices. The law also mandates that municipalities build sanitary landfills and supports the development of a formal recycling sector. As a result, investments in solid waste treatment technologies and waste-to-energy projects in sanitary and hazardous landfills are expanding significantly. The Brazilian government plans to invest USD 870 million in solid waste treatment projects, replacement of landfills, introduction of selective waste collection services and financing cooperatives of waste collectors.

According to BNDES's sector analysis, current technologies for waste collection (i.e., compactor trucks) and for sanitary landfills (i.e., earth moving equipment, polyethylene landfill liners with leachate and gas collection pipes) are all made in Brazil. Some new waste valorization technologies, however, are being imported. With total investments of USD 20 million, Loga and Ecourbis, two concessionaires in charge of waste management in the city of São Paulo, built two automated waste separation plants, which were the first of their kind in the country. The equipment was imported from Germany, France and Spain. São Paulo plans to build two additional plants in the near future.

Power generators above 1 MW capacity to produce energy from bio gas are also imported. The use of container mounted power modules used in landfills is relatively common in Brazil.

In addition to Law 12,305, other notable regulations include CONAMA Resolution # 5 of 1993, which determines that the residue generator be responsible for the preparation and execution of a waste management plan. Environmental Crime Law 9605 of February 13, 1998 establishes penalties for inadequate disposal of solid, liquid or gas waste. This regulation is complemented by technical standards of the Brazilian Association of Technical Standards, which provides standards for treatment and disposal of residues. There are also regulations, laws and resolutions at the federal, state and municipal levels on industrial waste treatment and disposal. The Brazilian Association of Technical Standards (ABNT/NB - 843) establishes the requirements for landfill operation, including the adequate treatment of liquid and gas effluents.

Municipal Solid Waste

In an effort to comply with the *National Solid Waste Policy*, several municipalities in Brazil are adopting measures to improve segregated collection, recycling and organic waste recycling. For example, the municipality of São Paulo recently announced that collection of recyclable waste will be extended to all of the city districts by June 2016. The municipality will invest BRL 11 million (USD 3 million) in trucks, security equipment, uniforms and warehouses. The National Bank for Economic and Social Development (BNDES) lent BRL 41 million (USD 11 million) for the construction of three waste sorting plants and the refurbishing of 10 existing plants. With investments of BRL 59 million (USD 22 million), the municipality recently opened two automated recyclable waste sorting and bailing plants, with the capacity to process 500 million tons of waste per day, a pioneer process in Latin America. Two additional plants are expected to be inaugurated in 2016, increasing the amount of segregated and bailed waste to 1,250 million tons per day.

Similar to *Plansab*, the *National Solid Waste Policy* requires that municipalities develop local solid waste management plans, but in general, development and implementation of those plans are moving slowly. Brazil's National Institute of Geography and Statistics reports that only 32 percent of the 5,565 municipalities in Brazil have some sort of selective waste collection

system and that a mere 10 percent met an August 2012 deadline to present a solid waste management plan to the Environmental Ministry as articulated in the *National Solid Waste Policy*.

Market analysts have expressed pessimism that most municipalities will comply with standards set forth in the law, such as replacing dumps with sanitary landfills and implementing selective waste and recycling programs, requirements which were scheduled to be met by mid-2014.¹²⁴

Despite this slow pace in compliance, significant opportunities remain in solid waste management. An estimated 80 percent of solid waste management in Brazil is conducted by private sector companies. Municipal waste management services are currently valued at USD 10 billion annually with the expectation that the market will be worth USD 22 billion annually by 2016 once law 12,305 is enforced. The Brazilian government expects that income from recycling activities will increase from USD 1.1 billion to USD 4.7 billion annually.¹²⁵

Technologies and Services in Demand:

- Waste collection technologies
- Sanitary landfill systems
- Environmental monitoring and analytical equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste incinerators

Hazardous and Medical Waste Management

Brazil's *National Solid Waste Policy* outlines the development of a system that compels companies that produce hazardous waste to register in the "National Registry of Hazardous Waste Operators" and prove their technical capability in managing hazardous waste streams.¹²⁶ This enhanced focus on the management of hazardous waste affords opportunities for U.S. companies capable of providing relevant hazardous waste management systems and services.

In 2001, São Paulo's environmental authority (CETESB) initiated a Reference List for soil and groundwater pollution levels. CETESB publishes a list with the amount of chemical substances in the soil and groundwater. The amounts serve as a reference to

determine if the area is clean, requires attention or needs intervention. This list is revised every four years and is based on the U.S. EPA model. Amounts of chemical products are based on the risk analysis for the specific area. This information is available on CETESB's website (www.cetesb.sp.gov.br).

Improved access to medical treatment in Brazil will also increase the need to address chemical and biological healthcare waste. According to the Brazilian Association of Urban Cleaning and Waste Treatment Companies, only 32 percent of the 1,059 million tons of healthcare waste generated per day in Brazil is treated. Brazil's overall goals to provide safe waste management practices society-wide will drive focus in reducing the public health risks associated with poorly managed medical waste.

Key Technologies in Demand:

- Hazardous waste handling equipment
- Hazardous waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment
- Hospital and medical grade incinerators
- Industrial autoclaves

Industrial Waste Management

In Brazil, the private sector addresses waste policy compliance by setting industry standards within respective industry trade associations for the treatment and disposal of industrial wastes. Industry associations thus provide a market for feasibility studies and consulting and design for de-manufacturing and reverse logistics methods. Associations act as critical market multipliers as they will often determine where waste collection points will exist for their industries and what technologies will be deployed for industry specific waste management practices. Involvement in industry association decision making on waste management policies may provide downstream opportunities for implementation of waste management technologies and services.

Technologies and Services in Demand:

- Environmental engineering and consulting
- Waste handling equipment
- Waste management services
- Waste incinerators
- Recycling equipment

Environmental Engineering and Consulting

In Brazil, the environment is classified as a common usage asset and governed by the National Environment Policy of 1981 as outlined in Federal Law No. 6,938/81. Environmental law in Brazil stipulates that the obtainment of an environmental license is mandatory for the construction, installation, enlargement, modification and operation of facilities that use environmental resources and could cause environmental damage. Activities that may result in significant environmental impact must present an Environmental Impact Assessment and Report ("EIA/RIMA") during the licensing proceeding. The report or assessment will describe potential environmental damage or impact and proposed preventive and control measures to reduce the effects. Certain activities are required to provide a biannual assessment to the environmental agency.

Brazil is projected to experience a significant decline in the demand for construction and, correspondingly, in its market for Environmental Impact Assessment and related environmental engineering and consulting activities. The strong demographics that supported Brazilian growth appear to be reversing, leading to a plateau effect on the demand for construction over the long-term.

Key Technologies in Demand:

- Environmental Impact Assessment

ETWG Agency Initiatives and Programs

U.S.-Brazil Commercial Dialogue

In 2014, the International Trade Administration and Brazil Ministry of Industry and Trade initiated a working group to address common areas of interest in the development of environmental markets. The effort is designed to facilitate technical exchanges to improve mutual understanding of U.S. and Brazilian environmental regimes, approaches and markets.

WEFTEC International Buyer Program

WEFTEC, the largest water technology exhibition in North America, works with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to exchange relevant technical information and to advance U.S.-Brazilian water cooperation through targeted activities at WEFTEC.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to exchange relevant technical information and to advance U.S.-Brazilian waste management cooperation in ongoing bilateral and multi-lateral forums.

U.S. Environmental Solutions Toolkit

The Toolkit is an online searchable database that marries U.S. Environmental Protection Agency (U.S. EPA) expertise on solving environmental challenges and developing environmental rules with a catalogue of U.S. technology providers. In late 2014, the International Trade Administration and U.S. EPA introduced a Portuguese version of the Toolkit. It is used as a reference tool in bilateral engagements that focus on increasing Brazilian capacity to address environmental concerns, including follow up to the U.S.-Brazil Joint Initiative on Urban Sustainability (JIUS), the U.S.-Brazil Commercial Dialogue and others.

Market Contacts and Program References

Brazilian Association of Environmental and Sanitation Engineering (ABES)
www.abesrio.org.br

Brazilian Association of Private Concessionaires of Sanitation Services (ABCON – SINDICON)
<http://abconsindcon.com.br/>

Brazilian Association of Urban Cleaning Companies (ABRELPE)
www.abrelpe.org.br

Brazilian Environmental Institute (IBAMA)
www.ibama.gov.br

Environmental Authority of the State of São Paulo (CETESB)
www.cetesb.sp.gov.br

Brazilian Association of Solid Waste Treatment Companies (ABETRE)
www.abetre.org.br

South Korea

Since 2010, South Korea has worked to integrate green growth into its overall industrial development strategy. As a result, the market is making great strides in the implementation of advanced water treatment systems, air pollution control measures, and waste treatment and recycling. With an overall market valued at USD 20.6 billion and the U.S.–Korea FTA (KORUS) in place, Korea is a growing market for U.S. environmental technologies exporters. Domestic competition, however, is highly sophisticated, and understanding how to work within the Chaebol system is necessary.

Overall Rank

5

Air Pollution Control

3

Water

10

Waste & Recycling

9

State of the Environmental Regime

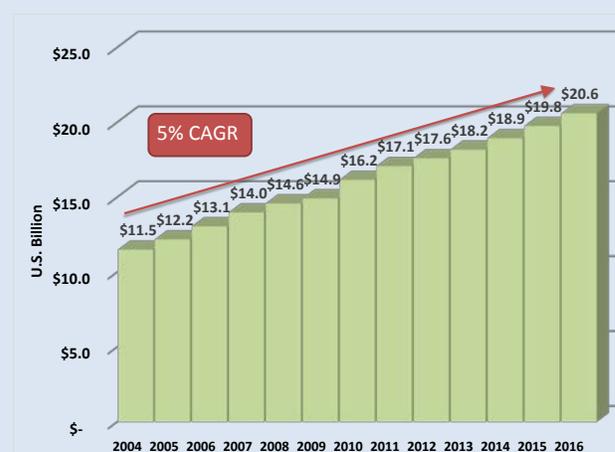
South Korea's environmental regime is above average for an emerging market, with a score of 5.3 on The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent in the world). This score is a 1.8 point improvement over its ranking of 3.4 in 2005. On the World Economic Forum's 2011 Index for Regulatory Stringency, South Korea ranked 41st and 36th globally, with scores of 4.13 and 4.07 for regulatory stringency and enforcement, respectively.

Market Barriers

The U.S.-Korea FTA (KORUS) was implemented on March 15, 2012. By 2017, 95 percent of tariffs on U.S. exports to South Korea,¹²⁷ including environmental goods, will be eliminated.¹²⁸ KORUS also has expanded opportunities for trade in services, improved transparency in South Korea's regulatory system, strengthened intellectual property protection and enhanced market access for U.S. exporters of all sizes.¹²⁹ Potential challenges for foreign firms wishing to enter the market derive from the need for specialized, locally-focused knowledge about South Korea's business sector, including the language and culture, as well as the workings of its Chaebol system.

Industry experts in the Office of Energy and Environmental Industries (OEEI) have identified the following potential barriers for environmental technologies companies attempting to export to, or work in, South Korea:

Figure 1: South Korea Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis. 2016.

1. Price sensitivity

Expectations by South Korean buyers for high quality at “rock bottom” prices may make contract negotiations challenging and may adversely impact the competitiveness of U.S. technologies as compared with lower-priced alternatives.

2. Standards and marking requirements

The Korean Agency for Technology and Standards (KATS) requires separate, often redundant, safety certifications for certain electrical products. Additional testing for products that already meet international standards can be required and, together with Korea-specific labeling stipulations, can be burdensome for U.S. companies.

Market Opportunities

Air Pollution Control

Air Quality Monitoring

In its Nationally Determined Contribution (NDC) under the December 2015 Paris Climate Agreement, South Korea committed to reduce its greenhouse gas (GHG) emissions by 37 percent from a business-as-usual level across all economic sectors by 2030.

In 2010, the government implemented its National Strategy for Low Carbon Green Growth, including medium and long-term greenhouse gas emissions targets. Objectives of the Strategy include expanding the green technology sector and integrating standards for low GHG emissions into industries such as transportation, finance and tourism. The Strategy emphasizes working with small and medium enterprises to help “green” their businesses. In 2014, South Korea developed a Roadmap to achieve its GHG reduction targets that includes the building, transportation, agricultural, industrial and waste sectors. The government aims to manage large GHG emitters and energy consumers that are not covered by the emissions trading scheme through a national-level GHG and Energy Target Management System (TMS). In 2015, it launched a nationwide Emissions Trading Scheme (ETS) that includes 525 of the country’s largest polluters in 23 sectors and accounts for two-thirds of the nation’s non-vehicular emissions.¹³⁰

The government has paid increasing attention to urban air quality in recent years, including through setting up monitoring stations in and around Seoul and other cities and making the data publicly available online. Seoul’s First Metropolitan Air Quality Control Master Plan (2005-2014) emphasized reduction of PM10 and nitrogen dioxide concentrations in particular, with a goal of reaching 40 micrograms per cubic meter and 20 ppb, respectively, by the end of the plan period. The Second Master Plan (2015-2024) added ultrafine particles (PM 2.5) and ozone to the list of managed pollutants, which also includes SOx, NOx and Volatile Organic Compounds (VOCs). The Second Master Plan aims to reduce the emission of each pollutant by 34 to 56 percent of business-as-usual.¹³¹ Air quality monitoring tenders are listed on South Korea’s Public Procurement Service (PPS) website.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

Industrial Air Pollution Reduction

Under the National Strategy for Low Carbon Green Growth, South Korea has seen an expansion of the pollution control equipment industry, with imports accounting for about 10 percent of the total market. Japan and the United States are the leading foreign suppliers at 50 percent and 30 percent market share, respectively. Local manufacturers are seeking advanced products and technologies to meet the government’s increasingly strict standards.

Control measures to achieve the goals set forth in the National Strategy consist of automobile management, including a project to reduce exhaust gases from vehicles in operation; management of emission facilities, including the total load management system for large establishments; and management of eco-friendly energy and cities. Projects to simultaneously reduce air pollutants and greenhouse gases will be carried out to improve air quality and make a positive contribution to climate change. Examples include distribution of low NOx burners households in Seoul, equipping vehicles with idle stop and go systems, and expanding green spaces in urban regions.

In Seoul, the Second Metropolitan Air Quality Control Master Plan also aims to manage high-risk pollutants distributed throughout everyday surroundings. The city government is prescribing strict control measures for VOC sources, such as laundry shops, gas stations, painting facilities, printing offices and everyday consumables.¹³² To help reduce total PM 2.5 emissions, the city offered subsidies to help 10,000 Korean barbecue restaurants and 1,135 bathhouses install filters in 2015.¹³³

A national chemical emissions survey conducted in 2010 found that approximately 61 percent of the 50,000 tons of annual emissions of 388 hazardous air pollutants (HAPs) were fugitive emissions from non-smokestack facilities and processes.¹³⁴ The government responded by amending the Clean Air

Conservation Act in 2012. The amendments introduced facility management standards for HAP-emitting facilities, effective as of January 2015. Each facility now is responsible for meeting the permissible emission levels, installation and operation of reduction technologies, leakage monitoring, and maintenance standards.

According to the U.S. Foreign Commercial Service, highly customized solutions for specific applications offer potential opportunities for U.S. exporters.

Key Technologies in Demand:

- Carbon Capture and Storage (CCS)
- Volatile Organic Compounds (VOC) control
- Dioxin abatement
- Advanced sulfur oxides/nitrogen oxides abatement in power plants and steel mills
- Energy saving and waste to energy in steel mills and municipal landfills
- Pollution-free and low-emission vehicles and engineering technology
- Pollution abatement technologies for the automobile and oil refinery industries
- Environmentally-friendly construction materials

Power Plant Emissions Reduction

According to the U.S. Energy Information Agency, coal-fired power plants currently make up about 28 percent of South Korea's total generation capacity. Per the country's proposed new electricity plan, the share of coal capacity will increase to 32.2 percent by 2029.¹³⁵ Some estimate that as much as 60 percent of the country's air pollution is caused by pollution from power generation. South Korea will need advanced abatement technologies if it is to increase its fossil fuel fleet and still attempt to meet its emissions reduction and climate change targets.

Key Technologies in Demand:

- Continuous emissions monitoring systems
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies

Waste Management and Recycling

Solid Waste and Recycling

Over the past two decades, the Korean government has made substantial efforts to increase recycling and reuse of waste, reduce landfilling and improve waste to energy capacity. The combined volume of commercial, industrial and construction waste generated has increased over 45 percent since 2000, from 180 to 333 thousand tons per day in 2012. Despite the country's strong economic growth, per capita household waste production has increased only marginally since 1995 due to the implementation of the Volume Based Waste Fee (VBWF) system, which operates under the "producer pays" principle. The Extended Producer Responsibility (EPR) system, implemented in 2003, currently requires manufacturers and importers to recycle certain product categories, including 27 electrical and electronic devices, as well as tires, lubricant, batteries, fluorescent lamps, Styrofoam float and packaging materials. The Ministry of Environment sets a mandatory recycling ratio for each EPR product category annually.

In 2002, the government established the "Allbaro" system, an online mechanism that tracks waste from generation to transport to disposal. The system has streamlined the waste treatment verification process and served as a basis for domestic waste-related policy development.

The government has actively facilitated WtE initiatives as well, increasing capacity from just 0.7 million tons in 1995 to 3.1 million tons at 35 WtE plants in 2010. While waste-to-energy can be part of more comprehensive waste management strategies, source reduction and recycling are recognized as preferred methods for solid waste management ("Reduce, Reuse, Recycle"). Additionally, any waste-to-energy solutions should give due attention to air pollution and climate risks.

Key Technologies in Demand:

- Waste collection technologies
- Sanitary landfill systems
- Environmental monitoring and analytical equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment

- Collection services, containers and vehicles
- Recycling process expertise
- Waste incinerators
- Waste-to-energy technology

Hazardous Waste Management

The Korean government has set objectives to reduce pollution generated by industrial activity and restrict the use of hazardous materials in manufacturing. It has supported the development of cleaner technologies, including drafting a strategy to reduce or substitute the use of rare metals used in electronic appliances and automobile manufacturing. As of January 2016, certain types of hazardous waste – including acidic and alkaline waste, spent oil and organic solvents, synthesized high molecular compounds, dust and sludge¹³⁶ - must be physically separated from other solid wastes under the country's Waste Control Act. The Ministry of Environment also recently announced plans to establish a national-level institutional framework for mercury management (2016 to 2020), per the provisions of the Minamata Convention on Mercury, to which South Korea is a signatory, though they have not yet ratified the Convention. The plans include environmental monitoring; emissions reduction; more environmentally-friendly disposal of mercury, including a take-back program for, and the ultimate phase-out of, mercury-containing products.¹³⁷

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Testing and monitoring equipment

Water and Wastewater Treatment

Municipal Water and Wastewater Treatment

South Korea hosts a comprehensive water treatment system with 78.8 percent of the population connected to a municipal wastewater collection system and 89 percent of the population connected to a municipal drinking water system.¹³⁸ The private sector is a major player in the provision of public water systems with the government typically favoring build-own-operate-transfer (BOOT) structured contracts. The federal government typically covers 50 percent of constructions costs with the balance covered by the contractor.¹³⁹ High adherence to rate paying among the population has made public water a profitable

endeavor in South Korea, and the Chaebols, as well as smaller companies, are increasingly participating in the water technologies market. There is strong demand among these players for more advanced technologies for which they look to potential foreign suppliers.¹⁴⁰

The government is also implementing advanced treatment processes for drinking water plants nationally. Since 2013, this effort has resulted in the application of advanced treatment process in 32 plants, a total of 3 percent of all facilities. The government plans to increase the ratio up to 53 percent by 2017.¹⁴¹

There is a robust market for sludge management that has emerged as result of legal changes prohibiting landfill disposal and limiting the volume of sludge discharged into the ocean. Korea discharges an estimated 2.5 million tons of sewage sludge per year, 72 percent of which is discharged into the ocean. As a result of regulatory changes, demand for advanced solutions for volume reduction and recycling of sewage sludge has increased. The Korean government constructs more than 10 new sewage treatment plants annually, and upgrading existing sewage treatment plants to install tertiary processes, such as activated carbon filtering and advanced disinfection processes, is common.¹⁴²

Furthermore, private sewage treatment facilities are constructed where public sewage systems are cost-prohibitive. As of 2012, there are 416,075 private sewage treatment facilities operating outside of the sewage service zone. Since 2007, any private sewage treatment facility of a certain size or larger must have a designated specialist manager and must be constructed by professional service companies.¹⁴³

Key Technologies in Demand:

- Testing equipment
- Engineering, procurement and construction services
- Advanced filtration
- Membrane filtration
- Waste to energy technology
- Sludge dewatering systems
- Membrane bioreactors
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Biogas and natural gas recovery

Process Water and Industrial Wastewater Treatment

Korea's vast high-tech industrial base and stringent effluent standards¹⁴⁴ fuel a robust process and industrial wastewater treatment industry. According to South Korea's Ministry of Environment, there are more than 155 registered industrial complexes and approximately 47,000 operating facilities for small and medium-sized wastewater management firms. Korean industry implements the spectrum of water treatment technologies. There is also demand for ultrapure water treatment technologies to complement the electronics sector.

Key Technologies in Demand:

- Engineering and construction services
- Water reuse equipment and services (process specific)
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Testing equipment.

Desalination

Korea is investing heavily in desalination technology. In 2014, South Korea completed construction of its first commercial seawater desalination plant. The plant employs ultrafiltration, reverse osmosis and seawater reverse osmosis methods to supply approximately 30,000 tons of industrial water a day.¹⁴⁵ The government is setting out to develop new desalination technology using natural gas hydrate. From 2011 to 2016, the Ministry of Land, Transport and Maritime Affairs plans to provide USD 9.2 million to the Korea Institute of Industrial Technology, a state-run think tank, to further develop the technology.¹⁴⁶ South Korea has also developed a small nuclear reactor design for cogeneration of electricity and potable water.¹⁴⁷

Key Technologies in Demand:

- Engineering and construction services
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Flash distillation

Environmental Consulting and Engineering

The Integrated Environmental Impacts Assessment Act came into force in July of 2012. The new law streamlines the Environmental Impact Assessment (EIA) process and covers three categories: Strategic Environmental Assessment (SEA) for public and private development projects, EIA, and small scale EIA.¹⁴⁸ Administrative plans as targets of SEA are divided into policy plans and development master plans based on plan characteristics. As of 2011, main EIA project categories included urban development (156 projects in 2011), road construction (33 projects), industrial complex development (33 projects), ports (39 projects) and public water projects (36 projects). Target projects are determined in advance based on type and size. EIAs are required for 17 development categories: urban and comprehensive regional development projects; industrial site development; infrastructure projects, specifically energy projects, as well as port, road, water resources, rail and airport construction; stream use and development; land and public water reclamation; tourism complexes; mountain area development and mining of soil, sand and minerals; sports facility construction projects; waste treatment facility development; and defense and military construction projects.

Key Technologies in Demand:

- Engineering and construction services
- Environmental Impact Assessment (EIA)

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA) environmental regulations, related underlying research and a directory of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with South Korean participants

and to foster business relationships between Korean end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with South Korean participants and to introduce Korean buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Korean officials and business representatives to WEFTEC to explore relevant U.S. technologies and

work with U.S. exporters on approaches to water resource management.

Market Contacts and Program References

Ministry of Environment

<http://eng.me.go.kr/main.do>

Korea National Cleaner Production Center

<http://www.kncpc.or.kr/en/main/main.asp>

Public Procurement Service (PPS)

<http://www.pps.go.kr/english/>

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Nathan Huh

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

Saudi Arabia

Saudi Arabia has a limited domestic environmental technologies industry and therefore imports the balance of the goods and services required to meet its environmental goals. Its preference for imported goods, pronounced water scarcity issues, and vast oil and gas industry make it a top market for U.S. environmental technologies. Recent budgetary tightening resulting from low oil prices, however, could slow implementation of the project pipeline.



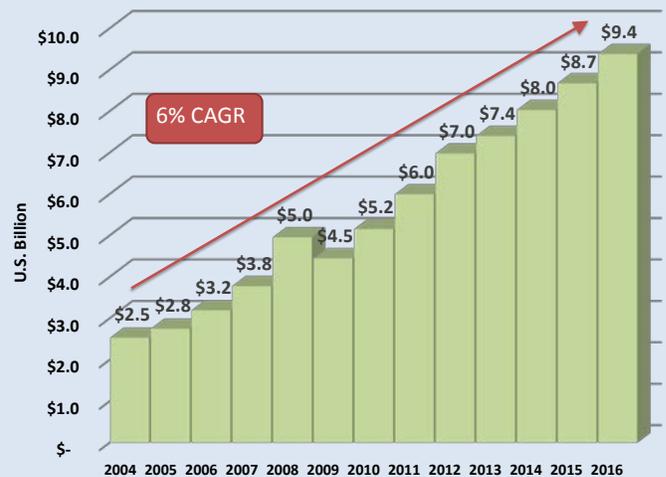
Saudi Arabia ranked sixth globally on the 2016 Top Markets Study (TMS) with a composite environmental technologies score of 25.9. Within the environmental industry segments, Saudi Arabia ranked fifth for water with a score of 12.0, highlighting the relatively important role that water and wastewater technology plays in Saudi’s desert climate. Saudi Arabia ranked seventh for air pollution control markets with a score of 10.9 and sixth for waste and recycling with a score of 3.03 (see Appendix 1 for global rankings).

State of the Environmental Regime

Saudi Arabia hosts a moderately stringent environmental regime. The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent in the world), scored Saudi Arabia a 4.2 in 2012, a 0.7 point improvement from its 2005 score of 3.5. Saudi Arabia’s score of 4.81 on the World Economic Forum’s 2011 Index for Regulatory Stringency (on a similar scale to that of EBJ-OECD) reflects a slightly higher perception of stringency from the perspective of international businesses operating there.

Saudi Arabia’s ranking in the same survey for enforcement is 21st globally with a score of 4.87, reflecting the Kingdom’s improving enforcement efforts. This is evidenced both by the government’s recent allocation of USD 300 million for environmental protection and pollution control¹⁴⁹ and its 2009 announcement of the formation of a Green Police unit

Figure 1: Saudi Arabia Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis, 2016.

to improve monitoring and enforcement of environmental rules.¹⁵⁰ Saudi Arabia also named several environmental protection goals in its 10th Development Plan (2015-2019), including improvement of waste management and mobile and stationary source emissions reduction and protection of coastal and territorial waters.

Market Barriers

The Environmental Technologies Trade Advisory Committee (ETTAC) identified the following barriers as most problematic for environmental technologies companies attempting to export to or work in Saudi Arabia:

1. Local partnership is required.

American exporters are not required to appoint a local Saudi agent or distributor to sell to Saudi companies, but commercial regulations restrict importing for resale and direct commercial marketing within the Kingdom to Saudi nationals, wholly Saudi-owned companies and Saudi-foreign partnerships where the foreign partner holds 25 percent equity.¹⁵¹ Furthermore, the Saudi government appears to favor joint-venture arrangements with Saudi partners in the lead in public tenders over those led by foreign firms.

2. Certification and safety approvals fail to recognize equivalents from the exporting market.

The Saudi Food and Drug Authority applies unnecessary additional testing requirements for products that have dual use in water analysis and medical applications (such as spectrophotometers). Additional testing imposes undue burden in terms of cost and time-to-market for technologies that are applied to environmental rather than medical uses.

Market Opportunities

Air Pollution Control

Air Emissions Control and Monitoring

The Presidency of Meteorology and Environment (PME) not only monitors and regulates air quality but also issues tenders. In late 2012, PME introduced new ambient air quality and stationary and mobile source emissions standards. In March 2014, the agency decreed that all companies would have five years to meet the new requirements, bringing maximum pollutant levels into line with international benchmarks.¹⁵² The Kingdom is a signatory to the Kyoto Protocol and has undertaken an effort to enforce emissions standards for large industrial facilities.

In its Nationally Determined Contribution (NDC) under the December 2015 Paris Climate Agreement, the Kingdom committed to achieve mitigation co-benefits of up to 130 million tons of CO₂ equivalent avoided annually by 2030 through contributions to economic diversification and adaptation. The NDC specifically

emphasized the need to expedite conversion of its single cycle power plants to combined cycle as part of its overall emissions reduction strategy. It also included a plan to build the world's largest carbon capture and use facility, which would capture and purify about 1,500 tons of carbon dioxide per day for use in Saudi Arabia's petrochemical plants.

Saudi efforts to monitor air quality have increased alongside efforts to develop and enforce environmental standards and regulations, creating demand for ambient air quality surveys and emission source monitoring. The Saudi government has ordered all major industrial projects to conform to international air standards and allocated USD 300 million for environmental protection and pollution controls in 2010. Major emitting industries in Saudi Arabia include oil refineries, power generation, petrochemical development, cement plants and metals foundries. Saudi's annual imports of air pollution control and monitoring equipment is estimated at USD 50 million,¹⁵³ with U.S. companies meeting almost 75 percent of demand.

The industrial cities of Jubail and Yanbu are prime examples of adoption of advanced monitoring and control technologies within a finite industrial zone for existing and new facilities, presenting continued vast opportunities to U.S. technology providers.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Fenceline monitoring equipment
- Ambient air monitoring equipment
- Source emissions measurement technologies
- Environmental testing and laboratory instrumentation and services
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls

Waste Management and Recycling

Municipal and Industrial Waste

In July 2013, the Saudi Cabinet approved new Municipal Solid Waste (MSW) management regulations. The new regulations aim to ensure the implementation of an integrated framework for

municipal solid waste management in the country. Studies conducted by the Ministry of Municipal and Rural Affairs in collaboration with the Saudi Arabian Basic Industries Corporation (SABIC) recommend that the ministry establish a joint stock company for the treatment and recycling of solid waste in the Kingdom using the latest technology to dispose of the massive quantity of waste generated in the country in an environmentally friendly manner. The ministry is known to be finalizing the executive bylaws for the management of solid waste.

Recycling and solid waste management is regulated, and related tenders are issued by the Ministry of Municipal and Rural Affairs in conjunction with local municipalities. A substantial portion of the USD 3 billion budget of Saudi Arabia's Ministry of Municipality and Housing is dedicated to handling, processing, managing and disposal of solid waste.¹⁵⁴ Saudi Arabia generates 15.3 million tons per year, the majority of which ends up untreated and landfilled.¹⁵⁵

While few recycling initiatives exist, there is increasing demand for incineration technologies to deter the creation of more landfills. Production of domestic, industrial, chemical and hazardous wastes is also growing in Saudi Arabia. The burgeoning healthcare sector, which generates an estimated 50,000 tons of healthcare waste per year, also offers increasing commercial opportunities. The Kingdom currently boasts 1,850 health centers, with 79 hospitals under construction, and plans to establish an additional 250 new primary care centers,¹⁵⁶ creating demand for a variety of incineration and medical waste handling technologies.

Technologies and Services in Demand:

- Hazardous waste transportation
- Waste sampling, characterization and analysis
- Waste minimization
- Hazardous waste removal and tank cleaning
- Contaminated land site assessment and remediation
- Industrial and hazardous waste treatment and disposal
- Air pollution control equipment and monitoring devices
- Solid waste management systems

Water and Wastewater Treatment

Water resources are regulated by the Ministry of Water and Electricity and tendered by the National

Water Company (NWC). The NWC was created in 2008 to oversee water tenders and manage the development of Public Private Partnerships (PPP) for water infrastructure development.¹⁵⁷ The NWC is currently a government-owned entity but is designed to evolve into a private sector holding company as the Saudi water sector becomes completely privatized.¹⁵⁸

According to the NWC's plans, between 2012 and 2020 approximately USD 66.4 billion will be invested in new water infrastructure and related services, USD 30 billion of which will be directed towards capital expenditures.¹⁵⁹ Similarly, the Water and Electricity Company (WEC) was created in 2003 as a limited-liability corporation to manage the consumer market for water and power with an overarching mission of keeping tariffs low.¹⁶⁰ The Saline Water Conversion Corporation (SWCC) operates the state's 36 desalination facilities.

Most recently, Saudi Arabia moved to restructure water tariffs, which have been among the lowest in the world. The impact of declining oil prices combined with years of wasteful overuse has moved the Ministry of Water and Electricity (MOWE) to increase industrial and commercial water tariffs by 125 percent.¹⁶¹ Increases for residential customers have also been implemented, though they will be negligible up to 15m³ per month. From that departure point the new graduated tariff scheme more than doubles for every 15m³ increment providing users ample incentive to limit consumption and fueling a fundamental shift in how water resources are managed in the Kingdom.¹⁶²

Municipal Water Treatment and Water Efficiency

Demand for water services in Saudi Arabia is high as urbanization and population growth increases but groundwater resources dwindle. The 2014 Saudi Arabia Country Commercial Guide estimates that USD 5 billion are need annually over the next 20 years for new water infrastructure investments. With the development of 12 Operations-and-Management joint ventures, in the near-term, there are substantial opportunities for management of existing facilities as well as new facility construction and upgrades. The NWC is expected to invest USD 12.8 billion in capital expenditures and USD 17.9 billion in operations expenditures in fresh water treatment and distribution between 2012 and 2020.¹⁶³

The NWC privatization scheme will transfer management to private companies to ameliorate the

problem of non-revenue water. This will be achieved by improvements in transmission infrastructure, use of leakage detection systems and enhancements to revenue collection, which include upgrading metering and billing technologies and services. There is also an emphasis on improving the sewer system and creating separate systems for storm water management. Approximately 40 percent of the Saudi Arabia utilizes combined sewers which has exacerbated flooding in recent years.¹⁶⁴

Technologies and Services in Demand:

- Engineering services
- Operations and management services
- Pipes, pumps and valves
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- Multiple Effect Distillation (MED)
- UV disinfection
- Ozone disinfection
- Water loss technology
- Smart metering

Desalination

Water demand surpasses renewable water resources by approximately 10 billion cubic meters a year.¹⁶⁵ Saudi Arabia meets excess demand through seawater desalination, though desalination remains critical for groundwater treatment in the Kingdom as well due to high groundwater salinity. The SWCC currently operates 36 desalination facilities that address 60 to 70 percent of freshwater demand.¹⁶⁶ Expansion of the Saudi desalination program will be needed to meet future fresh water needs in the Kingdom.¹⁶⁷

The SWCC plans to invest USD 11.7 billion in capital expenditures and USD 4.5 billion in operations expenditures through 2020,¹⁶⁸ highlighting the vast opportunities for desalination technology and Engineering, Procurement, and Construction (EPC) firms. The SWCC has traditionally granted large EPC contracts for the development of facilities and continues to do so; however, it has also recently included Build Own Operate models in its portfolio that will expand the desalination market further into services. This trend may accelerate as budgetary shortfalls due to falling oil prices create demand for alternative financing models.

There are six major projects expected to tender during the 2016 timeframe. The largest is the Jubail 3 thermal

and reverse osmosis project estimated to be worth USD 3 billion.¹⁶⁹ The remaining five projects are all saline water conversion plants utilizing reverse osmosis; they include Haradh BWRO, USD 1.6 billion; Rabigh Phase 4, USD 1.2 billion; Yanbu 4, USD 900 million; Jeddah 4, USD 800 million; and Al Khafji Solar-powered SWRO phase 2, USD 600 million.¹⁷⁰

Technologies and Services in Demand:

- Engineering services
- Management and operations services
- Multistage flash distillation
- Multiple Effect Distillation (MED)
- Reverse osmosis membrane technology
- Solar and energy efficient desalination technology

Industrial Wastewater Treatment and Water Reuse

Saudi Arabia's lack of a fee system for wastewater treatment services makes it a difficult economic prospect for privatization without government subsidies, but new fees for industrial freshwater make effluent treatment and reuse an attractive prospect.

Wastewater treatment is growing robustly in the Kingdom; the NWC is expected to invest USD 23.9 billion in capital expenditures and USD 11.9 billion in operations expenditures in wastewater treatment between 2012 and 2020.¹⁷¹ The Kingdom's wastewater treatment capacity is expected to expand by 12.8 percent annually.¹⁷² The NWC plans to enhance the economic attractiveness of wastewater projects by facilitating waste-to-energy programs within treatment plants and promoting the sale of treated wastewater for industrial uses.¹⁷³ Waste-to-energy projects are key components of the national wastewater management program and are likely to emphasize biogas combined heat and power facilities.¹⁷⁴

NWC has signed private sales contracts of treated wastewater to Saudi Aramco and power generation company, Saudi Electric Company.¹⁷⁵ At the writing of this report, one major project was announced for the 2015 to 2016 tender period: the South Dhahran Wastewater Treatment Plant will provide municipal treatment services for Dhahran, and treated effluent will be used by Saudi Aramco for industrial purposes. The project is expected to have a daily capacity of 70,000 m³ and is estimated at USD 28 million.¹⁷⁶

Water reuse provides growing opportunities. The Saudi government has instituted treatment standards for various modes of reuse. A stated goal of increasing

reuse by 16 percent by 2016 further underscores this priority.¹⁷⁷ Focusing water reuse on industrial purposes has the intended impact of reducing the amount of saline conversion necessary for potable uses and is economically more viable in terms of the operational costs associated with desalination versus membrane-based wastewater treatment. The NWC intends to play a major role in the water reuse market and estimates that sales from reused wastewater will exceed those for potable water in six large cities by 2030, yielding USD 900 million in revenues over the forecast period.¹⁷⁸ Major industrial reuse projects announced include the Manfouha WWTP expansion valued at USD 320 million; the Al Hayer WWTP, Phase 2 valued at USD 160 million; and the Arana WWTP, Phase 2 valued at USD 100 million,¹⁷⁹ all of which are being developed with the intention of selling treated effluent to industrial users.

Technologies and Services in Demand:

- Engineering and construction services
- Water reuse equipment and services (process specific)
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Anaerobic digestion
- Nitrification
- Biological denitrification

Environmental Engineering and Consulting

Four new Economic Cities are currently in various stages of development throughout the Kingdom: King Abdullah Economic City (KAEC) in Rabigh, Prince Abdulaziz bin Musaid Economic City (PABMEC) in Ha'il, Knowledge Economic City (KEC) in Medina and Jazan Economic City (JEC). Each city is intended to encourage growth in specific sectors - such as logistics, healthcare, education, energy and agriculture – that are associated with its theme. The goal is to generate domestic jobs through workforce development, professional training and academic institutions.¹⁸⁰ The Saudi Arabian General Investment Authority (SAGIA) has stated that sustainability and energy efficiency are key elements of the cities' development strategy. All of these massive projects are being built entirely from scratch, creating huge demand for construction, engineering, design and related services.

Key Services in Demand:

- Environmental Impact Assessment (EIA)
- Engineering, design and construction services
- Environmental monitoring and analysis

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA) environmental regulations, related underlying research and a list of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. The Toolkit is used by U.S. EPA officials or environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns. In 2016, an Arabic-language version of the Toolkit will be introduced to facilitate ease of use in Saudi Arabia.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Saudi participants and to foster business relationships between Saudi end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Saudi participants and to introduce Saudi buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Saudi officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

Market Contacts and Program References

Saline Water Conversion Corporation:
www.swcc.gov.sa

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www.momra.gov.sa

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Saudi Water and Power (SWPF), Jeddah, Saudi Arabia
www.ksawpf.com

WEPower, Dammam, Saudi Arabia
www.wepower-sa.com

WETEX, Dubai, UAE
www.wetex.ae

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Indonesia

Indonesia ranks seventh overall on the 2015 Top Markets Study (TMS) with the market for environmental technologies valued at USD 6.3 billion in 2016. Despite efforts to establish a modern environmental regime, weak technical capacity in the public sector and poor administration of assets increases the likelihood that the application of environmental technologies in Indonesia for the short term will remain the purview of the private sector and donor organizations.

| | | | |
|--------------|---|-----------------------|---|
| Overall Rank | 7 | Air Pollution Control | 8 |
| Water | 8 | Waste & Recycling | 2 |

The overall environmental technologies market in Indonesia including goods and services is valued at USD 6.3 billion (2016).¹⁸¹ Indonesia ranks seventh overall on the 2015 Top Markets Study (TMS) with a Composite Environmental Technologies Score of 23.4. Indonesia ranks eighth for air pollution control and water markets with a score of 9.9 and 9.3, respectively. Waste and recycling ranks second for with a score of 4.2 (see Appendix 1 for global rankings).

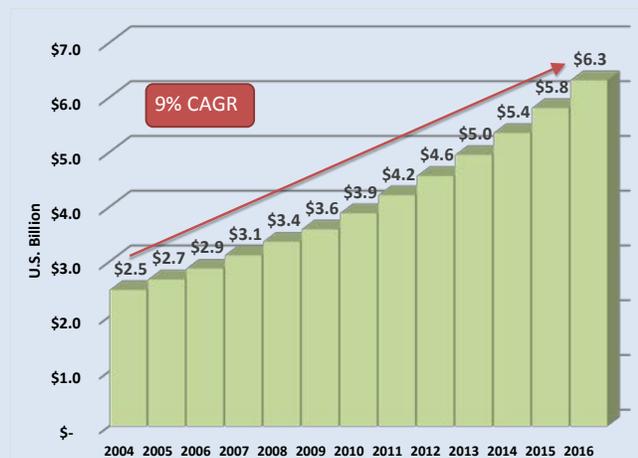
State of the Environmental Regime

The Ministry of the Environment and Forestry (MoEF) is the primary administrator of environmental law in Indonesia, which is principally regulated by Law No. 32 on Environmental Management and Protection. The MoEF and its authorities are responsible for environmental protection and management, and the supervision of compliance by parties responsible for business and activities conducted within their administrative areas.

Substantial investment in environment and natural resources policy and staff development coupled with strong support for policy and capacity development from both within the government and with international partners has led to only limited success with difficult and slow actual implementation of rules and procedures. This is mainly due to weak commitment by sector agencies, low awareness in local departments and capacity challenges at all levels.¹⁸²

Despite these challenges, Indonesia's environmental regime is improving in both regulatory development

Figure 1: Indonesia Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis, 2016.

and efforts to enforce environmental rules. According to the U.S. Environmental Protection Agency (U.S. EPA), these changes are the result of a government effort to strengthen both environmental rules and enforcement. Recent developments can be seen through the Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent), which scored Indonesia a 3.5 in 2012, a 1.3 point improvement from its 2005 score of 2.2. Similarly, Indonesia ranks 58th on the World Economic Forum's 2011 Index for Regulatory Stringency with a score of 3.76 (on a similar scale to that of EBJ-OECD). Indonesia

scored just above the median at 3.63 on the same survey for enforcement.

Market Barriers

Market barriers in Indonesia are substantial and often insurmountable in the public sector. The following barriers are most problematic for environmental technologies companies attempting to export to or work in Indonesia:

1. Weak technical capacity to implement advanced environmental systems

The technical capacity to implement advanced environmental solutions varies depending on the sector at issue, with public providers of environmental services exhibiting low to medium technical capacity. This shortfall in capacity contributes to delays in project development and weak administration of existing projects.

2. Poor asset management in public projects

Indonesia is plagued in the public sector by poor asset management and, in many cases, a lack of any asset management policy or attendant know-how. This has led to a variety of premature infrastructure failures. The decoupling of construction from downstream maintenance and operations compounds these problems by divorcing accountability between those that develop infrastructure from those responsible for maintaining it.¹⁸³

3. Perpetual delays in announced projects

Indonesia had developed an ambitious national agenda for environmental infrastructure development centered on a Public Private Partnership (PPP) model; however, repeated failures to secure financing have mired projects in the conceptual stage. The flaw in Indonesia's PPP model is a wholesale transfer of risk to the private sector without appropriate profit incentives.¹⁸⁴

4. Difficulty making market linkages through client industries

The most promising areas for environmental technologies originate from client sectors such as oil and gas or mining. It can be difficult for new-to-market exporters to develop relationships that lead to export sales with these clients, however.

5. Lack of regulatory implementation, transparency and corruption in public tenders

U.S. companies have reported that tender requirements may be murky and that corrupt practices are common in many public tenders. Furthermore, projects and industrial activities, and their regulations fall directly under the command of governors or district heads. Actual implementation of rules and procedures on the local level in Indonesia has been poor.

Market Opportunities

Air Pollution Control

Power Plant Emissions Reduction

Indonesia's coal consumption now accounts for 22 percent of total energy consumption, surpassing gas as the second most consumed fuel used in conventional thermal generation. Indonesia currently has 51 gigawatts (GW) of installed generation capacity and electrification has reached about 87 percent¹⁸⁵, but many remote areas still have very limited access to electricity and those that are connected to the grid suffer from power shortages.¹⁸⁶ To address these capacity issues, in 2006 the government embarked upon the first stage of its "fast track" plan, designed to accelerate power plant development.

The government managed to add 8.1 GW under the first phase and planned to complete Phase One by the end of 2015. Phase Two includes approximately 18 GW of new capacity (60 percent from coal), expected to come online by 2022.¹⁸⁷ More than a dozen smaller units are to be installed on Sumatera, Kalimantan and Bali during the same timeframe.¹⁸⁸ In mid-2015, President Joko Widodo announced additional installation goals of 36.7 GW by 2019, including 20 GW from coal-fired plants, 13 GW from gas-fired and 3.7 GW from renewable sources.¹⁸⁹

In the first phase, electricity sector demand for coal more than doubled by 2014 as a result of coal-fired generation capacity additions.¹⁹⁰ 80 percent of the power plants built during the next decade will come from fossil fuel combustion, further opening the market for U.S. air pollution control technologies and services. The scope for deployment of air pollution control technologies in Indonesia is contingent on

improvements in both enforcement and technological expertise -- areas where the United States has engaged bilaterally since the 1990's.¹⁹¹

Key Technologies in Demand:

- Continuous emissions monitoring systems
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies
- Selective non-catalytic reduction controls
- Urea to ammonia reagent systems
- Electrostatic precipitators (wet and dry)

Air Quality Monitoring

The U.S. EPA collaborated with the Ministry of Environment on a 2013 study which showed that 60 percent of Jakarta's population suffered from various air pollution-related health effects, including asthma and coronary disease. The study concluded that the total direct health cost of these illnesses was 38.5 trillion rupiah (about USD 2.8 billion) a year.¹⁹² Indonesia launched an urban air quality improvement in 2006 that included installation of air quality management systems in 10 cities. The system, however, never operated effectively due to its high costs, and it lacked the capacity to monitor fine particulates.¹⁹³ The International Atomic Energy Agency (IAEA) recently worked with Indonesia's National Nuclear Energy Agency (BATAN) to add nuclear analytical techniques to the national air quality monitoring program. The project includes collaboration with local cities, provincial environmental protection agencies, and the Ministry of the Environment and Forestry (MoEF) and BATAN. There are now sampling locations in 16 cities covering Indonesia's largest islands, and the project is expected to expand to cover 34 cities over the next three to five years.¹⁹⁴

Monitoring data has already helped to lower legal thresholds of lead concentrations in ambient air, and it will serve as a foundation for tracking air quality and developing corrective actions going forward. MOEF recently indicated that the ministry is planning to purchase and install seven PM 2.5 monitors in 2016 and 2017. The City of Jakarta also recently purchased two PM 2.5 air monitors and has indicated its plans to budget for the purchase of additional monitoring equipment. U.S. technology providers interested in

developing a foothold in this market should pursue opportunities through official tenders as well as through donor efforts, including those of the Asian Development Bank, the World Bank, technical facilities within Asia Pacific Economic Cooperation (APEC) and the U.S. Agency for International Development (USAID).

Key Technologies in Demand:

- Fenceline monitoring
- Continuous emissions monitoring
- Ambient air quality monitoring equipment
- Source emissions measurement technologies

Mobile Source Emissions Reduction

The primary cause of air pollution in Jakarta and other major cities continues to come from vehicle emissions. According to the Indonesian Ministry of Environment and Forestry (MoEF), the source of around 70 percent of the country's urban air pollution is the transportation sector, and 90 percent of those emissions come from land transportation. Several factors contribute to worsening pollution in the transportation sector, including lenient emissions and fuel quality standards as compared with other Asian megacities, as well as lax enforcement. The government has stated that it plans to move from Euro 2/II, promulgated in 2006, to Euro 4/IV -equivalent standards soon.¹⁹⁵ At least one source also reports that the government is in the process of improving emissions standards for new vehicles beginning in 2017.¹⁹⁶ Considering the double-digit growth of vehicle sales in Indonesia since 2007¹⁹⁷, if such policy reform is implemented, it could offer significant opportunities for U.S. companies in the medium-term.

Key Technologies in Demand:

- Emissions control technologies for passenger cars, light duty vehicles (LDVs) and heavy duty vehicles (HDVs)

Waste Management and Recycling

Municipal Solid Waste and Landfill Management

As of 2015, 69 percent of the 64 million tons of the solid waste generated in Indonesia each year was sent to largely unsanitary landfills. The national recycling rate hovers around 2 percent, with a slightly higher rate (7.5 percent) in urban areas.¹⁹⁸ Jakarta city residents alone dump approximately 6,700 tons of untreated solid waste every day into a single landfill -

Bantar Gebang, the country's largest - which is on track to reach capacity by 2019. Waste picking in open dumpsites is common and sustains an unregulated, informal recovery sector.

The Indonesian government recently has made efforts to improve the country's management of solid waste. In 2008, it passed *Law Number 18 Regarding Waste Management*, which focuses on the management of municipal solid waste, guides the management of solid waste stream and encourages recycling. The law seeks to establish a national framework under which new technologies are utilized to address environmental issues and create economic value from the waste generated by citizens. It charges the national government and local authorities with the implementation of proper waste management procedures and facilities.

In 2011, the government introduced a municipal "garbage bank" (*bank sampah*) program to encourage source separation. Under the program, households weigh and record their non-organic solid waste, which is then dropped off at local collection points in exchange for funds deposited into household accounts. A system based on GPS technology is being created to improve residents' participation and coordinate waste banks across the country.¹⁹⁹ A robust national *bank sampah* program would help centralize waste collection in communities and facilitate the development of waste management infrastructure.

Key Technologies in Demand:

- Waste collection technologies
- Environmental monitoring and analytical equipment

Waste-to-Energy

In its Nationally Determined Contribution (NDC) to the December 2015 Paris Climate Agreement, Indonesia committed to "develop a comprehensive [waste management] strategy to improve policy and institutional capacity at the local level." The NDC text specifically refers to reduction of the amount of waste sent to landfill, reduction of waste-based greenhouse gas emissions and addition of renewable sources, including waste-to-energy specifically, into Indonesia's energy mix. While waste-to-energy can be part of more comprehensive waste management strategies, source reduction and recycling are recognized as preferred methods for solid waste management

("Reduce, Reuse, Recycle"). Additionally, any waste-to-energy solutions should give due attention to air pollution and climate risks.

In early 2016, the government submitted a draft presidential regulation (*Perpres*) to President Widodo focused on developing waste-to-energy (WtE) power plants as part of an effort to resolve acute waste management issues in seven pilot cities: Jakarta, Bandung, Tangerang, Semarang, Surabaya, Surakarta and Makassar.²⁰⁰ Less than a handful of WtE plants are currently in operation across the archipelago. A new directive fostering public private partnerships (*Perpres* 38/2015)²⁰¹ should help to increase private sector engagement. Together with the government's ambitious power generation goals (see "Power Plant Emissions Reduction" above) and its increased emphasis on waste reduction, WtE is likely to offer opportunities for U.S. firms going forward.

Key Technologies in Demand:

- Waste-to-energy technologies and equipment
- Environmental engineering and design services

Water and Wastewater Treatment

Municipal Water Treatment and Transmission Systems

Municipal drinking water treatment is expanding in Indonesia, albeit slowly, to meet the country's National Medium-Term Development Plan, the Rencana Pembangunan Jangka Menengah Nasional (RPJMN), which set the goal of 100 percent access to drinking water and sanitation services during the 2015 to 2019 period. Drinking water and sanitation access were 68.5 percent and 60.5 percent, respectively, in 2014.²⁰² Indonesia has an estimated USD 225.5 billion of water supply investments planned and is electing to use Public Private Partnership (PPP) models to finance approximately 35 percent of the projects.²⁰³

Underpinned by Build-Own-Transfer (BOT) models, the Indonesia PPP projects in practice have been financed through bilateral and multilateral aid agencies²⁰⁴ and tendered at a much more gradual pace than envisioned in national development plans. The government seeks to remedy previous difficulties with PPP projects through its recently promulgated PPP regulation, the Presidential Regulation (PR) number 38/2015. The PR broadens the type of infrastructure projects for which PPP is available, including social infrastructure, and allows for forms of payment other than end-user fees.²⁰⁵

The Ministry of National Development Planning's (BAPPENAS) PPP Book lists 15 water infrastructure projects planned with a total value of USD 1.59 billion.²⁰⁶ The majority of projects are focused on drinking water storage, treatment and transmission, leaving wastewater treatment as the next hurdle in satisfying Indonesia's need for basic water and sanitation services. A few wastewater treatment projects in urban areas are listed, such as the DKI Jakarta Sewage Treatment Plant, a planned USD 512 million²⁰⁷ project to be tendered.²⁰⁸

Announced projects for the 2016 tendering period have a cumulative estimated value of USD 1.56 Billion.²⁰⁹ Marquee opportunities include the Karian-Serpong water conveyance scheme valued at USD 536 million, the Jakarta wastewater treatment project valued at USD 173.5 million, the Jatiluhur-Jakarta water supply valued at USD 134.4 million, the Pekanbaru Seletan Water Supply valued USD 132 million and the Jatigede water supply system valued at USD 117 million.

After basic infrastructure and supply needs are met, the predominant concern for Indonesia is likely to become drinking water quality. For the 20 percent of the population that does have a mains water connection, the quality of the municipal water supply is low, and drinking water directly from the tap is discouraged.²¹⁰ In the short term this will continue to fuel a strong Point-of-Use (POU) technology market. In the longer-term, utilities will need to grapple with improving water quality and reliability and reducing non-revenue water.

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Operations services
- Advanced filtration
- Membrane filtration
- Sludge dewatering equipment
- Waste to energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Monitoring equipment
- Testing equipment
- Point-of-Use devices

Process and Produced Water

The Indonesian government's Master Plan identifies 22 key industries for priority expansion and investment. Among those 22 sectors, several are key client industries for the water sector, especially mining (nickel, copper), coal, oil and gas, food and beverages, textiles, steel, and aluminum smelting.²¹¹ Coupled with government emphasis on water resource protection, effluent management and water reuse are likely to be growth markets in addition to influent treatment technologies.

The burgeoning oil and gas sector should provide growing opportunities for process based water treatment, particularly as offshore development continues. The prevalence of international oil companies working in Indonesia could provide a rational sales conduit for qualified producers of process water technologies. Furthermore, the government recently initiated four shale gas study projects and expects commercial shale gas production to begin by 2018.²¹² Shale gas development will necessarily yield opportunities for both process and produced water treatment.

Technologies and Services in Demand:

- Wastewater treatment technologies
- Advanced filtration
- Membrane filtration
- Purification equipment
- Petrochemical and mining effluent treatment systems

Environmental Consulting and Engineering

Environmental impact assessments are administrated by the AMDAL Appraisal Commission, which evaluates environmental proposals and documentation in order to provide the MoEF with input and recommendations on the feasibility of business activities. In order to conduct business activities that may damage the environment, a permit is required to obtain a business license. Indonesian environmental law stipulates that everyone has the right to access documentation, such as environmental impact analysis, reports and evaluation results. The MoEF works to encourage citizen participation.

Coupled with high expected growth in its construction sector, which is expected to surpass Japan by 2030,

Indonesia may also become a center for environmental engineering and consulting services contingent on the government's stringency with requiring adequate site assessment for forthcoming projects.

Technologies and Services in Demand:

- Environmental Impact Assessment and analysis

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA) environmental regulations, related underlying research and a list of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. The Toolkit is used by U.S. EPA officials or environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Indonesian participants and to foster business relationships between Indonesian end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Indonesian

participants and to introduce Indonesia buyers to U.S. waste management technology providers.

U.S. EPA Collaboration

The U.S. Environmental Protection Agency (U.S. EPA) has worked with the Indonesian government through the "Breathe Easy Jakarta" program to facilitate improved technical capacity to implement an air monitoring network. Other areas of collaboration have included training in environmental enforcement, environmental impact assessment and site remediation. U.S. EPA also cooperates with Indonesian partners and the United Nations Environment Programme (UNEP) under the Global Partnership for Clean Fuels and Vehicles (PCFV) and Climate and Clean Air Coalition (CCAC).

Market Reference and Key Contacts

BAPPENAS

<http://www.indonesia.go.id/en/ministries/ministers/state-minister-for-chairperson-of-the-national-development-planning-agency/1646-profile/277-kementerian-perencanaan-pembangunan-nasional.html>

Directorate General of Electricity, Ministry of Energy and Mineral Resources

<http://www.djlpe.esdm.go.id/>

Ministry of Energy and Mineral Resources

www.esdm.go.id

Foreign Commercial Service Jakarta

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

USAID Indonesia

<https://www.usaid.gov/indonesia/environment>

Indonesian Petroleum Association

www.ipa.go.id

Turkey

The overall environmental technologies market in Turkey including goods and services is valued at an estimated USD 7.3 billion (2016). Growth in the Turkish market is driven by European Union (EU) mandates and a national effort to provide basic sanitation services. Turkey ranks eighth in the 2016 Top Markets Report overall with a composite environmental technologies score of 22.1. Turkey ranks fourth for air pollution control markets with a score of 17.4. It ranks 24th for water with a score of 2.8 and 11th with a score of 1.82 for waste and recycling.



State of the Environmental Regime

Turkey's environmental regime is steadily improving, both in terms of rulemaking and enforcement. Turkey's EU accession agenda is working to advance both areas as part of the environmental and climate acquis. Improvements in this area are evidenced in the Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being the most stringent) and scored Turkey a 3.3 in 2012, a 0.8 point improvement from its 2005 score of 2.5.

Turkey's ranking on the World Economic Forum's 2011 Index for Regulatory Stringency of 62nd globally with a Score of 3.65 (on a similar scale to that of EBJ-OECD) echoes the results of the EBJ-OECD survey, while Turkey's ranking in the same survey for enforcement is 55th globally with a score of 3.47. At the national level, the Ministry of Environment and Urbanization is the procurement agency for environmental projects.

On August 11, 1983, the Turkish government published Law Number 2872, better known as the Environment Law. The purpose of this law is to protect and improve the environment. Environmental law is overseen by the Ministry of Environment and Forestry, which was organized for this purpose in 2003.

While substantial progress has been made in implementation of environmental rules, the European Commission notes that additional national legislation is needed in the areas of ambient air quality, national

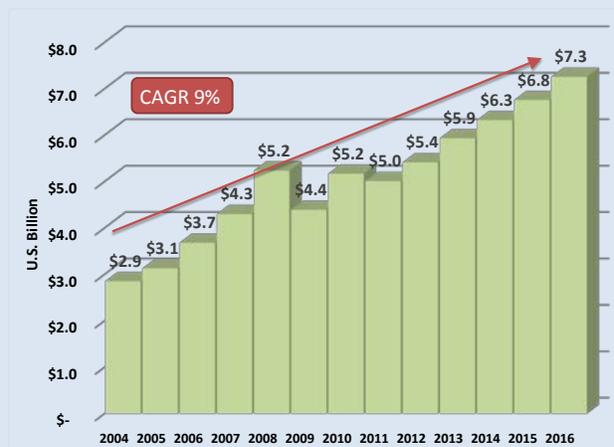
emissions ceilings, volatile organic compounds, waste separation and reducing biodegradables in waste disposal. Furthermore, requirements related to the EU Waste Framework Directive, as well as legislation consistent with both the Mining Waste Directive and the Industrial Emissions Directive, need to be implemented.²¹³

Market Barriers

Market barriers in Turkey in general are associated with the differences in regulation and standards' development approaches of the United States and the EU. The following barriers are most problematic for environmental technologies companies attempting to export to or work in Turkey:

- 1. Failure to recognize many international standards**
The existing European Regulation on Standardization (EU) No 1025/2012 recognizes international standards from only three international standards bodies: the International Organization for Standardisation (ISO), the International Telecommunications Union (ITU) and the International Electrotechnical Commission (IEC). Failure to recognize other international standards bodies prohibits the application of equivalent U.S. technologies in market.
- 2. A preference for design based standards over performance based standards**
In the United States, standards for environmental technology generally meet a performance threshold, such as mitigation of

Figure 1: Turkey's Environmental Technologies Market



Source: Environmental Business International with OEEI Analysis, 2016.

pollution below a level that the scientific method has determined is consistent with protection of human health. This performance based approach allows for both innovation and a diversity of approaches to meet a specific goal. In the EU, many standards require technology to meet a design specification, thus prohibiting use of any technology that meets the same performance standard but lacks the design specifications.

3. Application of the precautionary principle in standards and regulations

In Europe, the identification of hazards and subsequent limitations on application is tied to unknown future costs as opposed to the risk based approach, which assesses the likelihood of both unknown and known risks against known benefits. Application of the precautionary principle in standards and regulations levies many billions of dollars on manufacturers and services providers for testing and redesign without a clear definition of the resulting benefits. Furthermore, applying the precautionary principle to environmental technologies slows their delivery to market even when the pollutant stream that is addressed poses greater harm to human health than the chemical or technology under evaluation.

4. EU assistance and subsidies for environmental projects

In an effort to help Turkey meet EU environmental standards, the EU often funds or subsidizes the development of environmental infrastructure. Within tenders, there is a strong preference for European providers, placing U.S. bidders at a competitive disadvantage.

5. Lag in implementation of EU environmental rules

Despite the differences in the regulatory and standards systems of the EU and the United States, adoption of and adherence to EU environmental rules drives development of environmental projects. The lag in adherence to EU mandates in this area has created a corresponding lag in the development and tendering of projects, thus slowing market growth overall.

6. Tendency of corruption in public tenders

U.S. companies acknowledge that transparency is common in EU funded projects and in dealing with the private sector, as the instance of corrupt practices in tendering does occur for some public sector and local public sector tenders.

Market Opportunities

Air Pollution Controls

Turkey has made great strides in improving monitoring of air quality and has instituted a national air pollution monitoring program. The By-law on Ambient Air Quality Assessment and Management (BAQAM) set air quality standards for 13 pollutants²¹⁴ and expanded the network of air monitoring stations. As of early 2016, Turkey had, in place, 199 national stations in its clean air network, including four mobile stations and eight regional Clean Air Centers, with a future target total of 330 stations.²¹⁵ Turkey also is in the early stages of developing a national monitoring, verification and reporting (MRV) system. Together with the World Bank Group's Partnership for Market Readiness (PMR), Turkey has mandated for approximately 2,000 firms in the electricity, cement and refining sectors to participate in a MRV pilot prior to launch of a full program.²¹⁶

Although monitoring and control regulation is present, implementation of control measures has been slow, according to the Commercial Service Istanbul. The main sources of ambient air pollution in Turkey, according to the Ministry of Environment and Forestry,

include thermal energy generation through coal-fired power plants, home heating units, motor vehicles and industrial sources.²¹⁷ Turkey is in the process of aligning its standards with the EU *acquis*, including its national emissions limits and ambient air quality requirements, particularly volatile organic compounds (VOCs).²¹⁸ The government is requiring the installation of flue gas desulfurization (FGD) units on all new and existing power plants, opening up high-value projects in the air pollution control market.

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

Water and Wastewater Treatment

Turkey's 10th Development Plan (2014- 2018) outlines a series of challenges in protecting the country's water resources; these include institutional shortcomings, fragmented legal frameworks for water resources management, lack of a common data collection system and inadequate monitoring systems. Turkey faces imminent problems with water scarcity and, as a result, plans to implement improved monitoring systems for both surface and groundwater resources.

Municipal Water and Wastewater Treatment

The Ministry of Environment and Urbanization is leading the charge in implementing universal wastewater treatment by the 2023 deadline. Consequently, USD 50 billion of water infrastructure investments are planned through 2023 for both drinking and wastewater.²¹⁹ The Turkish government estimates that approximately USD 2 billion annually must be invested in water infrastructure projects to meet EU standards.²²⁰ Roughly one-quarter of Turkey's 2,950 municipalities currently have a wastewater treatment plant.

The lack of functional treatment of wastewater has become an issue of national importance, as untreated sewage in recent years has corrupted reservoirs and other surface fresh water sources that large urban populations, such as Istanbul, rely upon.²²¹ Substantial problems with non-revenue water in its existing infrastructure will drive demand for leak detections

systems, smart meters and loss prevention technologies.

Technologies and Services in Demand:

- Engineering, procurement and construction services
- Pumps and conveyance systems
- SCADA systems
- Metering
- Membrane filtration
- Anaerobic digestion
- Monitoring equipment
- Testing equipment
- Sludge treatment

Process Water, Industrial Wastewater Treatment and Water Reuse

The Turkish government estimates that the private sector will need to invest USD 15 billion in water treatment technologies to mitigate pollution to levels required by EU mandates. Key sectors for process and industrial wastewater include power plants, mining, textiles, cement, iron and steel foundries, food processing, and automotive sectors and manufacturing industries.

The Action Plan on Climate Change outlines several strategies to improve water efficiency and promote reuse. Turkey is currently revising its industry strategy document to integrate water efficiency practices and is developing a national strategy to promote the use of treated wastewater and sludge products in agriculture. The plan also calls for the implementation of loss detection technology and the expansion of SCADA water management systems nationally by 2020.²²²

Technologies and Services in Demand:

- Engineering and construction services
- Water reuse equipment and services (process specific)
- Leak detection equipment and services
- SCADA Systems
- Smart meters
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- *Anaerobic digestion*
- Nitrification
- Biological denitrification
- Testing equipment

Waste Management and Recycling

Municipal Solid Waste

Turkey has two fundamental pieces of legislation to govern waste management: the Regulation on General Principles of Waste Management and the Regulation on Solid Waste Control.²²³ Implementation of programming has been slow, however, and capacity to develop comprehensive waste management systems is lacking.²²⁴

According to the Turkish Statistical Institute, 113 controlled landfill sites, four incineration facilities, four composting plants and 864 other types of recovery facilities were in operation as of 2014. Of the 28 million tons of waste collected by municipal waste collection services that year, 63.5 percent was transferred to controlled landfills, 35.5 percent was disposed of in municipal dumping sites and 1 percent was disposed of by other methods.²²⁵

To meet universal waste management goals via the Waste Management Action Plan, 2.1 billion Euros of investment is needed between now and the 2023 goal deadline. The plan stipulates the development of regional solid waste processing and recycling facilities and sanitary landfills. In addition, 1.9 billion Euros of the action plan budget is to be allocated toward landfill creation and management, with the remaining directed toward plastics and packaging recycling facilities. Both Turkey's Climate Change Action Plan and the Waste Management Action Plan stipulate increased resource utilization through recycling.

Remediation and upgrading of existing unsanitary landfills is also a major effort the government plans to undertake through the Waste Management Action Plan. The Ministry of Environment and Urbanization estimates that there are 1,400 of these sites, necessitating a 350 million Euro investment for closure and improvement. Full implementation of the EU Landfill Directive is to be carried out by 2025.

Technologies and Services in Demand:

- Waste collection technologies
- Sanitary landfill systems
- Environmental monitoring and analytical equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles

- Recycling process expertise
- Waste incinerators

Environmental Consulting and Engineering

Businesses that may cause environmental problems via their operations are obliged to obtain Environmental Impact Assessment reports (EIA's). Turkey's EIA requirement was first imposed in 1993, followed by various revisions over time. EIAs are evaluated by the Evaluation and Assessment Commission, which was convened by the Ministry of Environment and Forestry, and ultimately the Ministry adjudicates the environmental feasibility of the project in conjunction with the Evaluation and Assessment Commission. The Ministry of Environment and Forestry is also responsible for implementing a monitoring program.

As of November 25, 2014, further provisions were added to the Environmental Impact Assessment Regulation. These newly adopted provisions include lower thresholds with respect to the capacity and size of the proposed projects, and EIAs are now required for railways not exceeding 100 kilometers, airport runways not exceeding 2,100 meters, housing projects with a maximum of 500 residences and tourist facilities with a maximum capacity of 100 rooms. Shopping centers and ceramic facilities (with a production activity of 300,000 tons/year) are no longer exempt from EIA regulation. Further changes to Turkey's EIA policies are expected as it seeks to harmonize with the European Union EIA Directive.

Key Technologies in Demand:

- Environmental Impact Assessment

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA) environmental regulations, related underlying research and a list of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. The Toolkit is used by U.S. EPA officials or environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Turkish participants and to foster business relationships between Turkish end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Turkish participants and to introduce Turkish buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Turkish officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

Market Contacts and References

Ministry of Environment and Urbanization
<http://www.csb.gov.tr/>

General Directorate of State Hydraulic Works
<http://www.dsi.gov.tr/>

Iller Bank
<http://www.ilbank.gov.tr/>

Environment Protection and Packing Wastes Utilization Foundation <http://www.cevko.org.tr/>

Istanbul Water and Sewerage Authority – ISKI
<http://www.iski.gov.tr/>

Commercial Service Market Contact
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Poland

The overall environmental technologies market in Poland including goods and services has an estimated value of USD 7.0 billion (2016). Advanced by European Union (EU) mandates, Poland’s environmental technologies market continues to grow. A disparate standards development system based on the precautionary principal can make it difficult for U.S. technology providers to compete.

| | | | |
|--------------|---|-----------------------|----|
| Overall Rank | 9 | Air Pollution Control | 9 |
| Water | 9 | Waste & Recycling | 16 |

Poland ranks ninth overall on the 2016 Top Markets Report with a composite environmental technologies score of 17.7. Poland ranks ninth for water markets with a score of 8.4 and ninth for air pollution control market with a score of 8.6. Its waste and recycling market trails behind with a rank of 16th and a score of 0.7.

The Polish environmental market has largely been driven by regulatory implementation demands associated with EU membership. During the 10 years of EU membership, EU financing programs have built over 1,000 new wastewater treatment plants and thousands of miles of new piping systems, reduced emission of CO2 more than 30 percent, built hundreds of new municipal and hazardous waste management facilities, and developed long-term programs to protect hundreds of endangered plant and animal species. The current tranche of EU investments in Poland is estimated to be over 70 billion Euros between 2013 and 2020.²²⁶

State of the Environmental Regime

Poland’s environmental regime has steadily improved since its accession to the EU in 2004. The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being the most stringent), scored Poland a 4.4 in 2012, a 2.0 point improvement from its 2005 score of 2.4.

Similarly, Poland’s ranking on the World Economic Forum’s 2011 Index for Regulatory Stringency of 35th globally with a score of 4.71 (on a similar scale to that of EBJ-OECD) demonstrates the relative increase in

Figure 1: Poland’s Environmental Technologies Market



Source: Environmental Business International with OEEI analysis, 2016.

environmental stringency. Poland’s ranking in the same survey for enforcement is 35th globally with a score of 4.10 highlighting improvements in environmental enforcement as well.

The 2001 Act on the Protection of the Environment, 1 (Ustawa z dnia 27 kwietnia 2001 r. – Prawo ochrony środowiska) provides the legal framework for all commercial and environmental activities in Poland. The Ministry of the Environment (MoE) is the highest national office responsible for the preparation and implementation of environmental legislation and strategies. In accordance with EU directives, the Polish government prepares a national plan for the implementation of environmental rules and correspondingly directs regional governments

(voivodeships) to develop and implement cascading local plans.

Overall in Poland, environmental administration exhibits a high level of federal, regional and municipal coordination. Enforcement of environmental norms is fixed and relatively free from corruption while overall compliance rates are high.²²⁷

Market Barriers

Market barriers in Poland in general are associated with the differences in regulation and standards' development philosophies of the United States and the EU. The following barriers are most problematic for environmental technologies companies attempting to export to or work in Poland:

- 1. Failure to recognize international standards**
The existing European Regulation on Standardization (EU) No 1025/2012 recognizes international standards from only three international standards bodies: the International Organization for Standardisation (ISO), the International Telecommunications Union (ITU) and the International Electrotechnical Commission (IEC). Failure to recognize other international standards bodies prohibits the application of equivalent U.S. technologies in market. In Poland, the CE mark is broadly required. The Polish Center for Research and Certification (PCBC) (Polskie Centrum Badan i Certyfikacji) is the relevant national testing and certification office.
- 2. A preference for design based standards over performance based standards**
In the United States, standards for environmental technology generally meet a performance threshold, such as mitigation of pollution below a level that the scientific method has determined is consistent with protection of human health. This performance based approach allows for both innovation and a diversity of approaches to meet a specific goal. In the EU, many standards require technology to meet a design specification, thus prohibiting use of any technology that meets the same performance standard but lacks the design specifications.
- 3. Application of the precautionary principle in standards and regulations**
In Europe, the identification of hazards and subsequent limitations on application is tied

to unknown future costs as opposed to the risk based approach, which assesses the likelihood of both unknown and known risks against known benefits. Application of the precautionary principle in standards and regulations levies many billions of dollars on manufacturers and services providers for testing and redesign without a clear definition of the resulting benefits. Furthermore, applying the precautionary principle to environmental technologies slows their delivery to market even when the pollutant stream that is addressed poses greater harm to human health than the chemical or technology under evaluation.

4. EU assistance and subsidies for environmental projects

In an effort to help the Polish Republic meet EU environmental standards, the EU often funds or subsidizes the development of environmental infrastructure. Within tenders, there is a strong preference for European providers, placing U.S. bidders at a competitive disadvantage.

5. Lag in implementation of EU environmental rules

Adoption of and adherence to EU environmental rules drives development of environmental projects. The lag in adherence to EU mandates in this area has created a corresponding lag in the development and tendering of projects, thus slowing market growth overall.

Market Opportunities

Air Pollution Control

Since Poland's accession to the EU in 2004, the country has made significant progress in reducing its emissions of GHG and NOx/SOx. Nevertheless, it remains the most fossil energy-intensive economy in the EU. Fossil fuels comprised 91 percent of Poland's energy mix (54 percent coal, 23 percent oil, 14 percent natural gas) in 2013, and coal is expected to remain the country's primary energy source in the medium-term.²²⁸ In 2012, Poland recorded the highest levels of PM 2.5 in Europe, at least partly as a result of domestic combustion of biomass and coal for heating. To help address this issue, in October 2015, President Andrzej Duda signed an 'anti-smog' law that empowers local authorities to ban burning of coal and other environmentally unfriendly substances in domestic

properties.²²⁹ Emissions from coal-fired power plants also still lead to excessive output of particulate matter and other air pollutants. Particulate matter from transportation, small industrial plants and small boilers is also a substantial contributor to Poland's persistent air quality problems. Other contributors include industrial sources in areas where the geography prevents dispersion, such as in Krakow or Upper Silesia, which are located in mountain or river valleys.²³⁰

Opportunities for the air pollution control sector lie in compliance with EU Air Quality Directive 2008/50/EC, which includes air quality objectives. Poland will achieve improved air quality by implementing measures on the voivodeship (regional) level. Attention to regional air quality plans and related tenders is the most rational approach for U.S. businesses seeking to work in Poland's air pollution control market.²³¹

Technologies and Services in Demand:

- Wet/dry scrubbers (particularly systems that remove multiple pollutants)
- Carbon injection systems (for reduction in mercury and organics)
- Particulate matter control systems (particularly new bagging systems)
- NOx, mercury, CO2 and particulate matter monitoring and continuous monitoring systems
- Selective catalytic and non-catalytic reduction controls
- Oxygen enrichment, fuel injection and other efficient combustion technologies
- Innovative specialty cements
- Mixing technologies
- Pumping and fluid handling equipment
- Engineering and plant design
- Leak detection
- Alternative fuel technologies used to fire cement kilns

Water and Wastewater Treatment

Municipal Wastewater Treatment and Storm Management

Expansion and development of sewerage networks and treatment facilities under Poland's National Programme of Municipal Wastewater Treatment (NPMWT) offers prominent opportunities. In 2013, only 67 percent of Polish peoples were connected to sewers with an expected increase to 70 percent by

2018.²³² For example, the Nowogrodziec municipality issued a recent tender for the 25km expansion of its network valued at USD 23 million.²³³ Existing treatment facilities will also undergo upgrading in 2016 to reach the annual goal outlined by the NPMWT to reduce nitrogen and phosphorus loads in wastewater by 75 percent.²³⁴

Large scale floods have also generated interest in storm water management systems while conversely long-term projections of water scarcity²³⁵ have spurred interest in water efficiency through wastewater reuse. The Polish government has tendered a contract for the design and development of a management plan for all river basins,²³⁶ providing an attractive project pipeline for U.S. companies with expertise in storm water management infrastructure.

The Polish government is also focusing on implementation of a new water pricing scheme to promote reuse and efficiency for consumer, industrial and agricultural applications. The National Plan estimates budgetary outlays during 2013 to 2016 of USD 9 billion.²³⁷

Technologies and Services in Demand:

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

Industrial Process and Wastewater

Poland is subject to relative water scarcity with per capita resources averaging 1,450 to 1,700 m³/year.²³⁸ Industry is the largest consumer of freshwater resources in Poland, accounting for 70 percent of water intake,²³⁹ and this is the predominant focus for water efficiency and reuse programs. Among the domestic industry segments fossil fuel extraction, process and power generation are collectively the largest consumer of water. Additional key consumers include metals and mining, pulp and paper, cement manufacturers, and building and constructions segments.²⁴⁰

Incentives for improved industrial water efficiency are expected to be implemented under the National Plan, which attributes overconsumption to low prices. The Polish government estimates that industry water consumption is two to three times higher in Poland than other EU nations.²⁴¹ Government led increases in water tariffs will increase the burden on industry consumers to find water efficient solutions for both process and industrial wastewater.

Additional treatment burdens will also arise as a result of implantation of the EU Priority Substance Directive (PSD), which will limit the effluent allowances of a new class of chemical substances.²⁴²

Sludge Treatment and Reuse

Sludge treatment is also a major issue to be addressed in Poland. Poland produces over 700,000 tons of sludge per year, and due to EU obligations related to landfill waste reduction, it will no longer be legal to landfill sludge,²⁴³ meaning that the full spectrum of sludge treatment technologies will need to be employed. The National Plan for Waste Management outlines that by 2018, 60 percent of sludge is to be processed through incineration,²⁴⁴ a 25 percentage point increase from current levels. There is also a proposal to use treated sludge as biomass fuel stock to help meet Poland's renewable energy targets.²⁴⁵

Limited capacity to develop and operate sludge drying and incineration technologies will generate demand for attendant services and technologies. Cities with stated needs in this area include Warsaw, Lodz, Krakow, Gdansk, Poznan and Szczecin.²⁴⁶

Technologies and Services in Demand:

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

Waste Management and Recycling

Municipal Solid Waste and Recycling

Landfills remain the predominant waste management method in Poland with approximately 86 percent of the waste generated destined for one of the country's 800 landfills.²⁴⁷ There is rising pressure to rebalance Poland's waste management approach in order to meet its EU accession obligations. Contingent with Poland's accession to the EU, the country must reduce its landfill waste by 50 percent, which will inevitably give rise to increased use of recycling and incineration technologies.

Poland missed its 2013 deadline to meet this mandate and thus is in a position to play catch-up with meeting its accession obligations to avoid daily fines of 40,000 Euros levied by the European Commission. In its National Development Plan, Poland outlined its waste reduction plan to include introduction of a selective waste collection system, construction of facilities for waste recovery and recycling, and closure on unsanitary landfills. Waste management responsibilities are the purview of municipal and regional governments, and forthcoming tenders emanating from national plans will be issued at the city or voivodeship level. According to the country's 2015 OECD Environmental Review, investment of over 6 billion Euros in waste infrastructure - particularly for incineration, recycling and composting - will be needed to meet Poland's and the EU's 2020 targets.

EU mandates and attendant funding for project development are also driving waste incineration and waste-to-energy projects. While waste-to-energy can be part of more comprehensive waste management strategies, source reduction and recycling are recognized as preferred methods for solid waste management ("Reduce, Reuse, Recycle"). Additionally, any waste-to-energy solutions should give due attention to air pollution and climate risks.

Eleven waste-to-energy facilities with a capacity of 200,000 tons each are slated for development, with six to be developed in 2015 and 2016. Those projects include facilities in Bialystok, Bydgoszcz and Torun, Konin, Krakow, Poznan, and Szczecin with a total value of USD 1 billion.²⁴⁸ The Poznan facility is being developed under a Public Private Partnership (PPP) model. Ministry of Environment and Treasury support for forthcoming PPPs could yield opportunities for U.S. Engineering, Procurement and Construction (EPC)

technology providers and operators. Projections for projects in the 2016 to 2020 timeframe for waste-to-energy facility development include those for the Silesian agglomeration, lower Silesia, Tri-City, Warsaw, Olsztyn, Lodz, the Mazovian district, the Sub-Carpathian region and the Lublin region.²⁴⁹

Technologies and Services in Demand:

- Waste collection technologies
- Sanitary landfill systems
- Environmental monitoring and analytical equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste incinerators

Environmental Consulting and Engineering

The most important authorities regulating the use of environmental resources are the Ministry of Environmental Protection, the Main Inspector of Environmental Protection and the Main Director of Environmental Protection. The Main Inspector of Environmental Protection supervises compliance with environmental protection provisions, while the Main Director of Environmental Protection issues Environmental Impact Assessments (EIAs).

Polish administrative authorities strongly emphasize firm compliance with national and EU environmental law and regulation. There is a general tendency toward stricter compliance with environmental protection. Breaching a permit is punishable by fines and criminal liability. Operations will also be ceased.

Types of permits include integrated and single/separate permits. Integrated permits are required when activity could cause harm to the environment in general. These permits are reviewed every five years and are more strictly regulated. Single/separate permits are issued for activity that may affect an aspect of the environment that is protected from pollution, such as air and water. Single/separate permits are valid for a maximum of 10 years.

EIAs are regulated by the Act on Disclosing Information about the Environment and its Protection, the Participation of Society in Environmental Protection and Environmental Impact Assessments of October 3, 2008. An EIA is required where an industrial

infrastructure project may have serious impact on the environment or when a project could have an impact on a Natura 2000 area (an area that is protected due to significance to the environment).²⁵⁰

Technologies and Services in Demand:

- Environmental Impact Assessment (EIA)

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency (U.S. EPA) environmental regulations, related underlying research and a list of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad. The Toolkit is used by U.S. EPA officials or environmental consultants as a reference tool within bilateral activities that focus on addressing environmental concerns.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Polish participants and to foster business relationships between Polish end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Polish participants and to introduce Polish buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Polish officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with

U.S. exporters on approaches to water resource management.

Market Contacts and Program References

Ministry of Environment

<http://www.mos.gov.pl>

Chief Environment Inspectorate

<http://www.gios.gov.pl>

Main Director of Environmental Protection

<http://www.gdos.gov.pl>

Public Procurement Office

<https://www.uzp.gov.pl>

Tender Electronic Daily

<http://ted.europa.eu/TED/main/HomePage.do>

The Polish Center for Research and Certification (PCBC)

<http://www.pcbc.gov.pl>

Environmental Technology Verification (ETV) pilot program

<http://ec.europa.eu/environment/etv>

POLECOSYSTEM

<http://www.polecosystem.pl/en>

October 10 -14, 2016, Poznan

GREENPOWER

<http://greenpower.mtp.pl/en>

May 10-12, 2016, Poznan

American Chamber of Commerce in Poland

<http://amcham.pl>

United Arab Emirates

The United Arab Emirates (UAE) environmental technologies market, including goods and services, is valued at USD 5.8 billion (2016). UAE ranks 10th overall on the 2016 Top Markets Study (TMS), with a composite environmental technologies score of 15.8. UAE's high relative score in the water and wastewater segment drives its ranking in this study, as data reporting for both the air pollution monitoring and control market and the waste and recycling market are lacking. There is evidence, however, that UAE is host to a robust air pollution control market and growing waste management market, validating its inclusion in the top 10 priority markets.

| | | | |
|--------------|----|-----------------------|----|
| Overall Rank | 10 | Air Pollution Control | NA |
| Water | 3 | Waste & Recycling | NA |

State of the Environmental Regime

UAE's environmental regime is above average with a score of 4.5 on The Environmental Business Journal-OECD Environmental Stringency Survey, which ranks environmental regimes on a scale from 1 to 7 (with 1 being lax and 7 being among the most stringent in the world). This score is a 0.67 point improvement over its ranking of 3.9 in 2005. On the World Economic Forum's 2011 Index for Regulatory Stringency, UAE ranked 24th and 16th globally, with scores of 5.2 and 5.19 for regulatory stringency and enforcement, respectively.

In 1999, Federal Law No. 24 (the "Federal Environment Law") was enacted, which regulates the protection and development of the environment in the United Arab Emirates (UAE). The Federal Environment Law is the key legislation in the UAE for environmental protection, addressing environmental impact assessments (EIA), protection of the marine environment, pollution from land sources, soil protection, protection from air pollution and the handling of hazardous substances and wastes. The Federal Environmental Law is administered by both the Ministry of Environment and Water and the Federal Environmental Agency.

Despite coherent national legislation, UAE's environmental enforcement regime is characterized by fragmentation among its seven emirates. While the Ministry of Environment and Water (MOEW) maintains federal authority for environmental rules and regulations across the emirates, administration is managed within Emirati-level institutions. Checks and

balances are provided by a number of environmental watchdog organizations that ensure sustainability standards are upheld.²⁵¹ Furthermore, environmental protection is an increasingly important feature in both Dubai and the UAE. In March 2014, the Ministry of Environment and Water received new powers to penalize polluters and develop recycling. This bill, which introduced changes to the 1999 Federal Environmental Law, includes tougher penalties for offenders.

UAE is making large strides in developing and implementing environmental policies. The 2014 MOEW report on the State of the Green Economy highlights efforts to establish new rules on waste management, recycling and hazardous waste management.²⁵² The UAE Green Growth Strategy prioritizes water and electricity efficiency, waste recycling, and protection of natural resources and calls for investment in carbon capture and storage (CCS), waste-to-energy, and energy efficient desalination technologies.²⁵³ Finally, UAE's Vision 2021 National Agenda sets ambitious targets for improving air quality, managing water resources and developing sustainable infrastructure.²⁵⁴

Market Barriers

Market barriers are relatively few in UAE. The Environmental Technologies Trade Advisory Committee (ETTAC), along with industry experts in the Office of Energy and Environmental Industries (OEEI) and the Commercial Service Dubai, identified the following barriers as most problematic for

environmental technologies companies attempting to export to, or work in, UAE:

1. Disparate use of international standards poses adherence challenges

U.S. companies note a lack of country-specific environmental standards favoring international standards from a variety of sources, including the United States, UK, EU, Japan and Singapore. The lack of coherence can make it difficult for exporters to determine the relevant standard and complicates larger projects where a cacophony of standards may be relevant within a given environmental system.²⁵⁵

2. Local partnerships encouraged

UAE is generally open to foreign technologies and service providers, but partnership with a local firm is strongly encouraged, and brokering contracts demands knowledge of UAE's unique negotiating style and mores.²⁵⁶

3. Market proximity benefits European competitors

The geographic distance between the U.S. and UAE compared to European markets makes U.S. products less attractive due to time-in-trade. Marine shipping takes 45 days from the United States versus three weeks for European products.²⁵⁷

Market Opportunities

Air Pollution Control

Ambient Air Monitoring

Air quality is included among the UAE's National Key Performance Indicators for sustainable development under the country's Vision 2021 National Agenda, which sets a goal of increasing the Air Quality Index to 90 percent by 2021 from a base of 66.7 percent (2014) for four criteria pollutants.²⁵⁸ The UAE currently maintains a total of 46 air quality monitoring stations.²⁵⁹ Of these, 20 fixed stations and two mobile stations are located in the Abu Dhabi Emirate. Abu Dhabi's fixed stations are distributed across the city and its suburbs, as well as in Al Ain city and its suburbs, and in major towns in the western region.²⁶⁰

In June 2015, the World Bank's *Little Green Data Book* listed the UAE as having the world's highest mean average of fine particles that are 2.5 micrometers in

diameter or smaller (PM 2.5). There are currently no established national limits for PM 2.5. The Environment Agency - Abu Dhabi (EAD) publishes air quality reports on a quarterly basis and noted in one of its most recent reports that the desert environment and frequent dust storms in the region are key contributors to elevated PM10 concentrations, along with traffic, industrial activities and construction. The daily average PM 10 values exceeded federal standards at all of the stations, and 95 percent were two to five times above federal thresholds.²⁶¹

In September 2015, the Ministry of Environment and Water signed a memorandum of understanding (MOU) with EAD as well as with the National Centre for Meteorology and Seismology; Dubai, Sharjah and Fujairah Municipalities; and the Municipality and Planning Department in Ajman to launch the UAE Air Quality Network in order to meet the 2021 goal of 90 percent air quality.²⁶² Eleven new monitoring stations are to be built in Ajman and the Northern Emirates as part of the network.²⁶³

Technologies and Services in Demand:

- Continuous emissions monitoring systems
- Ambient air quality monitoring equipment
- Source emissions measurement technologies
- Analytical and laboratory testing goods and services
- Air pollution control equipment
- Fuel vapor control systems

Industrial Air Pollution Reduction

According to the Ministry of Energy, the UAE emitted 199 million tons of carbon dioxide and other greenhouse gases in 2013. Of this total, cement and aluminum production each contributed about 8 percent, and the oil and gas sector contributed about 15 percent. Per capita greenhouse gas emissions stood at approximately 24 tons.

The UAE is the second largest manufacturer of cement and steel in the Gulf region, after Saudi Arabia. Large deposits of limestone in the northern part of the country facilitate production of construction aggregate, cement, gypsum and rock wool.²⁶⁴ Cabinet Resolution No. 20 of 2008 and Ministerial Resolution No. 567 of 2014 regulate industrial facilities at quarrying and crusher sites to ensure compliance with operating and environmental regulations. In May 2015,

the Ministry of Environment and Water shut down 14 plants for violating the regulations.

In its Nationally Determined Contribution (NDC) under the December 2015 UNFCC Paris Climate Agreement, the UAE committed to "improve carbon abatement and increase resource efficiency" in its oil and gas sector. Abu Dhabi in particular is taking steps to reduce greenhouse gas (GHG) emissions from its oil and gas industry. According to the 2014 Abu Dhabi Air Quality Policy Brief, less than 5 percent of the emirate's oil and gas facilities were implementing "effective emissions management systems" in 2013. Abu Dhabi's goal is to increase that amount to 70 percent by 2018 and 100 percent by 2030. Separately, Dubai created a Carbon Abatement Committee comprised of representatives from a variety of the emirate's public organizations to provide recommendations for the city's carbon reduction efforts. The Committee recently endorsed a plan to decrease Dubai's carbon emissions by 16 percent over the next six years, in line with the Vision 2021 National Agenda.²⁶⁵

The UAE government's increased emphasis on GHG emissions reduction and climate mitigation after the Paris Agreement should produce meaningful opportunities for U.S. companies.

Key Technologies in Demand:

- Wet and dry scrubbers
- Carbon injection systems for reduction in mercury and organics
- Particulate matter control systems (particularly new bagging systems)
- Selective catalytic and non-catalytic reduction controls
- Oxygen enrichment, fuel injection and other efficient combustion technologies
- Innovative specialty cements
- Mixing technologies
- Pumping and fluid handling equipment
- Engineering and plant design
- Leak detection equipment
- Alternative fuel technologies used to fire cement kilns
- Carbon Capture Utilization and Storage (CCUS) technologies

Power Plant Emissions Reduction

Nearly 100 percent of the 110 billion kilowatt hours of electricity generated by the UAE in 2013 was produced

using fossil fuels,²⁶⁶ largely natural gas. All of the country's currently installed capacity of 27 Gigawatts (GW) is being utilized. Electricity demand has increased at a rate of approximately 8 percent per year since 2007, commensurate with the country's rapid industrial and population growth.²⁶⁷

To meet rapidly rising demand, the government is investing heavily in its energy infrastructure while at the same time aiming to reduce its dependence on gas-fired generation. The 2012 Dubai Electricity and Water Authority's (DEWA) capital expenditure plan sets a goal for power generation capacity to triple to 22 GW by 2017. Dubai's Integrated Energy Strategy 2030 states that by 2030, natural gas will provide 71 percent of the emirate's total power output, while 12 percent will come from nuclear sources, 12 percent from "clean" coal and 5 percent from solar energy. In April 2014, DEWA allocated USD 3.5 billion in funding for a new 1,200 MW "clean"-coal power plant, which is likely to be the largest such plant in the Gulf region by the time it is completed in 2021.²⁶⁸

The government's interest in sustainable growth, together with the increase in installed capacity, should generate opportunities for U.S. companies, particularly in Dubai and Abu Dhabi emirates.

Key Technologies in Demand:

- Continuous emissions monitoring systems
- Dry sorbent injection technologies
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Inspection, adjustment, maintenance and repair services
- Selective catalytic reduction technologies

Waste Management and Recycling

Solid Waste and Recycling

The UAE's per capita solid waste generation rate is among the highest in the world. Solid waste management is typically coordinated by local authorities. Of the 26 million tons of waste collected in 2012, the majority ended up in landfills or dump sites.²⁶⁹ About two-thirds, or 17 million tons, of the total was generated by construction and demolition (C&D), and nearly one-quarter (6.2 million tons) was comprised of municipal solid waste (MSW).

Recycling is a relatively new concept in the UAE as a whole. The recovery rate in 2013 was just 23 percent nationwide (15 percent recycled, 8 percent composted).²⁷⁰ Over the past few years, however, several initiatives have been put into place to create the required infrastructure for recycling and to get the public involved. As part of its Green Growth Strategy, the UAE government aims to achieve a 75 percent recovery rate and 0.9 kg of per capita municipal waste generation per day by 2021.²⁷¹ Abu Dhabi has set a goal of diverting more than 80 percent of solid waste from landfill by 2018 and to increase the percentage of waste that is disposed of in sanitary landfills from less than 20 percent in 2013 to 100 percent by 2018.²⁷² Last year, the municipality's waste management authority, Tadweer, announced a targeted, ambitious 25-year recycling plan, the first of its kind in the region.²⁷³

Waste-to-energy (WtE) is another area of nascent interest in the UAE. A new WtE facility in Abu Dhabi Industrial City is scheduled to begin operating by 2017.²⁷⁴ Sharjah emirate also recently announced plans to set up one of the world's largest waste-to-energy facilities, which will employ gasification technology. Upon completion, the facility is set to process 400,000 tons of waste per year and generate 80 megawatts of energy.²⁷⁵ While waste-to-energy can be part of more comprehensive waste management strategies, source reduction and recycling are recognized as preferred methods for solid waste management ("Reduce, Reuse, Recycle"). Additionally, any waste-to-energy solutions should give due attention to air pollution and climate risks.

Key Technologies in Demand:

- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste-to-energy technology

Hazardous Waste Management

Abu Dhabi and Dubai generate about 43 percent and 36 percent, respectively, of the approximately 80,000 tons of hazardous waste produced in the UAE annually.²⁷⁶ That total is likely to grow as the country diversifies its economy going forward. The pharmaceuticals, plastic, pulp and paper, and fertilizer

industries typically send their waste to municipal landfills, which are not set up to manage it safely and efficiently. Only two landfills – one in Dubai (Jebel Ali) and one near Abu Dhabi – are currently designated to handle hazardous waste.²⁷⁷ The oil and gas sector does process some of the hazardous waste it generates, but much of the industry's processing equipment is aging and does not meet international environmental standards. The UAE government is in the process of updating its hazardous waste management regulations, which should offer opportunities for U.S. solution providers.

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Water and Wastewater Treatment

Key themes and priorities for water and wastewater in the emirates include promoting the development of Integrated Water and Power Plants (IWPPs), transitioning thermal desalination to reverse osmosis technologies, building out the wastewater treatment network, promoting wastewater treatment and reuse, and increasing freshwater efficiency with smart technology.

Budgetary declines related to low oil prices have led to a corresponding decline in the number of projects under development. For the 2016 tender period, just four major tenders valued at a cumulative USD 919.4 million are in the pipeline. Those include the Jebel Ali STP Phase 2, Al Zawra 3 SWRO plant, Ajman Fujairah 3 IWPP and Fujairah Fresh Water SWRO.²⁷⁸

Budget woes are also reigniting interest in public private partnerships (PPPs). With so called independent water projects (IWPs) in the gulf region, UAE's Federal Electricity and Water Authority (FEWA), plans to develop a 200,000 m³/d capacity desalination plant in Umm al Quwain utilizing a private or semi-private contract model.^{279, 280}

Municipal Wastewater Network and Plant Development

Municipal water and wastewater tenders originate from four major providers in the emirates: Abu Dhabi

Water & Electricity Authority (ADWEA), Dubai Electricity & Water Authority (DEWA), Sharjah Electricity & Water Authority (SEWA) and the Federal Electricity and Water Authority (FEWA), which services the emirates of Ajman, Ras Al Khaimah, Umm Al Quwain and Fujairah.^{281, 282}

Developing and expanding wastewater collection and treatment networks are a major pillar in the effort to manage scarce water resources. The Strategic Tunnel Enhancement Programme (STEP), a widespread gravity-driven hydraulic wastewater network, is one of the crucial mega projects in the Abu Dhabi 2030 Plan that is working to address this priority. Planned to be completed by the end of 2015 by the Abu Dhabi Sewerage Services Company (ADSSC), the objective of the project is to increase the waste water collection and treatment from nearly 450,000 m³ to 800,000 m³ of wastewater a day.²⁸³ Once the network is in place, treatment capacity, and corresponding projects to enable it, should expand to meet the 350,000 m³/d of additional wastewater.

Similarly in Dubai, the Jebel Ali STP, phase 2 project was recently announced to develop a 375,000 m³/d sewage treatment plant valued at USD 380 million. The plant will feature UV disinfection, activated sludge treatment, anaerobic digestion and methane gas generation technologies.

Key Technologies in Demand:

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

Drinking Water and Desalination

Drinking water and other fresh water needs are met almost entirely by desalination in the UAE, and capacity is expected to increase steadily in the near-term, totaling 96.5 percent of all water produced by 2019²⁸⁴ from a base of 42 percent in 2014.²⁸⁵ UAE has 70 major desalination plants accounting for 14 percent of the world's total production of desalinated water.²⁸⁶ Much of UAE's capacity, however, relies on energy

intensive thermal desalination technologies belying an increasing need to transition to energy efficient desalination technologies. Concerns regarding the energy intensity of thermal desalination and its incongruence with national environmental plans are driving the shift toward reverse osmosis. There recently has been talk from Abu Dhabi Water & Electricity Authority (ADWEA) officials of a potential move to convert half of Abu Dhabi's desalination capacity from thermal to membrane technology within the next five years.²⁸⁷

Correspondingly, efficient energy and resource management is a major trend in the UAE desalination market. Efforts include shifting existing capacity from thermal to reverse osmosis technology platforms, developing energy-efficient and renewable energy based desalination capabilities, a renewed focus on Integrated Water and Power Plant (IWPP) development, and exploring ways to manage saline waste streams. The scope of opportunity during this transition is vast, implementing reverse osmosis technologies where thermal desalination currently predominates would translate to nearly 2 million m³/d of new reverse osmosis capacity in UAE.²⁸⁸

Similarly, the integrated water and power plant (IWPP) market,²⁸⁹ where desalinated water is produced using excess heat from power generation, is nascent but growing in UAE. In 2016, the marquee IWPP project is the Fujairah 3 IWPP with a desalination capacity of 318,220 m³/d and valued at USD 373.9 million²⁹⁰

Another key priority is the development of solar-powered desalination technology.²⁹¹ A series of demonstration projects are ongoing through Abu Dhabi's Masdar suite of sustainability programs.²⁹² U.S. technology providers that can demonstrate innovative and energy efficiency desalination technologies through UAE pilot programs, such as those that take place through Masdar, may benefit long-term from early market entry.

Finally, the saline waste products from desalination is another key priority for which the government is seeking a technological solution. For some time, the saline wastes have been discharged into the Arabian Gulf, and increased salinity has harmed the local marine environment and impacted fisheries productivity.²⁹³

Key Technologies in Demand:

- Engineering and design services
- Monitoring equipment
- Non-revenue water control software
- Membranes
- Advanced filtration
- Low-loss distribution equipment
- Storage equipment
- Advanced filtration
- Membrane filtration
- Reverse osmosis
- UV disinfection
- Ion exchange technology
- Saline waste treatment, reuse and disposal

Process and Produced Water

UAE's growing manufacturing base coupled with its focus on sustainability is driving investment in efficient process and industrial wastewater treatment technologies. High-end manufacturing in electrical machinery, aerospace, biotechnology, telecommunications, pharmaceuticals, aerospace and healthcare will continue to create demand for ultra-pure treatment technologies for process water. The UAE also hosts a large and growing aluminum and steel production industry,²⁹⁴ which correspondingly drives demand for wastewater treatment and reuse technologies.

Key Technologies in Demand:

- Engineering and design
- Monitoring equipment
- Membranes
- Advanced filtration
- UV disinfection
- Ion exchange technology
- Secondary wastewater treatment
- Sludge treatment technologies
- Reuse technologies

Environmental Engineering and Consulting

Any business whose operations may affect the environment must obtain a permit or license, which will only be granted after an Environmental Impact Assessment (EIA) has been completed and approved. After approval, the licensee must comply with the strict terms of the license. Any licensed entity that violates the terms of the license will be subject to a fine of between AED 200,000 and 500,000 and a sentence of imprisonment of between two and five

years. This prohibition applies to drilling, exploring, testing, extracting and production oil or gas.

Key Technologies in Demand:

- Environmental Impact Assessment

ETWG Agency Initiatives and Programs

U.S. Environmental Solutions Toolkit

The Toolkit compiles the U.S. Environmental Protection Agency's (U.S. EPA)'s environmental regulations, related underlying research and a directory of U.S. companies that provide technologies necessary to implement similar environmental regulatory actions abroad.

Power-Gen International Buyer Program

Power-Gen, one of the leading U.S. power generation equipment and services trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform is leveraged to discuss policies and exchange technical information regarding power plant emissions control with Emirati participants and to foster business relationships between Emirati end-users and U.S. emissions control providers.

WasteExpo International Buyer Program

WasteExpo, one of the leading U.S. waste management trade shows, has partnered with the U.S. Department of Commerce's International Buyer Program to encourage foreign participation in the show. This platform was leveraged to exchange relevant technical information with Emirati participants and to introduce Emirati buyers to U.S. waste management technology providers.

Water Environment Federation Technical Exhibition and Conference (WEFTEC) International Buyer Program

The U.S. Department of Commerce, through its International Buyer Program, leads a delegation of Emirati officials and business representatives to WEFTEC to explore relevant U.S. technologies and work with U.S. exporters on approaches to water resource management.

Market Contacts and Program References

UAE Environmental Regulations

<https://www.ead.ae/Documents/PDF-Files/Federal-Law-No.-24-of-1999-Eng.pdf>

UAE Green Growth Strategy

<http://www.moew.gov.ae/assets/e3bd136a/uae-state-of-green-economy-report-2014.aspx>

UAE Vision 2021

www.vision2021.ae/en

Dubai Electricity and Water Authority

<https://new.dewa.gov.ae/en>

Abu Dhabi Waste Management

<https://www.abudhabi.ae/>

Dubai waste management -

<https://www.dm.gov.ae/wps/>

Ministry of Environment and Water Calendar of Events

<http://www.moew.gov.ae/en/media-centre/environmental-events.aspx>

World Future Energy Summit, Abu Dhabi (WFES), Abu Dhabi

www.worldfutureenergysummit.com

WETEX, Dubai

www.wetex.ae

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Southeast Asia

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

Regional Market Overview

In 2014, if the members of ASEAN had been a single country, they would have been the seventh largest economy in the world (USD 2.6 trillion) and the third largest country by population (622 million).²⁹⁵ The regional market for environmental technologies is similarly large and growing. If it had been scored as a single country for this report, it would rank among the top three.

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

The ASEAN Socio-Cultural Community Blueprint (2009-2015) also highlights the use of "environmentally sound technologies" to promote sustainable development in the region. To grow sustainably, the Blueprint states that Southeast Asian nations must address deforestation, biodiversity loss, trans-

boundary haze and areas with severe air and water pollution. Southeast Asia also is highly vulnerable to the effects of climate change. With extreme weather events projected to increase in frequency and severity and rising sea levels threatening the region's heavily populated and economically critical coastlines, adaptation and mitigation efforts are imperative. A number of ASEAN countries have now set climate targets. Specifically, Malaysia aims to reduce the carbon intensity of its gross domestic product (GDP) by 40 percent by 2020 from 2005 levels; Thailand has proposed a 20 percent reduction in emissions by 2030, compared to business-as-usual levels, that could increase to 25 percent with international support, and Singapore has committed to reduce greenhouse gas (GHG) emissions by 16 percent from business-as-usual levels by 2020.²⁹⁶

The ASEAN Economic Community (AEC) is a newly-launched initiative that aims to promote freer trade and capital flows among member states. In addition, four Southeast Asian nations (Singapore, Malaysia, Vietnam and Brunei) are parties to the Trans Pacific Partnership Agreement (TPP), which has the highest environmental standards of any trade deal. As such, the TPP Agreement upgrades the environmental provisions in the U.S. Free Trade Agreement (FTA) with Singapore. The Government Procurement chapter of the TPP Agreement also contains additional commitments beyond previous agreements and affirms the parties' commitment to ensure transparent bidding procedures, non-discriminatory technical specifications and objective review of procurement decisions. The TPP Agreement was concluded in October 2015 and signed in February 2016. It is currently undergoing ratification processes in each of its 12 partner countries. This high-standard agreement will help to facilitate trade in environmental goods and services through both strengthening environmental regimes and eliminating tariffs on environmental

goods, thus increasing competitiveness of U.S. technologies in TPP markets in Southeast Asia and elsewhere. Increased attention to environmental matters from policymakers, along with freer-flowing trade, aggressive project pipelines and innovative financing models, should result in numerous opportunities for U.S. companies interested in capitalizing on robust growth in the region.

Market Barriers

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

- 1. Corruption**
Some countries in the region are perceived to be highly corrupt, while others much less so. In Transparency International's 2015 Corruption Perceptions Index, of ASEAN member states, only Malaysia and Singapore scored above 50 out of 100, with 100 being extremely clean.
- 2. Preferential Treatment/Procurement**
The ETTAC reports instances of preferential treatment for companies from certain countries (e.g. China, Japan) over companies from other countries, in either the public or private sectors or both, depending on the country.
- 3. Regulatory Enforcement**
While regulatory structures support environmental technology market growth in general in the region, weak regulatory enforcement in some markets reduces technology demand and impedes market growth and export opportunities.

Philippines

Air Pollution Control

The Philippine Clean Air Act of 1999 (Rep. Act No. 8749) charges the Department of Environment and Natural Resources (DENR) with developing an Air Quality Control Action Plan; designating ambient air quality standards in coordination with other concerned agencies to protect public health, safety and general welfare; and issuing or denying permits. The Air

Quality Control Action Plan under the Clean Air Act provides for the establishment and operation of appropriate devices, methods, systems and procedures necessary to monitor, compile and analyze data on ambient air quality.²⁹⁷ The Clean Air Act also stipulates an Integrated Air Quality Improvement Framework, which charges local government units (LGUs) with developing an action plan aimed at attaining and maintaining ambient air quality standards.

DENR's Environmental Management Bureau (EMB) data show that the average pollutant concentration in the National Capital Region reached 101 micrograms per normal cubic meter ($\mu\text{g}/\text{Ncm}$) in terms of total suspended particulates (TSP) in the second half of 2015, down from 106 $\mu\text{g}/\text{Ncm}$ during the same period of 2014. According to the results of the 2012 National Emissions Inventory, 69 percent of air pollution comes from mobile sources.²⁹⁸ The remainder comes from stationary and area sources, such as construction activities and unpaved roadways.²⁹⁹ In Metro Manila, 90 percent of the air pollution comes from mobile sources.

In response to growing demand for electricity and lower coal prices, in June 2015, the Filipino government announced that 23 new coal-fired power plants would come online by 2020, including two in Davao City, a 400 MW expansion of existing facilities in Quezon Province, a 600 MW plant in Subic and a 600 MW plant in Bataan.³⁰⁰ Coal is projected to make up a significant percentage of the energy mix into the future, even as the Philippines strives to meet its climate commitments, which include tripling installed generating capacity from renewable sources by 2030. In addition to emissions control technologies, those associated with emissions inventories, source testing, evaluation and installation, and system maintenance and repair are in demand and are typically purchased abroad and shipped to the Philippines for installation by local distributors or agents.³⁰¹

Key Technologies in Demand:

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

Waste Management and Recycling

Waste management in the Philippines is regulated by the Ecological Solid Waste Management Act of 2000 (Rep. Act No. 9003 (2000)) and the 1990 Toxic Substances and Hazardous Wastes Control Act (Rep. Act No. 6969). There is a robust informal sector, with a large number of people actively involved in waste collection, separation and recycling. Local government units (LGUs) are officially responsible for solid waste management, including collection and disposal. Delivery of these services, however, often remains challenging due to capital constraints, budget and personnel constraints, as well as physical infrastructure limitations, particularly in urban areas. Currently only about 85 percent of the more than 9,000 tons of garbage produced every day in Metro Manila is collected. Nationwide, the estimated amount generated per day is 40,000 tons, of which between 40 and 85 percent is collected. Most of the solid waste that is collected is taken to open dump sites that often catch fire and contaminate local water supplies with untreated leachate.³⁰² As of the end of 2015, the Philippines had 350 open dump sites, 203 controlled disposal facilities and 84 sanitary landfills. There are 17 sanitary landfills currently under construction.

In 2016, the Department of Environment and Natural Resources (DENR) received P500 million (about USD 10.8 million) from Congress for solid waste management capacity building to help local governments comply with the Solid Waste Management Act. The Act stipulates the replacement of open dumps with sanitary landfills or materials recovery facilities and, together with the recent allocation of funds, may present opportunities for U.S. companies in this area.³⁰³

Key Technologies in Demand:

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

Water and Wastewater Treatment

Municipal Water Treatment and Supply

There is a need to expand drinking water treatment and conveyance in the Philippines. Approximately 43

percent of the population has mains access for drinking water concentrated mostly in urban areas, where access nears 61 percent (as opposed to rural areas where access is just 25 percent).³⁰⁴ Demographic trends, including rapid urbanization and an overall growing population, are placing pressure on existing system's ability to meet demand and subsequently widens the access gaps further. For instance, it is estimated that Manila, the Philippines' industrial and population center, currently suffers a 400,000 m³/D water deficit with shortfalls expected to grow rapidly in the coming years.³⁰⁵

To meet the existing access gap and address projected future needs, the government is placing significant focus on the development of water treatment and supply projects. In December 2015, the Metropolitan Waterworks and Sewerage System, the government agency in charge of the water and sewerage system in Metro Manila, awarded the Bulacan Bulk Water Supply Project to the Luzon Clean Water Development Corporation. It is currently bidding the USD 398 million New Centennial Water Supply Project. Both projects are under the Philippine government's public private partnership program.³⁰⁶ Despite the government's ambition, most public sector infrastructure projects are co-financed through a combination of federal funds, multilateral development banks and bilateral aid, which dampens the likelihood all planned projects will come to fruition in the near-term.³⁰⁷ Through specialized financing vehicles at the Asian Development Bank, however, a variety of projects are expected to be delivered, including the Angat Water Transmission Improvement Project, Water District Development Sector Project, and Metro Manila Water and Sanitation Development Project.

Key Technologies in Demand:

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

Municipal Wastewater Treatment and Sludge Management

Corresponding to a lack of access to drinking water mains is limited access to wastewater treatment, with less than 5 percent of households connected to the sewerage network.³⁰⁸ Maynilad, the utility serving western Manila, announced that it will invest USD 129 million for wastewater projects in 2016.³⁰⁹ Maynilad has five ongoing sewerage system projects, namely the 66 million liters per day (MLD) Muntinlupa Sewerage System, the 60 MLD Valenzuela Sewerage System, the 76 MLD Paranaque Sewerage System and the 21 MLD Cavite Sewerage System. The 140 MLD Central Manila Sewerage System will be bid out as soon as Maynilad acquires land for the project.

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

Key Technologies in Demand:

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

Process and Produced Water

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

Key Technologies in Demand:

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

Market Links and Contacts

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

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

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

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

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

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

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

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

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

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

Malaysia

Air Pollution Control

The Government of Malaysia is aware of the country's vulnerability to climate change. Malaysia's recent climate goals include reducing its greenhouse gas emissions intensity by 35 percent based on GDP by 2030, with the possibility of increasing to 45 percent upon receipt of financial and technical assistance from other countries, as indicated in its Nationally Determined Contribution under the December 2015 UNFCCC Paris Climate Agreement.³¹⁰ Providers of air quality monitoring technologies and emissions inventory expertise may find opportunities here as a result of these new climate-related targets.

Though Malaysia enjoys good to moderate levels of air quality overall, air pollution continues to be a severe problem in cities and industrial zones such as Selangor, Johor and parts of Sarawak. Land transportation, industrial production for electronics, rubber and palm oil, smelting, and petroleum production and refining, as well as open burning activities, are the major sources of air pollution.³¹¹ Land transportation is

currently the country's most significant source of air pollution, accounting for approximately 70 percent of annual totals.

Malaysia's Ministry of Natural Resources and Environment (NRE) specifies conditions for emission, discharge or deposit of environmentally hazardous substances, pollutants or wastes or the emission of noise into any area, segment or element of the environment. Air quality is regulated by the Environmental Quality Act (Clean Air) 2014 and by the New Ambient Air Quality Standard (2013). The 2013 Standard updates the 1989 Standard by adding PM 2.5 to the list of covered criteria pollutants, which also includes PM 10, NOx, SOx, carbon monoxide and ground-level ozone. According to the government's 11th Malaysia Plan (2016-2020), air quality standards must be refined and localized emissions and open burning activities must be controlled in order to mitigate air pollution.³¹²

In addition to localized air pollution issues, "transboundary haze" is also an annual problem that is especially prevalent during the drier summer months, when monsoon winds blow smoke from slash-and-burn land-clearing for palm oil production in Indonesia (Sumatra and Kalimantan) across the Malacca Strait to Malaysia and Singapore.³¹³ In 2013, and again in 2015, the haze regularly shut down schools and airports. The ASEAN Agreement on Transboundary Haze Pollution was initiated in 2002 and ratified by all ASEAN members as of 2014; however, at this time, there is no mechanism in place to enforce the agreement.

The Commercial Service Kuala Lumpur notes that sales to the government require a local agent and/or a joint venture partner and generally necessitate a local partner that is *bumiputra* (ethnic Malay). Additionally, direct involvement and demonstrations of long-term commitment to the local market are essential for contracts of significant size.³¹⁴

Key Technologies in Demand:

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

Waste Management and Recycling

According to Urban Wellbeing, Housing and Local Government Minister Datuk Abdul Rahman Dahlan, Malaysia currently has 170 waste disposal sites, only 14 of which are sanitary landfills. As of 2012, approximately 50 percent of the country's municipal solid waste was deposited in open dumpsites. A mandatory household source separation program was introduced last year with the aim of reducing the amount of solid waste sent to dumpsites by 40 percent by the year 2020. Eight states and federal territories are involved in this initiative so far, including Johor, Pahang, Selangor, Kedah, Malacca, Negri Sembilan, Perlis, Kuala Lumpur and Putrajaya.³¹⁵

Local municipal and district governments are responsible for municipal solid waste (MSW) management in Malaysia, including collection, transportation, treatment and final disposal, while state governments are charged with siting landfills and treatment facilities. The system was partially privatized in the mid-1990s to help relieve the financial burden on localities. Partial privatization created opportunities for growth and specialization of private service providers to complement those provided by the public sector.³¹⁶ In 2007, the Solid Waste and Public Cleansing Management Act (Act 672) bestowed authority on the Solid Waste and Public Cleansing Management Corporation (PPSPPA), under the Ministry of Housing and Local Governments (MHLG), for monitoring local privatization activities. Only some states, however, have adopted Act 672. Funding constraints have further limited adoption of the latest collection, separation, treatment and disposal technologies.³¹⁷

A majority of the composition of Malaysia's MSW is organic matter with high moisture content. In recent years, landfill gas (LFG) recovery systems have gained increased attention and may present opportunities for U.S. providers of LFG recovery technologies. LFG systems are well positioned in the market because of the relatively high cost of incineration and the suitability of LFG recovery systems to the climate and waste composition.³¹⁸

Key Technologies in Demand:

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

Water and Wastewater Treatment

Municipal Drinking Water and Wastewater

The government aims to have 99 percent of the population served by "clean and treated" water by 2020.³¹⁹ Malaysia appears to be close to reaching that goal, as roughly 98 percent of the population had access to an improved water source as of 2015.³²⁰ The Government of Malaysia's predominant focus in the water area is the production and supply of clean potable water by investing in improved water infrastructure and rehabilitating and expanding existing drinking water treatment plans and distribution networks.³²¹

Malaysia's wastewater and sewage treatment segment lags behind its drinking water counterpart in terms of development. The Indah Water Konsortium, the country's main sewerage operator, highlights that the country has not developed tertiary treatment capabilities and relies principally on primary and secondary treatment.³²² Opportunities are growing, however, in tertiary treatment systems as removal of agricultural run-off has presented itself as a treatment challenge.³²³ Furthermore, only 56 percent of the population is served by a wastewater treatment plant, with the remainder relying on septic tanks and pour flush systems.³²⁴ Limited connectivity to sewerage networks, as well as limited coverage of those networks, has stymied growth in the sector; however, there is a strong expectation that that will change in the coming years as large wastewater infrastructure projects are introduced and come on-line. Within existing and expected plants, the suite of treatment technologies is also advancing with an increased interest in mechanical treatment methods such as Extended Aeration (EA), Oxidation Ditch (OD), Rotating Biological Contactors (RBC), Sequenced Batch Reactors (SBR) and Trickling Filters.³²⁵ Malaysian utilities favor build transfer (BT) models for project development where the capital ownership, operations and maintenance remain the purview of the utility.³²⁶

Currently, Malaysia's project pipeline remains limited to the Sungai Perak raw water supply scheme, which promises construction of a 1 million m³/D drinking water plant in addition to pumping stations and transmission infrastructure. The Sungai Perak project itself has been subject to years of delays related to local government disputes on project scope, management and distribution of tariffs,³²⁷ revealing

the difficulty in Malaysia of moving projects past the conceptual phase.

Key Technologies in Demand:

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

Industrial Water

The industrial water market in Malaysia is focused on the food and beverage, power, automotive, and palm oil industries.³²⁸ Malaysia produces more than a third of the world's certified sustainable palm oil³²⁹ and correspondingly requires vast resources for palm mill effluent and solids management. With growth in the palm oil sector expected to continue in order to meet global demands for biofuels, industrial wastewater technologies for palm oil production will remain in demand as Malaysia maintains high effluent standards for the palm oil industry in particular.³³⁰

Key Technologies in Demand:

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

Water Efficiency and Reuse

Widespread drought is drawing attention to the need for water efficiency practices in Malaysia. Malaysia is focusing on integrated water management in buildings, improved metering capabilities and reduction of non-revenue water.³³¹ This shift is fueling interest in water

efficient consumer products as well as rainwater harvesting systems, smart meters and advance leak detection equipment.

Key Technologies in Demand:

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

Market Links and Contacts

Indah Water Consortium

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

Foreign Commercial Service Kuala Lumpur

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

Singapore

Air Pollution Control

Singapore enjoys one of the cleanest urban environments in Asia, including clean air for much of the year. During the summer months, however, slash-and-burn agriculture in Indonesia typically blankets Singapore in a thick smog known as “transboundary haze”. The resultant hazardous levels of air pollution have caused notable economic losses in the form of medical expenses, employment absences and business closures each year. The matter is addressed by the ASEAN Agreement on Transboundary Haze Pollution. After particularly severe issues in 2013, however, Singapore’s parliament passed the Transboundary Haze Pollution Act (2014), which now empowers regulators to prosecute firms and individuals that cause severe air pollution in Singapore by burning forests and peatlands in nearby countries.³³²

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

cars that meet LTA’s low carbon emissions requirements will qualify for rebates.³³³

Industrial emissions are another key contributing source of air pollution. Major emitters, such as refineries, power stations and waste incineration plants, must install stack emission monitors that are linked to the National Environmental Agency (NEA) telemetrically. Industrial facilities are required to conduct source emission tests regularly to ensure compliance with the NEA’s standards. Singapore has not yet met the 2020 air quality targets for particulate matter (PM) and sulfur dioxide (SO₂) that are listed in the Ministry of the Environment and Water Resources’ Sustainable Singapore Blueprint 2015. The NEA has indicated that it plans to tighten industrial emissions standards in the near-term, which could generate opportunities for U.S. providers of advanced control technologies.

In its Nationally Determined Contribution under the December 2015 Paris Climate Agreement, Singapore committed to reduce its emissions intensity by 36 percent from 2005 levels by 2030 and to peak its emissions around 2030. Singapore has had success in reducing its carbon emissions by switching most of its energy production to natural gas. As of 2014, over 95 percent of the country’s power was generated by natural gas fired plants.³³⁴ Most of Singapore’s new and proposed generation capacity is gas-based, as well, so this trend is expected to continue as the country’s economy grows. Singapore’s climate change strategy going forward will focus primarily on adaptation, given the country’s vulnerability to high sea-level rise.³³⁵

Key Technologies in Demand:

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

Waste Management and Recycling

With a total land area that is just over 277 square miles, together with one of the highest population densities in the world, Singapore does not have the physical space to landfill much of its solid waste. The

island nation's entire solid waste disposal infrastructure instead consists of four waste-to-energy (WtE) plants and one offshore sanitary landfill, Semakau, which handles incinerator ash and all non-combustible waste. Only about 2 percent of Singapore's solid waste ends up in the landfill; 38 percent of it is incinerated to generate electricity, and the remaining 60 percent is recycled.³³⁶

The National Environment Agency (NEA) has stated that it is planning a fifth waste-to-energy plant to be operational by 2019. NEA also has plans for a new solid waste processing facility that will bring all types of waste-handling under one roof, along with a water-reclamation plant to boost energy efficiency and maximize resource recovery.³³⁷

The handling, transportation, treatment and disposal of toxic industrial waste in Singapore is controlled under the Environmental Public Health (Toxic Industrial Waste) Regulations 1988. Singapore imports nearly all of its hazardous waste control equipment, and the United States currently is the leader in waste control equipment and technology exports to Singapore.³³⁸

Key Technologies in Demand:

- Solid and hazardous waste handling equipment
- Waste treatment technologies

Water and Wastewater Treatment

Municipal Water and Wastewater Treatment

Water resources in the Singaporean city-state are governed by the Public Utilities Board (PUB), which triples as a utility, research development center and water technology export platform in what the Singaporean state has dubbed its "global hydrohub." In its utility role, PUB has defined "Four National Taps," which include local water catchments areas and reservoirs (20 percent of supply); imported water from Johor, Malaysia (30 percent of supply); recycled wastewater dubbed "NEWater" (30 percent of supply) and desalinated seawater (10 percent of supply).³³⁹ With the development of major national water projects such as NEWater (recycled water), the Deep Tunnel Sewerage System (DTSS), desalination and rainfall storage like the Marina Barrage, Singapore is becoming increasingly independent when it comes to water.

Singapore has invested heavily in research and technology over the last four decades and has become

a center of excellence in water resource management. The result is a thriving industry with more than 180 international and local companies active in the market. The water technologies market has been, and will continue to be, large and highly sophisticated as the country aims for water independence. Reaching this goal will continue to require investments in water storage, pollution mitigation, reuse and efficiency technologies. Over the past decade, PUB has outsourced some USD 3.0 billion worth of water infrastructure projects, such as the Deep Tunnel Sewerage System, Marina Barrage, NEWater facilities and desalination plants, to the private sector.³⁴⁰

Demand for advanced water technology and infrastructure in Singapore presents commercial opportunities for U.S. water technology providers. According to PUB's former CEO, Khoo Teng Chye, the agency has plans to increase the country's desalination and NEWater capacities enough to meet up to 50 percent of freshwater demand by 2060.³⁴¹ Singapore has five NEWater treatment facilities and one operational desalination plant, with plans to construct up to five more desalination plants in the near future.³⁴² Key opportunities include the Water Reclamation Plant (WRP) in Tuas, with an expected capacity of 228,000 m³/d, and the Singapore Marina East desalination plant, with an expected capacity of 136,380 m³/d.³⁴³ The Tuas WRP will have an integrated NEWater factory to facilitate large-scale water recycling and will be co-located with National Environment Agency's Integrated Waste Management Facility (IWWMF) in an effort to reap the potential synergies of used water and solid waste treatment processes while minimizing the land footprint.³⁴⁴

Key Technologies in Demand:

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

- Storage equipment

Water efficiency and reuse

The increase in water self-sufficiency has only been made possible with an increased use of energy. The water sector uses an exceptional amount of energy to pump, treat, recycle, desalinate and produce NEWater. Since Singapore lacks both water and energy sources and has to import both, there are debates on the desirability of improving water security at the cost of increasing energy insecurity.³⁴⁵ Technologies for efficiency both in the water sector and the energy sector will be required to help with the paradox of water security and energy insecurity. Between 2011 and 2012, the Singaporean government announced more than USD 584 million of new public sector R&D funding to address energy, water, green buildings and land scarcity issues³⁴⁶.

Key Technologies in Demand:

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

Process and Produced Water

In addition, the Government of Singapore (GOS) is encouraging industrial users to conserve and recycle water through media campaigns, legislation and economic incentives.³⁴⁷ Key industrial water clients in Singapore include construction, hotel and restaurant services, as well as manufacturers in the electronics, chemical and petroleum industries. Currently, Singapore's water demand is about 400 m³/D, with household water consumption accounting for about 45 percent of total water use and industrial and commercial consumption accounting for the remaining 55 percent.³⁴⁸

Key Technologies in Demand:

- Engineering, design and construction services
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems

- Anaerobic digestion
- Advanced chemical treatment and rectification
- Membrane technology
- Advanced filtration

Market Links and Contacts

National Environment Agency

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

Ministry of the Environment and Water Resources

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

PUB Tenders

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

U.S. Commercial Service Singapore

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

Thailand

Air Pollution Control

Air pollution in Thailand comes from several major sources: vehicle emissions in urban areas, biomass burning and transboundary haze in rural and border areas, thermal power generation, and industrial emissions in concentrated industrialized zones.³⁴⁹ Construction, coal-fired power plants, manufacturing, mining, refineries, cement plants and quarries are the main sources of industrial air pollution in areas such as Nah Pralan sub-district, Saraburi; Mae Moe, Lampang and Samutprakarn.³⁵⁰

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

Pollution from mobile sources is of particular concern in urban areas like the Bangkok Metropolitan Region, as well as in Chiang Mai, Khonkaen, Songkhla and Phuket.³⁵¹ Recent air quality data suggest that particulate matter, specifically PM 10, is on the rise in both urban and rural areas. In Bangkok, air quality monitoring performed by the PCD for the past decade

has revealed that the levels of PM 10 have regularly exceeded both annual ($50 \mu\text{g}/\text{m}^3$) and 24 hour ($120 \mu\text{g}/\text{m}^3$) national standards due to increasing traffic congestion in the city.

Key Technologies in Demand:

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

Waste Management and Recycling

Bangkok's Environmental Department and 50 district offices are responsible for collection of the city's municipal solid waste (MSW). Collected waste is transported to three transfer stations, where it is processed and sent to one of two sanitary landfills, located in Kumpuang Saen district Nakhon Phathom province and Bang Plee district in Samut Prakarn province.³⁵² The Bangkok Metropolitan Authority (BMA) operates the country's largest single solid waste management system. BMA has promoted recycling through official programs in an effort to reduce the quantity of waste transferred to landfills for final disposal. Recycling, however, is still dominated by informal sector activities, such as waste picking, and recycling rates remain low (about 22 percent nationally).³⁵³

The Thai government recently adopted a national "Solid and Hazardous Waste Management Roadmap" that may provide the policy foundation to help address challenges faced in this area. Insufficient infrastructure and resources, as well as a poorly maintained fleet, limit solid waste collection rates in and around Bangkok, where more than 20 percent of the country's solid waste is generated. Open dumpsites are still common throughout the country, but economic and regulatory pressure is beginning to drive adoption of more modern and efficient waste management practices.³⁵⁴

Waste management in provincial municipalities in particular is often underdeveloped but will likely grow

in tandem with an increasingly mature market. Management of non-hazardous industrial waste and waste from commercial residential sites may present additional near-term opportunities for U.S. products and services, especially for those that are adaptable to the waste composition and tropical climate.³⁵⁵

Key Technologies in Demand:

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

Water and Wastewater Treatment

Access to potable water remains limited in Thailand with just 47 percent of all households receiving piped water.³⁵⁶ In rural areas, 62 percent of households consume water from unprotected sources, such as rainfall collection, rivers, canals and ponds.³⁵⁷ Potable water is provided by the Ministry of Natural Resources and Environment's Wastewater Management Authority (WMA) in Bangkok and the Provincial Water Authority elsewhere. Despite major short-falls in drinking water access, the emphasis remains on mitigation of water pollution and treatment of wastewater.

Bangkok and the five surrounding provinces generate more than 3.05 million m^3 of wastewater daily but treat just 40 percent. WMA announced its plans in 2014 to introduce a series of wastewater treatment projects to address the shortfall. Four projects, Om Noi, Samut Prakarn, Krathum Ban and Rangist, will provide an additional 1.8 million m^3/D of treatment capacity and are collectively valued at USD 308 million.³⁵⁸ Thailand favors EPC project structure but, with a new PPP policy in place, is considering private sector operations and management (O&M) contracts once the infrastructure has been developed by an EPC.³⁵⁹ Thailand's total market size for wastewater treatment is estimated at over USD 1 billion, with construction and engineering services accounting for 85 percent of the market.³⁶⁰ Thailand imports approximately 80 percent of its water technology.³⁶¹ The main tenderers of water projects include the following: the Sewerage and Drainage Department (SDD), Bangkok Metropolitan Administration (BMA),

Department of Local Administration (DOLA), Ministry of Interior, the Public Works Department (PWD) and the Industrial Estate Authority of Thailand (IEAT).³⁶²

Technologies and Services in Demand:

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

Process and Produced Water

Annual growth in the industrial water market is expected to reach 10 percent, fueled by expansion in real estate developments, manufacturing and agriculture.³⁶³ Key industrial clients include food and beverage producers, paper and rubber processing plants, chemical industries, shopping malls, residential and commercial buildings, and livestock and aquaculture farms.³⁶⁴ Growing areas of interest include anaerobic digestion, biogas development and waste-to-energy solutions.

Technologies and Services in Demand:

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

Market Links and Contacts

Ministry of Natural Resources and Environment

<http://webeng.mnre.go.th/>

NRE Pollution Control Department

<http://www.pcd.go.th/indexEng.cfm>

Office of Environmental Policy and Planning

<http://www.onep.go.th/>

Provincial Waterworks Authority (PWA)

<http://en.pwa.co.th/>

Wastewater Management Authority (WMA)

<http://www.wma.or.th/content/>

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Vietnam

Air Pollution Control and Monitoring

Like most other Southeast Asian countries, Vietnam is aware of its vulnerability to climate change. Saline intrusion and drought is already impacting the Mekong Delta region, and sea level rise is projected to adversely impact the economic activity of busy coastal regions as well as the Red River Delta.³⁶⁵ In 2012, Vietnam's government approved the country's National Green Growth Strategy with the goal of reducing greenhouse gas emissions and boosting growth in "green" sectors. Then, in its Nationally Determined Contribution under the December 2015 United Nations Framework on Climate Change (UNFCCC) Climate Agreement in Paris, Vietnam committed to an 8 percent reduction in emissions by 2030 compared to a business-as-usual scenario, with the potential to increase this to 25 percent, conditional upon international financial and technical support.

Although two-thirds of Vietnam's population lives in rural areas, the two major cities - Hanoi and Ho Chi Minh City - are plagued by air pollution from vehicle emissions, largely motorcycles. More than 37 million motorcycles and 2 million cars are registered in Vietnam, which has a population of over 90 million. The number of cars and motorcycles on the road increased by 16 percent per year on average from 2000 to 2012 and is unlikely to slow in the near-term.³⁶⁶ The Vietnamese government has plans to control motorcycle emissions, beginning with five cities - Hanoi, Ho Chi Minh City, Da Nang, Can Tho and Hai Phong - which will implement Euro 3 equivalent standards beginning next year. For cars, the government has adopted Euro 2 emissions standards, with plans to move to Euro 4 equivalent standards in 2017.³⁶⁷

The Ministry of Natural Resources and Environment's (MONRE) has drafted a National Action Plan on Air Quality Management (2020 to 2025). The draft Action Plan includes a 20 percent reduction target for NOx, SOx and particulate matter emitted by cement, chemicals, fertilizer and petroleum production facilities.³⁶⁸ Separately, a draft National Technical Regulation on Emissions for the Steel Industry is in the works as well. Vietnam's new Environmental Law (55/2014/QH13) also contains air quality management requirements, including point source registration, emissions inventory and installation of continuous emission monitoring systems for the biggest stationary source emitters. This increasing regulatory stringency is likely to drive growth in the air quality management market and provide opportunities for U.S. solution providers, especially in industrial sectors.

Key Technologies in Demand:

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

Waste Management and Recycling

Solid waste generation in Vietnam is growing on pace with its urbanizing population and economy; however, most solid waste is still inadequately managed.

According to the Ministry of Natural Resources and Environment (MONRE), the majority of the country's solid waste (73.5 percent) is deposited in open dump sites. There are only 26 combined treatment plants in urban areas. Technologies currently in use include incinerators; combined incineration and composting; and, most commonly, composting combined with landfills.³⁶⁹ Additionally, more than 60 percent of Vietnam's rural household waste and 16 percent of urban household waste is not collected.³⁷⁰

Urban Environment Company (URENCO) is the state-owned enterprise that manages solid waste collection

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

In 2009, Vietnam adopted its "National Strategy for Integrated Solid Waste Management to 2025, with a vision toward 2050." The National Strategy sets goals for management of municipal solid waste (MSW), industrial waste and medical waste, based on specific target years (2015, 2020 and 2025). Decision No. 798/QD-TTg (2011) approved a program for investment in solid waste treatment through 2020. The program's ambitious goals include collecting and treating "up to environmental standards" at least 90 percent of urban and 70 percent of rural solid waste, as well as 90 percent of both hazardous and non-hazardous industrial solid waste and 100 percent of healthcare waste. The Vietnamese government also is in the process of developing producer responsibility requirements for manufacturers and importers of electrical and electronic equipment to help address the country's e-waste in a more sustainable manner.

Rapidly growing industrial production has resulted in an equally robust industrial solid waste management market that was projected at an impressive 19 percent compound annual growth rate (CAGR) between 2011 and 2015.³⁷¹ Many of Vietnam's new solid waste management projects are being funded by donor-financing, as well as by foreign countries and international institutions. Strong market growth is expected to continue in most areas of solid waste management in Vietnam going forward.

Key Technologies in Demand:

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

Water and Wastewater Treatment

With GDP growth hovering around 6 percent a year,³⁷² a rapidly growing industrial base and an expanding middle class, Vietnam has initiated an ambitious plan to address its water infrastructure needs. Vietnam's regulatory environment is shifting to accommodate improved water resource management and to spur development of water projects nationally. In June of 2015, the Vietnamese government issued Decree No. 54/2015/ND-CP, which provides incentives for economical and efficient water use activities and limits these incentives to economical and effective use of water, water reuse and production, and importation of water-efficient equipment and technologies. In 2014, Vietnam drafted a new Law on Environmental Protection that went into effect on January 1, 2015. According to the new law, prior to being discharged into the environment, wastewater must be collected and treated to meet environmental technical regulations.

To meet the new regulatory burden, Vietnam is developing a series of nationally and development financed water projects. Overall, the Vietnamese government plans to invest USD 2.78 billion in the water sector by 2020. To support the Government of Vietnam (GVN) program, the Asian Development Bank (ADB) approved a multi-tranche financing facility (MFF) of up to USD 1 billion for 2011 to 2020 to finance water supply and sanitation projects in Danang, Haiphong, Ho Chi Minh City and Hue, as well as the National Nonrevenue Water (NRW) Program.³⁷³ Additionally, in November 2015, the World Bank approved a USD 200 million financing package for water and sanitation, and the Vietnamese government will provide an additional USD 25.5 million to finance related projects.³⁷⁴ Approximately, 23 major water treatment projects have been announced for the 2016 to 2018 tendering period, ranging in value from USD 635 million to USD 19 million.³⁷⁵ Overall, the water infrastructure industry is expected to average 5.4 percent growth annually between 2014 and 2018.³⁷⁶

The aggressive project pipeline in Vietnam denotes the growing need for improved water infrastructure. Water mains access is limited with 10 percent of rural households and 61 percent of urban households.³⁷⁷ Periodic drought, rapid industrialization and increasing household demand all place pressure on Vietnam's freshwater resources. Marquee opportunities include the Ho Chi Minh City NLTN wastewater treatment plant designed to address pollution in the Nhieu Loc-

Thi Nghe Canal. With a capacity of 830,000 m³/D upon completion, it will become the largest wastewater treatment facility in South East Asia.³⁷⁸ In the public private partnership (PPP) arena, the Tan Hoa Lo Gom canal basin wastewater treatment plant in Ho Chi Minh City is expected to have a capacity of 300,000 m³/D. Investment of USD 300 million is needed to bring the project to fruition. Finally, the Yen Xa wastewater treatment system will be Hanoi's largest wastewater treatment plant and attendant sewer network. The plant will have a capacity of 270,000 m³/D and will be situated on approximately 13 hectares of land in the Thanh Tri District of the city, treating the sewage from the districts of Thanh Xuan, Dong Da, Ba Dinh, Hoang Mai, Ha Dong, Tu Liem and Thanh Tri. The project is valued at USD 635 million.³⁷⁹

Technologies and Services in Demand:

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

Market Links and Contacts

Ministry of Natural Resources and Environment (MONRE): www.monre.gov.vn

Vietnam Environment Administration:
www.nea.gov.vn

Vietnam Water Supply and Sewerage Association (VWSA): www.vwsa.org.vn

Vietwater 2016, Ho Chi Minh City, November 9-11
<http://www.vietwater.com>

Ms. Ngo Anh, Commercial Specialist (Hanoi)
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FTA South America

Home to 34 percent of the world's plant and 27 percent of mammal species, South America contains five of the world's 10 most biodiverse countries. Its nations are faced with harmonizing internal and external pressures to establish strict environmental protection regimes with pursuit of economic development and efficiency. Over the past decade, a commodity boom pulled millions out of poverty, but it also triggered a scramble for oil, minerals and cropland. Common environmental challenges include deforestation, soil erosion, severe urban air pollution, water scarcity and vulnerability to climate change. In recent years, an increasing number of South American nations have adopted more comprehensive legal frameworks and stronger environmental policy regimes to try to address these issues. This has boosted demand for environmental technologies and, together with the relatively free flow of goods and services trade between the United States and its Free Trade Agreement (FTA) partners, helps to make U.S. environmental solutions much sought-after in these markets.

Regional Market Overview

Over much of the past decade, Chile, Colombia, Mexico and Peru have been some of the Americas' fastest-growing emerging markets, with GDP growth at an average annual rate of 4 percent or higher through 2014. The United States currently maintains free trade agreements (FTAs) with all of these countries, and bilateral FTAs with three: Chile, Colombia and Peru. The U.S.-Chile FTA went into force in 2004 and all duties on U.S. originating goods entering Chile were eliminated on January 1, 2015. Over 80 percent of U.S. originating consumer and industrial products exported to Colombia became duty free when the U.S.-Colombia Trade Promotion Agreement (TPA) entered into force on May 15, 2012, with the remaining 20% to follow within 10 years. The Peru Trade Promotion Agreement entered into force on February 1, 2009, with similar provisions. All three trade agreements include strong commitments to protect the environment. For example, in all three cases, both parties have agreed to effectively enforce their own domestic environmental laws.

In addition to bilateral FTAs with the United States, Chile and Peru are also parties to the Trans Pacific Partnership Agreement (TPP), which has the highest environmental standards of any trade deal. Chile, Peru and Mexico are U.S. partners in the TPP, along with 8 other countries (Australia, Brunei Darussalam, Canada, Japan, Malaysia, New Zealand, Singapore, and

Vietnam). The 12 TPP partners together represent 40 percent of the global economy. The TPP Agreement was concluded in October 2015 and signed in February 2016 and is currently undergoing ratification in each of its partner countries. The TPP Agreement upgrades the environmental provisions in the FTAs with Mexico, Chile and Peru. Strong environmental regimes drive demand for environmental technologies, and all parties to TPP must commit to the environmental requirements in order to participate. FTAs help to facilitate trade in environmental goods and services through both amplifying this key market driver and eliminating tariffs on environmental goods, thus increasing competitiveness of U.S. technologies in partner markets.

Together with steady projected industrial and economic growth, improved regulatory frameworks and enhanced capacity for many environmental and enforcement agencies in the region, these markets offer strong prospects for U.S. environmental technology and service providers.

Regional Market Opportunities: Water

The water and wastewater market serving the expanding Latin American mining industry is set to grow by 3.3 percent to USD 4.9 billion over the next six years as mining firms look to maintain production in the face of mounting environmental and demographic challenges. Spending on process water management (including water reuse) is expected to see the highest levels of growth in the next six years, with a CAGR of 5.4 percent, followed by growth in investment in

wastewater treatment. Global Water Intelligence's (GWI) report estimates that capital spending in the water for the mining market in Latin America will be around USD 4.0 billion in 2014, with expenditure in the water supply sector representing around 46 percent of this figure. This percentage is expected to decrease to around 41 percent by 2020, with growing investment in the process water and wastewater sectors. Civil engineering infrastructure (including pipelines) is the component of the water for mining market with the single highest expenditure, which in 2014 is estimated to be just under USD 2.8 billion. In the equipment sector, seawater desalination systems are expected to experience the highest growth, with a CAGR of 10 percent in the period of 2014 to 2020. This compound annual growth rate is distorted, however, by the high cost of large individual desalination projects. Treatment methods and management systems that favor water recycling are expected to show the highest growth after seawater desalination systems in the Latin American market, with a CAGR of 5.5 percent in the period 2014 to 2020. The four main markets for mining in Latin America are Chile, Peru, Brazil and Mexico.³⁸⁰

Water sector investment in Latin America needs to grow by 300 percent in order to achieve a satisfactory level of services by 2025, although this figure is likely to rise as climate change adaptation requirements are increasingly taken into account.

This prognosis, calculated by Corporación Andina de Fomento (CAF), takes as its basis the fact that only 7 percent of the region's wastewater is treated, while 27 percent of periurban dwellers lack adequate water supply but do not incorporate costs associated with mitigation measures to counteract the effects of the severe water shortages currently affecting northern Mexico, central Chile and Brazil's São Paulo region.³⁸¹

Market Barriers

FTAs with Chile, Colombia, Peru and Mexico have significantly reduced or eliminated the vast majority of tariff and non-tariff market barriers for U.S. exports to these countries. Areas to note include:

1. Intellectual Property Rights (IPR) Protection and Enforcement

The U.S. Trade Representative's Special 301 Report is an annual review of the state of IPR protection and enforcement in U.S. trading

partners. Despite strong FTA IPR protection provisions, Chile, Colombia, Peru and Mexico all were included on the 2015 Special 301 Watch List due to certain weaknesses in the adequacy and/or effectiveness of their IPR protection regimes. Common issues included the prevalence of pirated or counterfeit goods and the lack of coordination among enforcement agencies.

2. Corruption

Most countries in the region are perceived to be highly corrupt. In Transparency International's 2015 Corruption Perceptions Index, the only three countries in Central and South America that scored above 50 on a scale from 0 to 100, with 100 being extremely clean, were Costa Rica (55), Chile (70) and Uruguay (74).

Chile

Air Pollution Control

Most of Chile's population centers are located in between two mountain ranges - the Andes and the Cordillera de la Costa. This unique geography favors the creation of weather patterns that generate a stable layer of air near the earth's surface, allowing thick smog to stagnate over Santiago and other urban areas, particularly in fall and winter. In summer, nitrogen oxide emissions (NOx) and volatile organic compounds (VOCs) from mobile as well as non-anthropogenic sources boost the formation of ground-level ozone (O₃).³⁸²

The Ministry of Environment (MMA) currently maintains air quality standards for seven criteria pollutants (SO₂, O₃, NO₂, CO, PM₁₀, PM_{2.5} and lead (Pb)) and is in the process of revising its requirements for all except PM 2.5 and Pb. The current PM 2.5 standard, enacted in 2012 through the Primary Standard on Fine Inhalable Particulate Matter PM_{2.5}, is set at a daily maximum concentration of 50 milligrams per cubic meter air (µg/m³) and an annual maximum concentration of 20 µg/m³.³⁸³ Areas where the pollutant concentrations are between 80 and 100 percent of the set air quality standards are designated as "latent" non-attainment areas, while areas where the pollutant concentration exceeds the set standard are "saturated" non-attainment areas. These designations form the basis of the atmospheric

prevention plans (APP) and atmospheric contamination plans (ADP), respectively.³⁸⁴

Air pollutant concentrations that consistently register above standard levels in Chile's northern urban and mining zones are largely a result of the high levels of SO₂ and PM 10 from copper foundries and coal-fired power plants. In the central region of the country, PM 10, O₃ and SO₂ from mobile and point sources are of primary concern, and in the south, the key issue is PM 10 produced by residential wood combustion.³⁸⁵ The mining, iron, steel, cement and wood product industries also impact air quality.³⁸⁶

In September 2014, Chile approved a carbon tax for thermal power generators (thermal input equal to or above 50MW, biomass power plants exempt), which is set to take effect in 2017. Emitters will have to pay USD 5 per metric ton of CO₂ they emit, as well as a to-be-determined taxes on other GHG emissions.³⁸⁷ The government also has promulgated financial incentives for businesses to introduce technologies and processes that promote "clean" production, such as the Clean Production Agreement (*Acuerdo de Producción Limpia*). An update of the National Action Plan for Climate Change (2016-2020) is also underway, which will help continue to guide development of policies and regulatory frameworks that will be favorable for producers of technologies that support the country's adaptation and mitigation targets.

Key Technologies in Demand:

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

Waste Management and Recycling

Chile's generation of municipal solid waste (MSW) has increased significantly over the past decade, on pace

with the country's steady population growth, rising living standards and increasing GDP per capita. Chilean municipalities are responsible for collecting and disposing of their own waste. Most decide to award contracts to collection agencies that transport it to privately managed landfills. According the Ministry of Environment, of the 17 million tons of solid waste that are generated each year, 33 percent is recoverable, but only about 10 percent is currently recycled.³⁸⁸ In general, the municipalities' contracts with collection agencies offer no incentive to reduce waste, as municipalities typically agree to pay less per ton based on increasing volume. The newly approved Extended Producer Responsibility (EPR) law should improve the recovery rate of at least nine classes of products: lubricating oils, electrical and electronic equipment, periodicals, packaging, pharmaceuticals, tires, batteries, expired pesticides, and vehicles.³⁸⁹ Most in-country producers and importers of these products will need to upgrade their processes and technologies to ensure compliance.

Hazardous waste, including chemical powders and toxic liquids, must be transported to one of seven special treatment sites. About 5 percent of hazardous waste is converted into alternative fuels, while the rest is buried in leak-proof containers. Hazardous waste is tracked through an online System for Declaring and Monitoring Hazardous Waste (SIDREP); however, enforcement can be challenging.³⁹⁰

Industry projections for solid waste management in Chile indicate that between 2014 and 2018 investment by the private and public sector will exceed USD 30 billion.³⁹¹

Key Technologies in Demand:

- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste-to-Energy technologies
- Landfill gas recovery
- Sanitary landfill design and associated technologies (especially liners and covers)

Water and Wastewater Treatment

Municipal Water Treatment and Supply

16.1 million are served, 94.8 percent of which by private operators³⁹².

Key Technologies in Demand:

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

Municipal Wastewater Treatment and Sludge Management

The Chilean public water market is governed by the Public Works Ministry (MOP), which manages water resources, grants concessions and provides water for the rural population.³⁹³ Chile privatized urban water and wastewater resource management in 1989 through the General Law for Water and Sanitation Services (DFL MOP 382/1988).³⁹⁴ In 1998, Chile created the world's most liberal water market by further privatizing the underlying utility assets and property. Prior to 1998, water concessions remained the property of the government.³⁹⁵ As a result, 94.8 percent of the population is served by a private water and wastewater company,³⁹⁶ which cumulatively serve 5 million metered homes daily in urban areas.³⁹⁷

U.S. exporters seeking to work in Chile's municipal market must go directly to the private water providers to identify opportunities and project pipelines. Major property holding water companies include Aguas Cordillera, Aguas Manquehue, Essal, Esval, Essbio and Aguas Andinas.³⁹⁸ Concessionaire companies include: Nuevosur, Aguas Magallanes, Altiplano, Aguas Patagonia, Aguas Chañar, Aguas Araucanía, Aguas Antofagasta and Aguas del Valle.³⁹⁹ The largest water company consortia is led by the Agbar-Suez economic group, which holds Aguas Cordillera, Aguas Manquehue, Aguas Andinas and Essal and serves 42.9 percent of the market. Other major economic groups

include the Ontario Teach Pension Plan, which holds Essbio, Esval, Aguas del Valle and Nuevosur with 36.2 percent of the market, and the Marubeni group, which holds Aguas de Altiplano, Aguas Araucanía and Aguas Magallanes, with 9.2 percent of the market.⁴⁰⁰

Key concerns of Chilean water companies include managing water scarcity with efficient technologies, storage, reducing non-revenue water, and energy efficient treatment and transmission technologies.⁴⁰¹

Key Technologies in Demand:

- Engineering, procurement and construction services
- Primary and secondary treatment technologies
- Advanced filtration
- Membrane filtration
- UV / Ozone disinfection
- Waste-to-energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Sludge handling equipment
- Smart meters
- Non-revenue water control software
- Low-loss distribution equipment
- Storage equipment
- Monitoring equipment
- Testing equipment

Desalination

In order to address water scarcity in the arid north, Chile is developing a series of reverse osmosis sea water desalination facilities. The central government plans to invest USD 280 million in the next five years.⁴⁰² There are eight major salt water conversion projects currently in the project pipeline. Major opportunities include the Aguas Chañar project of the Aguas Chañar utility (38,880 m³/D), the Arica project of MOP (17,000 m³/D), the Copiapó project of Econssa (80,000 m³/D), the Desaladora Sur project of Aguas de Antofagasta (51,840 m³/D) and the Aguas Atacama project of Agbar (86,400 M³/D).⁴⁰³

Key Technologies in Demand:

- Engineering, procurement and construction services
- Primary and secondary treatment technologies
- RO membrane filtration
- UV / ozone disinfection
- Monitoring equipment
- Testing equipment

Process and Produced Water

Chile's mining industry has created one of the largest global markets for process and produced water. Chile's mines are located in the country's water-scarce north, which has created water resource development challenges for the mining sector. Mining companies must procure sufficient water supply for both production and to meet the human consumption needs of communities living in the region. Similar to utilities, the mining sector is turning to large-scale desalination and reuse to meet demand.⁴⁰⁴ The mining industry expects consumption to increase 66 percent by 2025 and plans to meet increasing demand by desalinating 36 percent of its total process consumption by 2025.⁴⁰⁵ Ten major industrial desalination projects are in the pipeline, including the Relincho Copper Mine project valued at USD 3.5 billion for initial phase (60,480 m³/D), the El Abra Mine project (112,320 m³/D), the Mejillones desalination and distribution project valued at USD 292 million (86,400 m³/D), and the Dominga RO project (42,840 m³/D).⁴⁰⁶

Key Technologies in Demand:

- Engineering, procurement and construction services
- Primary and secondary treatment technologies
- RO membrane filtration
- UV / ozone disinfection
- Monitoring equipment
- Testing equipment

Market Links and Contacts

Commercial Service Santiago
www.export.gov/chile

Ministry of Environment
<http://portal.mma.gob.cl/>

Andess Chile – Chilean Water Company Association
<http://www.andess.cl/>

Ministry of Public Works
www.mopo.cl

AEPA Environmental Association
www.aepa.cl

Superintendencia de Servicios Sanitarios
www.siss.gob.cl

Dirección General de Aguas
www.dga.cl

Cochilco
www.cochilco.cl

Chilean Municipalities Association – ACHM
<http://www.munitel.cl/>

Assoc. of Mining Industry Suppliers – APRIMIN
<http://aprimin.cl/site/>

Plastics Association – ASIPLA
<http://www.asipla.cl/>

Environmental Directory – Induambiente
<http://www.induambiente.com/>

Commercial Events

IFT Agro
www.ift-agro.cl

Expomin
www.expomin.cl

Aquasur
www.aqua-sur.cl

Exponor
www.exponor.cl

Fullplast Chile
<http://www.fullplast.cl/>

Expomin
<http://www.expomin.cl/>

Colombia

Air Pollution Control

Over the past decade, Colombia has made substantial progress toward effective air pollution management. The 2010 Air Pollution Control and Prevention Policy in particular made progress in air quality assessment, monitoring, standardization of air quality inventories, fuel-quality improvement, and implementation of incentive programs for environmental control and monitoring.⁴⁰⁷ The capital city, Bogota, has 14 active air quality monitoring stations, most of which measure particulate matter (PM 10), ozone and nitrogen

dioxide, and some also measure sulfur dioxide. Just one monitors PM 2.5. Approximately 90 percent of the city's air pollution is attributed to mobile sources.⁴⁰⁸

The government is making efforts to address the issue, through stricter emissions regulations as well as other measures. Most recently, Resolution 1111 (2013) established that all light- and heavy-duty vehicles must adhere to Euro IV emissions standards as of 2015.

Environmental management via the country's National Environmental System (SINA) is complex and challenging, particularly for priority issues such as air quality, as full implementation of SINA necessitates collaboration and information sharing and production across 33 regional autonomous corporations with highly variable levels of capacity, accountability and funding.⁴⁰⁹ Colombia is Latin America's largest coal producer and fourth largest exporter of oil. Extractive industries, particularly those for fossil fuels and gold, as well as power plants and agricultural burning, are significant contributors to air pollution. In general, emissions standards for industrial and thermal sources are outdated and/or poorly enforced. The government recently has placed greater emphasis on promulgating policies that support sustainable growth, including in its 2010 to 2014 and 2014 to 2018 National Development Plans (DNP). There is likely to be low demand for air pollution control technologies without the introduction of updated emissions standards, stronger institutional accountability and increased incentives to comply with environmental regulations.

Key Technologies in Demand:

- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Emissions control technologies for motor vehicles and non-road (diesel) vehicles and machinery

Waste Management and Recycling

According to a recent report by the World Bank, around 79 percent of the 27 tons of solid waste that Colombia's cities generate every day is disposed of properly in landfills. One-fifth of Colombian municipalities located predominantly in rural areas do not have adequate waste disposal, and approximately 30 percent of the country's landfills are not properly managed and do not comply with environmental regulations.⁴¹⁰ Informal recycling is a key feature of Colombia's municipal waste management system. Approximately 26,000 informal and independent recyclers (*recicladores*) account for an estimated 55 percent of all recycled municipal waste and help to

balance the lack of source separation in cities and towns.

Title 2 of Decree 1077 (2015) sets the general regime for the management of conventional solid waste, including storage and disposal rules, while Title 6 of Decree 1076 sets forth rules for handling, storage and treatment of hazardous waste, including obligating generators to prepare a complete Hazardous Waste Management Plan, as well as to register as a hazardous waste generator with the relevant environmental authorities. Public utilities are charged with collecting and transferring municipal solid waste to disposal sites. The Ministry of Environment also recently has issued regulations regarding collection and management of several types of household hazardous waste, including pesticides, acid lead batteries, pharmaceuticals, batteries, tires, light bulbs, and electrical and electronic consumer products.⁴¹¹

Extractive industries are major sources of soil pollution in Colombia. The country's Antioquia administrative department registers as the world's largest mercury polluting area per capita, largely due to the prevalence of small-scale artisanal gold mining there.⁴¹² The adoption of Law 1658 in 2013 is an important step toward mercury reduction, as it aims to phase out the use of mercury in mining within five years and in all production processes within 10 years. As of 2016, Colombia lacks a coherent national framework for land contamination management, but increasing concern for environmental and ecosystem protection has brought the issue greater prominence and is likely to support positive regulatory and policy developments in this area.

Key Technologies in Demand:

- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Waste handling equipment
- Waste treatment technologies
- Brownfield site remediation design and equipment
- Soil contamination testing and monitoring equipment

Water and Wastewater Treatment

Municipal Water Treatment and Supply

Colombia is initiating an effort to introduce functional Public Private Partnerships (PPPs) in its water sector. Legal changes to the PPP law in 2012 have paved the way for greater private sector participation in the water sector by delineating clear guidelines for the deployment of PPPs in the water and sanitation sector.⁴¹³ The Colombian government has planned to invest USD 6.3 billion water projects between 2015 and 2018, noting that approximately 30 percent is expected to be financed privately.⁴¹⁴

Colombia's interest in encouraging greater private sector participation in the water sector is part of a broader government strategy to improve urban water quality, restore major tributaries such as the Bogotá River, and expand sanitation services and sludge treatment universally.⁴¹⁵ The preeminent opportunity is the development of the Canoas wastewater treatment plant of Empresa de Acueducto y Alcantarillado de Bogotá (EAAB). Upon commissioning, the Canoas project will be the largest wastewater treatment facility in the Andes with a daily capacity of 1.2 million m³ and an estimated total project value of USD 883 million.⁴¹⁶

On March 17, 2015, the Ministry replaced a 30-year-old regulation with Resolution 0631, which establishes the maximum allowable pollution limits from point sources to superficial bodies of water and public sewer systems. Resolution 0631 aims to reduce pollution loads to improve water quality and calls for more advanced industrial and municipal treatment processes. Up to 3.5 years transition compliance time has been afforded to the 73 production activities in the country. The resolution is available online at: www.minambiente.gov.co/images/normativa/app/resoluciones/d1-res_631_marz_2015.pdf

Key Technologies in Demand:

- Engineering, procurement and construction services
- Filtration
- Advanced filtration
- Chemical disinfection
- Pumps, pipes and valves
- Primary and secondary treatment technologies
- SCADA systems
- In-line monitoring systems

- Sludge disinfection systems
- Sludge dewatering and drying systems
- Anaerobic digestion
- Bio-gas/natural gas recovery
- Nitrogen and phosphorus recovery technologies

Market Links and Contacts

Ministry of Environment
www.minambiente.gov.co

Ministry of Housing and Territorial Development
<http://www.minvivienda.gov.co/viceministerios/viceministerio-de-agua>

Acueducto de Bogotá
www.acueducto.com.co

Commercial Service Bogotá
www.export.gov/colombia

Peru

Air Pollution Control

The World Health Organization (WHO) recently named Lima the Latin American city with the worst air pollution. According to the WHO, the average concentration of PM 2.5 and PM 10 registered between 38 and 63 micrograms per m³ on average, which is far in excess of the maximum levels (10 and 20 micrograms per m³, respectively) recommended by the organization. Lima's aging public transit vehicle fleet and low fuel quality are key contributors to the city's poor air quality. As Susan Villaran, former mayor of Lima, highlighted during a hearing before Congress "52 per cent of Lima's [12,050] buses and *combis* (smaller buses) are over 20 years old".⁴¹⁷ Lima's geography also helps to keep the smog in place. The city of 9 million is bordered on the west side by the Pacific. Ocean currents push the pollution eastward and inland, where it is blocked by the Andes.

In the country's urban and industrial areas, petroleum extraction and refining; natural gas extraction and liquefaction; mining for gold, copper, lead and zinc; steel, metal and cement production; textiles; and chemicals industries all impact Peru's air quality. Regulations are in place for some sectors, such as cement and smelting, while others, such as thermal power plants and brick production, remain under discussion.⁴¹⁸

According to a forward-looking 2012 Country Report by the Ministry of Environment (MINAM), “the national environmental authority must complement pending regulations related to atmospheric protection and must implement supervisory activities, monitoring and strengthening the governance of atmospheric protection actions.” Relevant supporting actions include strengthening and expanding air quality monitoring networks and implementing maximum permissible limits (LMP) in new regulations.⁴¹⁹

Key Technologies in Demand:

- Fenceline monitoring equipment
- Continuous emissions monitoring equipment
- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Fuel vapor control technologies
- Emissions control technologies for motor vehicles and non-road (diesel) vehicles and machinery
- Selective catalytic and non-catalytic reduction controls
- Particulate matter control systems
- Wet/dry scrubbers (particularly systems that remove multiple pollutants)

Waste Management and Recycling

According to a report by the Agency for Environmental Assessment and Enforcement (OEFA), as of 2014, there were just nine sanitary and two secure landfills in Peru. Moreover, outside of Lima, sanitary landfills are located in only four of the 25 regions (provinces), so much of the mountainous country does not have access to them. Lima alone generates over 7,400 tons per day, or about 41 percent of Peru’s total, and that amount is expected to more than double over the next two decades. The Ministry of Environment (MINAM) estimates that 81 percent of total solid waste is collected and transported to landfills, and that the country needs at least 100 landfills to manage all of its solid waste properly.⁴²⁰

The General Law on Solid Waste (Law No. 27314) and Supreme Decree No. 057-2004-PCM together provide the primary legal and regulatory framework for solid waste management. Provinces and district municipalities are responsible for handling their residents’ waste, and each province must develop and implement its own plan under the Solid Waste Environmental Management Program (PIGARS). The OEFA monitors compliance with their environmental enforcement functions. National policy is guided by

Peru’s 10-Year National Environmental Action Plan, which sets an ambitious 2021 goal of ensuring adequate treatment and disposal of 100 percent of the nation’s urban solid waste (Plan, Section 7.2).⁴²¹ The government is actively pursuing financing to help realize these goals, including from international institutions. In 2012, the Inter-American Development Bank (IDB) and the Japan International Cooperation Agency (JICA) provided loans “to support the development of 31 sustainable and efficient systems for managing solid waste in Peru.”⁴²²

Key Technologies in Demand:

- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Recycling process expertise
- Waste handling equipment
- Waste treatment technologies
- Sanitary landfill design and associated technologies (especially liners and covers)

Water and Wastewater Treatment

Municipal Water Treatment and Supply

With just 86.7 percent of Peruvians with access to a safe drinking water source and 76.2 percent with access to sanitation services, much remains to be done in terms of water and wastewater infrastructure.⁴²³

Similar to other Latin American countries, Peru is turning to Public Private Partnerships (PPPs) to close the finance gap for public infrastructure, improve the service quality and meet universal access goals. In Lima alone, USD 15.8 billion is needed to improve and expand service delivery.⁴²⁴ The preeminent opportunity for PPP in the water sector is the suite of zone based projects for Lima (including Lima Central, Lima South and Lima North projects) being developed by ProInversión, Peru’s investment agency.⁴²⁵ The program aims to increase revenue through improved metering and by developing operational efficiencies in process such as installing energy efficient pumping systems.⁴²⁶

The government has also committed to restoring Lake Titicaca by 2025 with the development of as many as 10 wastewater treatment plants in the Lake Titicaca region. Cumulatively, those projects in both Peru and

Bolivia focus on rehabilitation of Lake Titicaca are valued at USD 500 million.⁴²⁷

Key Technologies in Demand:

- Engineering, procurement and construction services
- Primary and secondary treatment technologies
- Anaerobic digestion
- Nitrification
- Filtration
- Advanced filtration
- Chemical disinfection
- UV disinfection
- Ozone disinfection
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems
- Leak detection equipment

Process and Produced Water

Water for mining is also a substantial market opportunity in Peru. Several major mining related projects are in the pipeline, including the Los Calatos Reverse Osmosis Plant, which has an expected value of USD 650 million, to treat process and produced water for the copper-molybdenum mining project led by Metminco.

Key Technologies in Demand:

- Primary and secondary treatment technologies
- Advanced filtration
- Membrane filtration
- UV / ozone disinfection
- Waste-to-energy technology
- Anaerobic digestion
- Nitrification
- Biological denitrification
- Sludge handling equipment
- Monitoring equipment
- Testing equipment

Market Links and Contacts

Ministry of Environment

<http://www.minam.gob.pe/>

Agency for Environmental Assessment and Enforcement (OEFA)

www.oefa.goeb.pe

U.S. Commercial Service - Lima

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

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Gulf States

Common challenges that the Gulf States face regarding environmentally sustainable development include the lack of urban development frameworks and regional precedents in energy and water conservation and scarce water and land resources. In order to address environmental issues resulting from the region's rapid growth and urbanization, most Gulf States have taken measures to develop national sustainability initiatives that are serving to facilitate implementation of new environmental policies and regulations. Together with resource scarcity, this helps drive demand for environmental technologies and should offer robust opportunities for U.S. solution providers, particularly in the water and waste sectors. Indeed, if it had been scored as a single country, the Gulf States region – specifically Saudi Arabia, the United Arab Emirates (UAE), Qatar, Bahrain and Oman – would have ranked among the top three markets in this report.

Regional Market Overview

In recent decades, the Gulf Cooperation Council (GCC) states of the Arabian Peninsula have experienced rapid, sustained population growth and urbanization. Today, over 90 percent of people living in the GCC live in urban areas. As incomes have risen with economic development, so too has consumption, which has placed increasing pressure on scarce land and water resources. Production of fossil fuels and petrochemicals, far and away the top source of income for the GCC countries, has created additional stresses on the environment, especially through inefficiencies in oil and gas generation, distribution and end use. Much of the region's coast is highly vulnerable to the effects of climate change, as well. Fresh water availability is projected to decline, while anticipated rising sea levels are likely to result in inundation and saltwater intrusion in many areas.⁴²⁸

New initiatives are being implemented across the region to help address some of these challenges. A number of GCC states have incorporated sustainable growth and environmental protection as integral features of their latest national development plans, as in the UAE's Vision 2021 National Agenda and Green Growth Strategy, Qatar's National Vision 2030 and Saudi Arabia's 10th Development Plan (2015-2019), prompting upgrades to environmental policies and regulations in order to meet their stated targets. For example, in the last few years, several GCC states have introduced new solid waste management (SWM) frameworks. The UAE and Oman in particular are seeking to rapidly upgrade the majority of their SWM infrastructure, from collections systems to sanitary

landfill design and construction and waste-to-energy plants. Also, investment in desalination facilities and water reuse technologies remain extremely strong, as demand continues to significantly outpace supply of renewable water resources in this arid region.

Environmental institutions in the GCC typically are accorded high priority and status, and a range of institutions has been established to implement policies, enforce laws and set standards and norms.⁴²⁹ National budgets, however, have been hit hard by low oil prices, and a number of governments intend to cut public investment as a result. It remains unclear how this period of reduced revenues and budget cuts might impact implementation of environmental initiatives and projects in the region. Saudi Arabia has responded with plans to reduce expenditures by 14 percent this year, and the UAE and Qatar have eliminated their fuel subsidies. The GCC countries are making efforts to mitigate the adverse effects on their economies, including through energy price reform, plans to collectively introduce a value-added tax (VAT) and economic diversification, all of which should help to increase their non-oil sources of revenue in the medium and long-term.⁴³⁰

Market Barriers

Commerce's Office of Energy and Environmental Industries has identified the following barriers as the most potentially problematic for environmental technologies companies attempting to do business in the Gulf region:

1. **Import License Requirements**

Qatar requires a license for the importation of most products, and only Qatari nationals may obtain an import license. In the UAE, only firms with 51 percent UAE ownership can obtain a license and import products.

- 2. Government Procurement Price Preferences**
Oman, Qatar, Saudi Arabia and the UAE all apply a 10 percent price preference to tenders that contain local content or content from other GCC member countries, but Oman may not apply such price preferences in procurements covered by the U.S.-Oman Free Trade Agreement.

Oman

Air Pollution Control

Oman's Regulation on Controlling Air Pollutants (MD 118/2004) is the principal regulation regarding air quality. It specifies minimum stack heights, depending on the emitter, and that facility owners must "use scientific means to prevent direct or indirect emissions of toxic and hazardous gases and particulates from site, and treat such gases and particulates appropriately to render them harmless and to comply with the ministry's standards." Primary emitters are oil production and refining, natural gas production, thermal power generation, construction, cement, copper, steel, chemicals and fiber optics manufacturing.⁴³¹

Key Technologies in Demand:

- Wet/dry scrubbers (particularly systems that remove multiple pollutants)
- Carbon injection systems (for reduction in mercury and organics)
- Particulate matter control systems (particularly new bagging systems)
- Continuous emissions monitoring systems
- Selective catalytic and non-catalytic reduction controls
- Oxygen enrichment, fuel injection, and other efficient combustion technologies
- Alternative fuel technologies used to fire cement kilns
- Flue gas desulfurization equipment
- Activated carbon injection technologies
- Electrostatic precipitators (wet and dry)

Waste Management and Recycling

The former Ministry of National Economy's Draft National Solid Waste Management Strategy Report provides the broad framework under which Oman's solid waste management program is being implemented. Ministerial Decisions No. 17/93 and 18/93, together with the Law Regulating the Circulation and Use of Chemicals (Royal Decree No. 46/95), provide the legal framework for managing solid and hazardous waste.

Royal Decree (46/2009) delegates full responsibility for the country's waste management on the Oman Environmental Services Holding Company (OESHCO), or Be'ah. Be'ah aims to close all 317 of Oman's unregulated dumpsites by 2016 and replace them with 13 engineered landfills and approximately 25 to 34 transfer stations.⁴³² Also, under its Integrated Hazardous Waste Management System, Be'ah plans to establish a thermal treatment plant, physical and chemical treatment plant, a solidification plant and disposal facilities. The plant will be located in Liwa, near Sohar city, which generates the majority (90 percent) of the country's industrial and hazardous waste, and will be fully operational by 2019.⁴³³ Be'ah has invited tenders for engineered landfills, material recovery facilities, transfer stations and waste management services in the upcoming Special Economic Zone at Duqum (SEZAD), among others.⁴³⁴

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers and vehicles
- Landfill design and engineering

Water and Wastewater Treatment

Municipal Water and Wastewater

Demand for water in Oman is growing at an aggressive pace at an average of 6 percent annually.⁴³⁵ Oman faces substantial water supply problems, including saline water intrusion, aquifer depletion and overall scarcity in the agricultural northern region.⁴³⁶ A recently introduced wastewater management scheme aims to reduce water stress by reusing treated wastewater in agriculture and aquifer recharge.⁴³⁷

Within this effort, a national water monitoring program will provide vast opportunities for monitoring technology providers.

As with most gulf nations, Oman will continue to rely upon desalinated water for its freshwater needs. Desalination projects in Oman are the purview of the Oman Power and Water Procurement Company (OPWP), a government owned corporation that is the sole producer and seller of desalinated water.⁴³⁸ OPWP announced plans in 2015 to double the number of desalination projects in the pipeline.⁴³⁹ This effort will focus on the northern region.

Oman has also had success developing Independent Water and Power Plants (IWPP), which undertake thermal desalination utilizing the waste heat from thermal power plants. Between now and 2020, OPWP plans to build six new IWPP facilities and expand three existing plants. The cumulative capacity of the new facilities will reach 900,000 m³/D.⁴⁴⁰

Managing wastewater also is a growing segment in Oman. The parastatal Haya Water is undertaking a USD 1 billion program to improve wastewater treatment and transmission in the Muscat area. The project will connect Muscat's six municipal districts to state-of-the-art wastewater treatment facilities by 2020. The overall program is valued at USD 4.3 billion.⁴⁴¹

Key Technologies in Demand:

- Engineering, procurement and construction services
- Filtration
- Advanced filtration
- Chemical disinfection
- UV disinfection
- Ozone disinfection
- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems
- Trenchless technologies
- Combined power and thermal desalination
- Anaerobic digestion
- Nitrification
- Biological denitrification

Market Links and Contacts

Oman Power and Water Procurement Company
<http://www.omanpwp.co.om>

Ministry of Environment and Climate Affairs
<http://www.meca.gov.om>

Oman Wastewater Services Company S.A.O.G
<http://www.owsc.com.om/>

Oman Environmental Services Holding Company
<http://www.oeshc.co.om> ; <http://www.beah.om/>

Haya Water Treatment & Distribution
<http://www.haya.com.om>

Public Authority for Electricity & Water
<http://www.paew.gov.om>

Ministry of Regional Municipality and Water Resources
<http://www.mrmwr.gov.om/en/>

Middle East Desalination Research Center (MEDRC)
<http://www.medrc.org/>

U.S. Commercial Service Oman
<http://www.export.gov/oman/omanhome/index.asp>

Qatar

Air Pollution Control

Measured on a per capita basis, this small country is the world's biggest emitter of greenhouse gases. It also has been the world's largest exporter of liquefied natural gas since 2006.⁴⁴² According to the Ministry of Municipality and Environment, fuel combusted during energy production accounted for 67 percent of Qatar's carbon dioxide emissions in 2011 (37 percent from energy expended in basic oil and gas production, 12 percent from gas flaring, and 18 percent from petrochemicals and industrial cogeneration). Households and commercial users account for the remaining 33 percent of the country's total emissions.⁴⁴³ Industrial emissions, particularly from fossil fuel production, are also a main source of criteria pollutants, such as sulfur dioxide.

Over the past decade, Qatar's population and economy have averaged breakneck growth rates, topping 16 percent per year multiple times, and the country's demand for energy and transportation has increased on-pace. Air pollution accordingly also has worsened. According to a 2011 Sustainable Development Indicators report by the Qatari Statistics Administration, particle pollutants in Qatar's capital

city, Doha, multiplied at a yearly rate of 5.4 percent between 2007 and 2010.⁴⁴⁴ Manufacturing and construction, as well as dust from land clearing, diesel engines, demolition, burning, concrete mixing and wood cutting, are the primary contributors to the airborne particulate matter.⁴⁴⁵ As in other desert Gulf states, sand and dust are also significant non-anthropogenic sources of particulates. In its National Development Strategy 2011-2016, the Qatari government recognizes the need to upgrade infrastructure and institutions in order to meet Qatar National Vision 2030 environmental goals. The Strategy indicates specific air quality targets, including maintaining ground-level ozone below international standard levels at all times. Additionally, according to the Strategy, air quality monitoring stations will need to be integrated and unified to support an online database with real-time readings, and new rules on emissions, including regulation of volatile organic compounds (VOCs), will need to be established and violators penalized. If implemented, these goals should lead to opportunities for U.S. technologies.

Key Technologies in Demand:

- Fenceline monitoring equipment
- Continuous emissions monitoring equipment
- Ambient air quality monitoring equipment
- Source emission measurement technologies
- Air pollution control equipment
- Particulate matter control systems (particularly new bagging systems)
- Engineering and plant design
- Inspection, adjustment, maintenance and repair services
- Selective catalytic and non-catalytic reduction technologies

Waste Management and Recycling

According to the country's National Development Strategy 2011-2016, Qatar generates over 7,000 tons of solid waste each day, 70 percent of which is from construction & demolition (C&D), commercial facilities and industrial sites. The underdeveloped recycling industry handles only 8 percent of the total solid waste generated, and the sorting that does take place is carried out at landfills, rather than at the source. There currently are three landfills in Qatar, all of which are running out of space.

Qatar's ambitious waste management targets include a recycling rate of 38 percent by 2016 (up from 8 percent five years ago) and a final disposal rate

reduced to 53 percent. A state-of-the-art Domestic Solid Waste Management Center (DSWMC) opened in 2011 near Mesaieed. Of the 2,300 tons/day of the mixed domestic solid waste processed at the DSWMC, 95 percent is recycled, composted or converted. The DSWMC's full capacity, however, already has proven inadequate for the rising volumes of waste generated by the country's growing, affluent population, and 400 tons/day of surplus are now being landfilled.⁴⁴⁶ The Qatari Ministry of Municipality and Environment has introduced plans to address the problem by expanding the capacity of the DSWMC by over 130 percent to 5,300 tons/day by 2022. Additionally, a new solid waste treatment center with a capacity of 3,000 tons/day is to be built in the northern part of the country.⁴⁴⁷

Key Technologies in Demand:

- Waste handling equipment
- Waste treatment technologies
- Composting equipment
- Sorting machines
- Crushing and grinding machines
- Materials handling equipment
- Collection services, containers, and vehicles
- Recycling process expertise
- Waste-to-Energy (WtE) and other conversion technologies

Water and Wastewater Treatment

Municipal Water and Wastewater

Qatar faces a variety of water challenges that derive from its unusually high consumption rates despite being a desert nation. Water consumption per capita is among the highest in the world, but the country has just 48 hours of emergency supply.⁴⁴⁸ Water is regulated by the Qatar General Electricity & Water Corporation, the so called "Kahramaa." Individual projects, however, are tendered and managed by the Public Works Authority, which is known as "Ashghal" locally. Ashghal also coordinates large-scale funding of major projects. The third major player in the Qatari water market is the Qatar Electricity and Water Company (QEWC), the semi-private water corporation which operates 70 percent of the country's desalination capacity.⁴⁴⁹

Desalination remains the priority for Qatar water authorities, though developing and expanding the wastewater collection and treatment network is

becoming a close second.⁴⁵⁰ Desalination projects are expected to reach their peak around 2015 or 2016 and decline starting around 2018.⁴⁵¹ The Kahramaa recently awarded a contract for Qatar's first largescale saline water reverse osmosis plan at Ras Abu Fontas. Expanding Qatar's desalination capacity beyond thermal desalination and toward reverse osmosis technologies will provide growing opportunities for U.S. water treatment companies.

Wastewater collection and treatment is a growing market in Qatar as the country grapples with increasing output and demand for reuse strategies. The issue is being addressed through the Doha Resewerage Implementation Strategy (IDRIS), which is developing a series of wastewater treatment plants and conveyance networks in and around the capital of Doha under five major procurement packages. The most notable forthcoming opportunity under the scope of IDRIS is the Doha South wastewater treatment plant project, which will have a daily capacity of 500,000 m³ and aims to reuse the balance of the treated effluent. Qatar has estimated the IDRIS effort in its entirety to be worth some USD 3.3 billion.⁴⁵²

Key Technologies in Demand:

- Engineering, procurement and construction services
- Filtration
- Advanced filtration
- Chemical disinfection
- UV disinfection
- Ozone disinfection

- Pumps, pipes and valves
- Storage technologies
- SCADA systems
- In-line monitoring systems
- Trenchless technologies
- Anaerobic digestion
- Nitrification
- Biological denitrification

Market Links and Contacts

Ministry of the Environment
www.moe.gov.qa/English/SitePages/Default.aspx
www.ctc.gov.qa/tender-en.aspx

Qatar Petroleum Qatar Petroleum
www.qp.com.qa/en/SupplyManagement/Tenders/Pages/Tenders.aspx

Qatar Gas
www.qatargas.com.qa/English/Tenders/Pages/default.aspx

RasGas Company Limited
www.rasgas.com/ContactUs.html

KAHRAMAA Qatar General Electricity & Water Corporation
www.km.com.qa/Business/Pages/Tenders.aspx

U.S. Commercial Service Qatar
www.export.gov/qatar

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Addendum: Environmental Technologies Exporter Resource Guide

The Environmental Technologies Export Initiative is a U.S. government program that promotes the worldwide deployment of U.S. environmental solutions by providing tailored services to environmental exporters and by developing demand for U.S. environmental technologies and services in growing environmental markets. The U.S. government has numerous resources available to help U.S. exporters: from additional market research to guides to export financing to overseas trade missions to staff around the country and the world. For additional information about services from the International Trade Administration (ITA), please visit www.export.gov. This guide provides an overview of U.S. government programs for the following topics:

- [TRADE AGREEMENTS](#)
- [TRADE BARRIERS](#)
- [BUYERS GUIDES](#)
- [CUSTOM EXPORT DEVELOPMENT SERVICES](#)
- [TRADE DATA](#)
- [ENVIRONMENTAL TECHNICAL ASSISTANCE AND CAPACITY BUILDING](#)
- [ENVIRONMENTAL AND TRADE POLICY DEVELOPMENT](#)
- [TRADE EVENTS](#)
- [EXPORT CONTROLS](#)
- [TRADE FINANCE](#)
- [INSURANCE](#)
- [INTERNATIONAL TENDERS](#)
- [MARKET DEVELOPMENT](#)
- [MARKET RESEARCH](#)
- [TRADE MISSIONS](#)
- [NEW TO EXPORT](#)
- [PROJECT FINANCE](#)
- [SMALL BUSINESS](#)
- [SUSTAINABLE MANUFACTURING](#)

TRADE AGREEMENTS

FTA Tariff Tool

<http://export.gov/fta/FTATariffTool/>

The FTA Tariff Tool provides tariff information and product-specific rules of origin for any US FTA Partner. The Tariff Tool not only provides information on current tariff lines but also provides transparency on future tariffs and the year in which those products become duty free.

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Exporter's Guide to Trade Agreements

http://tcc.export.gov/Trade_Agreements/Exporters_Guides/List_All_Guides/index.asp

Trade agreements afford U.S. businesses improved market access, transparent procedures and mechanisms for dispute resolution. The unique benefits of individual U.S. trade agreements for the exporter are provided in this guide.

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TRADE BARRIERS

Office of Trade Agreements Negotiation and Compliance (TANC)

http://tcc.export.gov/country_market_research/index.asp

Trade barriers inhibit fair competition in export markets. Examples include high tariffs, investment restrictions such as local content requirements, weak enforcement of intellectual property rights, non-transparent regulations and licensing regimes, burdensome certification requirements not required of domestic manufacturers, non-uniform application of customs procedures, lack of competitive bidding for foreign government tenders, and provision of direct or indirect subsidies by a foreign government in favor of its domestic suppliers. The Office of Trade Agreements Negotiation and Compliance (TANC) works with U.S. companies to remedy the trade barriers they encounter in export markets. Companies can confidentially report a trade barrier and request assistance here:

http://tcc.export.gov/Report_a_Barrier/index.asp

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BUYERS GUIDES

U.S. Environmental Solutions Toolkit

<https://new.export.gov/envirotech/toolkit>

U.S. Environmental Solutions Toolkit provides foreign environmental clients with U.S. EPA guidance on environmental protection and information on how to access U.S. technology providers. The Toolkit provides information on a variety of environmental topics. U.S. environmental companies interested in exhibiting their technologies on the Toolkit can register at:

<https://new.export.gov/envirotech/toolkit>

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Featured U.S. Exporters (FUSE)

<http://export.gov/fuse/fuseinformation037538.asp>

FUSE is an online directory of U.S. products and services featured on U.S. Commercial Service websites around the world. It gives companies an opportunity to reach prospects in the local language of the target market.

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CUSTOM EXPORT DEVELOPMENT SERVICES

U.S. Commercial Service

<http://www.export.gov/usoffices/index.asp>

With offices throughout the United States and in U.S. Embassies and Consulates in nearly 80 countries, the U.S. Commercial Service utilizes its global network of trade professionals to connect U.S. companies with international buyers worldwide. Whether looking to make their first export sale or expand to additional international markets, companies will find the expertise they need to tap into lucrative opportunities and increase their bottom line, including trade counseling, actionable market intelligence, business matchmaking and commercial diplomacy.

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TRADE DATA

TradeStats Express™

<http://tse.export.gov/tse/tsehome.aspx>

TradeStats Express provides annual and quarterly trade data enabling users to customize retrieve, visualize, analyze, print and download customized queries.

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Trade Data Basics

http://www.trade.gov/mas/ian/referenceinfo/tg_ian_001872.asp

This online guide provides users with a guide on the basics of trade data collection, classification and manipulation.

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USA Trade Online

<https://www.census.gov/foreign-trade/reference/products/catalog/usatradeonline.html>

An online subscription service of the U.S. Census Bureau provides U.S. export statistics of commodities at the 2, 4, 6 and 10-digit Harmonized Schedule (HS) level.

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ENVIRONMENTAL TECHNICAL ASSISTANCE AND CAPACITY BUILDING

U.S. Environmental Solutions Toolkit

<https://new.export.gov/envirotech/toolkit>

The U.S. Environmental Solutions Toolkit marries U.S. EPA guidance on environmental protection with information on how to access U.S. technology providers. The Toolkit currently provides insight on environmental solutions for 15 distinct environmental issue areas.

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U.S Trade and Development Agency

www.ustda.gov

The *U.S. Trade and Development Agency* (USTDA) supports project development in partner countries through the funding of technical assistance provided by U.S. companies and firms. These activities are diverse and reflect the coupling of U.S. industry capabilities and products and USTDA's overseas project partners needs and goals. By supporting activities such as legal and regulatory reforms related to commercial activities and infrastructure development, feasibility studies and demonstration projects, and establishment of industry standards, USTDA facilitates the creation of favorable business and trade environments for U.S.-based goods and services worldwide. Reach out to [USTDA regional staff directly](#) to learn more about programs in markets of interest.

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TRADE EVENTS

Certified Trade Fairs

http://www.export.gov/eac/show_short_trade_events.asp?CountryName=null&StateName=null&IndustryName=null&TypeName=International%20Trade%20Fair&StartDate=null&EndDate=null

The Department of Commerce's trade fair certification program endorses overseas trade shows that are a reliable venue and a good market for U.S. firms to sell their products and services abroad. These shows serve as a vital access vehicle for U.S. firms to enter and expand to foreign markets. The certified show/U.S. pavilion ensures a high-quality, multi-faceted opportunity for American companies to successfully market overseas. Among other benefits, certified trade fairs provide U.S. exhibitors with help facilitating contacts, market information, counseling and other services to enhance their marketing efforts.

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International Buyer Program <http://export.gov/ibp/>

The International Buyer Program (IBP) brings thousands of international buyers to the United States for business-to-business matchmaking with U.S. firms exhibiting at major industry trade shows. Every year, the International Buyer Program results in millions of dollars in new business for U.S. companies by bringing pre-screened international buyers, representatives and distributors to selected shows. U.S. country and industry experts are on site at IBP shows to provide hands-on export counseling, market analysis and matchmaking services. Each IBP show also has an International Business Center where U.S. companies can meet privately with prospective international buyers, prospective sales representatives and business partners and obtain assistance from experienced ITA staff.

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TRADE FINANCE

Trade Finance Guide: A Quick Reference for U.S. Exporters

<http://www.export.gov/tradefinanceguide/index.asp>

Trade Finance Guide: A Quick Reference for U.S.

Exporters is designed to help U.S. companies, especially small and medium-sized enterprises, learn the basics of trade finance so that they can turn their export opportunities into actual sales and achieve the ultimate goal of getting paid—especially on time—for those sales. Concise, two-page chapters offer the

basics of numerous financing techniques, from open accounts to forfeiting to government assisted foreign-buyer financing.

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Environmental Exports Program at the Export-Import Bank of the United States

<http://www.exim.gov/what-we-do/get-financing>

The Environmental Exports Program from the Export-Import Bank of the United States (Ex-Im Bank) offers enhanced financial support for environmental companies, including the Export Working Capital Guarantee Program, which enables exporters to finance materials, labor and overhead to produce goods or services for export.

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EXPORT CONTROLS

Export Control Basics

https://www.bis.doc.gov/index.php/forms-documents/doc_view/142-eccn-pdf

The Department of Commerce's Bureau of Industry and Security (BIS) is responsible for implementing and enforcing the Export Administration Regulations (EAR), which regulate the export and re-export of most commercial items. This publication is designed to give people who are new to exporting and, in particular, new to export controls a general understanding of our regulations and how to use them.

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INSURANCE

Export Credit Insurance at the Export-Import Bank of the United States

<http://www.exim.gov/what-we-do/export-credit-insurance>

Short-Term Environmental Export Insurance provides the exporter with the ability to offer credit terms to its foreign customers for up to 180 days. The features include 95 percent commercial coverage and 95 percent political coverage with no deductible, advance deposit of USD 500, and enhanced provision for assignment of insured receivables. Standard Export credit insurance from Ex-Im Bank enables U.S. exporters to offer short and medium-term credit directly to their customers during the pre and post-shipment phases.

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Political Risk Insurance at the Overseas Private Investment Corporation

<https://www.opic.gov/what-we-offer/political-risk-insurance>

Political risk insurance is used to mitigate political or sovereign risks for U.S. investors, operators and lenders (e.g. expropriation, political violence, currency inconvertibility and breach of contracts with foreign government-owned entities, such as power purchase agreements and concessions) associated with doing business in emerging markets.

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INTERNATIONAL TENDERS

The Advocacy Center

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

The Advocacy Center coordinates U.S. government interagency advocacy efforts on behalf of U.S. exporters bidding on public-sector contracts with overseas governments, government agencies and multilateral development banks. The Advocacy Center helps to ensure that sales of U.S. products and services have the best possible chance competing abroad. Advocacy assistance is wide and varied but often involves companies that want the U.S. government to communicate a message to foreign governments or government-owned corporations on behalf of their commercial interest, typically in a competitive bid contest. Get started with your advocacy request by filing an [Advocacy Questionnaire and Anti-Bribery Agreement](#) with the Advocacy Center.

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MARKET DEVELOPMENT

U.S Trade and Development Agency

www.ustda.gov

The *U.S. Trade and Development Agency* (USTDA) supports project development in partner countries through the funding of technical assistance provided by U.S. companies and firms. These activities are diverse and reflect the coupling of U.S. industry capabilities and products and USTDA's overseas project partners needs and goals. By supporting activities such as legal and regulatory reforms related to commercial activities and infrastructure development, feasibility studies and demonstration projects, and establishment of industry standards, USTDA is facilitating the creation of favorable business and trade environments for U.S.-based goods and services worldwide. Reach out

to [USTDA regional staff directly](#) to learn more about programs in markets of interest.

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MARKET RESEARCH

Top Markets Studies

<http://trade.gov/topmarkets/>

The International Trade Administration's *Top Markets Series* is meant to help exporters determine their next export market by comparing opportunities across borders. Each report ranks future export opportunities within a particular industry based on a sector-specific methodology. The reports provide a detailed assessment of the competitiveness landscape within a sector, as well as the opportunities and challenges facing U.S. exporters in key markets. Each report is available for download. Interested exporters can also download or view individual case studies within larger reports.

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Country Commercial Guides

<http://export.gov/ccg/>

Written by U.S. Embassy trade experts worldwide, the Country Commercial Guides provide an excellent starting point for what you need to know about exporting and doing business in a foreign market. The reports include sections addressing market overview, challenges, opportunities and entry strategies; political environment; selling U.S. products and services; trade regulations, customs and standards; and much more.

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TRADE MISSIONS

Trade Missions

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

Department of Commerce trade missions are overseas programs for U.S. firms that wish to explore and pursue export opportunities by meeting directly with potential clients in their markets. Trade missions include, among other activities, one-on-one meetings with foreign industry executives and government officials that are pre-screened to match specific business objectives.

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NEW TO EXPORT

Basic Guide to Exporting

<http://export.gov/basicguide/>

A Basic Guide to Exporting addresses virtually every issue a company looking to export might face. Numerous sections, charts, lists and definitions throughout the book's 19 chapters provide in-depth information and solid advice about the key activities and issues relevant to any prospective exporter.

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PROJECT FINANCE

Structured Finance Loan Guarantees

www.opic.gov

The Overseas Private Investment Corporation (OPIC) medium to long-term financing through loan guarantees significant capital for those projects in need of it, such as infrastructure projects.

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Project and Structured Finance Direct Loans

www.exim.gov

The Ex-Im Bank offers project and structured finance through direct loans, involving long-term arrangements for funding large U.S. investments that emphasize exports in both developed and emerging markets, assessed project cash flows or corporate balance sheet risk.

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SMALL BUSINESS

Small Business Administration

www.sba.gov

Business experts at the U.S. Small Business Administration (SBA) can help you with exporting or other areas of entrepreneurship to help your business start and grow. SBA offices serve every state and territory. In addition, more than 850 Small Business Development Centers, 380 chapters of SCORE (an SBA resource partner with more than 13,000 volunteer counselors and trainers to small businesses) and 110 Women's Business Centers are available. The SBA also has a senior international trade and finance specialist co-located with U.S. Commercial Service professionals in 18 of the 109 U.S. Export Assistance Centers.

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STANDARDS

The Office of Standards and Investment Policy

<http://www.trade.gov/td/standards/>

The Office of Standards and Investment Policy Standards Team leads ITA in standards-related policy issues, including those related to the standards development process, barriers to market access and capacity building, and serves as the liaison to the American National Standards Institute, Standards Development Organizations, and DOC's National Institute of Standards and Technology.

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NIST Standards Information Center

<http://www.nist.gov/director/sco/ncsci/>

The Standards Information Center provides research services on standards, technical regulations, and conformity assessment procedures for non-agricultural products or when marking, labeling, grading or packaging of agricultural products is at issue.

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SUSTAINABLE MANUFACTURING

The Sustainable Business Clearinghouse

<https://yosemite.epa.gov/opei/opeipub.nsf/advs?openform>

The Sustainable Manufacturing Clearinghouse was created to provide U.S. companies with a central portal for information on programs and resources that can assist in enhancing competitiveness and profitability in environmentally sustainable ways. It includes about 800 federal, state and non-governmental resources. These resources include case studies, compliance assistance, financial assistance, general information, how-to guides, metrics/assessment tools, research, tax incentives, technical assistance, training opportunities, and voluntary or partnership programs.

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Participating Agencies

[International Trade Administration, U.S. Department of Commerce](#)

The International Trade Administration (ITA) leads the industry and commercial aspects of the Environmental Technologies Export Initiative and coordinates inter-agency activities through the Environmental Trade Working Group of the [Trade Promotion Coordinating](#)

[Committee](#). ITA leads various commercial dialogues in pivotal developing markets and through the U.S. & Foreign Commercial Service's 109 domestic and 128 foreign posts provides U.S. businesses with a variety of [export development and trade promotion services](#).

[U.S. Environmental Protection Agency](#)

The U.S. Environmental Protection Agency (EPA) co-launched the Environmental Technologies Export Initiative in conjunction with ITA. The Agency works to protect human health and the environment internationally by offering policy guidance on environmental issues, disseminating scientific information, and promoting green commerce and sustainable development around the world.

[U.S. Trade & Development Agency](#)

The U.S. Trade and Development Agency (USTDA) promotes U.S. job growth by helping create export opportunities for U.S. companies for priority development projects in emerging economies. USTDA links U.S. businesses to export opportunities by funding project planning activities, pilot projects and reverse trade missions while creating sustainable infrastructure and economic growth in partner countries. Many priority development projects require environmental technologies, such as water quality improvement.

[U.S. Small Business Administration](#)

The U.S. Small Business Administration (SBA) provides guidance, loans and advocacy to small businesses in the U.S. to promote job growth. With offices in every state and territory, SBA will be critical to assisting small and medium enterprises (SMEs) grow their green businesses.

[U.S. Department of State](#)

The U.S. Department of State advances U.S. objectives and interests in the world by developing and implementing the president's foreign policy agenda. The Department of State is the lead U.S. agency in implementing the international components of policies to address climate change and to foster sustainable development. The Department of State undertakes technical assistance delineated in the environmental chapters of U.S. multi and bi-lateral trade agreements.

[U.S. Trade Representative](#)

The [U.S. Trade Representative](#) (USTR) is a Cabinet member who serves as the President's principal trade advisor, negotiator and spokesperson on trade issues. USTR coordinates trade policy, resolves disagreements and frames issues for presidential decision. USTR negotiates free trade agreements and trade and investment framework agreements that help to open foreign markets to U.S. exports. USTR's Office of Environment and Natural Resources has broad responsibilities to leverage trade negotiations and relationships to pursue environmental goals, including the reduction of trade barriers facing the environmental technology industries.

[U.S. Agency for International Development](#)

Agency for International Development (USAID) is an independent federal government agency that receives overall foreign policy guidance from the Secretary of State. Our work supports long-term and equitable economic growth and advances U.S. foreign policy objectives by supporting economic growth, agriculture and trade; global health; and democracy, conflict prevention and humanitarian assistance. USAID sponsors [environmental and climate change projects](#) across the world.

[Export-Import Bank of the United States](#)

The [Export-Import Bank of the United States](#) (Ex-Im Bank) is the official export credit agency of the United States. Ex-Im Bank assists in financing the export of U.S. goods and services to international markets by providing export financing products that fill gaps in trade financing and assuming credit and country risks that the private sector is unable or unwilling to accept. Ex-Im Bank has special provisions aimed at leveling the playing field for U.S. exporters by matching the financing that other governments provide to their exporters. Ex-Im Bank provides working capital guarantees, export credit insurance, loan guarantees, direct loans, and project and structured finance.

[Overseas Private Investment Corporation](#)

The Overseas Private Investment Corporation (OPIC) helps U.S. businesses invest overseas, fosters economic development in new and emerging markets, complements the private sector in managing risks associated with foreign direct investment, and supports U.S. foreign policy. OPIC financing provides

medium to long-term funding through direct loans and loan guarantees to eligible investment projects in developing countries and emerging markets. By complementing the private sector, OPIC can provide financing in countries where conventional financial institutions often are reluctant or unable to lend on such a basis.

[U.S. Department of Energy](#)

The U.S. Department of Energy seeks to advance the national, economic and energy security of the United States; to develop technologies to mitigate the effects of climate change and to enable adaptation; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex.

[U.S. Department of Treasury](#)

The U.S. Department of Treasury's mission is to maintain a strong economy and create economic and job opportunities by promoting the conditions that enable economic growth and stability at home and abroad, strengthen national security by combating threats and protecting the integrity of the financial system, and manage the U.S. government's finances and resources effectively. The department supports the Environmental Export Initiative by serving as an advisor to the Environmental Trade Working Group of the [Trade Promotion Coordinating Committee](#).

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Appendix 1: Environmental Technologies Top Markets Ranking

| Water | | Air | | Waste | | Composite Environmental Technologies Score | | |
|-------|--------------------------|------|--------------------------|-------|--------------------------|--|--------------------------|-------|
| 1 | China | 44.9 | China | 47.4 | China | 7.7 | China | 100.0 |
| 2 | India | 16.3 | Mexico | 26.2 | Indonesia | 4.2 | Mexico | 37.1 |
| 3 | United Arab Emirates | 15.8 | Korea | 18.3 | Pakistan | 3.7 | India | 31.7 |
| 4 | Oman | 15.3 | Turkey | 17.4 | Brazil | 3.6 | Brazil | 29.4 |
| 5 | Saudi Arabia | 12.0 | Brazil | 15.3 | Thailand | 3.3 | Korea | 27.3 |
| 6 | Brazil | 10.5 | India | 12.8 | Saudi Arabia | 3.0 | Saudi Arabia | 25.9 |
| 7 | Mexico | 9.5 | Saudi Arabia | 10.9 | India | 2.7 | Indonesia | 23.4 |
| 8 | Indonesia | 9.3 | Indonesia | 9.9 | Vietnam | 2.1 | Turkey | 22.1 |
| 9 | Poland | 8.4 | Poland | 8.6 | Korea | 2.1 | Poland | 17.7 |
| 10 | Korea | 6.9 | Czech Republic | 8.0 | Egypt | 1.9 | United Arab Emirates | 15.8 |
| 11 | Thailand | 6.6 | Vietnam | 7.3 | Turkey | 1.8 | Oman | 15.6 |
| 12 | Peru | 6.5 | Kazakhstan | 5.9 | Malaysia | 1.6 | Thailand | 13.6 |
| 13 | Venezuela | 6.1 | Algeria | 5.1 | Mexico | 1.4 | Vietnam | 12.9 |
| 14 | Singapore | 5.7 | Romania | 4.8 | Argentina | 1.0 | Czech Republic | 12.1 |
| 15 | Argentina | 5.4 | Slovakia | 4.6 | Colombia | 0.9 | Argentina | 10.5 |
| 16 | Chile | 4.6 | Colombia | 4.4 | Poland | 0.7 | Kazakhstan | 10.5 |
| 17 | Kazakhstan | 4.1 | Egypt | 4.4 | Peru | 0.7 | Singapore | 10.5 |
| 18 | Malaysia | 4.0 | Argentina | 4.1 | Netherlands | 0.7 | Peru | 10.2 |
| 19 | Colombia | 3.9 | Singapore | 4.1 | Norway | 0.6 | Venezuela | 9.8 |
| 20 | Czech Republic | 3.9 | Nigeria | 3.8 | Singapore | 0.6 | Egypt | 9.7 |
| 21 | Republic of South Africa | 3.8 | Thailand | 3.8 | Sweden | 0.6 | Malaysia | 9.2 |
| 22 | Vietnam | 3.4 | Malaysia | 3.6 | Morocco | 0.6 | Colombia | 9.2 |
| 23 | Egypt | 3.4 | Venezuela | 3.3 | Kazakhstan | 0.6 | Chile | 7.6 |
| 24 | Turkey | 2.8 | Peru | 3.1 | Chile | 0.5 | Romania | 7.2 |
| 25 | Bangladesh | 2.7 | Republic of South Africa | 2.6 | Venezuela | 0.5 | Algeria | 6.9 |
| 26 | Belarus | 2.7 | Ukraine | 2.6 | Nigeria | 0.4 | Pakistan | 6.8 |
| 27 | Ghana | 2.5 | Chile | 2.4 | Bangladesh | 0.4 | Republic of South Africa | 6.7 |
| 28 | Pakistan | 2.5 | Dominican Republic | 1.9 | Hong Kong | 0.4 | Nigeria | 6.4 |
| 29 | Morocco | 2.4 | Belarus | 1.3 | Oman | 0.3 | Slovakia | 5.7 |
| 30 | Romania | 2.3 | Lithuania | 1.3 | Republic of South Africa | 0.3 | Bangladesh | 4.3 |
| 31 | Nigeria | 2.2 | Mozambique | 1.2 | Ecuador | 0.3 | Belarus | 4.0 |
| 32 | Hong Kong | 2.0 | Bangladesh | 1.2 | Lithuania | 0.3 | Ukraine | 3.7 |
| 33 | Algeria | 1.8 | Azerbaijan | 1.2 | Panama | 0.3 | Morocco | 3.4 |
| 34 | Macedonia | 1.7 | Hungary | 1.2 | Estonia | 0.3 | Azerbaijan | 3.0 |
| 35 | Panama | 1.7 | Ecuador | 1.0 | Zambia | 0.3 | Ghana | 3.0 |
| 36 | Azerbaijan | 1.6 | Slovenia | 0.9 | Tunisia | 0.2 | Hong Kong | 2.9 |
| 37 | Hungary | 1.2 | Bahrain | 0.7 | Czech Republic | 0.2 | Lithuania | 2.6 |
| 38 | Ecuador | 1.1 | Pakistan | 0.7 | Guatemala | 0.2 | Ecuador | 2.4 |
| 39 | Slovakia | 1.1 | Philippines | 0.6 | Bahrain | 0.2 | Hungary | 2.4 |
| 40 | Lithuania | 1.0 | Zambia | 0.6 | Jordan | 0.2 | Dominican Republic | 2.3 |
| 41 | Guatemala | 1.0 | Hong Kong | 0.5 | Philippines | 0.2 | Panama | 2.2 |
| 42 | Trinidad and Tobago | 0.9 | Trinidad and Tobago | 0.4 | Uruguay | 0.2 | Macedonia | 1.9 |
| 43 | Ukraine | 0.9 | Morocco | 0.4 | Azerbaijan | 0.2 | Zambia | 1.6 |
| 44 | Kuwait | 0.8 | Greece | 0.4 | Ethiopia | 0.2 | Mozambique | 1.6 |
| 45 | Tunisia | 0.8 | Latvia | 0.4 | Sri Lanka (Ceylon) | 0.2 | Philippines | 1.5 |
| 46 | Zambia | 0.8 | Ethiopia | 0.4 | Paraguay | 0.2 | Bahrain | 1.5 |
| 47 | Greece | 0.8 | Gabon | 0.4 | Ukraine | 0.2 | Slovenia | 1.5 |
| 48 | Papua New Guinea | 0.7 | Tunisia | 0.3 | Portugal | 0.1 | Tunisia | 1.4 |
| 49 | Philippines | 0.7 | Qatar | 0.3 | Ghana | 0.1 | Trinidad and Tobago | 1.4 |
| 50 | Portugal | 0.7 | Georgia | 0.3 | New Zealand | 0.13 | Guatemala | 1.2 |

Appendix 2: Methodology

The *Environmental Technologies Top Markets Study* was developed to facilitate the identification of a series of export markets where coordinated U.S. government policy and technical assistance interventions could yield the greatest outcome for U.S. businesses in terms of increased goods and services export sales. The resulting *Country Case Studies* were developed to engender coordinated U.S. government programs and activities that address critical policy barriers in the environmental and commercial space for markets identified through the *Top Markets Study*. While the case studies provide an in-depth look at key market segments as well as the U.S. technologies in demand, their functional role is to delineate a series of coordinated projects designed by the agencies of the Environmental Trade Working Group (ETWG) of the Trade Promotion Coordinating Committee (TPCC).

Environmental Technologies Top Markets Study

Developing the list of key foreign markets began by commencing the *Environmental Technologies Top Markets Study*. The Study utilizes a three-part methodology that involves both quantitative and qualitative methods to filter for markets that satisfy three general criteria: first, large and growing; second, markets in which U.S. environmental technologies exports can be improved upon; and third, where policy interventions in the commercial or environmental regime are likely to catalyze opportunities for the U.S. industry. Due to challenges inherent to this endeavor, the Department of Commerce's International Trade Administration (ITA) attempted to design a methodology that considered an array of trade, economic, policy and environmental factors. While historical trade figures can convey some useful information about an environmental market's future potential, many other factors play a role. This methodology sought to account for these additional factors as best possible.

Part I: Dynamic and Growing

The first part of the methodology forecasted the most significant U.S. environmental technology export markets in 2019, as well as the largest foreign country importers of environmental technologies in 2019 (representing a five-year projection based on the most recent ten-year time series). Because the Harmonized System (the most commonly used system to measure trade in goods) rarely designates product codes for specific environmental technologies, ITA selected "proxy codes" for each environmental subsector that it believed provided the best representation of trade in that subsector. For example, the code designated to water filtration and purifying machinery (8421.21) equipment that is used in most water treatment projects around the world was used as the proxy for the water/wastewater treatment sector as a whole.

Using these proxy codes, ITA conducted a linear regression analysis of U.S. air pollution control, water/wastewater management and solid waste management equipment exports over a ten-year period (2004 to 2014) and used the results to project disaggregated 2019 U.S. exports in these three sectors to all U.S. trading partners. The same exercise was then conducted for foreign country importers of environmental technologies using disaggregated global import data. The resulting projections were used to predict U.S. annual export growth rates from 2014 to 2019 and annual foreign country import growth rates from 2014 to 2019.⁴⁵³ The export and import values were then weighted by the average predicted annual growth of U.S. exports and foreign ET imports through 2019 to weight the size of the export market against its growth. This analysis provided ITA staff with a sense of the relative size and attractiveness from a growth perspective of specific markets in 2019, thus satisfying the identification of dynamic and growing markets for the study's purposes.

Part II: Room for Improvement

The second part of ITA's methodology involved an "export gap" analysis. This was used to give staff a sense of unexploited export potential in each environmental technology sub-sector for each U.S. trading partner. Using a gravity model, a tool commonly used to predict bilateral trade flows based on the economic size and geographic distance between two countries, ITA calculated a U.S. "export gap"—the difference between gravity model-predicted exports and actual exports—for each U.S. trading partner in 2014. The resulting export gap values were

then given a 10 percent weight in the overall model. The gravity model employs regression analysis using variables such as economic size and geographic distance. While variables related to environmental quality and infrastructure were included in the initial analysis, most of these variables were found to be statistically insignificant in the model.

Part III: Ripe for Policy Interventions

Following completion of the export market forecasting and export gap analysis, ITA staff developed a shortlist of "high potential" export markets by adding the weighted values for each media category to provide a media-based market score and similarly adding together the media scores for each country to provide a composite environmental technologies score. For this report, the lists were further filtered to exclude markets with highly developed environmental regimes that also host mature environmental technology markets and possess highly developed environmental technology industries of their own by eliminating markets growing at less than 4 percent annually.

The rationale informing this decision was that well-developed markets, while prime candidates for traditional "export promotion" activities, are already well served by private sector groups and not ideal recipients for targeted technical assistance for market development or similar emerging market policy development efforts. Consensus among U.S. environmental technology companies and associations that ITA consulted suggests that federal government services are most needed in quickly growing emerging markets, which feature nascent environmental regimes and fierce global competition for market share. Countries that the United States has officially sanctioned were also struck from the list.

Raw scores were then scaled 0 to 100, with 100 being the largest possible composite ET market score and with individual market subsector scores totaling to their composite market score. Ranked in descending order, the composite score constituted the "high potential" market ranking of the overall study and provided a market indicator in which cumulative market and subsector scores can be compared within and across various markets.

Upon completion of "high potential" market shortlists for each of the three environmental technology subsectors, ITA began the third and final stage of analysis, which involved a qualitative assessment of the shortlist by leveraging the sector-specific expertise of ITA industry analysts. Items considered in this analysis included new policy announcements in foreign markets that could impact U.S. exports (e.g. new public sector investments in water infrastructure), perceived ease of doing business (based on experience working with U.S. exporters in a given market), knowledge of "in the pipeline" projects where demand for U.S. goods was anticipated and political risk assessment of the market. This effort served to substantiate rankings based on real-world factors that impact environmental markets. This research informed background, strategies and recommendations for each country case study.

Environmental Technologies Country Case Studies

After the top 10 collective markets for air pollution control, water and wastewater, and waste management were identified through the *Top Markets Study*, a *Country Case Study* was developed for each. *Country Case Studies* are comprised of three main components: first, an analysis of the key market segments that provide export opportunities to U.S. firms; second, an assessment of the key technologies in demand for which the United States holds a competitive advantage; and third, a list of coordinated government activities and programs that support development of environmental technologies' export markets through targeted technical assistance, policy development, demonstration programs, and traditional trade policy and export promotion activities.

The market analysis was developed by conducting a literature review of key *Country Case Study* government sources, such as published national plans and reports on environmental rule making. The literature review also included analysis of market reports from key industry journals and media sources and, where relevant, technical reports from donor and non-profit organizations. The literature review was supplemented by consultations with

relevant Foreign Commercial Service and Environment, Science, Technology and Health (ESTH) officers at U.S. Embassies to get a sense of the "ground reality" that desk research alone cannot provide. After the literature review was complete, Environmental Technology Specialists at the U.S. Environmental Protection Agency (EPA) conducted a review of the key U.S. technologies in demand for each market segment. Based on this research, the agencies of the ETWG, led by the U.S. Department of Commerce and EPA, developed a series of coordinated activities to address the identified opportunities and challenges in market.

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