

Washington State Clean Technology Defense Export Market Research

Discussion Draft

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Department of Commerce
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Prepared by:

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*Community Attributes Inc. tells data-rich stories about communities
that are important to decision makers.*

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EXECUTIVE SUMMARY

Background and Purpose

The clean technology sector in Washington is an important contributor to the state economy. In fiscal year 2015, the Department of Defense and U.S. Coast Guard awarded nearly \$68 million in contracts for clean technology-related work. Clean technology defense contracts in Washington are organized into the following four categories of products and services:

- **Environmental testing, consulting, and remediation Services**, including many water resource testing and consulting firms.
- **Green construction**, including designs intended to improve energy efficiencies.
- **Recycling and hazardous waste disposal**, such as resource reuse and proper disposal of regulated materials.
- **Energy hardware and software**, including power converters and energy management software.

Despite the robust nature of the clean technology defense sector, future possible changes in federal spending may challenge the continued vitality and health of these businesses. One method for hedging against these possible headwinds is the expansion into overseas markets, both for defense and civilian work.

The Washington State Department of Commerce (Commerce) has requested this report to assess overseas exporting opportunities for Washington-based clean technology defense contractors. This report includes a review of defense activities in Washington, global trends in the clean technology sector (defense and civilian), potential market opportunities, and a set of recommended strategies for implementation by Commerce to help these firms diversify abroad.

Exporting entails numerous challenges, including regulatory/export controls, economies of scale needed to expand overseas, and important information gaps on where opportunities might exist. This report will help address many of these challenges and provide a strategic framework for Commerce to help defense contractors expand their business into overseas markets. Recommendations address key trends and considerations specific to clean technology businesses in Washington engaged in defense contracting.

Key Findings

Research findings presented in this report include industrywide trends and market conditions shaping clean technology exporting opportunities. These findings are summarized below.

Industry Trends and Baseline Conditions

- **Washington clean technology defense contracting is dominated by two higher-level categories.** The environmental testing, consulting, and remediation services and green construction subsectors together accounted for almost 40% of all clean technology contracts awarded in FY 2015.
- **Limited exporting activity among clean technology defense contractors.** There are significant export barriers for the majority of clean technology firms. Industry stakeholders and online research also confirmed a robust domestic market. As a result, many clean technology contractors do not have a strong desire to grow their international presence. Those firms who provide products and services to overseas markets have targeted, country-specific approaches and do not require extensive export assistance.
- **DOD investment in clean technologies is driven by factors unrelated to environmental stewardship.** Clean technology products reduce costs, improve on and off-base safety, and conserve scarce resources. The DOD rarely invests in green technologies primarily for the sake of ecological conservation.

Geopolitical and Macroeconomic Factors

- **Resource scarcity is the primary driver of clean technology development.** The viability of clean technology submarkets is hinged upon which resources are scarce in particular countries. For example, water security in the United Arab Emirates drives demand for innovation in water management technologies.
- **Regulatory asymmetry makes exporting clean technologies difficult.** Most developed nations have their own set of standards and certifications for environmental technologies. Tailoring products and services to fit the diversity of regulations makes exporting to multiple countries and regions cost-prohibitive for most clean technology firms.
- **Developing countries will account for some of the largest clean technology markets as the economic status of their populations improve.** Worldwide, more than 1.3 billion people do not have access to electricity. As the global middle class continues to expand, clean technologies will be key to resource management.

Markets and Opportunities

The following countries represent notable potential clean technology markets: China, India, Brazil, United Arab Emirates, and Japan. Excluding the UAE, these markets have significant barriers to entry and other challenges.

- **China** is the largest clean technology market in the world, especially for green construction, hazardous waste solutions, environmental testing, and consulting services. Market barriers include local protectionism, a complex regulatory system, and failure to recognize international certifications.
- **India** will likely be a viable clean technology market in the future. Currently, the market is fragmented, tariffs on clean technologies are high, and the political regime does not prioritize resource conservation. India is expected to have strong demand for green construction, water monitoring and testing products and services, and renewable energy management technologies.
- **Brazil** has an ambitious environmental plan to increase reliance on renewable energy sources and conserve water. However, the recent economic downturn has limited investment in these endeavors.
- Some of the **UAE's** primary focuses are clean energy, sustainable building, and water conservation and security. These technologies and services are in high demand in the country, and there are very few barriers to market entry. Connecting Masdar—a commercial renewable energy and clean real estate company in Abu Dhabi—to Washington entities would further expand statewide clean technology market opportunities.
- **Japan** is a key market for clean energy technologies. The Fukushima reactor meltdown in March 2011 left the country's energy policy in limbo, and the nation has a strong interest in reducing its dependence on nuclear power. Industry stakeholders report that forming partnerships with Japanese firms and patience over a longer-than-normal time horizon for business deals to come to fruition are crucial for entry into the Japanese clean technology market.
- **Germany** is one of the largest and most established clean technology markets in the world. A strict environmental regime facilitates strong demand for innovative energy and resource management technologies. Regulatory hurdles in the Germany are minimal, and the abundance of trade fairs hosted by the country make market entry practical.

Strategies for Supporting Clean Technology Defense Contractors

Opportunity/Theme	Key Findings/Considerations	Strategy	Type of Assistance
Industry-wide	Companies need more information on current and future trends in global defense spending.	Expand the Washington Military & Defense Economic Impact Tool to include current information on clean technology defense trends. The WMA can be broadened to serve the information gathering needs of aerospace defense contractors in Washington by providing regular newsfeeds and content published on the site as well as sent via SMS and email to registered subscribers.	Education and training/market research
	Companies need support understanding defense regulations and require related technical assistance.	Technical support. Consider hiring a position to focus on technical outreach in the defense market. This position would act as an ombudsperson for clean technology (and other targeted sectors) by liaising with technical contacts at DOD and related agencies, and by acting as a traffic cop to connect companies to the right resources and contacts.	Technical assistance
	Many firms remain unaware of the services offered by the Washington State Department of Commerce.	Disseminate information. Build out and update the section of the Washington State Department of Commerce website with information and data on target markets, regulations, financing information and support, trends and contact info for Clean Technology Sector Lead.	Education and training

Opportunity/Theme	Key Findings/Considerations	Strategy	Type of Assistance
Germany	One of the largest global markets for clean technology products and services, and entry point into the large EU market.	Lead a clean technology delegation to one of the relevant trade fairs in Germany: IFAT, Wasser Berlin International and Hanover Messe (which the Washington State Department of Commerce is already engaged with).	Market research
		Provide information to Washington companies on how to enter the German market and include this information on clean tech section on Commerce website.	Market research/ education and training
Japan	Relationship-driven market.	Develop a list of possible distributors, representatives and agents in Japan.	Education and training
		Relationship building. Work with JETRO, Japanese Consulate and other Japanese partners to develop relationships with key entities in the clean technology sector of Japan, including the Japanese government.	Market research/ education and training
UAE	UAE is one of the most viable clean technology markets from a regulatory standpoint. UAE governments and companies are generally open to new technology developed overseas.	Develop relationship with the UAE government, including working with TDA and other partners that already have relationships. Develop a relationship with MASDAR and work to introduce them to Washington companies for possible collaboration.	Advocacy/market research
		Develop a list of possible distributors, representatives and agents in the UAE.	Market research

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INTRODUCTION

Background and Purpose

Economic development practitioners have become increasingly concerned with how best to support defense contractors to weather future uncertainty in the federal defense budget. Defense contractors are an essential link in the U.S.'s defense supply chain, and the U.S. Department of Defense (DOD) wants to ensure that they will be available for future defense needs. Export markets are an important opportunity to mitigate this uncertainty for defense firms, reducing individual contractor reliance on defense contracts.

Washington is already one of the most trade-reliant states in the U.S. The state has one of the most extensive port systems in North America, and has a long history of linkages with other parts of the world, including Asia and Northern Europe. The Washington Council on International Trade and Trade Development Alliance of Greater Seattle (TDA) in 2012 found that 40% of all jobs across the state were tied to trade, the majority through export activities. TDA confirmed and updated this estimate in 2015 in partnership with the Brookings Institute and JPMorgan Chase Global Cities Initiative.

However, trade comes with risks. In addition to finance risk and uncertainty in overseas markets, local defense firms must also comply with U.S. federal government export controls, including the International Traffic in Arms Regulations (ITAR). Failure to comply with ITAR can result in significant penalties that may deter businesses from pursuing export opportunities. Export Administration Regulations apply to commercial products with potential military applications, and rules vary based on the country destination of sales. The U.S. government also administers financial sanctions through the Office of Foreign Assets Control. These sanctions cover specific individuals, organizations, and nations pursuant to the U.S.'s national security goals.

With these considerations in mind and pursuant to the goal of ensuring defense contractor stability, the Washington State Department of Commerce (Commerce) contracted Community Attributes Inc. to develop an analysis of overseas market opportunities for clean technology defense contractors in Washington state. Analytics leverage public data sources, interviews, reports, news articles, and other sources to present an extensive survey of the opportunities and challenges clean technology companies will face in overseas markets.

Based on these findings, a set of actionable strategies was developed to help defense contractors diversify into overseas markets.

Methods

This project has required a hybrid research methodology, leveraging a wide spectrum sources and materials. These include:

- Existing federal and private sector research reports
- News articles
- Exporting and defense contractor data
- Industry forecasts
- Military spending data, sourced from national government budget reports and the Stockholm International Peace Research Institute, among other sources.
- Interviews with: 1) existing exporters in the clean technology sector; 2) defense clean technology contractors; 3) government and policy officials, including in the Department of Defense and U.S. Foreign Commercial Service; and 4) industry experts.

Method for developing recommendations

Recommendations are focused on addressing market opportunities specific to defense clean technology activities and contractors in Washington. Variables considered include: 1) characteristics unique to defense contractors, including size and ability to scale to foreign sales; domestic factors, such as regulatory considerations and pull of the domestic U.S. market over international markets; 3) foreign government factors, including state policies biased to indigenous industries; 4) industry and technology factors, such as the exportability of certain products and services; 5) macroeconomic conditions; 6) regional and geopolitical factors, and 7) considerations specific to defense versus civilian opportunities.

Recommendations were further synthesized according to existing resources at the Washington State Department of Commerce. These include education and training, technical and regulatory assistance, market research, and advocacy support. A more detailed discussion of how recommendations were developed can be found in the **Appendix**.

Organization of Report

- **Clean technology Defense Spending in Washington.** An overview of leading clean technology subsectors and contractors in Washington.
- **Key Industry Trends and Global Considerations.** Factors and trends shaping opportunities and challenges for clean technology defense contractors, including domestic and overseas barriers.
- **Exporting and Competitiveness Factors.** Strengths and weaknesses of Washington clean technology defense contractors in overseas markets.

- **Market Opportunities.** Country and region-specific opportunities for defense contractors, based on the matching of current, resident capabilities and overseas demand and market conditions.
- **Recommended Strategies.** Actionable strategies the Washington State Department of Commerce can undertake to support clean technology defense contractor exports.

DEFENSE SPENDING IN WASHINGTON

The Washington CleanTech Alliance asserts that clean technology spans every industry or subsector that employs methods to operate more efficiently and sustainably. This definition includes specific industries and sectors, such as agriculture, efficient transportation, energy storage, environmental remediation, and pollution prevention. These activities are indirectly supported by a myriad of other services, including supply chain management, financing, manufacturing, and shipping and logistics (Washington CleanTech Alliance, 2016). This definition is used to identify specific contractors in Washington performing clean technology work for the Department of Defense and U.S. Coast Guard.

Based on contracts data, four categories emerged for clean technology defense contract products and services, those being:

- **Environmental testing, consulting, and remediation Services,** including many water resource testing and consulting firms.
- **Green construction,** including designs intended to improve energy efficiencies.
- **Recycling and hazardous waste disposal,** such as resource reuse and proper disposal of regulated materials.
- **Energy hardware and software,** including power converters and energy management software.

In FY 2015, there were 91 unique businesses in Washington engaged in some facet of clean technology for the Department of Defense. These contractors sold almost \$68 million in goods and services to the Department of Defense, including the Army, Navy, Air Force, and Coast Guard in fiscal year 2015 (Office of Management and Budget, 2016).

Of the top nine largest contracts by value in FY 2015, four of them—including the top three—are firms in the green construction subsector (**Exhibit 1**). The combined value of these four contracts make up two-thirds (66%) of the total value of the top nine clean technology contracts. Four more companies among those with the largest contract values operate in the recycling and hazardous waste clean technology subsector. One environmental consultant—Sealaska Environmental Services—also had a significant clean technology contract in FY 2015 worth \$1.9 million.

Exhibit 1. Largest Clean Technology Defense Contractors, FY 2015

Contractor	Contract Value (\$ Mil)	Clean Tech Subsector	Contractor Location
Vet Industrial, Inc.	\$12.9	Green Construction	Bremerton
Knight Construction & Supply, Inc.	\$9.9	Green Construction	Deer Park
Shape Construction, Inc.	\$9.0	Green Construction	Bremerton
Harold Lemay Enterprises, Inc.	\$7.9	Recycling & Hazardous Waste Disposal	Tacoma
City of Tacoma	\$4.0	Recycling & Hazardous Waste Disposal	Tacoma
Garco Construction, Inc.	\$2.5	Green Construction	Spokane
Emerald Services, Inc.	\$2.0	Recycling & Hazardous Waste Disposal	Seattle
Sealaska Environmental Services,	\$1.9	Environmental Testing, Consulting, & Remediation	Bellevue
US Ecology Washington, Inc.	\$1.5	Recycling & Hazardous Waste Disposal	Richland

Source: Office of Management and Budget, 2015; Community Attributes Inc., 2016.

When delineated by NAICS, the primary sectors in which DOD clean technology contracts are awarded are: Heavy and Civil Engineering Construction; Waste Management and Remediation Services; Construction of Buildings; Rental and Leasing Services; and Utilities (**Exhibit 2**). The contract values of the two sectors related to construction activities total \$32.7 million, or 48% of the aggregate contract value for all sectors. Waste management and remediation services accounted for \$16.3 million of all clean technology-related DOD contracts.

Comparatively, contracts in the utilities sector totaled \$4.1 million in 2015. Other sectors represented in the remainder category included: professional, scientific and technical services; computer and electronic product manufacturing; and data processing, hosting, and related services, among others.

Exhibit 2. Clean Technology Defense Contracts (millions \$) by Industry Code, FY 2015

NAICS	Industry	Contract Value (\$ Mil)
237	Heavy and Civil Engineering Construction	\$19.2
562	Waste Management and Remediation Services	\$16.3
236	Construction of Buildings	\$13.5
221	Utilities	\$4.1
	Other	\$14.6
	Total	\$67.7

Source: Office of Management and Budgeting, 2015; Community Attributes, 2016.

In this analysis, clean technology defense activities in Washington are organized into the following categories: 1) Environmental Testing,

Consulting, and Remediation, 2) Green Building, 3) Recycling and Hazardous Waste Disposal, and 4) Energy Hardware and Software.

Environmental Testing, Consulting, and Remediation Services

Resource testing, such as soil or groundwater evaluation, determines the extent of pollution present. Subsequently, a consulting plan is formulated to address the remediation of harmful pollutants and a maintenance plan to preserve the environmental health of the site.

Based on analysis of OMB data, 16 contracts are classified as falling under this category, worth more than \$4.7 million in FY 2015. Some of the largest included a \$1.9 million contract to **Sealaska Environmental Services**; a \$0.87 million contract to **GS Environmental Services**; and a \$0.29 million contract to **Brooks Applied Labs**. Notable companies in this space include:

- Sealaska Environmental Services
- Analytical Resources, Inc.
- CDM Constructors and Engineers, Inc.
- Kane Environmental, Inc.
- Herrera Environmental Consultants

Sealaska Environmental Services is an Alaska-based environmental remediation firm with offices in Seattle, Poulsbo, and Richland. The company's Washington defense activities accounted for almost \$8.5 million worth of DOD contracts between 2008 and 2015. In FY 2015, Sealaska was awarded a \$1.9 million contract for on-base environmental services and analytical support (Office of Management and Budget, 2016).

Environmental remediation services can include contaminated soil removal, ecological restoration, waterway dredging and sediment remediation, and PCB testing and removal. Sealaska also has environmental consulting and construction management expertise as well as with remediation and reclamation proficiency. The firm's consulting and management services incorporate stormwater mitigation, and extensive knowledge about Federal and State environmental laws and regulations (Sealaska, 2016).

Analytical Resources, Inc. (ARI) is a Tukwila-based laboratory with more than 40 scientists and 60 support staff that specialize in environmental chemistry. ARI offers full-service environmental testing, monitoring how chemicals enter the air, water, and soil and determining the extent of their impacts. Data gleaned from these investigations can be used to ascertain the effects of existing operations, pollution, or new product development to ensure clients are compliant with environmental standards. In addition to lab analyses, ARI's quality assurance, client

services, and computer services divisions assist clients in developing and implementing an environmental management plan (Analytical Resources, Inc., 2016).

Since 2008, ARI has been the prime recipient of \$1.2 million of DOD contracts as well as being awarded \$0.4 million in subcontracts (Office of Management and Budget, 2016). In FY 2015, the company was awarded a \$180,000 to continue its dioxin/furan analyses with the Army Corps of Engineers and the Navy (Analytical Resources, Inc., 2016). Dioxins and furans (a specific dioxin subset) are highly toxic unintentional byproducts of industrial processes involving the combustion of chlorine.

Waste incineration, chemical and pesticide manufacturing, and pulp and paper bleaching are all activities that can introduce dioxin into the environment. Dioxin is fat-soluble, causing it to bioaccumulate in animal-based food sources such as milk, eggs, and pork. Fish are potent carriers of dioxin—if it is introduced to waterways, the dioxin levels in fish can be 100,000 times that of the surrounding habitat. It is possible for humans to develop cancer after moderate or severe exposure to this chemical subset. Dioxin can also cause substantial reproductive and developmental problems (Center for Disease Control, 2015).

CDM Constructors and Engineers Inc. is a subsidiary of Boston-based CDM Smith with offices in Bellevue and Seattle. The subsidiary has expertise in environmental remediation and green building, frequently providing contamination cleanup plans to prepare for construction staging. The firm has strong expertise in state, federal, and international environmental compliance laws, and uses these constraints to prepare remediation models and schedules for its clients (CDM Smith, 2016). Between 2008 and 2016, CDM was awarded nearly \$91 million in prime DOD contracts. In 2015, the company received a \$682,000 DOD contract for environmental remediation services (Office of Management and Budget, 2016).

Kane Environmental, Inc. offers similar remediation consulting expertise to its developer clients, specializing in preparing brownfield sites for redevelopment. The term ‘brownfield’ applies to underused industrial and commercial properties that typically detract from community aesthetic and hinder economic development. Kane works to solve environmental problems at these sites while also creating opportunities for community investment and growth.

Headquartered in Seattle with offices in Portland and San Francisco, Kane provides site assessments, remediation consulting services, storage tank removals, geotechnical services, stormwater plans, and litigation support to clients on the West Coast and beyond (Kane Environmental, Inc., 2016).

In FY 2014, Kane Environmental was awarded a \$5 million, five-year DOD contract to provide analytical lab services to nine separate U.S. Navy facilities in the Puget Sound area (Puget Sound Business Journal, 2014). Remediation services under this contract include soil and groundwater remediation, pollution prevention planning, and green remediation system design and monitoring (Kane Environmental, Inc., 2016).

Herrera Environmental Consultants, headquartered in Seattle, has more than 100 employees across its five western U.S. offices. The firm's three areas of practice are water, restoration, and sustainable development consulting. Herrera's projects include a contract under the Army Corps of Engineers to reduce the presence of lead dust in the Fort Vancouver Barracks indoor firing ranges. For this project, the consulting firm provided cleanup oversight and performed daily on-site air quality analysis (Herrera Environmental Consultants, 2016).

In FY 2015, Herrera received \$82,000 of DOD contracts for environmental studies and site assessments. Between FY 2008 and 2015, Herrera was awarded almost \$824 million for environmental consulting and remediation services (Office of Management and Budget, 2016).

Green Construction

Green construction refers to an environmentally-responsible construction process where the building's life cycle—design, construction, operation, maintenance, and even demolition—is sustainable. This category also includes construction related to energy production, such as the construction of a dam for hydroelectricity. In FY 2015, 20 of 91 clean technology contracts were awarded to firms with core competencies in green building (Office of Management and Budget, 2016). Two notable companies in this space are:

- Garco Construction, Inc.
- Burton Construction, Inc.

Garco Construction, Inc. is headquartered in Spokane with additional offices in Tacoma. The general contracting and construction management company has worked in the Pacific Northwest and throughout the U.S. for 35 years. Garco has a commitment to sustainable design and construction. In 2013, the company finished the Spokane Convention Center expansion project, a LEED Silver building. Its low environmental impact design is accompanied by a 100,000 square-foot green roof (Garco Construction, Inc., 2016).

Garco focused its efforts on acquiring DOD contracts early in the company's tenure. During the seven years between 2008 and 2015, the company was awarded a total of \$376.4 million in DOD contracts (Office

of Management and Budget, 2016). Garco built the Fairchild, Yakima, and Vancouver Armed Forces Reserve Centers in 2009, 2010, and 2011 respectively (Garco Construction, Inc., 2016). In FY 2015, the firm was awarded \$2.6 million for maintenance and repair of the Chief Joseph Dam in Bridgeport, Washington through the Army Corps of Engineers. These funds were the first of the project's \$15.8 million contracted budget, and is slated for completion in October 2017 (Department of Defense, 2015).

The construction firm was also awarded a comparable contract through the Army Corps of Engineers in 2014. Garco was awarded a \$48.3 million contracted project to remodel the juvenile salmon facility on the Lower Granite Dam facility on the Snake River. The facility was previously below ground, and endangered species experts at NOAA urged that an above ground rework would be less disorienting and stressful for the salmon. The Lower Granit Dam is the fish's first encounter with the Snake River hydropower system, and increasing the survival rate of the juveniles would increase the likelihood that the salmon would survive and be able to navigate other dams on the Snake. The construction is scheduled to be completed in early 2017, so as not to impact inbound salmon returning to the river in 2015 or the out-migration of juveniles in the Spring of 2016 (The Columbia Basin Fish and Wildlife News Bulletin, 2014).

Burton Construction, Inc., also headquartered in Spokane, is a general construction firm that places emphasis on sustainable building. The vast majority of Burton's work is performed for public agencies. Burton's DOD contract work is related to retrofitting existing buildings to improve energy efficiency and minimize environmental and cost impacts (Burton Construction, Inc., 2016). One such method is to reduce the 'plug and process' electrical loads in a particular building. Plug and process loads (PPLs) are defined as all electrical uses not attributed to lighting, heat, cooling, and other conditioning of space to maintain comfort and amenities for occupants. Computers, elevators, and kitchen appliances all fall under the PPL category. Installing smart systems to manage the load of these products when they're not in use can dramatically lower energy waste (National Renewable Energy Laboratory, 2012). In FY 2015, Burton was awarded a \$662,000 DOD contract (Office of Management and Budget, 2016).

Recycling and Hazardous Waste Disposal

The recycling and hazardous waste disposal subsector encompasses activities related to resource reuse and proper disposal of regulated materials. Firms who specialize in hazardous waste disposal have expertise in federal and state environmental laws that stipulate allowable levels of on-site hazardous waste products as well as environmentally compliant removal and disposal practices. Two notable companies operating in this subsector are:

- US Ecology Washington, Inc.
- Emerald Services, Inc.

US Ecology Washington, Inc. offers recycling and inorganic waste treatment services. Between 2008 and 2015, the company was awarded DOD contracts with a total value of \$14.6 million (Office of Management and Budget, 2016). Services for these contracts included maintenance, repair, or alteration of facilities with emergency procedure guidelines (EPGs), hazardous substance removal, and waste treatment and storage. Locations with EPGs produce waste with varying levels of toxicity during operations, such as a nuclear plant (US Ecology, 2016).

US Ecology is one of two full-service low-level radioactive waste disposal facilities in the nation, and currently has capacity for several more decades of operation. The company also assists firms with Resource Conservation and Recovery Act (RCRA) and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) compliance by ensuring waste treatments meet all criterion for safe disposal (US Ecology Washington, 2016).

Similarly, South Seattle-based **Emerald Services, Inc.** is a full-service industrial recycler that caters to companies in a wide variety of industries, such as healthcare, oil and gas, aerospace, and marine activities. In 2015, the company cleaned 10.6 million gallons of waste water, saved 15.8 million gallons of oil from being imported, and preserved 0.5 million kWh of energy by reclaiming and repurposing industrial material (Emerald Services, Inc., 2015). Emerald Services has been a long-time DOD contractor—the company was the recipient of \$17.9 million worth of contracts from 2008 through 2015. In FY 2015, the firm was awarded a \$2 million DOD contract for recycling and hazardous waste disposal (Office of Management and Budget, 2016).

Energy Hardware and Software

The energy hardware and software subsector encompasses activities related to grid and renewable energy hardware as well as energy management software. Two notable firms in this space are:

- OutBack Power
- Itron, Inc.

OutBack Power, based in Arlington, manufactures grid-interactive components for backup power, solar power, and off-grid stations. Between FY 2008 and 2016, OutBack was awarded more than \$2.2 million in DOD contracts. Contracts were primarily awarded for the company's rugged off-grid components. One such series of products comes from OutBack's Extreme Series Inverters/Chargers, which are designed to survive in harsh conditions, including extreme shaking,

vibration, salt, sand, dirt, flash floods, and heat. This series, and other similar ones, are ideal for adverse conditions in remote military locations as these products have both mobile and stationary applications (OutBack Power, 2016).

According to information gleaned from interviews and online research, harnessing renewable energy is especially crucial to off-grid, forward operating bases where transportation of fuel can be perilous. Upon analysis, the DOD determined that fuel convoy attacks accounted for a disproportionately large number of operation fatalities. In order to prevent unnecessary deaths, the DOD began employing alternative energy technology as opposed to standard diesel-powered generators for remote operations. As a result, many forward operating bases now use solar and wind power, and subsequently Outback Power converters to translate solar and wind DC into AC for electronics in the field, to power generators, and to charge batteries overnight.

The OutBack system can run seven to eight different operating modes depending on energy consumption and what's connected to power. Additionally, there are no moving parts in the OutBack system (there are in traditional generators), which limits the frequency of system failures and power interruptions (OutBack Power, 2016).

Itron, Inc. is headquartered in Liberty Lake, and specializes in resource management technology. Its holistic system approach—which the company refers to as an active grid—allows for communication between water, electricity, and gas systems hardware and accompanying monitoring software. For example, the Itron system can identify potential locations of water leaks, and communicate this information to the cloud, prompting human intervention (Itron, Inc., 2016).

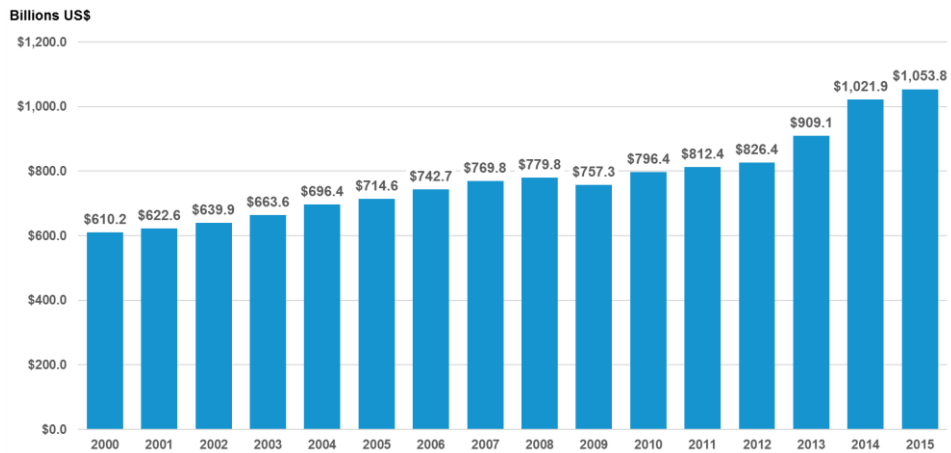
In FY 2015, Itron was awarded \$613,100 of a long-term DOD contract with the Navy for energy diagnostic and consulting services in its facilities (Office of Management and Budget, 2016). The Navy consumes \$1.2 billion worth of energy annually in its worldwide facilities. In 2005, a DOD-wide initiative was launched to reduce energy consumption by 20 percent across the department by 2015 (Itron, Inc., 2016). Since FY 2008, Itron has received almost \$2.5 million in DOD contracts associated with energy management software subscriptions and consulting services (Office of Management and Budget, 2016).

KEY INDUSTRY TRENDS AND GLOBAL CONSIDERATIONS

Global Market Trends in Clean Technology

The global clean technology market grew at a steady pace between 2000 and 2007—the market grew by 2-5 percent annually during the years leading up to the recession (**Exhibit 3**). Post-recession, the market experienced the same stable growth until 2012 and 2013 where the environmental technologies market grew by 10 percent and 12 percent, respectively. In 2015, the worldwide clean technology market was worth just over \$1.05 trillion.

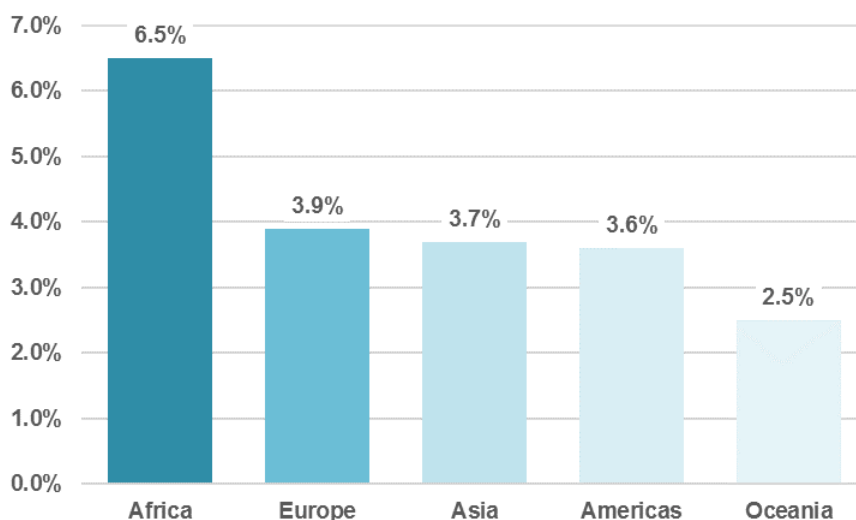
Exhibit 3. Global Environmental Technologies Market Value, 2000-2015



Source: International Trade Administration, 2016.

In 2012, clean technology sales increased by the largest margin (6.5%) in Africa (**Exhibit 4**). Regionally, Europe, Asia, and the Americas were evenly matched in sales growth, while Oceania nations experienced the least amount of clean technology sales growth.

Exhibit 4. Growth in Clean Technology Sales, by Region, 2012



Source: World Bank, 2012.

Demand from Developing Countries

Clean technology solutions are not only beneficial for the environment, but often provide cost effective solutions in developing economies lacking advanced infrastructure. The potential for clean technology market growth in developing countries is significant. As the economic conditions of these nations continues to improve, ensuring adequate energy supplies, limiting emissions, and preserving resources will be crucial to overall climate and environmental sustainability. In 2012, clean technology investment rose by 19 percent in developing countries (to \$112 billion per year) (World Bank Group, 2014). These countries are also less likely to have domestic companies able to meet this demand.

Approximately 1.3 billion people worldwide have no access to electricity at all, leaving substantial market potential for locally-produced renewable energy (United Nations Foundation, 2016). Developing countries in the Middle East and North Africa represent some of the strongest demand feasibility for solar and smart metering technology (World Bank Group, 2014).

In an effort to foster this market, the United Nations Foundation launched the Africa Rural Energy Enterprise Development (AREED). AREED offers energy entrepreneurs a combination of training, business plan support, and startup capital. Training is provided for a variety of products and services, including solar home system supply and service, energy-efficient stoves, solar-powered irrigation systems, and liquid

petroleum gas services. The AREED Initiative operates in Ghana, Mali, Senegal, Tanzania, and Zambia, and has launched 29 new enterprises since its inception in 1999. These businesses serve more than 400,000 people, and preserve 200,000 tons of firewood per year (United Nations Foundation, 2016).

According to the World Health Organization, 10 percent of people worldwide don't have access to clean drinking water. Additionally, in low and middle income countries, potable water is unavailable to one-third of all healthcare facilities. As the effects of climate change and water pollution continue to strain the world's reserves of drinkable water, water treatment and management products will be key technologies. Furthermore, individuals in poorer countries will be disproportionately affected by dwindling water supplies, largely because these nations lack infrastructure and policy necessary to monitor and preserve freshwater resources (WHO and UNICEF, 2015). As a result, it is expected that water monitoring and treatment technologies will be in increasing demand in the coming years, especially in undeveloped nations.

The wastewater treatment and management subsector is projected to have largest share of market potentiality in developing countries, with a worldwide value of \$2.8 trillion by 2023 (**Exhibit 5**). The clean technology subsector related to potable water supply and delivery is predicted to have the second largest value at \$0.79 billion. Environmental technology subsectors related to renewable energy production, waste management, and sustainable transit are also projected to have notable value in emerging markets in developing nations.

Exhibit 5. Projected Market Size through 2023 for 15 Clean Technologies in Developing Countries

Type of Technology	Projected Market Size, 2023 (trillions US \$)		Share
Wastewater	\$2.80		43.8%
Water	\$0.79		12.4%
Onshore Wind	\$0.67		10.5%
Solar Photovoltaic	\$0.48		7.5%
Small Hydro	\$0.32		5.0%
Waste Management	\$0.31		4.9%
Electric Vehicles	\$0.26		4.1%
Geothermal	\$0.19		3.0%
Bioenergy	\$0.15		2.3%
Concentrating Solar Power	\$0.14		2.2%
Electric Bikes	\$0.12		1.9%
Solar Thermal	\$0.06		0.9%
Bus Rapid Transit	\$0.04		0.6%
Natural Gas Vehicles	\$0.03		0.5%
Biofuels	\$0.03		0.5%
Total	\$6.39		100.0%

Source: World Bank Group, 2014.

According to the World Bank Group, China, Latin America, and Sub-Saharan Africa are the three largest developing markets, with expected market sizes of \$415 billion, \$349 billion, and \$235 billion, respectively (World Bank Group, 2014).

Clean Energy Expansion

The global clean energy market is highly fragmented. Additionally, there's a low degree of product diversification, making competition stiff among existing companies and those entering the field. Capital investment has historically been a barrier for green energy companies, but an increase in governmental support and subsidies for renewable energy production is expected to encourage new innovators to enter the market (Transparency Market Research, 2016).

According to one report, the global green energy market is projected to be worth \$832 billion by 2019. The hydroelectric power segment is projected to be worth about 57 percent, or \$474.2 of this (Transparency Market Research, 2016).

In conjunction with the rise of renewable energy technologies is an increasing emphasis on hybrid energy practices, particularly in locales where individual energy sources are unreliable on their own, but can be

combined to reduce instances of intermittency (Transparency Market Research, 2016).

The following exhibit presents the largest U.S. clean energy export markets (**Exhibit 6**). Data presented are based on a definition for clean technology exports (by harmonized system code) developed by the Trade Promotion Coordinating Committee (2012).

Mexico and Canada are the top two largest clean energy export markets for the U.S. as a whole, accounting for \$7.5 and \$7.3 billion, respectively. China is the third largest market for American clean energy products, but it trails Mexico and Canada by more than \$5 billion.

Exhibit 6. U.S. Clean Energy Export Markets, 2015

Rank	Country	Exports (mils \$)
1	Mexico	7,495.8
2	Canada	7,284.6
3	China	2,277.6
4	Germany	1,575.6
5	Japan	1,397.6
6	United Kingdom	1,206.7
7	Korea, South	1,466.3
8	Singapore	1,127.2
9	Hong Kong	879.6
10	France	837.3
	All other countries	14,729.7
	Total	40,278.1

Source: United States Census Bureau, 2016; Community Attributes, 2016.

Solar

The following exhibit depicts the weighted capital cost of a solar panel in five developed countries (**Exhibit 7**). The cost difference between a solar panel in the United Kingdom and a solar panel in Japan is more than \$1,600. The majority of this cost discrepancy is attributed to varying government-backed solar energy subsidies in these five nations. Subsidies can cause significant market distortions, misrepresenting the efficacy of a potential energy-saving investment. This market distortion can create both barriers and opportunities, depending on the regulatory structure and solar potential of particular nations (Renewable Energy Policy Network, 2015).

Exhibit 7. Weighted Capital Costs of a Rooftop Solar Panel, by Country, 2014

Country	Rooftop Solar Panel Weighted Capital Cost (2014\$)
United Kingdom	\$1,080
Germany	\$1,495
China	\$1,670
United States	\$2,218
Japan	\$2,710

Source: Renewable Energy Policy Network, 2015.

By the end of 2015, 20 countries had at least one gigawatt of solar capacity, an increase from 17 countries in 2013. The top three markets for solar power were China, Japan, and the United States, respectively. The United Kingdom and Germany were the fourth and fifth markets, respectively. These countries have significantly less capacity for solar than the top three due to global positioning and climate (Renewable Energy Policy Network, 2015). The U.K. and Germany have two of the most aggressive subsidies for solar power—rooftop panels in these countries were the cheapest of the five top-ranking markets for solar power (Exhibit 7).

Market Considerations

According to the World Bank Group, the top six clean technology subsectors in terms of global market size are: alternative fuels, building technologies, wind power, alternative fuel vehicles, geothermal, and water supply and wastewater treatment. Investment in wastewater treatment and drinking water management technologies represents more than a third of total likely clean technology investment in developing countries (about \$2.7 trillion) (World Bank Group, 2014).

The market for environmental technologies is highly dependent on an enforceable regulatory framework coupled with updated monitoring infrastructure. Countries currently lacking these components are not viable clean technology export markets. As worldwide resource scarcity is compounded, it will necessitate the development of markets for efficiency-driven clean technologies (International Trade Administration, 2016).

Green jobs tend to be more skilled, safer, and better paid than employment in other industries. However, high upfront capital requirements and longer payback periods for investors are two factors limiting the growth of the industry both domestically and worldwide (World Bank Group, 2014). Additionally, the average time horizon for

fostering a commercial relationship that leads to sales of environmental products and services is one to five years—notably longer than time horizons in other sectors (International Trade Administration, 2016).

U.S. Trends

U.S. clean technology products and services are highly sophisticated and favorably regarded in the global clean technology marketplace. Subsequently, these products have a consistently higher price compared to international competitors. This can have a negative impact on U.S. technologies' competitiveness in price-sensitive, emerging markets (International Trade Administration, 2016).

The United States is the single largest market for clean technology, accounting for \$303.0 billion in the global marketplace. The U.S. industry for environmental technologies employed approximately 1.6 million people nationwide, and had revenues of \$320.4 billion (International Trade Administration, 2016).

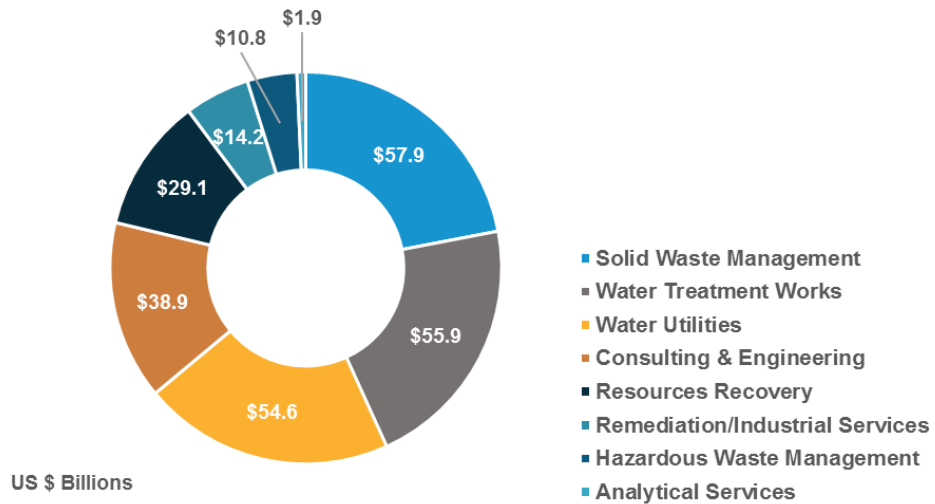
The water technologies subsector—spanning wastewater treatment, water use reduction, and industrial water remediation, among others—contributed \$154.6 billion to total industry revenues in 2014. The monitoring and instrumentation subsector, which includes monitors and testing equipment for resources, water metering technology, and laboratory testing services, garnered \$6.3 billion in 2014 revenues. Environmental consulting and engineering also collected \$28.9 billion in 2014 revenues (International Trade Administration, 2016).

The services market share is considerably larger than the manufacturing segment—\$253.3 billion compared to \$67.1 billion (**Exhibit 8 and 9**). The majority of these goods and services are sold domestically. In 2015, the U.S. exported \$51.2 billion worth of environmental goods and services, about 17 percent of all clean technology products and services produced within the country (International Trade Administration, 2016).

Solid waste management was the largest clean technology service in 2015 (\$57.9 billion), followed closely by water treatment works (\$55.9 billion) and water utilities (\$54.6 billion) (**Exhibit 8**). The three aforementioned subsectors represent a little over two-third (66%) of all clean technology services.

Consulting and engineering and resource recovery were also a significant proportion of services rendered in 2015, accounting for 15 and 11 percent of environmental services provided. Remediation services, hazardous waste management, and analytical services were the smallest components of the environmental services market—encompassing a little over 10% of the market together.

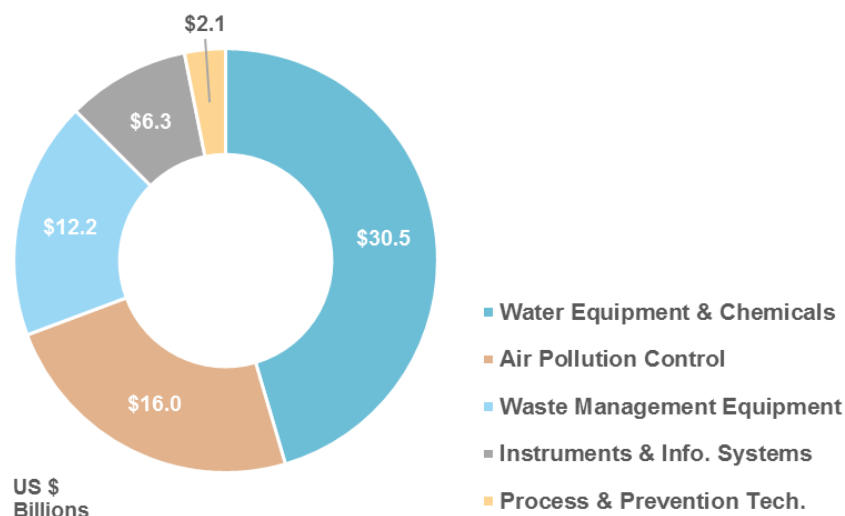
Exhibit 8. U.S. Industry Revenues by Clean Technology Segment, Services, 2015



Source: International Trade Administration, 2016.

Water equipment and chemicals represented the largest share (45%) of clean technology products in 2015 (**Exhibit 9**). Air pollution control products accounted for \$16 billion, or 24 percent, of the environmental technology manufacturing market. The remaining product subsectors account for about 31 percent of the market together.

Exhibit 9. U.S. Industry Revenues by Clean Technology Segment, Manufacturing, 2015



Source: International Trade Administration, 2016.

Clean Technology in Washington

Washington is a hub for clean technology activities, with core competencies in water management technologies, bio-energy, smart grid development, and green construction, among others. APANA, located in Bellingham, designs technology for water management for commercial and industrial companies. This technology assists businesses in tracking water use, allowing them to conserve water and save money (APANA, 2016). Regarding green building design and operation, Seattle-based McKinstry offers consulting services in addition to building design, build, operation, and maintenance packages. McKinstry has more than 1,800 employees across the Pacific Northwest and Midwest (McKinstry, 2016).

While Washington is home to a diverse collection of clean technology companies, not all products and services are exportable. Further, the degree to which Washington clean technology companies export is product and service-specific as opposed to subsector-specific. Export market success for one product or service does not necessarily translate to market attainment subsector-wide.

Exporting Activities

Current Washington clean technology exports include smart grid components, wave power solutions, and green solvents. OutBack Power is an Arlington-based power inverter, charge controller, and batter producer that provides smart grid-interactive solutions for backup power,

solar power, and global off-grid needs. The company has exported its products to several nations in Europe and as far as South Africa (OutBack Power, 2016). Tacoma-based Inland Technology, Inc. offers pollution-preventing solvent substitutes for aerospace organizations, as well as manufacturers in electronics, appliances, and computing industries. Inland Technology's international customers include a variety of European aerospace manufacturers (Inland Technology, Inc., 2016).

In 2015, Washington exported a total of \$596.6 million worth of clean energy products and services (**Exhibit 10**). Canada was the largest export market (\$95 million) for Washington-produced energy products, such as wind, solar, geothermal, and wave-powered products and services. The next two largest export markets combined—United Kingdom and Mexico—make up less than half of the Washington share of the Canadian export market.

There is a notable degree of overlap between Washington and the United States' top clean energy export markets—six of ten countries appear on both lists (**Exhibit 6** and **10**). The Netherlands, Brazil, Saudi Arabia, and United Arab Emirates are significant export markets for Washington state, but not for the country as a whole. Similarly, Germany, South Korea, Singapore, and Hong Kong are notable clean energy markets nationwide, but not for Washington-produced products and services. Washington clean energy exports capture 3.8 percent, 1.6 percent, 0.6 percent, of the British, Canadian, and Mexican markets, respectively.

Exhibit 10. Top Washington State Clean Energy Export Markets, 2015¹

Rank	Country	Exports (mils \$)
1	Canada	95.0
2	United Kingdom	46.9
3	Mexico	46.1
4	France	26.9
5	China	36.6
6	Japan	98.2
7	Netherlands	20.7
8	Brazil	18.5
9	Saudi Arabia	15.3
10	United Arab Emirates	11.7
All other countries		180.4
Total		596.6

Source: United States Census Bureau, 2016; Community Attributes, 2016.

Washington is also a hub for clean technology innovation. In late July 2016, Richland-located Pacific Northwest National Laboratory (PNNL) released VOLTTRON in partnership with the Department of Energy. VOLTTRON is a control and sensing software platform that augments the energy efficiency of buildings (Pacific Northwest National Laboratory, 2016). Grid modernization requires both energy supply and demand-side monitoring in order to reduce overall energy consumption.

In order to make renewable energy more viable by reducing the intermittency in supply, buildings have to be as smart as energy delivery systems. Commercial buildings consume 70% of the energy in the power grid at any given time, but a large percentage—up to 30 percent—is wasted. For responsive buildings, VOLTTRON diagnoses and corrects problems, as well as supports the exchange of information between the software platform and connected apps to automatically adjust energy loads using real-time energy demand and price signals. VOLTTRON is available as an open-source platform, and is currently being utilized by Kent-based Transformative Wave Technologies in its HVAC rooftop units (Washington CleanTech Alliance, 2016).

Seattle-based Impact Bioenergy demonstrated its portable microdigester, HORSE, at the Fremont Brewing Co. in June of 2016. The HORSE system was intentionally designed to reduce the scale and cost of anaerobic digestion; the system provides on-site generation of energy from food waste and other organic materials (Impact Bioenergy, 2016). HORSE can convert 960-35,000 pounds of organic waste per week into

¹ The definition of clean technology exports is based on a

liquid fertilizer. During this conversion process, renewable natural gas is generated, which can be used for building heat, electricity, cooking fuel, and hot water generation. Impact Bioenergy is now receiving orders for its HORSE digester from customers as far away as Albania and Zambia (Washington CleanTech Alliance, 2016).

EXPORTING AND COMPETITIVENESS FACTORS

Export Control Considerations

The United States' International Traffic in Arms Regulations (ITAR) controls the import and export of defense-related goods and services. For Washington's defense contractors, exporting the same products they sell to the Department of Defense may require ITAR compliance. In some cases, countries are exempt from ITAR controls. These include Australia, Canada, and the United Kingdom. The list of items controlled by ITAR changes over time, adding a layer of regulatory complexity for would-be exporters. ITAR has strict regulatory licensing requirements and does not address commercial applications of technology.

Export Administration Regulations (EAR) cover dual-use items. Things like green building, clean energy, and smart grid components could be used for either civilian or military purposes and are thus considered dual-use. Products that fall under the clean technology category are derived from a wide variety of sectors. EAR Categories 1 (materials chemicals microorganisms and toxins), 3 (electronics design development and production), and 5 (information security) all relate to clean technology activities.

Certifications

Certifications related to the clean technologies vary substantially from country to country. Because different nations have a diverse set of regulations surrounding resource management, pollution control, and clean energy, there are few internationally-recognized standards for products and services. Oftentimes, local certifications are not recognized as export market equivalents (International Trade Administration, 2016). The following examples of certifications associated with green building, smart grids, and clean energy activities are illustrative of the multiplicity of qualifications in clean technology subsectors.

LEED Green Building Certifications have a range of concentrations, including building design and neighborhood development. The standards vary by building type—the certification criterion is different for a retail building than it is for a residential building, for example. While the design standard began in the U.S., the LEED International Roundtable has 38 member nations that work to make LEED green building standards relevant for worldwide application. Aside from LEED, there are numerous other country-specific green building initiatives and standards.

Germany utilizes the DGNB Certification System; the United Arab Emirates applies Estidama; Australia, New Zealand, and South Africa employ Green Star, among a myriad of other standards (U.S. Green Building Council, 2016).

There are numerous national and multi-national-specific security regulations and certifications for countries that are considering implementing a smart grid or updating an existing grid. These regulations typically apply to the entire supply chain of all smart grid components. For example, the European Union Agency for Network and Information Security (ENISA) is tasked with enforcing security standards for grid components in EU smart grids, and ensuring there are no weak links that could leave member countries susceptible to cyber-attacks (European Union Agency for Network and Information Security, 2016).

Biofuels and biomass equivalents have a variety of standards and certifications. One is the International Sustainability Carbon Certificate (ISCC), which is based on the EU's Renewable Energy Directive (RED) initiatives. RED dictates the 2020 carbon reduction standards for EU member nations, and has some of the most stringent requirements for imported biofuels. RED is assigned on a country-by-country basis, and regulations are dependent on respective countries' target reduction goals.

Member nations with more advanced infrastructure systems and larger GDP's, such as Germany, have higher carbon reduction expectations than smaller, less wealthy nations, such as Malta. The ISCC evaluates biofuels on everything from sustainable agriculture practices to human labor and land use rights in the production process. While ISCC standards are rooted in European carbon caps, the ISCC works with more than 250 international member corporations, associations, and research institutions (International Sustainability Carbon Certificate, 2015).

MARKET OPPORTUNITIES

The sections above presented findings on leading markets globally for clean technology products and services. These findings were compared against subsector markets for product and services offered by clean technology defense contractors. Further criteria in market selection include:

- Washington's existing economic linkages with overseas markets, as evidenced by exports.
- U.S. International Trade Administration market reports.
- News articles and other reports and related literature.
- Feedback from interviews with clean technology exporters across the state, carried out during the spring and summer of 2016.

Based on these analytics, the following markets are assessed in more detail for potential exporting opportunities: 1) China; 2) India; 3) Brazil; 4) United Arab Emirates; 5) Japan; and 6) Germany.

China

Market Overview

In 2014, China completely restructured its approach to environmental regulatory enforcement by introducing the Environmental Protection Law (EPL). This statute allows for stronger enforcement of environmental rules. This coupled with the large emerging middle class in the country make China the largest and fastest growing emerging markets for clean technology (International Trade Administration, 2016).

China's population is experiencing rapid urbanization—more than half of the country's 1.34 billion people now live in urban areas. This urban migration has dramatically increased the nation's demand for residential and commercial buildings. China currently has more than 400 billion square feet of building space, and almost 20 billion square feet is added each year. Since these buildings account for more than a third of countrywide energy use, China has a strong interest in green building design and construction services (PricewaterhouseCoopers, 2013). Additionally, the new EPL requires environmental impact assessments for all new construction projects, and as a result, environmental consulting and engineering services will be in growing demand (International Trade Administration, 2016).

The Chinese Ministry of Environmental Protection (MEP) estimates 60 million tons of hazardous waste are generated annually as of 2015. Current disposal capacity is only at one-third of that amount. In order to address the disparity, \$4 billion has been set aside to construct 300 hazardous waste disposal facilities and initiate brown field remediation projects throughout China. As a result, waste treatment technologies and soil contamination testing and monitoring equipment and services will be in high demand in the coming years (International Trade Administration, 2016).

Similarly, the MEP announced it would invest \$329 billion to address water pollution in an effort to augment access to drinking water and sanitation. Subsequently, there will be increased demand for water monitoring and testing equipment (International Trade Administration, 2016).

Market Barriers

While China has made significant strides in addressing environmental regulation, these controls are enforced on both the provincial and municipal level, making compliance convoluted. Adding to these

intricacies of regulations, state-owned enterprises work to crowd out competitor technologies and establish state-sponsored monopolies. Government tenders also frequently prefer domestic bidders over foreign enterprises. For these reasons, companies with a local presence in China are often more successful than other international firms (International Trade Administration, 2016).

Aside from green construction standards, which adhere closely to the U.S. LEED system, other country-specific certifications and safety approvals are not recognized as China export market equivalents (PricewaterhouseCoopers, 2013). As a result, the certification process for clean technology products and services can be time and cost-prohibitive. Furthermore, intellectual property rights infringement continues to be a substantial concern for U.S. companies hoping to do business in China (International Trade Administration, 2016).

Market Assessment

While there is a wide array of barriers to entering the Chinese clean technology market, there is a significant amount of payoff potential for firms willing to navigate the complex regulatory and legal environment. The demand for clean technology products and services is forecasted to increase exponentially in the coming years as the economic status of China's population continues to rise. Washington has a strong existing trade relationship with China, and economic development entities such as the Washington State China Relations Council can provide clarity to potential exporters hoping to enter the Chinese market.

India

Market Overview

India's environmental conservation goals are dynamically evolving. The Ministry of Environment, Forest, and Climate Change (MoEFCC) is India's federal agency responsible for implementation and oversight of environmental laws. Enforcement remains a challenge in India because it is delegated to State Pollution Control Boards (SPCBs) who report to the state government rather than a federal authority (International Trade Administration, 2016).

Due to continued quality of life and infrastructure improvements, the Indian construction market is expected to grow twice as fast as China's until 2030. By 2021, the country is projected to be the third largest construction market in the world. If Environmental Impact Assessments are required and enforced, India would be an ideal market for environmental consulting, as well as green building design (International Trade Administration, 2016).

Water monitoring and testing technology and services continue to be in high demand in India. A large percentage of the Indian population does not have access to clean, potable water. Demand for water efficiency, reuse, and analysis products will continue to grow—India’s capital expenditures on water is projected to increase by 83 percent from 2015 to 2020 (International Trade Administration, 2016).

According to India’s Ministry of New and Renewable Energy, 4,089 megawatts of renewable energy capacity were added between 2014 and 2015, exceeding the targeted addition of 3,770 megawatts during that time period. India’s largest source for renewable energy expansion is its capacity for solar power—the country could derive 750 gigawatts of solar energy with the proper infrastructure (Forbes, 2015). If India continues to increase its reliance on renewable sources, there could be strong demand for smart grid hardware, software, and energy storage solutions.

Market Barriers

While India has ambitious policies regarding clean technology expansion, the country’s political and regulatory framework has the potential to hinder market growth. For example, the current Modi government could impede the development of an enforceable environmental regime by relying on industries to self-monitor and report their own levels of emissions and pollutants (International Trade Administration, 2016). It is likely that companies would underreport their environmental impact in an attempt to increase profits.

At present, environmental technology markets are highly fragmented across the country, which makes it problematic to locate a representative or a distributor that can connect Indian buyers with U.S. exporters on a national level. If exporters are able to gain access to a viable clean technology market segment, India has high tariffs for environmental technologies, especially resource monitoring equipment. As a result, the price of high quality instrumentation is notably less competitive than domestic/cheaper equipment. In general, Indian tenders have a tendency towards lowest bidder mentality regardless of lessened quality tradeoffs (International Trade Administration, 2016).

Market Assessment

The current barriers to entering the Indian clean technology market are likely cost-prohibitive to many potential exporters, but opportunities may become more viable as the political and regulatory climates within the country shift. As the economic condition of an increasing percentage of the population improves, pressure on the Indian government to address resource conservation and allocation will continue to mount. This will likely increase clarity in the country’s clean technology market, and widen opportunities for prospective exporters.

Brazil

Market Overview

Overall, the Brazilian government has high ambitions for environmental policy development, but limited means to achieve their environmental goals at present (International Trade Administration, 2016). In 2015, the Brazilian government set a goal to get almost 20 percent of the country's energy from renewable sources within 15 years. This resolve excludes hydropower, and would require the country to invest in multimillion-dollar transmission lines to connect wind turbines, solar panels, and biomass facilities to urban centers. Unfortunately, Brazil's economy shrank by 3.8 percent in 2015, preventing such investments from taking place in the near term (International Business Times, 2016).

In addition to renewable energy expansion, there is strong demand for water management products and services in Brazil. As of early 2015, the country's primary water reservoir was only 5.1 percent full. Specifically, smart water systems and software as well as advanced metering technology and software are necessary for managing Brazil's future water stock (International Trade Administration, 2016).

Market Barriers

In addition to the recent downturn in the Brazilian economy, tariffs can be expensive. There is a required minimum for locally produced content in imported products—depending on the type of product, 40 to 60 percent of its total value must be produced locally. If these minimums are not met, tariffs can be significant (International Trade Administration, 2016).

Additionally, Brazil's environmental certifications and safety approvals don't recognize international equivalents. As a result, it can be cumbersome and costly to certify products and services to abide by Brazil's standards (International Trade Administration, 2016). High tariffs and a challenging regulatory framework can make the Brazilian market cost-prohibitive for potential exporters.

Market Assessment

As Brazil's market recovers, investments in clean technologies and related infrastructure could match the country's ambitious policy framework, however, the recent downturn has focused government attention on more pressing issues. In the future, there could be sound opportunities for energy and water management hardware and software.

United Arab Emirates

Market Overview

The UAE has very coherent national legislation for environmental regulations, but their enforcement capabilities are fragmented among the seven emirates. The Ministry of Environment and Water (MOEW) maintains federal authority for environmental rules, however, administration of the policies is carried out by Emirati-level institutions. Further, several environmental watchdog organizations provide checks and balances to the system (International Trade Administration, 2016).

Water security is a paramount issue throughout the seven emirates. The UAE is in the process of promoting the development of Integrated Water and Power Plans (IWPPs), which includes increasing freshwater efficiency and reuse with smart technology. Efficiency monitoring and testing equipment as well as water management software will be in increased demand during this transition phase (International Trade Administration, 2016).

Masdar, an Abu Dhabi clean energy and sustainable real estate company with an independent research university, has several initiatives that help advance the clean technology market in the emirate. In 2008, the firm broke ground on Masdar City with the goal of creating the world's most sustainable eco-city. The City is centered around the Masdar Institute of Science and Technology, and when complete, is expected to be home to 40,000 people with an additional 50,000 commuting every day to work and study. Masdar City is powered by clean wind and solar energy, connected to a smart grid, and employs sustainable building technologies (Masdar, 2016).

Market Barriers

There are very few market barriers to entering UAE markets. The primary issue is the lack of clarity surrounding country-specific environmental standards and regulations. Each emirate can operate under different standards borrowed from other countries, which creates confusion among exporters. In order to simplify this process, local partnerships are encouraged. Business relationships are especially key to transactions in the UAE, even more so than in Asia (International Trade Administration, 2016).

Because the UAE clean technology market has limited barriers to entry, competition among exporters can be high depending on the product or service. For example, the UAE's proximity to robust European clean technology markets can make it difficult for U.S. companies to compete for market share (International Trade Administration, 2016).

Market Assessment

Increased competition aside, the UAE is one of the most viable clean technology markets from a regulatory standpoint. UAE governments and companies are generally open to new technology developed overseas. These two forces in tandem make the UAE a significant opportunity for potential exporters specializing in water management and testing, energy hardware and software, and green building.

Japan

Market Overview

In 2010, Japan announced a commitment to \$66 billion in clean energy investment over five years. Prior to this formal commitment, many Japanese companies have been leaders in a number of clean technology submarkets. For example, Sharp pioneered the mass marketing of solar photovoltaic modules and panels. In 2012, Japan was ranked third globally for total solar PV operating capacity (KACHAN and JETRO, 2012).

Since the Fukushima reactor meltdown in 2011, Japan's energy policy is in flux. In the wake of the March 2011 disaster, almost all 54 of the nation's nuclear reactors—providing 30 percent of the nation's power—were shut down. Japan lacks domestic hydrocarbon sources, and in order to maintain energy independence, the country has made substantial investments in fostering the production of local, renewable energy (KACHAN and JETRO, 2012).

In 2012, Japan introduced some of the highest feed-in tariffs (FITs)² of any country in the world, which was expected to attract investors hoping to generate higher-than-average returns on renewable energy assets. When the FIT mechanism was originally introduced, the rate for solar energy was \$0.53/kWh with the option to reevaluate the rate in six months. The Japanese government strategically offered high FIT rates at the inception of the program to incentivize rapid establishment of renewable energy projects (KACHAN and JETRO, 2012). By 2015, the FIT rate for solar decreased by almost half to \$0.33/kWh (International Energy Agency, 2015).

Between 2012 and 2014, the countrywide share of renewable energy rose from 10.4% to 12.2%. Furthermore, solar power accounted for 96% of the electricity produced from green sources during the three years following the implementation of the FIT program (The Japan Times,

² Feed-in tariffs pay typical energy users per kWh of renewable energy they produce on their properties. These users are effectively paid to use this self-generated renewable energy as opposed to consuming power from the grid, which typically has minimal clean sources. Employed on a large scale, feed-in tariffs have the ability to accelerate investment in renewable energy technologies by effectively subsidizing green energy use. FITs are usually funded by government levies.

2016). While Japan is known for high quality energy hardware components, there is significant market opportunity for energy and battery systems management software and smart metering. These products will be key to the continued expansion of clean energy in Japan (KACHAN and JETRO, 2012).

Market Barriers

Partnerships with domestic companies and other entities are key to entering the Japanese market. Many of the government clean technology incentives and subsidies are only available to Japanese companies or subsidiaries. Additionally, partners are crucial to navigating Japanese market and business customs. Building relationships is vital to deal-making because business transactions typically do not occur without a strong foundation of trust (KACHAN and JETRO, 2012).

Japanese companies and consumers are extremely sensitive about quality control and reliability of products and services. High quality and reliable solutions are paramount to gaining entry into Japanese markets (KACHAN and JETRO, 2012).

Market Assessment

Entering the Japanese clean technology market requires substantial time and capital investments, but there is strong potential for success. Washington State is the closest of the lower 48 states to Japan, and has a historically strong trade and technology partnership with the country (Washington CleanTech Alliance, 2015). Moreover, there is a considerable degree of intellectual property protection in Japan, affording market entrants a sense of security that is lacking in other Asian markets (KACHAN and JETRO, 2012). These factors and the nation's concomitant commitment to clean energy expansion make Japan a significant opportunity for resource and grid management software products and services.

Germany

Market Overview

Germany is both the largest economy in Europe and the largest clean technology market on the continent due to the nation's commitment to environmental sustainability. The country targets reducing greenhouse gas emissions by 40 percent by 2020. Furthermore, the domestic clean technology industry is projected to more than double in volume by 2025 (Bloomberg, 2012).

In addition to reducing greenhouse emissions, Germany has pledged to shut down all of its nuclear power plants by 2022. As a result, the country has to significantly increase its production and storage of renewable energies. Smart grid technology expansion will be integral to this—

Germany needs to expand its distribution grids by more than 36,000 miles. Investment needs for grid extension and modernization is projected to be \$20.4 billion by 2020 (International Trade Administration, 2016).

There are also significant market opportunities for water conservation, resource efficiency, and pollution control technologies. In 2015, the market volume for pollution control equipment and services was \$133 billion, and is expected to grow at an annual rate of 6.6 percent. The primary drivers for the demand in this subsector are stricter environmental regulations and anticipation of resource constriction due to climate change (International Trade Administration, 2016).

Market Barriers

Germany has a vibrant domestic clean technology market, but there is still substantial room for growth and entry. Germany's strict environmental regime encourages technological innovation and limits regulatory confusion. The country hosts the Hannover Messe and Wasser Berlin International trade fairs annually. The former is the largest industrial fair in the world, and devotes about a third of its exhibition space to energy technologies (Hannover Messe, 2016). In past years, both Kane Environmental and Oscilla Power attended the exhibition. The Wasser Berlin International fair focuses on global water management technologies and policies (Wasser Berlin International, 2016).

Market Assessment

Germany has one of the most established clean technology markets in the world, and is a key opportunity for Washington clean technology firms. Abundant technology fairs, well-defined environmental laws, and established infrastructure are conducive to market entry.

RECOMMENDATIONS AND ACTION STEPS

Industry-wide Strategies

- **Expand the Washington Military & Defense Economic Impact Tool to include current information on clean technology defense trends.** The WMA can be broadened to serve the information gathering needs of aerospace defense contractors in Washington by providing regular newsfeeds and content published on the site as well as sent via SMS and email to registered subscribers.
- **Consider hiring a position to focus on technical outreach in the defense market.** This position would act as an ombudsperson for clean technology (and other targeted sectors) by liaising with technical contacts at DOD and related agencies, and by acting as a traffic cop to connect companies to the right resources and contacts.

- **Information dissemination.** Build out and update the section of the Washington State Department of Commerce with information and data on target markets, regulations, financing information and support, trends and contact info for Clean Technology Sector Lead. A shared knowledge database for clean technology defense contractors can also include basic information on exporting, including on logistics, shipping, customs and more. Create a database of defense contractors willing to talk with each other and share experiences, tips and ideas. They may be selling different products and services but much of the export basics and challenges will be the same and they can learn from each other's experiences.

Market and Sector Specific Strategies

Germany

- Consider bringing a clean technology delegation to one of the relevant trade fairs in Germany: IFAT, Wasser Berlin International and Hanover Messe (which Commerce is already engaged with).
- Provide information to Washington companies on how to enter the German market (and include this information on clean tech section on Commerce website).

Japan

- Develop a list of possible distributors, representatives and agents in Japan.
- Work with JETRO, Japanese Consulate and other Japanese partners to develop relationships with key entities in the clean technology sector of Japan, including governmental entities.

UAE

- Develop relationship with UAE government, including working with TDA which already has some of these relationships. Develop a relationship with MASDAR and work to introduce them to Washington state area companies for possible collaboration.
- Develop a list of possible distributors, representatives and agents in the UAE.

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APPENDIX

Methodology for Developing Recommendations

The table below delineates key considerations that help shape development of strategy development for the information and communication technology sector.

Exhibit A-1. Framework for Developing Strategies for Supporting Information and Communication Technology Defense Contractors

Strategic Considerations	Description	Examples
Firm characteristics	<ul style="list-style-type: none"> • Firm size • Experience exporting 	<ul style="list-style-type: none"> • Small firm vs. large firm economies of scale • Ability and/or desire to export • Resources to invest in exporting effort
Domestic conditions	<ul style="list-style-type: none"> • Health of U.S. economy • Regulatory issues • U.S. government programs supporting exporting 	<ul style="list-style-type: none"> • Strength of U.S. market versus overseas opportunities • ITAR, EAR, FCPA, compliance challenges and access to necessary information • U.S. Foreign Military Sales Program and U.S. foreign military aid (e.g., Egypt, Israel) • Excess Defense Articles program • ITAR exemption status among certain allies, including Australia
Foreign market/ government conditions	<ul style="list-style-type: none"> • State policies supporting local industries • Weak/limited IPR enforcement • Cultural barriers 	<ul style="list-style-type: none"> • Taiwan's recent plan to support more domestic production of maritime vessels • China's weak record on IPR protection • Offset requirements • Relationship building • Finding overseas distributors • Foreign governments often demand for same hardware as U.S. military.
Firm characteristics	<ul style="list-style-type: none"> • Firm size • Experience exporting 	<ul style="list-style-type: none"> • Small firm vs. large firm economies of scale • Ability and/or desire to export • Resources to invest in exporting effort
Domestic conditions	<ul style="list-style-type: none"> • Health of U.S. economy • Regulatory issues • U.S. government programs supporting exporting 	<ul style="list-style-type: none"> • Strength of U.S. market versus overseas opportunities • ITAR, EAR, FCPA, compliance challenges and access to necessary information • U.S. Foreign Military Sales Program and U.S. foreign military aid (e.g., Egypt, Israel) • Excess Defense Articles program • ITAR exemption status among certain allies, including Australia
Foreign market/ government conditions	<ul style="list-style-type: none"> • State policies supporting local industries • Weak/limited IPR enforcement • Cultural barriers 	<ul style="list-style-type: none"> • Taiwan's recent plan to support more domestic production of maritime vessels • China's weak record on IPR protection • Offset requirements • Relationship building • Finding overseas distributors • Foreign governments often demand for same hardware as U.S. military.

A-2. Categories of Assistance and Support from the Washington State Department of Commerce

Type of Assistance	Examples
Education and Training	<ul style="list-style-type: none"> • Seminars on exporting opportunities, how to find market opportunities • Seminars on legal and trade barriers and issues • Trade delegations to learn about new markets, including trips to DC to meet with embassy officials. • Add info and links to existing website on resources
Technical and Legal Assistance	<ul style="list-style-type: none"> • Proper paperwork • Export finance • Export control compliance
Market Research	<ul style="list-style-type: none"> • Identifying overseas opportunities (defense and civilian) • Finding distributors and/or overseas representatives • Helping develop connections with the Foreign Military Sales program
Advocacy	<ul style="list-style-type: none"> • Helping firms dealing with trade disputes and IPR infringement cases and other barriers • Commerce as a first point of contact for defense contractors