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Industry Study

Final Report

Environment & Climate Industry Study



**The Dwight D. Eisenhower School for National Security and Resource Strategy
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ENVIRONMENT & CLIMATE INDUSTRY STUDY 2023

ABSTRACT: *The Environment & Climate Industry Study has sought to assess U.S. and international competitiveness in the environment/climate sector(s) of business, within the context of national security, broadly defined. The Environment/Climate industry is – as its label suggests, but also as a function of the numerous constituent industries that comprise it – essentially an industry of industries. Considering its long-standing presence and the many corporate mergers and acquisitions that have basically run their course, it is a mature industry. And, by virtue of its global reach; its contributions to national interests, aims, and priorities; and its measurable impact on the economy, it is truly a strategic industry. Although U.S. firms are at the forefront of the environmental sector, the United States is, at best, a mid-tier player compared to other countries in terms of overall national environmental performance. As such, this study concludes that for the United States to prevail strategically and keep healthy competition from devolving into unhealthy conflict, public- and private-sector decisionmakers alike must undertake a number of potentially transformative policy reforms.*

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“Let us permit nature to have her way. She understands her business better than we do.”

– Michel de Montaigne

Industry Study Outreach and Field Studies

Visiting Speakers

Center for International Environmental Law
Department of the Navy
Environmental Business International, Inc.
Export-Import Bank of the United States
George Washington University
Global Environment Facility
Greenpeace USA
Hogan Lovells US, LLP, Law Firm
International Food Policy Research Institute
National Aeronautics & Space Administration
Natural Resources Defense Council
Pure Strategies, Inc.
Smithfield Foods
United Nations, Economic and Social Council, Division for Sustainable Development Goals
United Nations Foundation
U.S. Council for International Business
U.S. Department of Commerce, NOAA,
National Weather Service
U.S. Department of Defense, Deputy Assistant Secretary for Environment & Energy Resilience
U.S. Environmental Protection Agency

- Assistant Administrator, International & Tribal Affairs
- Office of Environmental Justice and External Civil Rights
- Office of Chemical Safety and Pollution Prevention

U.S. Green Building Council
Veolia North America
Washington Post
Waste Management, Inc.
White House

- Council on Environmental Quality, Office of Federal Sustainability Officer
- National Security Council

Woodrow Wilson International Center for Scholars
World Bank, Sustainable Development Practice Group

Field Studies

- **Local:**
 - AES Spotsylvania Solar Energy Center
 - Clearway Pinnacle/Blackrock Wind Farms
 - Covanta Fairfax Waste-to-Energy Facility
 - D.C. Water Blue Plains Wastewater Treatment Facility
 - NOAA, National Weather Service, National Centers for Environmental Prediction
- **Domestic: Miami, Florida**
 - Everglades National Park/South Florida Natural Resources Center
 - Carnival Cruise Lines/Port Miami
 - Greenberg Traurig Law Firm
 - Miami Beach City Government, Environment & Sustainability Department
 - Miami-Dade County Government, Office of Resilience
 - NOAA, National Hurricane Center
 - U.S. Southern Command

- **International: Geneva, Switzerland**

Deloitte Switzerland

Intergovernmental Panel on Climate Change

International Organization for Standardization

United Nations Development Programme

United Nations Environment Programme

United Nations Office for Disaster Risk Reduction

United Nations Palais des Nations

U.S. Mission to the United Nations and Other International Organizations in Geneva

World Business Council for Sustainable Development

World Economic Forum

World Health Organization

World Meteorological Organization

World Trade Organization

Executive Summary

Climate change will increasingly exacerbate risks to U.S. national security interests as the physical impacts increase and geopolitical tensions mount about the global response to the challenge. The increasing physical effects of climate change also are likely to intensify or cause domestic and cross-border geopolitical flashpoints.¹

The foregoing 2023 Annual Threat Assessment of the U.S. Intelligence Community identifies climate – and, by association, the environment more generally – as critical to U.S. national security. Domestically, climate change impacts national security in a number of important ways: the increased incidence and severity of natural disasters, water scarcity, soil erosion, sea-level rise, and heat-related injuries, among them. Internationally, the negative impacts of dramatically changing, degraded environmental conditions can lead to hunger, migration, and inter- and intra-state conflict, all of which pose major challenges to U.S., regional, and global security.

Global Warming vs. Climate Change

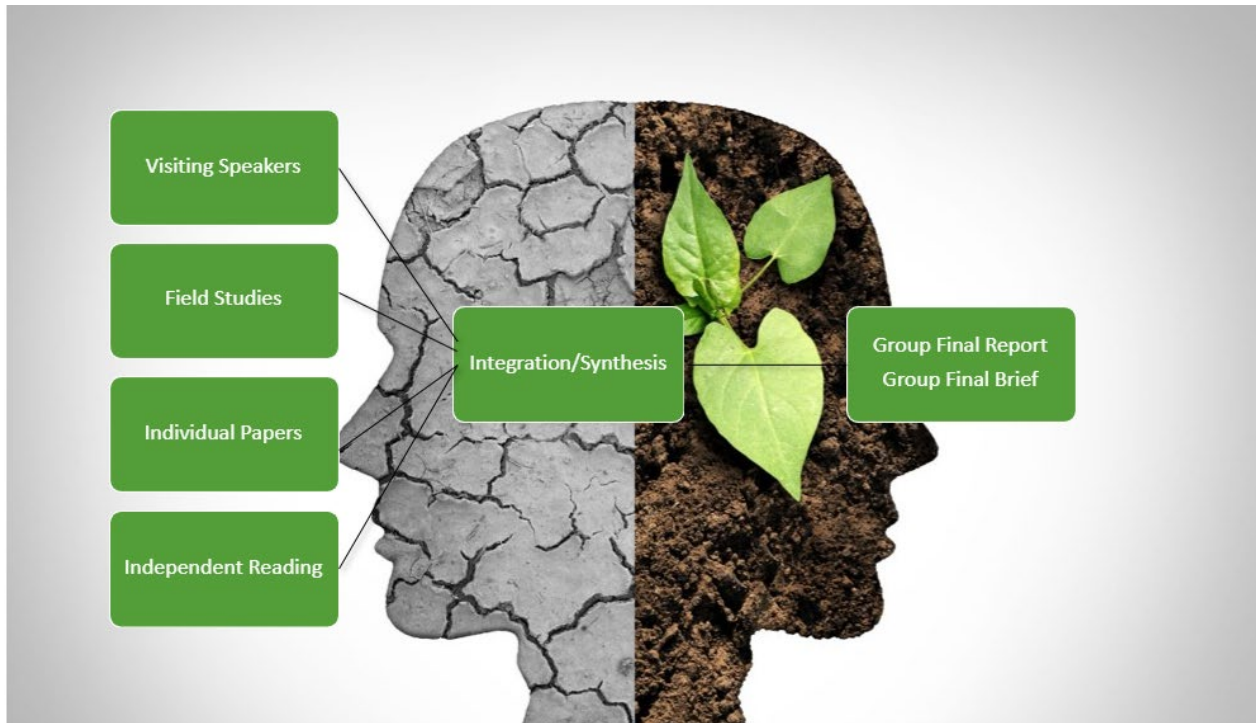
Global warming is the long-term heating of Earth's surface observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth's atmosphere. Climate change is a long-term change in the average weather patterns that have come to define Earth's local, regional, and global climates. These changes have a broad range of observed effects that are synonymous with the term.

If we are to take at face value the public pronouncements of the Biden administration, the U.S. aims to be a leader in addressing the climate crisis. The administration has taken concrete steps to increase U.S. leadership, including providing significant funding for environmental and climate initiatives. The increased funding, however, comes after decades of diminished levels of investment, thereby making the U.S. a lagging competitor internationally, compared to other countries.

To more fully realize its climate ambitions and fulfill its environmental leadership role more generally, the U.S. must undertake several important policy initiatives: 1) establishing and maintaining forward momentum to meet stated climate goals; 2) increasing U.S. international influence in the climate and environmental arenas; 3) mitigating the climate-related risks to national security; and 4) leading the development of new environmental technologies to sustain existing industry advantages.

In performing this assessment, the Environment and Climate Industry Study engaged a wide array

of stakeholders throughout the environmental community: government scientists, diplomats, and regulators; senior private-sector executives; international organization staffs; and non-governmental organizations. These engagements combined with individual research that, collectively, was integrated into this final report.



The Strategic Landscape

Climate change constitutes a serious threat to global security, an immediate risk to our national security. And make no mistake, it will impact how our military defends our country.²

This statement by former President Barack Obama succinctly conveys the generally accepted “fact” that climate change has become one of the most significant threats to the planet’s well-being and security. To ensure a sustainable future for generations to come, addressing the conjoined climate and environment crises before us is urgent. The Defense Department’s 2021 *Climate Risk Analysis* makes the case:

Climate change is reshaping the geostrategic, operational, and tactical environments with significant implications for U.S. national security and defense. Increasing temperatures; changing precipitation patterns; and more frequent, intense, and unpredictable extreme weather conditions caused by climate change are exacerbating existing risks and creating new security challenges for U.S. interests. The risks of climate change to Department of Defense (DoD) strategies, plans, capabilities, missions, and equipment, as well as those of

U.S. allies and partners, are growing. Global efforts to address climate change – including actions to address the causes as well as the effects – will influence DoD strategic interests, relationships, competition, and priorities.³

The impacts of climate change, resource scarcity and maldistribution, and sundry forms of environmental degradation have increasingly manifested themselves in the forms of conflict, migration, and political instability, among other security challenges. The idea is all too familiar.

“Environmental stress is both a cause and an effect of political tension and military conflict. Nations have fought to assert or resist control over raw materials, energy supplies, land, river basins, sea passages, and other key environmental resources. Such conflicts are likely to increase as these resources become scarcer and competition for them increases.”

– World Commission on Environment & Development
(Brundtland Commission)(1987)

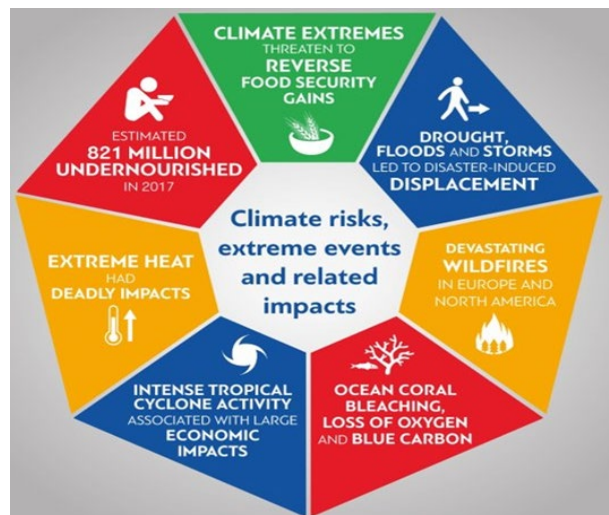
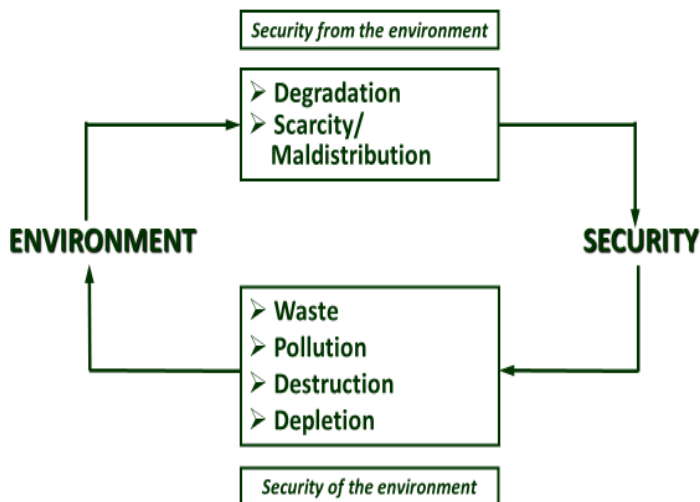
“Environmental deterioration, particularly in areas of pervasive poverty and recurrent drought, is a growing source of potential conflict. . . .These phenomena will, if unchecked, create on a much broader scale the underlying conditions that set the stage for future conflicts.”

– Commission on Global Governance (1995)

“Today, more than ever before, threats are interrelated and a threat to one is a threat to all. . . . Poverty, infectious disease, environmental degradation, and war feed one another in a deadly cycle. . . . Disease and poverty are connected to environmental degradation; climate exacerbates the occurrence of such infectious disease as malaria and dengue fever. Environmental stress, caused by large populations and shortages of land and other natural resources, can contribute to civil violence.”

– UN Secretary General’s High-Level Panel on Threats, Challenges,
and Change (2004)

Understanding the linkage(s) between the environment and security is critical for formulating sound policies and achieving relative competitive advantage, whether in the abstract (left, below) or in more precise, concrete terms (right, below).



Source: World Meteorological Organization (2019)

There are two primary approaches to addressing climate change: adaptation and mitigation.

Adaptation aims for adjustments in natural or human systems in anticipation of or in response to a changing environment to reduce the negative effects. Mitigation measures reduce the amount and speed of future climate change by reducing emissions or removing greenhouse gases from the atmosphere. To repeat:

Adaptation vs. Mitigation

Adaptation: the process of adjusting to the current and future effects of climate change.
Mitigation: making the impacts of climate change less severe by preventing or reducing the emission of greenhouse gases into the atmosphere.

The U.S. must work collaboratively with other pivotal environmental states – allies and adversaries alike – to overcome climate change within the context of strategic competition. Pivotal environmental states are countries that must be part of the global climate solution either because they have contributed significantly to global environmental problems or because without their participation, the international community will not be able to meet its climate goals. The U.S., China, Russia, France, Brazil, India, and Egypt are singled out here as key pivotal environmental states for further analysis.

Although there is a need to work collaboratively, the U.S. government cannot effectively address the national security threat represented by climate change and environmental degradation without a robust environmental industry to drive innovation. Maintaining U.S. success in the global marketplace will also help provide the funding needed to pay for the implementation of innovative technologies. Addressing the threats, risks, and opportunities to adapt supply chains and international trade is critical to U.S. economic prosperity. Furthermore, government and private investment in mitigation efforts that protect U.S. export competitiveness can unlock unlimited economic benefits due to already-established competitive advantages in many sectors of the environmental market.

The Environmental Industry Ecosystem

Environmental Industry Definition

Although there is no universally accepted definition of the “environmental industry,” the definition

proffered by Environmental Business International, a private firm that is the most authoritative source of data on the industry, is widely accepted as a starting point for further analysis:

All revenue generation associated with environmental protection, assessment, compliance with environmental regulations, pollution control, waste management, remediation of contaminated property and the provision and delivery of environmental resources.⁴

Complementing this basic definition are 14 business segments defined by EBI:

Segment	Description	Examples of Clients
Environmental Services		
Environmental Testing & Analytical Services	Provide testing of "environmental samples" (soil, water, air and some biological tissues)	Regulated industries, Gov't, C&E, Hazardous waste and remediation contractors
Wastewater Treatment Works	Collection and treatment of residential, commercial and industrial wastewaters. Facilities are commonly known as POTWs or publicly owned treatment works.	Municipalities, Commercial Establishments & All industries
Water Utilities	Selling water to end users: Municipal entities and private companies	Consumers, Commercial, All industries, Institutions
Solid Waste Management	Collection, processing and disposal of solid waste & commercial collection of recyclables	Municipalities & All industries
Hazardous Waste Management	Collection, processing and disposal of hazardous, medical waste, nuclear waste	Chemical, Petroleum, Mfgs Government agencies
Remediation and Industrial Services	Cleanup of contaminated sites, buildings and environmental cleaning of operating facilities	Government agencies Property owners, Developers Industry
Environmental Consulting & Engineering (C&E)	Engineering, consulting, design, assessment, permitting, project management, O&M, monitoring, etc.	Industry, Government Municipalities Waste Mgmt. companies, POTWs
Environmental Equipment		
Water Equipment & Chemicals	Provide equipment, supplies and maintenance in the delivery and treatment of water and wastewater.	Municipalities & All industries
Instruments & Information Systems	Produce instrumentation for the analysis of environmental samples. Includes info systems and software.	Analytical services, Gov't Regulated companies
Air Pollution Control Equipment	Produce equipment and tech. to control air pollution. Includes vehicle controls.	Utilities, Waste-to-energy Industries, Auto industry
Waste Management Equipment	Equipment for handling, storing or transporting solid, liquid or haz. waste. Includes recycling and remediation eqmnt.	Municipalities Generating industries Solid waste companies
Environmental Resources		
Water Utilities	Selling water to end users	Consumers, Municipalities & All industries
Resource Recovery	Selling materials recovered and converted from industrial by-products or post-consumer waste	Municipalities Generating industries Solid waste companies
Clean Energy Systems & Power	Solar, wind, biomass, fuel cell, geothermal, and wave & tidal: Systems / equipment sales and Power value	Utilities All industries and consumers

Source: Environmental Business International Inc., EBI Report 2020B (2022)

This typology, though generally inclusive, isn't entirely comprehensive (it doesn't include, for example, "low-carbon" goods like electric vehicles, that could be considered environmental products), but it does provide a basic foundation for organizing data collection and informing analysis. From this, we learn that the environmental industry represents total revenues of \$400+ billion, generated by about

30,000 private sector companies and more than 80,000 public sector entities in the United States, employing 1.7 million Americans, while the global environmental market is about \$900 billion.⁵

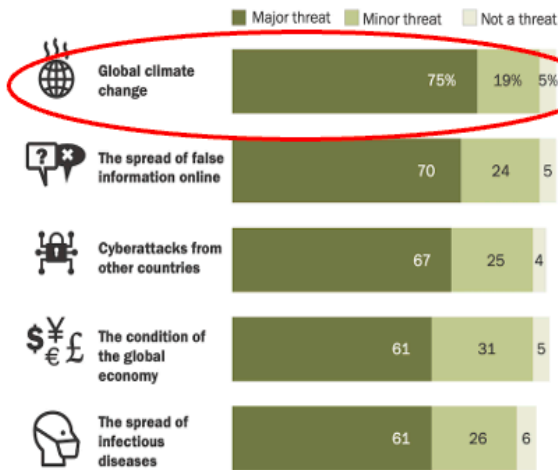
Key Factors Affecting Industry Performance

Factor: Public Opinion

Although U.S. policy elites have identified climate change and the environment as critical strategic threats, many Americans differ in their perceptions of the problem. Polling tends to show that Americans consider climate less “threatening” than other phenomena such as cyberattacks and the global economy. American views regularly differ with those in other parts of the world, where climate change is almost uniformly considered the top threat globally.

Three-in-four across 19 countries view global climate change as a major threat to their country

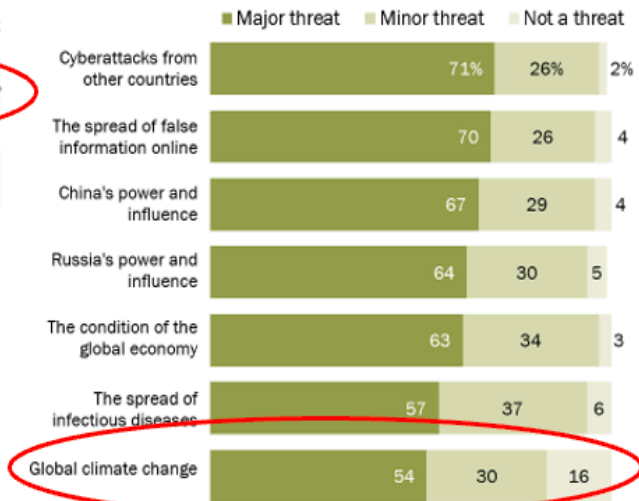
% who say ___ is a major threat, minor threat or not a threat to their country



Note: Percentages are medians based on 19 countries.
 Source: Spring 2022 Global Attitudes Survey, Q10a-e.
 "Climate Change Remains Top Global Threat Across 19-Country Survey"
 PEW RESEARCH CENTER

Around seven-in-ten Americans see cyberattacks and misinformation as major threats to the U.S.

% who say ___ is a major threat, minor threat or not a threat to the U.S.



Note: Those who did not answer are not shown.
 Source: Survey of U.S. adults conducted March 21-27, 2022, Q10a-e, Q43a&c.
 PEW RESEARCH CENTER

Factor: The Domestic Legal Landscape

Beyond public opinion, the legal landscape exerts a strong influence on U.S. environmental practice and performance. Government-mandated environmental regulations remain the main driver of demand and innovation across sectors of the environmental industry.⁶ The strength of environmental regulation is an important factor in both the domestic and international competitiveness of the environmental

industry.

The legal framework governing U.S. environmental matters is complex, with numerous departments and agencies managing climate and environmental issues at federal, state, and local levels. As a very simple example at the federal level, the White House Council on Environmental Quality oversees the all-important National Environmental Policy Act; the Environmental Protection Agency administers many noteworthy environmental laws – the Clean Air Act and the Clean Water Act among them; the National Oceanic and Atmospheric Administration is responsible for the Endangered Species Act and the Marine Mammal Protection Act. All of these pieces of legislation, along with many, many others serve as both constraint and incentive for environmental business.

Key Principles of Environmental Law

Precautionary Principle

If there is a strong suspicion that a certain activity may have environmentally harmful consequences, it is better to control that activity now rather than to wait for incontrovertible scientific evidence.

Prevention Principle

Preventing environmental harm is cheaper, easier, and less environmentally dangerous than reacting to environmental harm that already has taken place.

Polluter Pays Principle

Those who produce pollution should bear the costs of managing it to prevent damage to human health or the environment.

Common But Differentiated Responsibility Principle

All states are responsible for addressing global environmental destruction, yet not equally responsible. The principle balances, on the one hand, the need for all states to take responsibility for global environmental problems and, on the other hand, the need to recognize the wide differences in levels of economic development between states.

Factor: The International Legal Landscape

As with the domestic legal landscape, international environmental agreements and organizations are a patchwork of overlapping mandates, priorities, and resources. Under the 2015 Paris Climate Agreement, 196 nations, including the U.S., agreed to adopt mitigation practices to keep global warming from rising more than two degrees Celsius. This serves as the lodestar for global climate and GHG emission action. The Paris Agreement established an agenda for states to commit to reduced

GHG emissions. One of the key features of the agreement was the concept of nationally determined contributions (NDCs),⁷ whereby each country must submit its own plan for reducing emissions that are then reviewed by the other parties. Another important feature of the agreement is the financial support developed countries provide developing countries to help the transition to low-carbon technology.⁸

It is worth noting that there are several international environment agreements to which the United States is not a party. These include the 1982 UN Convention on the Law of the Sea, the 1992 Convention on Biological Diversity⁹ and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes,¹⁰ and the 2001 Stockholm Convention on Persistent Organic Pollutants.¹¹ As a non-party, the U.S. relinquishes its claim to leadership and places itself in the position of not being able to influence the direction of these agreements or their impact on global markets.

Other international commitments exist in the form of environmentally related trade agreements. Especially prominent among these is the European Union's newly enacted Carbon Border Adjustment Mechanism, which taxes carbon-intensive products that fail to meet EU climate standards.¹² This particular measure potentially threatens U.S. industry, as goods that don't meet EU standards may be diverted to the U.S. market, thereby harming U.S. manufacturers.

Factor: Environmental Management Systems

While legal frameworks provide an overarching structure, pro and con, for the conduct of business, voluntary standards such as environmental management systems (EMS) offer organizations incentives for improving environmental performance, innovation, and competitiveness. An EMS is a set of processes and practices that organizations can use to manage the environmental impacts of operations. EMSs are also useful for reporting a firm's progress toward environmental goals to both internal and external stakeholders. Adopting an EMS enables profit-driven organizations to respond to evolving environmental risks.¹³

The EMS with the broadest global application is the International Organization for

Standardization's ISO 14001 standard. ISO 14001 is the internationally recognized standard for continually improving organizations' environmental systems and approaches. All ISO standards are regularly reviewed by representatives of ISO's 160 member states to ensure relevance to current market trends. Recent improvements in ISO 14001 include increased prominence of environmental management in an organization's strategic planning process, with greater input from leadership and proactive initiatives required to boost environmental performance.¹⁴

Voluntary EMS standards are economically important because the process of continuous improvement in environmental performance can bolster innovation at the same time that it enhances coherence, durability, and universalization. Experience has shown that companies with EMSs in place are more likely to invest in research and development of new technologies or practices that reduce negative environmental impacts.

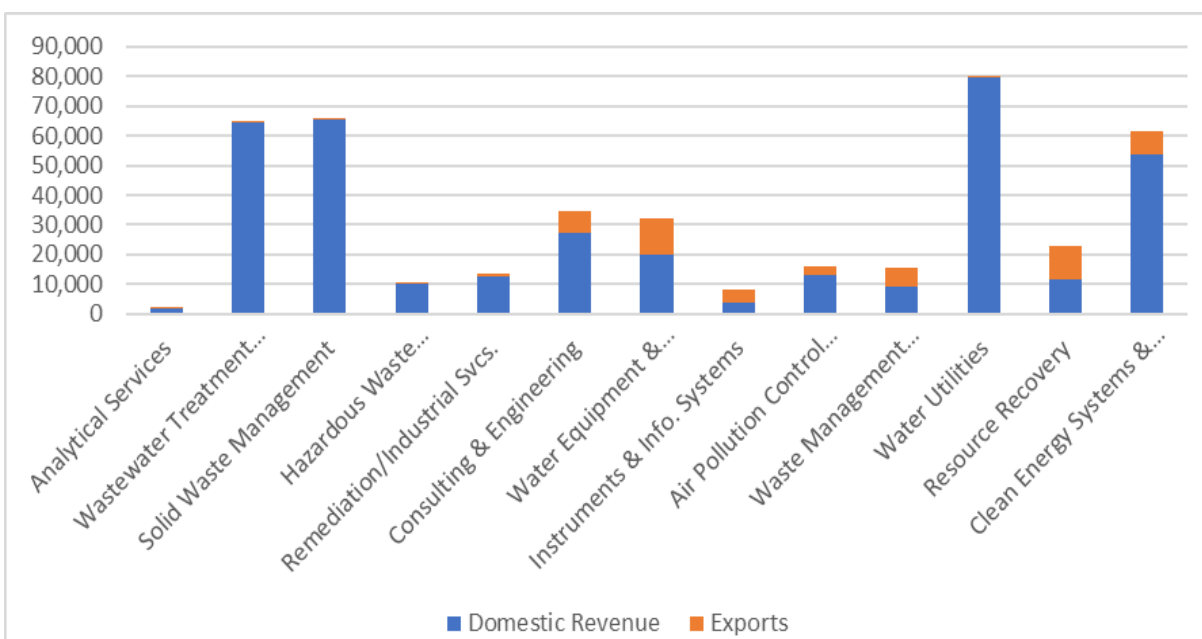
Factor: New U.S. Environmental Funding

In the United States, several recently passed bills provide significant funding and political support for environmental initiatives. The Build Back Better Act includes over \$160 billion for environmental projects, including \$12 billion for water infrastructure and \$32 billion for environmental climate and pollution reduction.¹⁵ The Infrastructure Investment and Jobs Act provides an additional \$55 billion for water infrastructure, \$21 billion for environmental remediation, and \$39 billion for public transit.¹⁶ Finally, the Inflation Reduction Act contains \$369 billion for environmental initiatives, including electrification of the transportation system and generation of clean energy.¹⁷

Combined, these bills provide more than \$600 billion for environmental initiatives. Although not all of this funding will directly benefit U.S. environmental businesses, this injection of funding provides a significant opportunity for U.S. companies to develop environmental technologies and improve their domestic and global competitiveness. The potential impact of such funding is already causing concern in foreign nations; the European Union, for example, is trying to fast-track its own investment plan to incentivize European companies.¹⁸

U.S. Environmental Economy Overview

The U.S. environmental industry generated \$426 billion in revenue in 2020, representing 2% of U.S. GDP.¹⁹ Within the industry, water is the largest subsector (particularly if wastewater treatment and utilities are combined), followed by solid waste management and clean energy. These particular industries are typically utilities in the United States, and thus are subject to strict local regulations governing distribution and pricing. Utility companies typically enjoy monopolistic markets of consumers who have limited access to alternative providers.



Source: Environmental Business International, EBI Report 2020B: U.S. Environmental Industry

Revenue in these three major sectors – water, energy, and waste – is almost entirely domestic because a company must have a local presence to provide such services.. The need for local presence requires U.S. companies wanting to service foreign markets to do so via direct investment. Data on U.S. investment, however, show that few U.S. utility companies have made such investments.

Among the three major utilities, only electricity generation companies have significant investments abroad. Foreign investments by waste and water companies are small and have declined in recent years. In contrast, foreign companies have significant investments in the U.S. market, particularly in electricity. The investment data for water and sewage is largely suppressed, but private-sector data

indicate that French company Veolia is the third largest water services provider in the U.S.²⁰

U.S. Investment Abroad	2018	2019	2020	2021
Electric power generation, transmission, and distribution	12,121	13,274	16,231	16,095
Water, sewage, and other systems	272	191	140	118
Waste management and remediation services	1,477	988	956	834
Foreign Investment in the U.S.	2018	2019	2020	2021
Electric power generation, transmission, and distribution	80,721	92,151	103,470	104,705
Water, sewage, and other systems	(D)	(D)	(D)	(D)
Waste management and remediation services	5,516	5,535	6,394	(D)

Source: U.S. Bureau of Economic Analysis, “Balance of Payments and Direct Investment Position Data” and “Balance of Payments and Direct Investment Position Data.” (D) indicates that data are suppressed to avoid disclosure of individual company data.

In contrast to the domestic focus of utilities, U.S. companies produce significant export revenue in sectors such as water equipment and environmental consulting, where local presence isn’t required. U.S. export success in these sectors is an indication that the U.S. is globally competitive. These sectors, however, generate significantly less revenue than the utility sectors, so it may be difficult for U.S. companies to grow out of these niche sectors without a larger revenue base.

Comparative and Competitive Advantage

Several organizations monitor and publish relative rankings on aspects of the environmental industry. For example, the annual Yale-Columbia Environmental Performance Index (EPI) ranks countries against a rich array of environmental performance indicators. The UN tracks national progress in achieving the 17 Sustainable Development Goals (SDGs) promulgated by UN member states in 2015. The World Intellectual Property Organization similarly ranks national innovative capacity across multiple measures. And *Engineering News-Record* produces an annual ranking of the world’s top 200 environmental firms.

Such ranking schemes make it possible to analyze U.S. competitiveness in the environmental industry across a range of key environmental sectors and markets. The EPI, for example, ranks the U.S. 43rd globally in overall national environmental performance, behind European leaders like Norway and the United Kingdom, but well ahead of Russia and China.²¹

RANK	COUNTRY	SCORE			SCORE
1	Denmark	77.9	38	São Tomé and Príncipe	52.9
2	United Kingdom	77.7	39	Antigua and Barbuda	52.4
3	Finland	76.5	39	United Arab Emirates	52.4
4	Malta	75.2	41	Bulgaria	51.9
5	Sweden	72.7	42	Dominica	51.2
6	Luxembourg	72.3	43	United States of America	51.1
7	Slovenia	67.3	44	Namibia	50.9
8	Austria	66.5	44	Singapore	50.9
9	Switzerland	65.9	46	Poland	50.6
10	Iceland	62.8	110	Nicaragua	37.7
11	Netherlands	62.6	110	Niger	37.7
12	France	62.5	112	Russia	37.5
13	Germany	62.4	113	Maldives	37.4
14	Estonia	61.4	113	Micronesia	37.4
15	Latvia	61.1	159	Mali	28.5
16	Croatia	60.2	160	China	28.4
17	Australia	60.1	160	Morocco	28.4
18	Slovakia	60.0	162	Nepal	28.3
19	Czech Republic	59.9	162	Nigeria	28.3
20	Norway	59.3			

Source: 2022 Environmental Performance Index

Such rankings show the U.S. as something considerably less than a global environmental leader, lagging well behind European countries in key sectors including water, renewable energy, and solid waste. On the other hand, the latest *Engineering News-Record* review of the top international environmental services firms (see below) shows something of a contrasting picture. Four of the top six, 13 of the top 20, and 35 of the top 50 are U.S. firms, indicating considerable private-sector success even in the face of the under-performing country they represent. Such success, combined with the impressive innovative capacity of U.S. industry, ranked number two globally in WIPO's annual Global Innovation Index, offers hope that, despite its current mid-tier position, the U.S. can improve its global competitiveness with more focused, integrated effort.

RANK		FIRM	2021 ENVIRONMENTAL REVENUE		
2022	2021		TOTAL (IN \$ MIL.)	% OF ALL FIRM REV.	% NON-U.S.
1	1	VEOLIA ENVIRONNEMENT, Paris, France	33,729.0	100	94
2	3	AECOM, Dallas, Texas	6,837.6	51	19
3	**	LARSEN & TOUBRO LTD., Mumbai, India	4,833.3	30	100
4	2	JACOBS, Dallas, Texas	4,833.0	34	31
5	**	CLEAN HARBORS INC., Norwell, Mass.	3,805.6	100	13
6	4	TETRA TECH INC., Pasadena, Calif.	3,306.0	100	33
7	8	WSP GLOBAL INC., Montreal, Quebec, Canada	2,797.0	33	75
8	6	BECHTEL, Reston, Va.	2,048.3	12	28
9	5	FLUOR CORP., Irving, Texas	2,047.6	17	2
10	11	WEBUILD SPA, Milan, Italy	1,793.4	23	83
11	7	MORTENSON, Minneapolis, Minn.	1,657.5	34	0
12	9	STANTEC INC., Edmonton, Alberta, Canada	1,472.9	40	48
13	**	ARCADIS NV, Amsterdam, Netherlands	1,462.0	36	34
14	10	HDR, Omaha, Neb.	1,230.7	44	9
15	12	SUEZ NORTH AMERICA, Paramus, N.J. ¹	1,200.0	100	6
16	20	ERM, London, U.K.	1,151.1	100	48
17	22	CDM SMITH, Boston, Mass.	1,104.0	81	18
18	**	AMENTUM, Germantown, Md.	1,100.0	25	5
19	13	GARNEY HOLDING CO., Kansas City, Mo.	1,068.4	100	0
20	14	KIEWIT CORP., Omaha, Neb.	1,053.3	9	6

Source: Engineering News-Record (July 25/August 1, 2022)

Sector Analysis – UN Sustainable Development Goals

In 2015, UN member states agreed to 17 interconnected SDGs to address the most pressing international challenges to building a more prosperous, sustainable world for all. UN General Assembly Resolution A/RES/70/1 of September 25, 2015, targets 2030 to achieve the SDGs with a “view toward ending all forms of poverty, fighting inequalities, and tackling climate change while ensuring that no one is left behind.”²² Meeting these ambitious goals is imperative for achieving sustainable development and shared global prosperity. Progress is reported in the annual UN Sustainable Development Report.

The SDGs are not merely altruistic; achieving the SDGs would create at least \$12 trillion of market opportunities in four economic systems: food and agriculture, cities, energy and materials, and health

and well-being.²³ To take advantage of these opportunities U.S. industry needs to be an active participant.

Despite its comparative wealth, the U.S. lags other wealthy countries in achieving progress on the SDGs, ranking only 41st out of 163 countries.²⁴ This lag is evident in the SDGs most closely linked to the environmental industry: SDG 6 – Clean Water and Sanitation; SDG 7 – Affordable and Clean Energy; and SDG 12 – Responsible Consumption. In these SDGs, the U.S. has major or significant challenges remaining.

Goal 6 – Clean Water and Sanitation

SDG 6 provides a blueprint for ensuring the availability and sustainable management of water and sanitation globally. Safe water, sanitation, and hygiene are among the most basic human needs for health and well-being and underpin the other SDGs. Progress on SDG 6 would create opportunities for economic benefits associated with improved health, poverty reduction, and socioeconomic development. Business opportunities center on the development of sustainable microgrids to treat water at remote locations at scale, technology to deploy systems to biodegrade plastic contaminants in water sources, and optimization of water recycling alternatives to reduce household consumption.

The U.S. population has access to basic drinking water and sanitation services, managed principally by water services and utilities, thus according the U.S. giving a relatively high ranking in the 2022 SDG Report. This high ranking does not, however, translate into international competitiveness. The U.S. water sector is extremely fragmented, with over 60,000 companies/public entities providing water and over 25,000 treating wastewater.²⁵ The vast majority of firms in the municipal sector are public utilities; only 15% of water supply and 5% of wastewater treatment providers to municipalities are private.²⁶ This level of fragmentation and public ownership in an industry with significant capital costs makes it difficult to innovate or adopt new technologies. Because of this fragmentation, U.S. companies in the water sector are at a significant disadvantage vis-a-vis their European competitors,

where water supply and treatment have been privatized and consolidated.²⁷ U.S. water companies and are therefore unlikely to be able to take advantage of opportunities stemming from SDG 6.

Despite the disadvantages of the U.S. market structure, there are opportunities for U.S. businesses in the water sector. U.S. environmental consulting and services companies are highly competitive in the global water utilities sector due to their robust capital in R&D, expertise, and technologies. There are also a limited number of large municipal water districts that may be able to develop technologies that are internationally competitive. For example, DC Water employs technologies for its enhanced nitrogen removal facilities, implementing the DEMON process – a novel anammox-based side stream treatment process²⁸ – in its filtrate treatment facilities. The DC Water DEMON process is the largest of its kind in the world and represents a breakthrough in nitrogen removal, providing the U.S. with a potential exportable product to help developing countries in water treatment.²⁹

Goal 7 – Affordable and Clean Energy

SDG 7 aims to “ensure access to affordable, reliable, sustainable, and modern energy for all.”³⁰ Global renewable energy production increased by 25% in the last decade, but as of 2020, it still accounted for only 17% of world electricity production capacity.³¹ The International Energy Agency identifies emerging markets and developing economy countries in Africa, Europe, Latin America, and Asia (but not China) as the key energy markets. These markets are most pivotal due to the energy sector’s relatively low per capita emissions resulting from low development and the expected growth as these regions strive to achieve SDG 7.

In the U.S., clean energy (including nuclear) accounted for 40% of energy production in 2022 (1.7 trillion kilowatt-hours).³² Within the clean energy sector, the three largest contributors were nuclear, wind, and hydropower. Solar power was the fourth largest contributor in 2022, but it is expected to eclipse both wind and hydro by 2027.³³ Unlike the traditional energy market, the U.S. renewable market is highly competitive with providers operating across multiple states.³⁴ After a period of rapid expansion, the U.S. market is beginning to consolidate around emerging leaders.³⁵ One of these leaders

is NextEra, which operates in the U.S., Canada, and Spain and is one of America’s largest generators of wind and solar power.³⁶ Despite this progress, the 2022 UN SDG report states that the U.S. has “significant challenges remaining” in achieving SDG 7.³⁷ This is partly due to the fragmented nature of the U.S. electrical grid, which is regulated at the state and local levels, thereby making it difficult to implement clean energy technologies.

Internationally, the Asia-Pacific and European regions are the leading producers of renewable energy.³⁸ Hydropower leads the Asian market, although solar and wind are growing rapidly. Public/state-owned energy producers dominate in most countries, providing additional opportunities for economies of scale. China is the world’s largest producer of renewable energy, led by the China Three Gorges Corporation, which operates in over 50 countries globally. In Europe, the focus has been on the development of offshore wind farms.³⁹ European energy companies have also established a strong foothold in the U.S. market with investments valued at more than \$400 billion (including both green and traditional energy).⁴⁰ The strength of European and Asian energy companies and their established presence internationally will make it difficult for U.S. companies to make inroads in the energy sector.

Goal 12 – Responsible Consumption

SDG 12 seeks to promote the sustainable production and use of consumer products, ensuring sustainable consumption patterns. This goal includes activities related to efficient resource use, waste management, recycling, and the circular economy. Consumption and production activities impact climate change because carbon emissions result from manufacturing, sourcing of raw materials, managing waste, and executing supply chains.

Circular Economy

A model of production and consumption that involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. It implies reducing waste to a minimum. When a product reaches the end of its life, its materials are kept within the economy wherever possible thanks to recycling. These can be productively used again to create added value.

Two key challenges related to this SDG include reducing food waste and supporting clean manufacturing processes. Due to the consumption focus of the U.S. – a country of shoppers and consumers – U.S. business firms play an integral part in this SDG. Industries with a notable impact in this space include sellers of consumer goods, manufacturers, waste management companies, and industries such as hotels, restaurants, the entertainment industry, and the transportation sector.

In contrast to the water industry, the solid waste industry in the U.S. has already undergone a significant degree of privatization and consolidation.⁴¹ The U.S. market is dominated by two private companies, Waste Management and Republic Services, each of which records more than \$10 billion in revenue annually.⁴² Although this level of revenue provides a solid platform for investing abroad, neither company has a significant international presence. Globally, the U.S. and Europe are the main competitors in solid waste management.⁴³ This despite the Asia-Pacific region, with its large population and manufacturing sector, leading global value.⁴⁴ All of the leading companies are engaged in broadening their client base, via expansion into either other services or new markets.⁴⁵

Pivotal Country Assessments

To address the global climate crisis, analyzing the environmental state of affairs in so-called pivotal environmental states, especially major polluters, is important for identifying areas of opportunity for U.S. business. Pivotal environmental states are defined as countries that must be part of the global climate solution, because either they have contributed significantly to global environmental problems or, without their participation, the international community will not be able to meet its climate goals. The U.S., China, Russia, France, Brazil, India, and Egypt are considered key pivotal environmental states, without whose cooperation climate change will remain a security threat for the U.S. – what President Biden has called “one of the greatest challenges of our time.”⁴⁶

Russia

Russia is a pivotal environmental state whose injurious actions – heavy industrial production and deforestation, poor stewardship of its natural resources, and a hydrocarbon-driven economy – have

significantly damaged Russia's environment and fueled the current climate crisis.⁴⁷ The 2022 EPI ranks Russia 112th out of 180 countries.⁴⁸ As the world's 5th largest GHG emitter,⁴⁹ "Russia is warming 2.5 times faster than the rest of the world," according to the Center for Strategic and International Studies.

Russia must be part of the solution to halt this environmental decline and have any hope of reversing it. Russia has an opening to address the climate crisis and its economic vulnerabilities by diversifying its economy to promote more clean-energy industries. Yet the state's overreliance on its oil and gas industry as the primary driver of Russia's economic power inhibits Moscow's ability to make significant environmental progress. Russia lacks the political will to address the climate crisis in a meaningful way and has yet to make substantial progress on its SDGs. Furthermore, with military operations in Ukraine sucking up time and money, it is unlikely Russia will focus adequately on a longer-term challenge like climate change.

Russian Business Climate for U.S. Firms. Potential clean-energy business opportunities to help Russia transition from oil and gas exist,⁵⁰ but lobbying by oil and gas oligarchs and restrictive government policies pose significant roadblocks. Furthermore, the weak rule of law, pervasive corruption, and long-standing international sanctions make it difficult for U.S. businesses to operate in Russia. Moscow's war in Ukraine has further heightened existing unfriendly market conditions for U.S. firms. Sanctions on Russian banking institutions make it difficult for U.S. companies⁵¹ to conduct financial transactions in Russia,⁵² and Executive Order 14068 prohibits all new investments in Russia by any U.S. entity.^{53,54} Many multinational companies have scaled back operations following intense pressure from shareholders to leave Russia; for example, top U.S. environmental firm AECOM has fully exited Russia.^{55,56} These hostile market conditions are pushing U.S. firms, including environmental ones, to other markets as Russia is currently too risky and inhospitable.⁵⁷

China

As the world's most populous country with the second largest economy, China has an enormous impact as a pivotal environmental state. However, the ruling Chinese Communist Party (CCP) has sacrificed climate, environment, and health in order to build its economy and expand the CCP's regional and global influence. These achievements have come at a grave cost to China and the planet. China now generates more carbon dioxide than the U.S., India, and the European Union combined.⁵⁸

Given China's population size and economic power, it has an outsized impact on the ability of the UN to achieve global SDGs and reduce GHG emissions to slow global warming. Officially, China endorses a public policy of environmental care and stewardship, but a closer look into the SDGs reveals a complete lack of progress on several critical environmental targets, including renewable energy, CO₂ emissions, wastewater treatment, and endangered species survivability.⁵⁹ Additionally, China's EPI score has steadily declined since 2016, dropping a staggering 37 points over that period and falling to 160th out of 180 nations.⁶⁰ China's pledged net-zero carbon target date of 2060 is 10 years behind the UN's goal.⁶¹ Without China's cooperation, it will be nearly impossible for the international community to address the growing global climate crisis.

Net Zero

A state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere. The term net zero is important because – for CO₂ at least – this is the state at which global warming stops.

Chinese Business Climate for U.S. Firms. The observed lack of environmental compliance in China creates conditions where U.S. environmental firms can penetrate the market but should do so carefully as CCP policies continue to infringe upon intellectual property, upend proprietary business procedures, and give state-owned enterprises a competitive advantage over foreign firms. The negative aspects of China's EPI and SDG scores, especially those that are stagnating or declining, suggest the possibility that U.S. environmental companies could have a competitive advantage over domestic firms

in the Chinese market, including solid waste and wastewater management, renewable energy, and sustainable food production.

India

Given its fast-growing economy and large, increasing population, India is another pivotal environmental state that must be part of the climate change solution. Like China, India prioritized economic growth over environmental protection to the detriment of the planet. In 2022, EPI ranked India 180th out of 180 countries, reflecting poor performance in air and water quality, biodiversity and habitat conservation, and climate change.⁶² Unlike China and Russia, however, India is taking steps to strengthen its environmental industry to address climate change. Pollution and waste management are serious environmental concerns for India, and its over-dependence on and government support of fossil fuel makes India the world's third largest GHG emitter. As such, India has pushed its target date for achieving net-zero emissions to 2070, 20 years behind the UN target.

Despite Indian Prime Minister Modi's commitments at the UN Framework Convention on Climate Change (UNFCCC) 26th Conference of Parties (COP26) in 2021 to help slow down climate change, India still lags in meeting its UN SDGs, as it ranks 121st out of 163 countries. Furthermore, India has well-documented environmental protection policies, laws, and regulations, but it fails to implement them effectively. To achieve Modi's COP26 targets, India must decouple its economic growth from its emissions.

COP

Conference of the Parties, an international climate meeting held each year by the United Nations involving those countries that joined – or are “party to” in legal terms – the international treaty called the U.N. Framework Convention on Climate Change (UNFCCC). COP 21 (2015): Paris; COP 27 (2022): Sharm el-Sheikh; COP 28 (2023): United Arab Emirates.

Indian Business Climate for U.S. Firms. With the 5th largest economy and annual GDP growth rates of 6-7%,⁶³ India is an attractive market for U.S. businesses. With 300 sunny days each year, vast landscapes, and long windy shorelines, India's renewable energy power generation potential is enormous, increasing 396% since 2014 and comprising approximately 42.5% of the country's total

energy capacity."⁶⁴ Although some barriers to entry into the Indian renewable energy markets exist, U.S. environmental firms are helping India reduce GHG emissions to achieve net zero as early as 2050. For example, AES (Applied Energy Services) Corporation and First Solar are investing in India's wind and solar power generation potential. Their investments not only help to accelerate the future of clean energy in India, but they also empower India as a potentially powerful ally in mitigating the global climate crisis.

France

France is an international leader in integrating environmental responsibility into its governance and economy. However, like the U.S., climate change threatens France's natural resources and jeopardizes its national security. Some of France's most consequential environmental issues are forest damage from acid rain, air pollution from industrial and vehicle emissions, water pollution from urban waste, and agricultural runoff. Most notably, increased global temperatures due to GHGs are threatening France's extensive agricultural industry; its agricultural yields are projected to decrease 50% by 2050 because of heatwaves that have increased one-hundredfold since the early 1900s due to air pollution.⁶⁵ To address the threats posed by climate change, France has implemented extensive legislation and policy, leading the world in responsible environmental stewardship.

French Business Climate for U.S. Firms. In addition to being close political allies, the U.S. and France have a long-standing economic relationship, approximately \$350 million in daily commercial transactions. In addition to trade, the U.S. and France enjoy large foreign investment footprints in each other's markets. The U.S. is a leading foreign investor in the French economy, accounting for over \$91 billion in direct investment in 2021.⁶⁶ France invests the most in the U.S. market compared to its foreign investment expenditure in any other country. However, neither country invests significantly in the other's energy market.⁶⁷ Consequently, there are significant opportunities to expand their economic cooperation as both transition towards clean energy.

Brazil

Brazil is the largest country in South America and the 6th most populous country globally. As a result, Brazil wields considerable geopolitical power and is a vital partner for the U.S. in advancing regional stability, security, and economic development. Although Brazil is a country of immense natural beauty and ecological diversity, its environment is under threat from deforestation, mining, agricultural run-off, and urbanization. Deforestation in the Amazon rainforest is significant because of its impact on the global climate system. Brazil has made progress toward becoming more environmentally conscious in recent years with the implementation of policies and initiatives to promote environmental conservation and sustainable development. However, the country faces significant environmental challenges, and recent political and economic factors have hindered progress in environmental protection.

Brazilian Business Climate for U.S. Firms. Brazil is a key U.S. partner with a set of environmental conditions and culture that can lead to business opportunities and entry into the country's environmental markets. According to the International Monetary Fund, Brazil has the 10th largest economy in terms of GDP and is ranked 8th globally for purchasing power.⁶⁸ Brazil is a major U.S. trading partner with bilateral trade totaling over \$100 billion in 2021, second only to Brazil's trade with China.⁶⁹ The U.S. is also one of Brazil's top sources of foreign investment, with American companies investing heavily in the country's energy, infrastructure, and technology sectors. Brazil is also a major player in the global energy market, with significant oil and gas reserves, and has the potential to become an important U.S. energy partner.

Egypt

Climate effects, combined with Egypt's insufficient infrastructure, challenge the country's environmental future and prosperity. The Nile River accounts for roughly 97% of freshwater resources in Egypt and has a unique and extremely vulnerable basin.⁷⁰ Population growth and water resource trends suggest that the country will reach extreme water scarcity in 2033.⁷¹ Desalination plants are

desperately needed to meet both current and future water demand, but their capacity growth is not high enough. Increases in heatwaves and desertification – Egypt loses 2% of its arable land per decade – threaten food security and the agricultural industry.⁷²

Despite its sunny climate, wind and solar energy production is surprisingly very low in Egypt. Natural gas and petroleum products account for more than 90% of Egypt's energy resources.⁷³ The vulnerability and potential stresses mentioned above threaten Egypt's future prosperity and overall resilience to climate change. The government of Egypt is aware of the effort it needs to take to face these challenges. It appointed a National Council for Climate Change that has developed a comprehensive national climate change strategy.⁷⁴

Egyptian Business Climate for U.S. Firms. Egypt has a large consumer market, with a diverse and young population of over 100 million. Its location in Africa and the Middle East makes Egypt a potential trade and logistics hub for many markets, including Europe. Egypt also has immense potential in renewable energy resources, particularly in solar and wind power. Furthermore, the rapid urbanization and population growth creates great opportunities for wastewater management and recycling processes that become ever more critical for the nation's basic survival. Moreover, the NCCC points out that agriculture and aquaculture are also sectors with a great need and potential for investments.⁷⁵ However, a decade ago the nation went through major political turbulence. Instability, together with lack of transparency and consistency in the legal framework, particularly related to property rights and contract enforcement, discourage long-term foreign investment.

Strategic Competition Within the Environmental Industry

The U.S. and its two major strategic competitors, China and Russia, have vastly different environmental and climate industries. To assess their respective business performance, it is helpful to conduct a line of effort (LOE) analysis. LOE analysis links multiple tasks to focus efforts toward establishing conditions that define desired objectives⁷⁶ and provides a convergent approach for comparing the business performance of the U.S. with China and Russia. The LOEs employed here are

derived from the 2022 UN SDG Report and WIPO’s 2022 Global Innovation Index. The analysis demonstrates that U.S. strength in innovation will be a key factor in its ability to position itself as a leader in the global environmental industry.

SDGs	USA	China	Russia	GII	USA	China	Russia
Overall Rank* (2022)	41	56	45	Overall Rank** (2022)	2	11	47
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE	Yellow	Yellow	Orange	Institutions	13	42	89
12 RESPONSIBLE CONSUMPTION AND PRODUCTION	Red	Yellow	Orange	Infrastructure	19	25	62
13 CLIMATE ACTION	Red	Yellow	Red	Business Sophistication	3	12	44
16 PEACE, JUSTICE AND STRONG INSTITUTIONS	Red	Yellow	Red	Knowledge & Technology Outputs	3	6	51

* The lower the number, the more progress the country is making in meeting its SDGs.

Key: Green = SDG achieved
 Yellow = challenges remain
 Orange = significant challenges remain
 Red = major challenges remain

** The lower the number, the better the country is showing in innovation performance.

Source: UN SDG Report (2022) and WIPO GII Report (2022)

LOE Analysis of Sustainable Development Goals

For the first string of LOEs, this analysis focuses on the four SDGs that most closely aligned with business performance: SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 16 (Peace, Justice, and Strong Institutions).⁷⁷ The U.S. ranks 41st, China 56th, and Russia 45th out of the 163 countries in the SDG report. The higher on the list a country is, the more progress it is making in meeting the SDGs. While the U.S. ranks higher than Russia and China overall, China leads in three out of the four SDGs (12, 13, and 16), while the U.S. leads in only one (9).

SDG 9 – Industry, Innovation, and Infrastructure.⁷⁸ *Of the three countries, the U.S. is leading in this area.* The U.S. is on track to achieve this SDG after it addresses its few remaining challenges, such as internet access by income. Like the U.S., China is also on track to meet this SDG if it addresses

challenges in internet access for its population. While significant challenges remain for Russia, it is moderately improving in this SDG as it strives to improve the quality of trade and transport-related infrastructure and its R&D expenditures.

SDG 12 – Responsible Consumption and Production.⁷⁹ *China leads the three countries in this SDG.* SDG 12 is China’s strongest of the four analyzed. While challenges remain for China (electronic waste), it is on track to achieve this SDG. Similarly, Russia is moderately improving as it strives to address its significant challenges with electronic waste, municipal solid waste, and nitrogen emissions embodied in imports. SDG 12 is the weakest one for the U.S. out of the four; major challenges (e.g., electronic waste, non-recycled municipal solid waste, and sulfur dioxide (SO₂) emissions) for the U.S. remain and are expected to worsen.

SDG 13 – Climate Action.⁸⁰ *China leads the three countries in this SDG.* China is moderately improving in meeting its remaining challenges associated with CO₂ emissions from fossil fuel combustion and cement production. While Russia is making moderate improvements in addressing the major challenges it faces with CO₂ emissions, the U.S. has stagnated in its progress to address its major CO₂ emissions challenges.

SDG 16 – Peace, Justice, and Strong Institutions.⁸¹ *China leads in this SDG.* Although significant challenges remain for China to achieve this SDG (corruption, access to justice, and lack of free press), it is making moderate improvements. The U.S. and Russia both demonstrate moderate improvements on the major challenges that remain for them to achieve this SDG. For the U.S., the challenges are homicides, access to and affordability of justice, persons held in prison, and major conventional weapons exports. Russia’s challenges include major conventional weapons exports, corruption, homicides, lack of free press, and property rights violations.

LOE Analysis of the Global Innovation Index

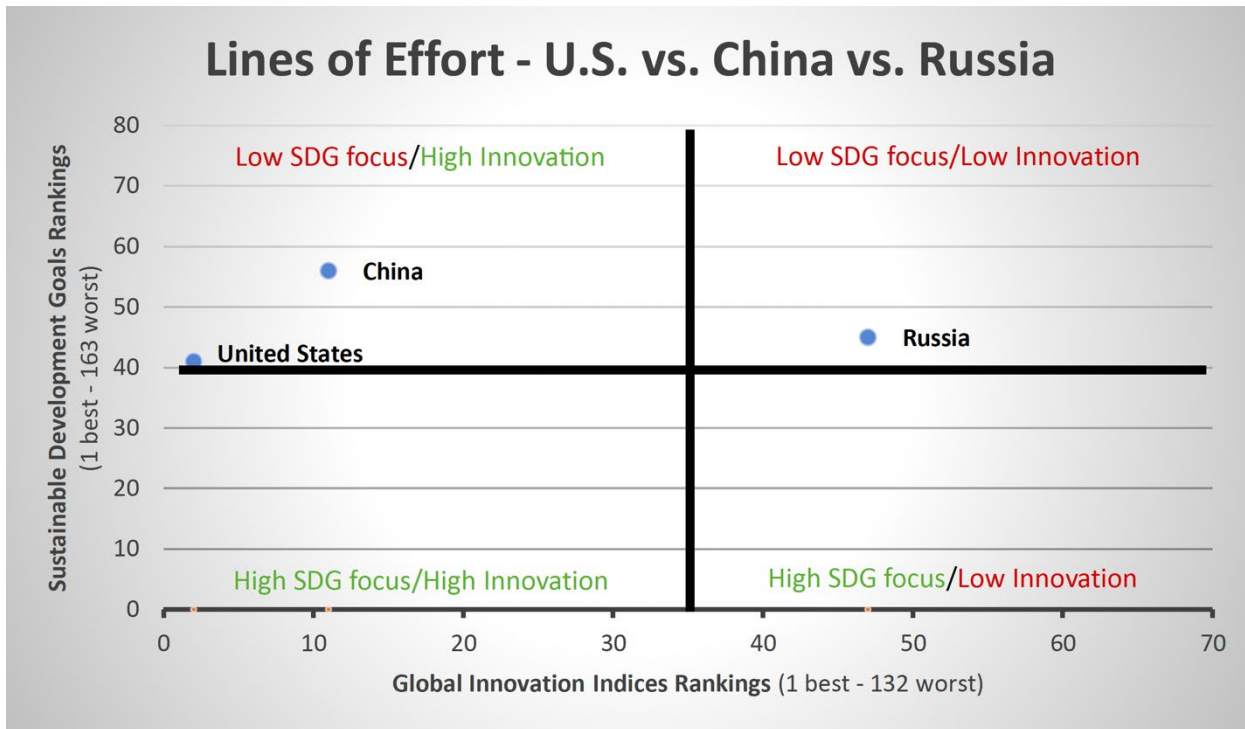
For the second string of LOEs, this analysis covers the most business-relevant measures, including Institutions, Infrastructure, Business Sophistication, and Knowledge and Technology.⁸² The GII

contains seven innovation pillars, feeding into the overall GII ranking. The higher a country ranks, the better it is doing in terms of innovation performance.

The U.S. leads in all the assessed GIIs and ranks 2nd out of 132 countries. Major U.S. strengths include e-participation within information and communication technologies; university-industry R&D collaboration; gross expenditure on R&D (GERD) performed by businesses within knowledge workers; patents by origin; and software spending. Major weaknesses include political and operational stability; gross capital formation in general infrastructure; gross domestic product (GDP) per unit of energy; and ISO 14001 certification.

China lags the U.S. with an overall ranking of 11. Its strongest areas include entrepreneurship policies and culture within the business environment; gross capital formation in general infrastructure; firms offering formal training; GERD financed by businesses; and patents and utility models by origin. Weaknesses include its regulatory environment; environmental performance; and GDP per unit of energy use.

Of the three countries, Russia is the least competitive with an overall ranking of 47. Russia's strengths include entrepreneurship policies culture within the business environment; employed women with advanced degrees; knowledge-intensive employment; and patents and utility models by origin. Its weakest areas are rule of law within the regulatory environment; overall business environment; GDP per unit of energy use; ISO 14001 certification; and FDI net inflows.



While the U.S., China, and Russia all struggle to meet SDG targets, China leads in the LOE analysis of these selected SDGs. Based on the SDGs alone, the U.S. doesn't emerge as a strong leader vis-à-vis its principal strategic competitors. However, the U.S. dominates the GII indicators with a significant lead over China and Russia. China is clearly working to close the gap. The U.S. is leading in the GII measures due to its overall strength in innovation and R&D, which will help secure the U.S. position as a leader in the global environmental industry. The chart above shows the U.S. ahead overall with both the U.S. and China in the "Low SDG Focus/High Innovation" quadrant and Russia in the "Low SDG Focus/Low Innovation" quadrant.

Overall, the U.S. and China have become significant players in the global environmental industry. Russia is less committed to environmental and climate-related reforms and is, therefore, not a leading player in the industry. However, each country has the resources and the potential to be the leading player in the industry if it can muster sufficient political will and overcome domestic structural hurdles.

Policy Recommendations

An analysis of the global environment industry shows that the U.S. is a mid-tier participant, playing catch-up to other leading (mainly European) countries. The magnitude of the climate threat and its increasing importance in the global business market mean that remaining mid-tier will have a negative impact on U.S. national security. To remain relevant in the climate-focused international order, the U.S. requires a whole-of-country strategy that leverages government and private sector capabilities to turn the U.S. into an environment industry leader. Specifically, the U.S should: 1) increase domestic momentum on climate change; 2) enhance the U.S. environmental industry through regulation and innovation; 3) expand U.S influence on climate issues internationally; and 4) mitigate climate-based threats to national security. To achieve these outcomes, the U.S. must act on the following recommendations. Doing so will provide the U.S. with the public support, strengthened industrial sector, and national governance needed to become a leading player in the international arena, advance U.S. environmental status and goals, and reduce the climate threat to U.S. national security.

Significant U.S. policy change will be required to achieve four desired outcomes in the environment and climate industry (see chart below). Each policy recommendation advances a desired outcome and is categorized into 11 different sectors. While these recommendations are meant to be enacted together as a comprehensive plan for maximum impact, selected recommendations highlighted in red in the chart are expanded upon below.

	Category	Desired Outcomes			
		Increase Domestic Momentum on Climate Change to Meet 2050 Climate Goals	Strengthen U.S. Environmental industry through Regulation and Innovation	Expand U.S. International Influence to Secure U.S. Environmental Leadership	Implement Climate Change Mitigation & Adaptation Policies to Bolster National Security
Recommendations by Category	Informational	-Informational campaign on climate issues			-Public Affairs diplomacy within the Department of the Environment
	Educational	-Educational campaign (K-12) through grants	-Vocational and university education for green technology, incentivize environment/climate		
	Economic & Financial			-Carbon Border Tax -Renewables in developing countries	-Fully fund U.S. commitments to International Adaptation
	Human Capital		-Mobilize U.S. Industry to solve climate issues, specify the problem, and let industry tell us what they need		
	Diplomacy			-Work with allies and partners -Seek avenues for dialogue with Russia on climate issues	
	Political	-Statehood expansion into territories and constitutional reform		-IPCC Reform	
	Organizational		-Establish federal program to encourage consolidation of water districts and waste water treatment		-Establish New cabinet-level Department of the Environment Responsible for: climate/Environment organization, SDG progress, EJ issues
	Legal/Regulatory	-Energy Grid Reform -Landfill and waste regulation	-Mandate EMS (ex: IS 14001) certification for government organizations and companies contracting with the USG	-Treaty ratification	
	Scientific		-Promising Climate technology (moonshot)	-Work with China through scientific channels on climate change issues (basic research)	

1. Increase Forward Momentum on Climate Change to Meet 2050 Climate Goals

Energy Grid Reform. The U.S. energy grid is largely privatized and regulated at the state or regional level, leading to significant inefficiencies for establishing transmission pathways for renewable energy. The U.S. should strive to standardize the regulatory and permitting framework at the national level to break through barriers preventing the widespread proliferation of renewable energy.

Education/Information Campaigns. To underscore the need for urgent action, misinformed U.S. public perceptions of the climate threat demand that government launch an “individual responsibility, collective progress/solution” environmental protection information campaign. Additionally, the government should improve environmental literacy through scholarships to high school students for pursuing environment-related training and college degrees, and grants to local school boards schools to include environment protection courses in K-12 curricula.

2. Strengthen U.S. Environmental Industry Through Regulation and Innovation

Fund Promising Climate Technologies. The U.S. should leverage its position as a global leader in innovation to invest in promising environmental technologies such as thin fabric solar cells, iron-air batteries, and small modular nuclear reactors. It should also work to improve the scalability and capacity of existing technologies, like direct air carbon-capture technology. Such technologies represent potential economic opportunities for U.S. industry and can be developed for export when mature and scalable.

3. Expand International Influence Through U.S. Environmental Leadership

Carbon Border Tax. The U.S. should introduce a tax based on the EU’s Carbon Border Adjustment Mechanism. A carbon border tax is designed to drive foreign manufacturers to reduce the carbon intensity of their products as they seek to export to two of the three largest markets in the world and protect U.S. industry from countries, like China, that produce carbon-intensive products that are relatively cheaper than their American counterparts (e.g., solar panels, steel).

Renewables in Developing Countries. The U.S. government and its Western partners should

encourage investment in wind and solar projects in developing countries to assist with their transition to green energy and help meet global climate goals. The U.S. government should pay particular attention to projects that expand U.S. domestic manufacturing capacity (e.g., FirstSolar solar panels, General Electric wind turbines) and reduce dependence on Chinese parts and materials. This initiative will also reduce the scope for Chinese investment in fossil fuel projects through the Belt and Road Initiative, and in particular its aggressive promotion of coal-fired power plants.

Treaty Ratification. To demonstrate its commitment to global environmental protection, the U.S. should ratify international environmental treaties the U.S. itself helped craft – e.g., the Convention on Biological Diversity, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, and the Stockholm Convention on Persistent Organic Pollutants. Ratification will improve U.S.-international collaboration on global environmental issues and provide access to funding and resources to support environmental initiatives that address the climate threat and improve national security.^{83,84}

4. Adopt Climate Change Mitigation & Adaptation Policies to Bolster National Security

Create New Cabinet Agency – Department of Environment and Climate. Establish a new, cabinet-level agency devoted to creating, implementing, and coordinating environment and climate policies within the U.S. government to positively impact U.S. sustainability efforts and national security. The Secretary for Environment and Climate would ensure a unified approach to addressing these challenges, integrate environmental considerations into the strategic decision-making process, represent the U.S. in global climate talks and collaborate with other nations to address shared environmental challenges, and raise public awareness and engagement about environmental issues and the importance of sustainability.

Fund U.S. Commitments for International Climate Adaptation and Resilience. The U.S. can exhibit leadership in international climate action by contributing additional U.S. foreign assistance resources to support the UN’s Adaptation Fund and the Least Developed Countries Fund, that were

established at the UNFCCC COP 26.⁸⁵ By assisting developing countries to fund climate adaptation and resilience programs, the U.S. will help mitigate the effects of climate change that could contribute to potential geopolitical tensions and conflicts that threaten U.S. national security.

Conclusion: Leveraging the Environmental Industry for Soft Power Advantage

The U.S. National Security Strategy identifies climate change as a crisis and the greatest existential challenge for all nations.⁸⁶ The greatest challenges require the greatest efforts. Strengthening the U.S. environmental industry is key to addressing the climate threat and bolstering U.S. national security. Using the industry as an instrument of soft power combined with public support and proper government support and structure will help the U.S. expand its influence on climate issues internationally and mitigate climate-based threats to national security. To achieve these outcomes, the U.S. should act on the recommendations presented here.

Future environmental industry research should focus on exploring the economic, social, and environmental benefits associated with these components in greater depth, as well as their potential to drive innovation and create value in the long term. Additionally, policymakers should consider developing additional strategies to encourage further business collaboration and technology transfers between public and private stakeholders. The U.S. is uniquely poised to achieve this, as it possesses the necessary resources and capacity to do so. This also presents opportunities for country-to-country collaboration and cooperation with partners and allies in support of a shared challenge.

These efforts will help U.S. businesses remain competitive and thrive in the increasingly competitive environmental industry. With the proper implementation of new policies, regulations, and incentives, companies can maximize their performance outcomes and successfully compete in the environmental industry. The U.S. can also restore its standing as a global leader in environmental policy, ensuring that the U.S. and allied nations are able to drive the agenda in this vital space.

Appendix

“A ‘Whole-of-Humanity’ Approach to ‘Build Back Better’ Ukraine’s Environment”

Assigned Task: *Given that U.S. policy is to support Ukraine in the ongoing war instigated by Russia, what options are available within the context of [the Environment and Climate] Industry Study to do so? Include recommendations to support broader U.S. policy.*

“The path to peace [includes meeting the challenge of] ecocide, the need for immediate protection of the environment. . . . We must find common responses to all environmental threats created by the war. Without this, there will be no return to a normal, stable life, and the reverberations of the war will remain for a long time. . . . This is not just a Ukrainian problem. This is a challenge for the whole world.”

– [Volodymyr Zelensky](#), President of Ukraine

“Some of our nature is lost forever.”

– [Ruslan Strilets](#), Ukraine Environmental Protection Minister

“War is not limited to the fears of people, but it spreads to every living thing. . . . We can quickly rebuild a bridge or a house, but it will take decades to renew the nature that they’ve destroyed . . . but we will try.”

– [Olena Kryvoruchko](#), Member of Ukrainian Parliament

The environment and security are inextricably linked – each affecting and affected by the other. Notwithstanding long-standing debate over whether there is a causal relationship between the environment and security, environmental conditions nonetheless may be seen to have a demonstrable impact on human well-being and, by association, the viability and stability of governments. The environmental damage created by the war in Ukraine – and, more to the point, how the United States and others respond to that damage – could therefore be considered a key determinant of Ukraine’s future as a sovereign state capable of fulfilling its responsibilities at home and abroad.

The environmental damage Ukraine has suffered to date has been profound. Best available estimates are that the country has suffered [\\$51-54 billion](#) of environmental damage, and that it will cost more than [\\$400 billion](#) (in President Zelensky’s estimation, up to [\\$1 trillion](#)) for recovery, repair, and reconstruction. Among the most pronounced examples of documented environmental devastation have been the [following](#):

- Some 2,300 instances of environmental damage caused by fighting.
- More than 6 million Ukrainians with limited or no access to clean water.
- 600 animal species and 880 plant species at risk of extinction.
- 3 million hectares of forest destroyed.
- 2.9 million hectares of protected areas at risk of destruction.
- 5 million hectares of agricultural land that can’t be sowed because of landmines.
- 687,000 tons of petrochemicals burned due to shelling.
- 1,600 tons of pollutants leaked into bodies of water.

Independent of the war, Ukraine has faced major environmental challenges over time, an enduring legacy of its Soviet past. The country ranks 52nd out of 180 countries in the annual [Yale-Columbia Environmental Performance Index](#), with low to middling performance in the areas of biodiversity,

ecosystem services, pesticide use, air quality, wastewater treatment, sanitation, and waste management. In annual assessments of Ukraine's performance in achieving the 17 Sustainable Development Goals agreed to by the member states of the United Nations in 2015, [Ukraine ranks 37th](#) out of 163 countries, with [major challenges](#) in measures associated with Life on Land and Life Below Water and [significant challenges](#) in Clean Water and Sanitation.

That the country ranks as high as it does in such environmental assessments is perhaps a reflection of its seriousness about environmental matters. In tangible terms, this is perhaps best reflected in the fact that [Ukraine is party](#) to virtually all major international treaties in the areas of air pollution, biodiversity, climate change, desertification, endangered species, environmental modification, hazardous wastes, marine dumping, nuclear test bans, ozone layer protection, ship pollution, and wetlands. For example, Ukraine is party to the Convention on Biological Diversity; the U.S. is not. Ukraine is party to the Basel Convention on Transboundary Movements of Hazardous Wastes; the U.S. is not. Ukraine is party to the UN Convention on the Law of the Sea; the U.S. is not. For President Zelensky to refer to the situation in his country as "ecocide," then, is not just inflated rhetoric; it is recognition, largely lost on others, of the environment's fundamental importance to national, regional, and global well-being and stability.

Crass and opportunistic though it may sound, environmental degradation like that being visited upon Ukraine represents lucrative markets for environmental business. The United States is in a seemingly unique position to assume leadership in taking strategic advantage of the situation. The [U.S. environmental industry](#) represents total revenues of over \$400 billion, generated by some 30,000 private-sector companies and more than 80,000 public-sector entities, employing 1.7 million Americans. The global environmental market is about \$900 billion. In [Engineering News-Record's annual rankings](#) of the top 200 environmental firms, 35 of the top 50 and 6 of the top 10 are U.S. firms (AECOM, Jacobs, Clean Harbors, Tetra Tech, Bechtel, and Fluor), nearly all with global presence.

Secretary of Commerce Gina Raimondo [has stated](#): "American businesses have a tremendous opportunity to play an outsized role to help rebuild Ukraine." Even in the pre-war period, the International Trade Administration ranked Ukraine 45th out of the top 50 markets for environmental technologies in [2017](#). Secretary Raimondo has gone on to say that "This has to be a public-private partnership if we're going to get this done."

This brings us to two questions that command our attention. The first is [why](#) environmental conditions in Ukraine warrant a strong, effective response. The answer to that is perhaps best captured in the relatively recent [UN General Assembly resolution](#) that reaffirms what many have long maintained: that a clean, healthy, sustainable environment is a fundamental human right. Because, as America's founders believed, the overriding purpose of government is to secure and preserve such natural rights, the continued legitimacy and viability of the state – Ukraine or any other – lies in its ability to fulfill that purpose. It is in everyone's interest to ensure that Ukraine succeeds in this regard.

The second question at hand is [how](#) to go about restoring Ukraine's environment to a state of normalcy and vibrancy. That answer is, in some sense, aptly captured in the mid-2022 [PERAC \(Protection of the Environment in Relation to Armed Conflicts\) principles](#) promulgated by the UN International Law Commission. Key among these non-binding, consensus-based principles are several that build on the precept that "effective protection of the environment in relation to armed conflicts requires that measures are taken by States, international organizations and other relevant actors to prevent, mitigate and remediate harm to the environment before, during and after an armed conflict."

This imperative for collective action to counteract and overcome the environmental devastation in Ukraine calls not only for a more fully integrated public-private posture that capitalizes on the inestimable strategic power of the private sector, specifically the environmental industry, but also for a robust array of federal interagency, intergovernmental, and civil society partnerships involving such

centrally important stakeholders as USAID, the International Development Finance Corporation, the Export-Import Bank, the International Monetary Fund and the International Finance Corporation, the U.S. Chamber of Commerce, the World Business Council for Sustainable Development, the United Nations Foundation, Ceres, the Gates Foundation, and many others. Already, the U.S. Chamber of Commerce, acting independently of government, has initiated movement in this direction with its [Ukraine Business Initiative](#).

Acting collectively in such “whole-of-humanity” fashion to mobilize massive resources for restorative and transformative environmental purposes could well be the moral and strategic equivalent of the post-World War II [Marshall Plan](#) – which President [Truman noted](#) in his memoirs “will go down in history as one of America’s greatest contributions to the peace of the world.” But, because the original Marshall Plan focused on economic (not environmental) recovery and took place in the aftermath of (not during) an already-concluded war, let us not mislead ourselves by the lure of either inflated or diminished expectations. The purpose of this “green Marshall Plan” would not in itself be capable of ending the war – nor would it be held indefinitely in abeyance until the conclusion of fighting via other channels. Its purpose is **resiliency** – restoring the quality of life and human well-being in Ukraine for the purpose of enhancing social cohesion and thereby demonstrating the enduring national resolve that could, in conjunction with other political forces, indirectly produce war termination. If this seems illogical and diametrically opposed to the natural order of things, perhaps that is because we haven’t been willing yet to give it a try.

Endnotes

1. Office of the Director of National Intelligence, *Annual Threat Assessment of the U.S. Intelligence Community*, February 6, 2023, <https://www.dni.gov/files/ODNI/documents/assessments/ATA-2023-Unclassified-Report.pdf>.
2. Barack Obama, Speech at United States Coast Guard Academy Commencement Ceremony, May 20, 2015, <https://obamawhitehouse.archives.gov/the-press-office/2015/05/20/remarks-president-united-states-coast-guard-academy-commencement>.
3. Department of Defense, *Department of Defense Climate Risk Analysis*, October 2021.
4. Environmental Business International, <https://ebionline.org/>.
5. Environmental Business International, *Report 2020B: U.S. Environmental Industry Overview*, Third Quarter 2022.
6. *EBI Report 2020B*.
7. United Nations, “The Paris Agreement,” <https://www.un.org/en/climatechange/paris-agreement>.
8. *Ibid*.
9. Defenders of Wildlife, “The U.S. and The Convention on Biological Diversity,” https://defenders.org/sites/default/files/publications/the_u.s._and_the_convention_on_biological_diversity.pdf.
10. Basel Convention, <http://www.basel.int>.
11. Stockholm Convention, <http://www.pops.int>.
12. European Commission, “Carbon Border Adjustment Mechanism,” https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en.
13. Trevor Price, *Environmental Management Systems: How to Boost Your Organization’s Environmental Performance*, CreateSpace, 2014, <https://www.amazon.com/Environmental-Management-Systems-organizational-environmental/dp/1502940930>.
14. International Organization for Standardization, “Introduction to ISO 14001: 2015,” <https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100371.pdf>.
15. “Fact Sheet: Environmental Justice Investments in the House Build Back Better Act,” Equitable and Just National Climate Platform, November 2021, <https://ajustclimate.org/pressrelease.html?pId=1018>.
16. Jordan Pascale, “Here’s Some of What’s in the Senate Infrastructure Bill for the D.C. Region,” NPR, August 12, 2021, <https://www.npr.org/local/305/2021/08/12/1027053595/here-s-some-of-what-s-in-the-senate-infrastructure-bill-for-the-d-c-region>.
17. Vanessa Glavinskas, “The Inflation Reduction Act is a victory for the climate. Here's what comes next.” Environmental Defense Fund, September 6, 2022, <https://www.edf.org/article/inflation->

reduction-act-victory-climate-heres-what-comes-next.

18. “Inflation Reduction Act: EU sees its competitiveness threatened by the US,” MarketLine, February 21, 2023, <https://www.marketline.com/blog/emrinflation-reduction-act-eu-sees-its-competitiveness-threatened-by-the-us>.

19. *EBI Report 2020B*.

20. Veolia, “Capital Market Day,” March 2, 2023.

21. Yale University, Environmental Performance Index, “2022 EPI Results,” <https://epi.yale.edu/epi-results/2022/component/epi>.

22. United Nations, SDG Guidelines, <https://sdgs.un.org/goals>.

23. Business & Sustainable Development Commission, *Better Business Better World*, 2017, <https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=2399&menu=1515>.

24. SDGs Global Dashboard, UN SDG Dashboard, <https://www.sdgsdashboard.org/>.

25. *EBI Report 2020B*.

26. Ibid.

27. Ibid.

28. DC Water, “Filtrate Treatment Facilities,” <https://www.dewater.com/projects/filtrate-treatment-facilities>.

29. Ibid.

30. United Nations, *The Sustainable Development Goals Report 2022*, <https://unstats.un.org/sdgs/report/2022>.

31. International Energy Agency, “Supply – Key World Energy Statistics 2021 – Analysis,” <https://www.iea.org/reports/key-world-energy-statistics-2021/supply>.

32. Energy Information Administration, “What is U.S. electricity generation by energy source?” <https://www.eia.gov/tools/faqs/faq.php?id=427&t=3>.

33. MarketLine, “Renewable Energy Global Industry Data,” January 25, 2023, <https://www.marketline.com/blog/category/renewable-energy>.

34. MarketLine, “Renewable Energy in the United States,” June 25, 2021, <https://www.marketline.com/blog/category/renewable-energy>.

35. Ibid.

36. Ibid.
37. Jeffrey Sachs, et al., *Sustainable Development Report 2022*, Cambridge University Press, 2022.
38. MarketLine, “Renewable Energy Global Industry Data,” <https://www.marketline.com/blog/category/renewable-energy>.
39. Ibid.
40. Daniel S. Hamilton, and Joseph Quinlan, “The Transatlantic Energy Economy,” The Wilson Center, April 2021, <https://www.wilsoncenter.org/article/transatlantic-energy-economy>.
41. *EBI Report 2020B*.
42. Ibid.
43. MarketLine, “Global Waste Management,” January 2023, https://store.marketline.com/search?s=global+waste+management&post_type=product.
44. Ibid.
45. Ibid.
46. White House, “National Security Strategy,” October 2022, <https://www.whitehouse.gov/wp-content/uploads/2022/10/Biden-Harris-Administrations-National-Security-Strategy-10.2022.pdf>.
47. Georgyi Kuleshov Nikolaevich, et al., “Legal Regulation of Environmental Safety in Russia and the European Union,” Varazdin Development and Entrepreneurship Agency, October 18, 2019.
48. Environmental Performance Index, “Russia.”
49. Johannes Friedrich, et al., “The Interactive Chart Shows the World’s Top 10 Emitters,” *World Resources Institute*, March 2, 2023.
50. While Russia’s RE market value and volume dropped in 2022 (2% and 7%, respectively), MarketLine predicts value and volume will grow by 15% and 7%, respectively, by 2027. MarketLine, Renewable Energy in Russia,” January 2023.
51. U.S. companies that violate the U.S. Department of Treasury’s Office of Foreign Asset Controls sanctions can face fines of up to millions of dollars and imprisonment of up to 30 years. Dow Jones, “What are the Penalties for Breaking OFAC Sanctions?” April 30, 2023.
52. International Trade Administration, “Doing Business in Russia – Sanctions Framework,” Russia – Country Commercial Guide, July 21, 2022, <https://www.trade.gov/country-commercial-guides/russia-market-overview?navcard=2375>.

53. Ibid.
54. MarketLine, "Macroeconomic Outlook Report: Russia," January 2023, <https://store.marketline.com/report/russia-pestle-and-macroeconomic-analysis/>.
55. Engineering News-Record, "ENR 2022 Top 200 Environmental Firms," July 31/August 1, 2022, <https://www.enr.com/toplists/2022-Top-200-Environmental-Firms-Preview>.
56. AECOM, "AECOM to Exit Its Russia Operations," Press Release, March 7, 2022, <https://aecom.com/press-releases/aecom-to-exit-its-russia-operations>.
57. Gabriela Gandovska, *Fleeing Russia: The Mass Corporate Exodus*, EMIS, July 18, 2022, https://www.emis.com/php/store/reports/RU/Fleeing_Russia_-_The_Mass_Corporate_Exodus_en_756163802.html.
58. Environmental Performance Index.
59. Sachs, et al., *Sustainable Development Report 2022*.
60. Environmental Performance Index.
61. Ibid.
62. Ibid.
63. International Monetary Fund, "World Economic Outlook," April 2023, <https://www.imf.org/en/Publications/WEO/Issues/2023/04/11/world-economic-outlook-april-2023>.
64. Invest India, "Renewable Energy in India - Indian Power Industry Investment," <https://www.investindia.gov.in/sector/renewable-energy#:~:text=India%27s%20installed%20non%2Dfossil%20fuel,additions%20of%209.83%25%20in%202022>.
65. Marvin Lee, "France," Earth.org, November 8, 2021, <https://earth.org/country/france>.
66. International Trade Administration, "France-Country Commercial Guide," February 3, 2023.
67. Bureau of Economic Analysis, "Direct Investment by Country and Industry, 2021," July 21, 2022, <https://www.bea.gov/data/intl-trade-investment/direct-investment-country-and-industry>.
68. International Monetary Fund, "Brazil," April 22, 2023, <https://www.imf.org/en/Countries/BRA>.
69. CIA, The World Factbook, <https://www.cia.gov/the-world-factbook>.
70. World Bank, "Egypt Country Climate and Development Report" November 8, 2022, <https://www.worldbank.org/en/country/egypt/publication/egypt-country-and-climate-development-report#:~:text=The%20Country%20Climate%20and%20Development,for%20increased%20private%2>

Dsector%20participation.

71. Ibid.

72. Ibid.

73. International Energy Agency, “Total energy supply (TES) by source, Egypt 1990-2020,” August 18, 2022, <https://www.iea.org/countries/egypt>.

74. World Bank, “Egypt Country Climate and Development Report.”

75. Ibid.

76. Army Publishing Directorate (ADP) 3-07, *Stability Operations*, July 31, 2019, https://armypubs.army.mil/epubs/DR_pubs/DR_a/pdf/web/ARN18011_ADP%203-07%20FINAL%20WEB.pdf.

77. Sachs, et al., *Sustainable Development Report 2022*.

78. Ibid.

79. Ibid.

80. Ibid.

81. Ibid.

82. Soumitra Dutta, et al., “Global Innovation Index 2022: What is the Future of Innovation-Driven Growth?” World Intellectual Property Organization, 2022, <https://www.wipo.int/edocs/pubdocs/en/wipo-pub-2000-2022-en-main-report-global-innovation-index-2022-15th-edition.pdf>.

83. Tara Lohan, “4 Major Environmental Treaties the U.S. Never Ratified — But Should,” *The Revelator*, August 2, 2021, <https://therevelator.org/environmental-treaties>.

84. UNCLOSdebate, “U.S. Failure to Ratify UNCLOS Has Been Detrimental,” April 29, 2023, <https://www.unclosdebate.org/argument/653/us-failure-ratify-unclos-has-been-detrimental>.

85. UN Framework Convention on Climate Change, The Paris Agreement, “COP26 Outcomes: Finance for Climate Adaptation,” https://unfccc.int/cop27?gclid=CjwKCAjwpayjBhAnEiwA-7ena4jeXGeUFheMfyYaDad4Q2drA8Y1JVQ1wmnFHKXAYPfPvFG_nMJw0RoCGt4QAvD_BwE.

86. White House, “Biden-Harris Administration's National Security Strategy,” October 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/10/12/fact-sheet-the-biden-harris-administrations-national-security-strategy>.