

THE ASPEN INSTITUTE
CONGRESSIONAL PROGRAM

ENERGY, SECURITY, AND THE ARCTIC: KEYS TO AMERICA'S COMPETITIVENESS

Essays on Energy Policy
May 2020

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DIRECTOR'S NOTE

This report includes essays that were prepared by scholars who had planned to participate in our congressional conference on energy policy issues, which was to have been held in Iceland the last week of May, 2020.

Regrettably, uncertainties related to the coronavirus pandemic did not allow us to convene at this time.

Nonetheless, we are proud to present the impressive and substantial work prepared by our scholars, and trust that it will contribute to the policy dialogue. Even though our convening was derailed, the issues themselves will not go away and these policy analyses provide a significant contribution for congressional consideration.

We had assembled a Republican majority of 23 Members of Congress to convene on these issues, as expressed on the included agenda. We hope we will still be able to convene and continue these policy discussions at a future date once the situation with the pandemic permits.

Dan Glickman

Executive Director

Aspen Institute Congressional Program

ESSAYS

**THE CHANGING ARCTIC:
CHALLENGES FOR SECURITY, GOVERNANCE,
CLIMATE, AND TRADE
OR
"WHAT HAPPENS IN THE ARCTIC DOESN'T STAY
IN THE ARCTIC"**

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What's happening in the Arctic today is the clearest evidence of how rising temperatures, melting sea ice and collapsing permafrost are reshaping the security landscape in which the U.S. Coast Guard, and our military forces, now operate. The opening of a new ocean is occurring within our lifetimes, and most dramatically within the last two decades. The Arctic Ocean is now an increasingly accessible, navigable, maritime border for the U.S. The Arctic region is warming at 2-3 times the global average, according to the latest report from the Intergovernmental Panel on Climate Change. And what happens in the Arctic doesn't stay in the Arctic. Greenland's ice storage keeps our coastal cities, like Miami and Houston, above water. Changing weather patterns in the lower 48 states, from the polar vortex creating extreme weather events to disruptive storms that wreak havoc in prime

agricultural regions, have all Americans feeling the effects of Arctic climate change.

My Bottom Line Up Front is:

- 1. Climate change is a threat multiplier, reshaping the strategic operating environment for the Coast Guard in the Arctic, and around the world.**
- 2. In the Arctic, a changing climate is emboldening our competitors and adversaries (Russia and China), creating new risks and complicating navigating conditions for the Coast Guard and our military.**
- 3. We have a "Responsibility to Prepare and Prevent" for changing Arctic conditions and the Coast Guard needs to enhance its operating capabilities in the Arctic, from**

additional ice breaking, to improved domain awareness (mapping and charting), communications and research capabilities¹

- 4. Leadership on Arctic security is essential to America's overall security and strategic interests and must be a whole of U.S. government and partnership effort including allies, communities, private sector, and others, that serves to undergird the rules-based order and support Arctic resilience.**

#1: Climate change is a threat multiplier, reshaping the strategic operating environment for the Coast Guard and US military in the Arctic, and around the world

The recent IPCC Special Report on Oceans and Cryosphere in a Changing Climate found that climate change is evident in the furthest reaches of the globe from the highest mountain peaks to the deepest oceans.² Greenland is now melting from the top down. Here are the key Arctic findings that shape the strategic operating environment for the Coast Guard and others operating in the region:

- “Arctic sea ice extent in September (when sea ice extent is at its minimum) has declined about 13%**

per decade (during the satellite era from 1979 to 2018), changes are likely unprecedented in at least 1,000 years. The Arctic's older, thicker sea ice, which acts as a bastion against melting of other sea ice, has almost completely disappeared. Only about 10% of sea ice is at least five years old.

- Ice sheets and glaciers are losing ice around the world.** Between 2006 and 2015, Greenland's ice sheet lost 278 gigatons (Gt) of mass per year. Antarctica's ice sheet lost 155 Gt per year, and glaciers around the world (beyond Greenland and Antarctica) lost 220 Gt a year. Combined, the ice loss between Greenland, Antarctica and other glaciers not part of ice sheets was 653 Gt per year. For context, a single gigaton of water would fill about 400,000 Olympic pools.³
- The Arctic has warmed more than double the global average in the last two decades.** During the winters of 2016 and 2018, surface temperatures in the central Arctic were 6 degrees Centigrade (10.8 degrees Fahrenheit) above the 1981-2010 average.
- From 2007 to 2016, permafrost temperatures increased by about 0.3 degrees C (0.5 degrees F), a record level of warming for permafrost.** Warming of permafrost can be a ticking time bomb. Arctic and boreal permafrost contains 1440-1600

¹ Werrell, Caitlin and Francesco Femia. "The Responsibility to Prepare and Prevent." The Center for Climate and Security. October 2019. <https://climateandsecurity.org/2019/01/31/interview-with-sherri-goodman-a-responsibility-to-prepare/>

² Maddox, Marisol. "Two Divergent Paths for Our Planet Revealed in New IPCC Report on Oceans and Cryosphere." New Security Beat. November 18, 2019. <https://www.newsecuritybeat.org/2019/11/divergent-paths-planet-revealed-ipcc-report-oceans-cryosphere/>

³ Walbolt, Kristen. "10 things: All about ice." NASA's Jet Propulsion Lab. March 28, 2018. <https://sealevel.nasa.gov/news/114/10-things-all-about-ice>

Gt of carbon. When it melts, that carbon is emitted into the atmosphere, fueling more warming."⁴

Arctic communities have already experienced disruptions to their freshwater supply, infrastructure, transportation, tourism and cultural traditions, due to a melting cryosphere. Many species dependent on cold temperatures, ice, and snow are at risk, with some facing extinction. These changes will worsen as warming continues.

Indeed, the Coast Guard's Strategic Outlook identifies that "the warming of the Arctic has led to longer and larger windows of reduced ice conditions," and that "from 2006 to 2018, satellite imagery observed the 12 lowest Arctic ice extents on record."

#2: In the Arctic, a changing climate is emboldening our competitors and adversaries (Russia and China), creating new risks and complicating navigating conditions for the Coast Guard and our military.

The Arctic has emerged as a region of geostrategic competition, primarily because rising temperatures, melting sea ice, and collapsing permafrost now grant access to this region previously locked in ice most of year. Indeed, climate change is enabling great power competition in the Arctic today. While the Arctic has, since the end of the Cold War, been a region characterized by cooperation and diplomacy, it has more recently become a zone of increased tensions over potential offensive capabilities of militarization, and

global interest in valuable energy, mineral resources, and access to shipping routes. The retreating and thinning of Arctic ice has given rise to exponential growth in economic and military activities, including shipping, resource extraction, and other commerce. The Coast Guard Strategic Outlook stresses that: "The Arctic maritime domain will continue to open and increased activity will create more demand for Coast Guard services. Near-term variability will result in a dynamic operating environment that exposes mariners and Arctic communities to unpredictable levels of risk." Rapid Arctic change is feeding into China's and Russia's strategic ambitions, both regionally and globally.

As I stated in an article in *Foreign Policy*, "China has large ambitions throughout the Arctic."⁵ This includes the advancement of both commercial and military objectives. For instance, China is aiming to use Russia's Northern Sea Route to ship goods and other materials between ports in Asia and Europe. This will shorten travel times compared to traditional routes through the Straits of Malacca and Suez Canal, offering China a new strategic advantage in terms of global trade and freedom of navigation. In January 2018, this ambition was formalized in China's first public Arctic policy, wherein China declared itself to be a "near Arctic State," and articulated its intention to build a "Polar Silk Road" that will stretch from Shanghai to Hamburg, first across the Northern Sea Route, and potentially later, across the

⁴ Levin, Kelly and Ezra Northrop. "4 Things to Know About the IPCC Special Report on the Ocean and Cryosphere." World Resources Institute. September 25, 2019. <https://www.wri.org/blog/2019/09/4-things-know-about-ipcc-special-report-ocean-and-cryosphere>

⁵ Goodman, Sherri, and Elisabeth Freese. "China's Ready to Cash In on a Melting Arctic." *Foreign Policy*. May 01, 2018. <https://foreignpolicy.com/2018/05/01/chinas-ready-to-cash-in-on-a-melting-arctic/>

central Arctic Ocean.⁶ In the long term, China foresees using the even shorter Transpolar Sea Route across the very top of the Arctic, when that opens in a few decades due to melting sea ice. This route, which might be available for several months each year, would save China from having to depend on Russian-controlled waters. As Li Zhenfu, director of Dalian Maritime University's research Center for Polar Maritime studies, noted, "[w]hoever has control over the Arctic route will control the new passage of world economics and international strategies."⁷

China also is deepening its Arctic presence through foreign direct investment in several Northern European Arctic States.⁸ China is exploiting climate change and the very real need for Arctic-based infrastructure investment to assert itself as a key partner in economic development and scientific exploration. This presence enhances their own domain awareness, and investments could plausibly be leveraged to influence policy to be more desirable for China's long-term strategic interests.⁹

In a recent article, Coast Guard Commander William Woityra points out that mistrust of China's actions and intentions in

the Arctic is firmly rooted in a pattern of behavior that it has displayed, which shows that "When it is convenient, and when there are economic incentives to cheat, China has a history of turning a blind eye to the illegal activity of its industries, or tacitly supporting them."¹⁰

Russia has been increasing its military presence and assertiveness in the Arctic—and a significant amount of it is proportionate to their vast Arctic territory—but their ambitions have political, military and commercial dimensions. On the political side, Russia has the longest Arctic coastline of any Arctic coastal state, and Russian identity has historically been tied to the Arctic. Expanding Arctic development as ice and permafrost melt is therefore likely to enjoy broad public support from a nation that identifies with its Arctic heritage. Commercially, approximately 20 percent of Russia's Gross Domestic Product is derived from Arctic activities, primarily energy, industrials and mining.¹¹ Russian President Vladimir Putin has set ambitious cargo shipping goals which would quadruple the volume to be shipped through the Northern Sea Route from 20 million tons to 80 million tons by 2024.¹² Though this cargo increase

⁶ State Council Information Office of the People's Republic of China. "Full Text: China's Arctic Policy." The State Council of the People's Republic of China. January 26, 2018. http://english.gov.cn/archive/white_paper/2018/01/26/content_281476026660336.htm.

⁷ Jakobson, Linda. "China Prepares for an Ice-Free Arctic." Insights on Peace and Security. March 2010. <https://www.sipri.org/sites/default/files/files/insight/SIPRIInsight1002.pdf>.

⁸ Rosen, Mark E and Cara B. Thuringer, "Unconstrained Foreign Direct Investment: An Emerging Challenge to Arctic Security." CNA. November 2017.

⁹ Goodman, Sherri and Marisol Maddox. "China's Growing Arctic Presence." China-US Focus. November 19, 2018. <https://www.chinausfocus.com/finance-economy/chinas-growing-arctic-presence>

¹⁰ Woityra, William. "China Can't Be Trusted in the Arctic. Proceedings. December 2019. Vol. 145/12/1,402.

¹¹ Devyatkin, Pavel. "Russia's Arctic Strategy: Aimed at Conflict or Cooperation? (Part I)." The Arctic Institute. February 6, 2018. <https://www.thearcticinstitute.org/russias-arctic-strategy-aimed-conflict-cooperation-part-one/>

¹² Staalesen, Atle. "It's an order from the Kremlin: shipping on Northern Sea Route to reach 80 million tons by 2024." The Barents Observer. May 15, 2018.

still represents a small portion of total global shipping, it is still a lofty goal for an environmentally sensitive region which does not yet have fully developed emergency response capabilities. Russia seeks to monetize the Northern Sea Route as a new access route from China to Europe which, as the ice melts, will presumably be available for several months each year. This could cut up to 15 days off the current route via the Suez Canal and the Strait of Malacca. It is noteworthy that President Putin has stated that he sees the Northern Sea Route as a future "global, competitive transport artery" that is "the key to the development of the Russian Arctic and the regions of the Far East."¹³

Militarily, Russia has been upgrading its bases along the Northern Sea Route and exerting increasingly aggressive behavior against our High North allies and partners. Russia has violated Swedish¹⁴ airspace, simulated attacking northern Norway¹⁵ and tested electronic warfare capabilities, including the jamming of GPS systems during the NATO exercise Trident Juncture, and in days since, as well.¹⁶ Russia claims

its military buildup is primarily for economic reasons, presenting the Northern Sea Route as a maritime toll road through the Arctic, and seeking to monetize the route by requiring transit vessels to pay a "toll" for military escort through the shallow waters close to the Russian coastline. However, it is clear that Russia would be able to use these forces and capabilities for other purposes as well. Just last month Russia tested a hypersonic missile for the first time in the Arctic¹⁷, and it plans to launch its first weaponized icebreaker, *Ivan Papanin* by 2023.¹⁸ In short, China and Russia are opportunistically expanding their power and influence in direct response to a melting Arctic, and this will have significant consequences for U.S. interests.

The increased presence of Russian and Chinese vessels in Arctic waters near the U.S. presents other risks as well. Among the new risks in a rapidly changing Arctic, one that "keeps me up at night," is a potential nuclear shipping incident in Arctic waters. Russia's nuclear safety record is deeply concerning, from Chernobyl, to the Kursk submarine sinking in 2000 to the

<https://thebarentsobserver.com/en/arctic/2018/05/its-order-kremlin-shipping-northern-sea-route-increase-80-million-tons-2024>

¹³ Staalesen, Atle. "Russia's Putin to turn Northern Sea Route into global shipping artery." Eye on the Arctic. May 15, 2018. <https://www.rcinet.ca/eye-on-the-arctic/2018/05/15/arctic-shipping-russia-policy-international-kremlin/>

¹⁴ Sweden: Russian Military Planes Briefly Violated Airspace." Associated Press. January 24, 2019. <https://apnews.com/097a3fd978f14f4e9a7f4e5cb4d1d600>

¹⁵ Nilsen, Thomas. "11 Russian Fighter Jets Made Mock Attack on Norwegian Arctic Radar." The Barents Observer. February 12, 2019. <https://thebarentsobserver.com/en/security/2019/02/11-russian-fighter-jets-made-mock-attack-norwegian-arctic-radar>

¹⁶ Staalesen, Atle. "GPS Jamming on Agenda as Russian Defence Delegation Sat down for Talks in Oslo." The Independent Barents Observer. March 18, 2019. <https://thebarentsobserver.com/en/security/2019/03/gpsjamming-agenda-russian-defence-delegation-sits-down-talks-oslo>.

¹⁷ Devitt, Polina. "Russia Tests Hypersonic Missile in Arctic, TASS cites Source." Reuters. November 30, 2019. <https://www.reuters.com/article/us-russia-arctic-missiles/russia-tests-hypersonic-missile-in-arctic-tass-cites-sources-idUSKBN1Y40BB>

¹⁸ "Russian Shipyard Launches Missile-Carrying Icebreaker." The Maritime Executive. October 28, 2019. <https://www.maritime-executive.com/article/russian-shipyard-launches-missile-carrying-icebreaker>

2019 failed recovery of the Skyfall missile and the nuclear submarine which caught on fire. These incidents reveal a Russian tendency to not only withhold critical incident information about extent and severity of radioactive contamination but to actually cover the incidents up in an attempt to evade accountability. This irresponsible practice has implications for Coast Guard and partner agency mission planning in responding to a crisis in the Arctic.

To help prepare for future such incidents, a scenario demonstration was conducted earlier this year by the Council on Strategic Risks, Sandia National Labs and the Wilson Center's Polar Institute at the Arctic Futures 2050 conference. With Coast Guard and Alaskan Native community participation, we demonstrated "how a table-top exercise can be used to bring science, indigenous and policy communities together to develop information, ideas and proposed actions to drive future research directions, policy initiatives and planning for emergency response in the Arctic of 2050. This exercise used as a triggering event an Arctic maritime incident that takes place in the year 2050 in which a Chinese-owned LNG tanker collides with its Russian nuclear-powered icebreaker escort in a winter storm."

Key takeaways from the exercise include:¹⁹

- "The initial operational response to any major Arctic shipping incident will follow well established search and rescue protocols and will be led by the U.S.Coast Guard."

- "If a nuclear incident of this type occurs, it is likely to become an incident of national significance and an incident command structure will be established. A nuclear accident in shallow water has the potential to become a very serious incident."
- "Important predictive capabilities for situational awareness and informing response decisions does not currently exist for winter Arctic conditions."
- "The US Arctic currently lacks multiple facets of both operational and research infrastructure needed to provide key elements of both short and long-term response to a major winter-time incident."
- "There must be a strong indigenous voice and participation in the response effort. Arctic indigenous communities have important knowledge to inform response decisions and must be part of response decisions."
- "This incident has the potential to rapidly become a major international incident. Communication lines with Russian (and other countries') institutions will be important. Confidence Building Measures could help to prepare both the U.S. and Russia for a future contingency."

#3: We have a Responsibility to Prepare for changing Arctic conditions and the Coast Guard needs to enhance its operating capabilities in the Arctic,

¹⁹ Goodman, Sherri, Peter Davies, Jim Townsend, Marisol Maddox. "Inclusive Planning for Changing Arctic Futures: Demonstrating a Scenario-Based Discussion." Council on Strategic Risks. September 5, 2019 <https://councilonstrategicrisks.org/2019/09/19/planning-for-a-changing-arctic-a-scenario-based-discussion-paper/>

from additional ice breaking, to improved domain awareness (mapping and charting), communications and research capabilities.

As former Secretary of Defense Mattis stated in 2018, “We need to up our game in the Arctic.” While the Coast Guard has a long and storied tradition of Arctic operations, for which I have deep respect, in the climate era we also need to enable the Coast Guard to “up its game in the Arctic,” to meet its essential missions. As the Coast Guard Strategic Outlook states: “The United States is an Arctic Nation, and the United States Coast Guard has served as the lead Federal agency for homeland security, safety and environmental stewardship in the Arctic region for over 150 years.”

Among the emerging needs the U.S. has in a changing Arctic is a strategic deep water port. Currently the closest deep water port to the U.S. Arctic is 800 miles away in Kodiak, Alaska. That is inadequate in the climate era with increased navigation, tourism, and other sea-based traffic and the accompanying risks for search and rescue. An Arctic deep water port is a strategic initiative that the U.S. government, engaging the private sector in a financially meaningful way, needs to plan for future maritime safety and other operations.

The U.S. has fallen behind in equipping our forces to operate safely and securely in a changing Arctic. There are 3 key components to the Coast Guard’s operational capability in the Arctic. Each one requires additional support:

1. Speed the deployment of additional ice breaking capability in the form of

the “polar security cutter, aviation assets and autonomous systems. Today, the Coast Guard has limited ice breaking capability that must fulfill missions at both poles, including Antarctica. As the Strategic Outlook diplomatically states: “This national fleet does not currently have the capability or capacity necessary to assure access in the high latitudes.” The Administration and Congress have authorized one new polar security cutter; however, the Coast Guard needs at least 6, of which 3 are “medium” and 3 are “heavy,” according to its own requirements. And from an acquisition standpoint, it is financially preferable to conduct a multiple buy, as a single vessel will have very high unit costs. At least one vessel in the Polar Security Cutter fleet should be science-ready so they are able to continue serving as a platform for scientific research that is critical to domain awareness and detection of changes over time.²⁰ Additionally, the Coast Guard needs modern aviation capability for search and rescue, as well as the autonomous systems that are able to substantially enhance a variety of Coast Guard mission sets, from illegal fishing detection to mapping and charting.

2. Improve Arctic Domain Awareness and Communications capabilities. Given the rapidly changing Arctic environmental and operating conditions, it is essential that we improve U.S. Arctic, including

²⁰ Congressional Research Service. “Coast Guard Polar Security Cutter (Polar Icebreaker) Program: Background and Issues for Congress.” Congressional Research Service. October 4, 2019. <https://fas.org/sgp/crs/weapons/RL34391.pdf>

maritime, domain awareness capabilities. Maritime Domain Awareness is a diverse set of capabilities, some of which are within the Coast Guard's budget, but many of which are supported by other agencies, and which also need to be harnessed from local communities with direct observations of the changing Arctic conditions. As the Coast Guard Strategic Outlook states, Arctic domain awareness requirements include:

1. Information about national defense and security
2. Information on vessel crew, passenger and cargo carried
3. Pollution detection and tracking capabilities
4. Weather and environmental observations, including ice reconnaissance
5. Assessment of living marine resources
6. Assessment of human activity and infrastructure.

Consider again the possible nuclear shipping incident with a Russian nuclear - powered icebreaker and a Chinese LNG vessel in the Bering Strait. Information on all of the above will be essential in responding to such a crisis should it occur. That is why we need to act today to increase our MDA and communications

capabilities in the Arctic which includes improving national communications infrastructure for broadband and satellite coverage to support security as well as commercial, recreational, and subsistence-based activities.

In 2019, the White House has announced an intent to develop a national strategy on mapping, exploring and characterizing the U.S. Exclusive Economic Zone (EEZ) and the shoreline and near-shoreline areas of Alaska. Some of our current Arctic charts date back to the 1800s and are wholly inadequate for today's needs. Only around 4% of Arctic waters off the coast of Alaska have been charted to modern standards.²¹ As the recent White House Memorandum stated, "Data and information about the ocean help to advance maritime commerce, domestic seafood production, healthy and sustainable fisheries, coastal resilience, energy production, tourism and recreation, environmental protection, national and homeland security, and other interests. Such activities contribute more than \$300 billion per year of economic activity, 3 million jobs, and \$129 billion in wages."²² Equally important, improved mapping and charting will help us prepare to operate in a changing Arctic, and to improve our predictive capabilities for better decision making.

3. Ensure the U.S. maintains its competitive edge in Arctic research and development. For decades, the U.S. has supported extensive

²¹ Cole, Dermot. "Outdated navigational charts are an Arctic maritime disaster in the making." Arctic Today. September 10, 2018. <https://www.arctictoday.com/outdated-navigational-charts-arctic-maritime-disaster-making/>

²² "Memorandum on Ocean Mapping of the United States Exclusive Economic Zone and the Shoreline and Nearshore of Alaska." The White House. November 19, 2019. <https://www.whitehouse.gov/presidential-actions/memorandum-ocean-mapping-united-states-exclusive-economic-zone-shoreline-nearshore-alaska/>

research on the Arctic, from marine to terrestrial systems, from space to ecosystems. This research, conducted by leading universities across the nation as well as federal agency laboratories, is a core component of America's competitive edge in the Arctic. The Coast Guard's icebreakers are host to the science missions conducted aboard to gather direct observations and data about Arctic conditions. America's scientific enterprise, and research and development capabilities, have long supported both our overall security posture and our global engagement strategies, as well as enabling us to better understand the natural world. Nowhere is this more important than in Arctic research. Today, China, Russia, and others are increasing their research capabilities both within and about the Arctic.

Research helps us better understand the pace of Arctic climate change and prepare for this changed future. For example, as global fish stocks migrate as waters warm toward the poles, we need to better understand how to manage emerging and potential fisheries, and growing potential for illegal and unregulated fishing. The Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean signed by multiple nations, including the U.S., Russia and China and others in 2018, is a good example of acting with the precautionary principle where we do not yet have sufficient knowledge to make decisions

about sustainable management of a fishery in this long ice-covered area.²³ Over the next decade, however, many nations will be seeking to develop this knowledge, and we need to ensure there is sufficient scientific knowledge to support sustainable management and prevent some of the worst outcomes of climate change.

The proposed High Arctic Research Center (HARC) facility at Oliktok Point is a great example of a physical location that would greatly complement the development of homeland security and defense missions in the Arctic and support a re-established leadership position in the region for the United States. The proposed Center, "could serve as a physical launch pad for scientists, giving them year-round, multi-domain access for research, development, Arctic technology testing, and domain awareness.... Research and extensive real-time observations in the Arctic could help researchers collect data that would fill critical gaps in monitoring, providing real-time information, enhancing forecasting, and creating better simulations for planning purposes to serve security and commercial enterprises."²⁴ The High Arctic Research Center would enable testing and demonstration of technologies for multiple Coast Guard missions.

#4: Leadership on Arctic security is essential to America's overall security and must be a whole of U.S. government and partnership effort, including allies, communities, private sector, and others, that serve to

²³ "Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean." <https://www.mofa.go.jp/mofaj/files/000449233.pdf>

²⁴ Goodman, Sherri, Peter Davies, Marisol Maddox, Clara Summers. "Research in a Changing Arctic Must be Prioritized." New Security Beat. October 8, 2019. <https://www.newsecuritybeat.org/2019/10/research-changing-arctic-prioritized/>

undergird the rules-based order and support resilience.

The Coast Guard and U.S. military are not alone in the Arctic. The keys to American leadership on Arctic Security are partnerships and unity of effort. This term refers to an inclusive approach that marshals all elements of capability, including the joint and interagency community, state and local government, industry, non-profit and academic organization. Key partnerships for the U.S., and in particular the Coast Guard, in the Arctic include:

- Alaska Native Community: those who live in the region are often best able to “ground truth” observations and will know what’s happening long before many in Washington do. They observe trends and recognize patterns that may not be distinguishable to others. That is why it is essential to “co-produce” knowledge with those closest to the Arctic domain. Both the Coast Guard and other interagency partners have been including the Alaska Native Community in developing both research approaches and improving domain awareness. As the Coast Guard Strategic Outlook states: “Alaska Natives are a critical layer of security in the Arctic.” The Alaska Native communities are also on the frontlines of climate disruption, from coastal erosion occurring at many villages, to permafrost thaw disrupting traditional livelihoods, to harmful algal blooms (HABs) harming fish stocks and megafauna, to extreme weather storms disrupting the critical supply chain of fuel and food delivery. These

changing conditions increase demands for Coast Guard support and response and stretch scarce resources even further.

- Arctic Coast Guard Forum: Another important security layer in the Arctic is the partnership the Coast Guard has with the Arctic Coast Guard Forum. Appropriately characterized as a bridge between “diplomacy and operations,” the Arctic Coast Guard Forum enables the Coast Guards of the eight Arctic nations both to strengthen working relationships, conduct exercises and combined operations, and coordinate emergency response, which becomes more necessary as climate challenges mount.
- Innovation and Technology: The U.S. has always been a technology and innovation leader. As the Arctic changes, we need to harness that capability to advance low-carbon and sustainable systems for Arctic operations, observations and planning. For example, wind and solar-powered ocean drones are now helping to map the Arctic. Other types of autonomous systems and advanced technologies will help keep the U.S. at the forefront of Arctic, low carbon and resilience innovation in the Arctic.
- International agreements and institutions that are the backbone of the rules based order—America’s security in the Arctic depends on key international organizations and agreements. They are even more important in an era of great power competition.

-Arctic Council: The Arctic Council provides an important intergovernmental forum for the 8 Arctic nations, Indigenous People's organizations, observer states and non-governmental organizations to engage on a wide range of Arctic issues (other than military security). It has also developed important agreements on Search and Rescue, Oil Spill Preparedness and Response, and Scientific Cooperation, that serve to strengthen cooperation in uncertain times.

- Law of the Sea Convention: the Law of the Sea Convention (UNCLOS) continues to be an important legal framework for the Coast Guard, the U.S. military and others operating in the region, despite the fact that the United States has not yet ratified it.

-International Maritime Organization (IMO) – the IMO's Polar Code, adopted in 2014, establishes important standards for design, construction, equipment, operation, training and environment protection and safety for ships operating in polar regions.

Recommendations

To summarize my recommendations above, here are the key areas where Congressional support and action is needed:

1. Advancing the acquisition of polar security cutters, and structurally equip them to carry out scientific research.
2. Increasing MDA capabilities in conjunction with other agencies.
3. Supporting continued Arctic research and development, demonstration, test and evaluation across multiple agencies.
4. Mapping and charting Alaskan waters and near shoreline for maritime safety.

5. Reducing further climate risk through sustainable and low-carbon approaches across all domains using a Responsibility to Prepare and Prevent approach.

Conclusion: Arctic leadership for the 21st century

As the Coast Guard Strategic Outlook appropriately states:

“Arctic Security requires leadership and cooperation across multiple national security areas of interest, including border security, economic security, environmental security, food security, freedom of navigation, geopolitical stability, human safety, national defense, natural resource protection and assertion and protection of U.S. sovereign rights.”

America's leadership on climate security is the other essential element to advancing America's Arctic interests in the 21st century.

The globally devastating Second World War precipitated the creation of an international system led by the United States, designed to protect the sovereignty of states against external aggression and decrease the likelihood of conflict between nations. This is the world order we are trying to preserve today. However, the rapid rate of climatic change—combined with other global threats and the increasing stress on security that follows—means that this system must adapt and adapt quickly. The U.S. should lead that effort, just as it led the effort to ensure global stability after the Second World War.

Fortunately, the difference between today and major global disruptions of the past is that we can spot impending disasters earlier and more easily. Though the risks

are unprecedented, our foresight is unprecedented as well. Technological developments have given us predictive tools that enhance our ability to anticipate and mitigate threats. In short, we have the ability to make our communities, institutions and individuals more resilient to a broad range of threats. This foresight underscores a responsibility to advance resilient solutions that are commensurate to the threat. That is our “Responsibility to Prepare and Prevent” which is most evident in what our Coast Guard needs to do to continue operating safely and securely in the changing Arctic. If we don’t, we’ll either have to watch our adversaries take the lead, or failing that, bear witness to an increasingly unstable world.

DISRUPTIVE GEOPOLITICS AND THE ARCTIC

Geir Westgaard

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The post-Cold War era is over. Geopolitics has become more disruptive. The main forces of order and stability in the international system have weakened. The balance of power has weakened. The risk of great power rivalry and confrontation has increased. Economic interdependence has weakened. A backlash against globalization has led to a surge in protectionist and nativist sentiments. Global governance has weakened. The rules of the game, in politics and business, have become more contested. Institutions, norms and laws count for less than they used to.

Disruptive geopolitics has also spilled over into the Arctic. Still, the region has seen less dramatic change than captions such as the “scramble for the Arctic” or the “new great game” would seem to indicate. Although climate change remains a key driver of developments in the Arctic, economic activity (especially oil/gas and shipping) has yet to pick up as expected. While great power competition in the region has intensified, Russia, the United States and China all approach Arctic policy with a combination of status quo/cooperative and revisionist elements. Notwithstanding Russia’s much-hyped planting of the flag on the seabed of the North Pole in the summer of 2007, the Arctic has not been conclusively transformed from an arena of cooperation to an arena of conflict in the intervening years.

Introduction

As the Cold War ended, the world entered a period of benign geopolitics. This is when globalization reached its prime in the 1990s and early 2000s. It’s when countries decided to follow the example or recipe of the West. They liberalized, privatized and democratized, all in order to create a level playing field, attract foreign investment and spur growth. The result, as we know, was increased capital flows, increased trade and increased economic growth.

In the words of *New York Times* columnist Thomas Friedman, the world was flat. The game was positive-sum or win-win. The attractiveness or soft power of the West was at an all-time high. The West had just emerged victorious in the ideological and geopolitical struggle with communism and the Soviet Union. Francis Fukuyama argued that humanity had reached the end of history: “the end-point of mankind’s evolution and the universalization of Western liberal democracy as the final form of human government.”

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Geopolitics has since become more disruptive. This is because the main forces of order and stability in the international system have all weakened over the last 15+ years: the balance of power has weakened; economic interdependence has weakened; global governance has weakened.

Balance of Power

The balance of power has been upset by the decline of the West and the rise of the Rest. With the rise of China and other emerging markets, power in the international system has shifted from the West to the East. This trend has become more pronounced since the global financial crisis of 2007-2008.

The West didn't look much like a winner in the wake of the Great Recession. The European Union started fraying after the global financial crisis and has struggled to get its mojo back ever since. There's been one crisis on top of another: the eurozone crisis, the crisis with Russia over Ukraine, the refugee crisis, Brexit. The United States is also in relative decline. It suffers from internal political dysfunction and decay. Yet, America's *capacity* to play a global leadership role is still second to none. It's the *will* to lead that has been seriously eroded. The U.S. has arguably been in strategic retreat since the overreach of the George W. Bush presidency, with its costly and unsuccessful wars in Afghanistan and Iraq.

Under Xi Jinping, the spectacular rise of China as a global economic powerhouse has been accompanied by greater assertiveness in foreign policy. China is no longer abiding by Deng Xiaoping's maxim: bide your time, hide your strength. We see this in China's Belt and Road Initiative, its hyper ambitious global development strategy launched in 2013. We

also see it in China's island building in the South China Sea, which has assumed foreign policy prominence equal to that of Taiwan and Tibet.

Can China continue to rise peacefully? That is the key question for world politics in the 21st century. The answer is that it depends on the actions of both China and its rivals, especially the U.S. History teaches us that rapid shifts in the balance of power can be profoundly destabilizing. We know that conflict often ensues when a rising power causes fear and insecurity in an established power. This is what Harvard University's Graham Allison refers to as the "Thucydides trap". We also know that China, Russia and other major powers won't acquiesce to American or Western leadership today the way they did in the 1990s and early 2000s.

Economic Interdependence

A backlash against globalization has led to a surge in economic nationalism, especially in the West. It is particularly noteworthy how the United States and the United Kingdom, countries who were the architects of neoliberal economic policies and globalization, have turned towards protectionism and nativism. Globalization tends to increase inequality within states even as it reduces inequality between states, and it is increased inequality that has given politics in much of the West an insurgent or populist quality over the last few years. This explains why the British voted for Brexit and the Americans voted for Trump in 2016.

If people see their own lives improving, they tend to be sanguine about the lives of others improving even more. However, when their own living standards have declined, and they expect their children's to be even worse, resentment

against those who are doing better tends to grow. Globalization is also leaving many people in the West feeling disempowered and disconnected. They see decisions that shape their lives being taken by people who aren't like them, in places that feel far away, whether in booming capital cities, central banks or corporate boardrooms. During the UK referendum campaign, the slogan that resonated the most was the promise to "take back control".

A surge in anti-trade rhetoric globally has been accompanied by a rise in protectionist measures, both tariffs and non-tariff barriers. China is widely seen as having flaunted the rules of international trade by limiting market access, forcing technology transfers and stealing intellectual property. Under Trump, the U.S. has responded by engaging in tariff warfare. "America First" means using Washington's economic power to force concessions from individual trading partners rather than build coalitions that can strengthen the multilateral trading system. Trump tends to focus on the negative aspects of trade and ignore all the benefits. He sees America as a "loser" in global trade whereas the rest of the world views America and its multinational corporations as "winners".

Globalization has also entered a phase in which some manufacturing is leaving "Factory Asia" and moving back closer to where the products are consumed, a phenomenon known as reshoring or nearshoring. In the words of GE's former chief executive Jeff Immelt, "the days of outsourcing are declining". There are basically three reasons why international business is reshoring. The first is the rise in relative wage costs in manufacturing hubs like China. The second is that production costs in more advanced economies have

fallen due to automation. The third is concern about security of supply, i.e. the growing realization that long and complex supply chains create both political and logistical risk.

Global Governance

The rules governing international relations are increasingly contested, as are the institutions and processes designed to apply these rules, such as Russia's attempt to undo the post-Cold War order in Europe through annexation of Crimea and incursion into Eastern Ukraine.

The Soviet Union was the last traditional empire to collapse and Russia is still struggling to come to terms with this. The history of decolonization tells us that it is easier to shed overseas colonies than to let go of contiguous or near-contiguous territory. Russia suffers from a form of PTSD or phantom pain that has left an enduring legacy of neo-imperialism.

But the conflict in and over Ukraine is not primarily about recolonization. It is about Russia using military and other means to limit the sovereignty of a post-Soviet neighbor and make sure that no third party, i.e. the West, can challenge Moscow's influence. It is also an attempt to have the current European order reconstituted on terms more favorable to Moscow. This is the order that was established in the dying days of the USSR, between 1989 and 1991. Russia has also joined China in pushing back against international institutions dominated by the West, partly through the establishment of competing institutions and partly by insisting that the ways of the West are not necessarily global norms and standards. Moscow insists that the so-called Washington consensus of the 1990s has been replaced by the Sinatra doctrine: sovereign countries do things their way.

The End of an Era

In short, the world has moved from benign geopolitics to disruptive geopolitics. It happened gradually at first, then more rapidly after the Great Recession of 2007-2008. The post-Cold War era is over, but we don't yet know for sure what will replace it. Some think we might be approaching a G-Zero world in which no country is able or willing to lead, be it by force or by example. Others see the international system moving towards bipolarity, with the U.S. and China making up the poles. The U.S.-China rivalry is multidimensional—political, economic, technological and military—and could become a zero-sum game with global ramifications. The COVID-19 crisis is also likely to cause greater geopolitical disruption, as great power rivalries intensify, international cooperation falters, the economy securitizes and deglobalizes, supply chains rupture and nativist sentiments harden.

The Arctic Then and Now

During the Cold War, military security dominated the geopolitics of the Arctic. The region was at the center of the "balance of terror". The shortest trajectory for an exchange of intercontinental ballistic missiles between the United States and the Soviet Union went across the North Pole. This made the Arctic crucially important for the deployment of early warning radars and missile defense systems on both sides. While the region has retained much of its military-strategic (i.e. nuclear) significance to this day, the end of the Cold War saw considerable reduction in international tension and the emergence of new Arctic governance structures focused on problem-solving and cooperation.

The Arctic Council has become the leading forum for addressing the issues

faced by the governments and indigenous people of the region. It promotes cooperation, coordination and interaction in the fields of non-military or "soft" security, focusing on issues of sustainable development, that is, environmental, economic and social/societal security. The method of the Arctic Council is to build consensual knowledge and understanding among its members. It works and is credited with having established "rules of the road" that strengthen overall security and stability in the region. The work of the Arctic Council is supplemented by other regional institutions/organizations such as the Barents Euro-Arctic Council and the Northern Forum.

The level of tension in the Arctic is much lower today than during the Cold War and much lower in the High North than in most other parts of the world. Some believe that this is due to "Arctic exceptionalism". The governments and people of the region are said to have a strong preference for cooperation over competition because they realize that you cannot get by without a little help from friends and neighbors if you live under harsh and hostile Arctic conditions. Yet, "Arctic exceptionalism" has not prevented disputes elsewhere from spilling over into the High North.

The crisis over Ukraine, for example, now affects how Western countries view Russia's intentions, including its build-up of military capabilities, in the Arctic. The West has also explicitly linked Ukraine to the Arctic through targeted financial and technological sanctions against oil and gas activity in the Russian Arctic. Moreover, the region has not been cordoned off from the growing Sino-American rivalry either. Washington is increasingly skeptical of China's claim to be a "near-Arctic state" and ambitions to help build a Polar Silk Road.

Planned Chinese investments in Greenland and Iceland have been of special concern, providing context for president Trump's much ridiculed offer to purchase Greenland from Denmark. So, yes, the level of tension in the Arctic is relatively low. But it is higher today than it was a decade ago.

False or Partial Narrative

The Arctic narrative that's been popularized since the Russians in the summer of 2007 used a mini submarine to plant their flag on the seabed of the North Pole can be depicted as follows: The climate is changing and, as a result, so is the physical environment of the Arctic. This opens new opportunities for fisheries, oil/gas and mineral extraction (uranium, rare earth metals, gold, diamonds, zinc, nickel, coal, graphite, palladium and iron ore), as well as maritime transport along the Northern Sea Route and eventually across the Arctic Ocean. A scramble for access to natural resources and economic benefit has ensued. This is a "new great game" intensified by governance gaps and disputes over sovereignty.

What's beyond doubt here, is the effect of climate change on the Arctic. Climate change is a key driver of environmental, economic and social developments—both opportunities and risks—in the region. Otherwise, the narrative exaggerates the size of the economic prize. Most Arctic oil and gas, for example, will likely not be competitive under conditions of lower-for-longer oil prices and expectations of peak demand within a decade or so. Additionally, investments in Russian oil and gas in the Arctic will be hampered by Western sanctions imposed after Moscow's annexation of Crimea and proxy war in Eastern Ukraine. High costs have also slowed the development of Arctic shipping,

the promise of which remains largely unfulfilled. The narrative is plainly wrong about the Arctic being a thinly governed space where it's a free-for-all among interested parties—Arctic, near-Arctic and non-Arctic states alike.

When it comes to assessing the hydrocarbons potential of the Arctic, we should keep in mind that one third of the Arctic area is land. This is where the finding and development costs are the lowest and where most of the Arctic exploration and production has taken place to date. It started back in the 1960s with the discoveries of the Tazovskoye¹³ field in Tyumen and Prudhoe Bay in Alaska. Another third of the Arctic area is continental shelves, which have been very lightly explored so far. The final third of the Arctic area is deep ocean waters over 5000 meters. This area remains inaccessible and unexplored. The U.S. Geological Survey estimates that the Arctic contains 13% of the world's undiscovered oil, 30% of the world's undiscovered natural gas and 20% of the world's undiscovered natural gas liquids. These are estimates of technically recoverable resources. Commercial viability is a different matter, however, and largely related to the global price of oil.

The Arctic is a high-cost area of operations. Under conditions of low oil price, exploration and production (E&P) in the region suffer reduced competitiveness. Several factors make Arctic E&P more expensive. Harsh, wintry conditions mean that equipment must be specially designed to withstand frigid temperatures. Onshore, poor soil conditions often require special preparation to prevent equipment and structures from sinking. Offshore, icepack can damage facilities and hinder shipment of personnel, materials, equipment and oil for long periods of time. Remoteness makes

for long supply lines and increased transportation costs. Equipment redundancy and a larger inventory of spare parts are needed to ensure safety and reliability.

Arctic shipping is subject to many of the same cost drivers. The rapidly melting sea ice notwithstanding, Arctic shipping also faces safety and reliability challenges. While destination shipping in the region has been stimulated by the Yamal-LNG project, the Northern Sea Route (NSR) still suffers from under-developed infrastructure. The NSR, running along the coast of Siberia from the Kara Sea to the Bering Strait, is not yet routinely navigable. Its competitiveness is also reduced by the opening of a second lane of the Suez Canal and removal of the piracy threat in the Indian Ocean.

Contrary to popular belief, the Arctic is neither terra nullius nor a legal no-man's land. There is an interplay of interests, power and law in the region that so far has kept competition rather controlled and well managed. So, while most of the Arctic may be wilderness, it is not lawless wilderness. The five Arctic coastal states—Canada, Denmark (Greenland), Norway, Russia and the United States—have all publicly committed to resolving outstanding legal issues through the framework of international law, more specifically the UN Convention of the Law of the Seas (UNCLOS). In the Ilulissat Declaration of 2008, for example, the five countries state that: "The law of the sea provides for important rights and obligations concerning the delineation of the outer limits of the continental shelf, the protection of the marine environment, including ice-covered areas, freedom of navigation, marine scientific research, and other uses of the sea. We remain committed to this legal framework and the orderly settlement of any possible overlapping claims."

To date, all members of the Arctic Council (the 5 plus Finland, Iceland and Sweden), as well as the 13 non-Arctic countries that are observers to the Arctic Council (France, Germany, Italy, Japan, the Netherlands, China, Poland, India, South Korea, Singapore, Spain Switzerland and the United Kingdom), have by and large accepted and respected this legal framework. While cooperation under the Arctic Council is not considered binding under international law, two legally binding agreements have, in fact, been drawn up under the Council. The first of these was the Arctic Search and Rescue Agreement signed in 2011. The second was the Agreement on Marine Oil Pollution Preparedness and Response in the Arctic, which was signed in 2013. Contributing to the further strengthening of environmental stewardship and governance in the Arctic are also more recent agreements such as the Polar Code to better regulate civilian maritime traffic in the Arctic, the Agreement on Enhancing International Arctic Scientific Cooperation, and the ban on fishing in the Central Arctic Ocean.

Great Powers: Russia in the Arctic

Russia has more at stake in the Arctic than most states do. It controls one-quarter of the Arctic coastline and 40% of the land area and is home to three-quarters of the Arctic's population. Russia receives 20% of its GDP from Arctic economic activities such as natural resources extraction. In the post-Cold War era, Russia has been looking for international partners to open its Arctic regions for development. Many in the West increasingly see Russia as a revisionist power, an unhappy camper who is playing a spoiler role in international affairs. When it comes to Russia in the Arctic, however, the picture is far more nuanced.

On the one hand, Russia is a status quo power in the region. The Kremlin appreciates good, stable relations with Arctic neighbours because Russia's interests in the region are well served by cooperation in areas as diverse as search and rescue, marine transportation and safety, environmental protection and scientific exploration. Moscow has so far also been operating within the UNCLOS framework in pursuit of its territorial claims in the Arctic. The Russians have learned that international law can serve their interests, such as the favourable decision in 2014 from the UN Commission on the Limits of the Continental Shelf (CLCS) regarding delimitation in the Sea of Okhotsk. Furthermore, Russia is interested in working closely with its Arctic neighbors to limit the "encroachment of outsiders" on the region. Moscow is deeply opposed to the idea of turning the Arctic into a "global commons" and espouses the primacy of sovereignty as the governing principle for the region.

On the other hand, Russia is to some extent changing the status quo of the post-Cold War era through its military build-up in the Arctic over the last decade or so. Russia's nuclear/strategic weapons modernization program affects the Arctic because that's the location of major components of the country's deterrence structure (i.e. the nuclear-armed submarines of the Northern Fleet). The accompanying conventional arms build-up helps protect Russia's nuclear forces. However, it also increases Russia's power projection capabilities in the Arctic and makes the country more dependent on military instruments of policy. This is where concern about Russian revisionism and assertiveness in the Arctic comes in.

Russia insists that its rearmament is a necessary upgrade and defensive in

nature. It is not something specific to the Arctic, but part of a broader military reform and restructuring effort. We should note, moreover, that the remilitarization of the Russian Arctic started from a low point, as much equipment and infrastructure fell into disarray in the 1990s. Today's military capabilities in the Arctic remain largely below Soviet-era capabilities. Yet, they can be used for either defensive or offensive purposes and Western reading of Russian intentions has become less benign since the Ukraine crisis of 2014. The Nordic countries therefore pay close attention to the potential for Russian air and sea incursions into their part of the Arctic. Norway is concerned about Russia's growing anti-access/area denial capability, which could prevent NATO from coming to its defence in the High North. Similar concerns have also brought Sweden and Finland closer to NATO and the U.S. The overall response from NATO has been to reassure allies through improved monitoring of Russian military activity in the region and increased joint training/exercises under Arctic conditions.

Pavel Baev of the Peace Research Institute in Oslo (PRIO) characterizes Russia's policy in the Arctic as incoherent, uncoordinated and mismanaged. By that he means that the elements of status quo and revisionism are too contradictory or conflicting to form the basis for a stable policy. Something has got to give. Baev argues that Russia's policy in the Arctic is likely to turn increasingly more revisionist and assertive. Why? Because the Arctic is unlikely to deliver as expected for Russia in economic terms. As Moscow grows disenchanted with the lack of rewards from cooperation in oil and gas, shipping and other economic activity, reliance on military instruments of policy is likely to increase. Russia thus becomes a more one-dimensional great power and the geopolitics

of the Arctic becomes less positive-sum and more zero-sum. It's important to note that this happens not because of the much-hyped scramble for resources but rather because the resource riches have failed to materialize.

Great Powers: The U.S. in the Arctic

The U.S. is a place of great diversity, rich in perspectives. But these days it is also an inward-looking country that is highly polarized politically. Consequently, U.S. Arctic policy is often reduced to one question: Are you for or against oil drilling in Alaska? Or more precisely, for or against the expansion of petroleum activity to federal land and waters in Alaska? On one side of the argument you have the Republicans and president Trump who are for expansion. On the other side you have the Democrats and, previously, the Obama administration who are against expansion, to a greater or lesser extent.

The proponents or supporters of increased petroleum activity in Alaska point to the following factors: First, geopolitics. The race for the Arctic is on. There is a convergence of Russian and Chinese economic interests in the Arctic, such as the Yamal LNG Project and the Polar Silk Road. The U.S. must respond by increasing its presence and activity in the region (Alaska, Greenland, Iceland). Stepping up in the Arctic will serve U.S. economic, national security, and energy security interests. Second, resource potential and demand. There is a high potential for large accumulations of oil and gas yet to be discovered in the Arctic. The majority is expected to be Russian gas. When it comes to the offshore Arctic oil potential, however, the U.S. and Russia are assessed to have equal portions of the resource.

There will also be demand for Arctic oil and gas even in a carbon constrained world. This is not likely to be a stranded asset. Third, trust in Big Oil. The industry has a proven track record, a long history of successful operations in Arctic conditions, enabled by continuing technology and operational advances.

The opponents of increased petroleum activity in Alaska tend to focus on climate, the environment and the rights of indigenous people, and otherwise flip or dispute some of the arguments above. To fight the emerging climate crisis, the world needs to wean itself off fossil fuels as quickly as possible. Besides, this is a largely pristine area, too wild, too important and too special to be spoiled for both humans and rare species by oil and gas development. Trump has demonstrated that he is a *drill, baby, drill* advocate with little regard for climate and the environment, such as his decision to pull the U.S. out of the Paris Climate Agreement. But it's expensive to operate in the Arctic. Oil from the region needs much higher prices to give investors a decent return. High cost barrels are therefore more likely to be left in the ground. It isn't worth the risk, especially when you consider the industry's performance regarding health, safety and the environment, such as Exxon Valdez (1989), the Alaska oil pipeline spill (2006) and Macondo/ Deepwater Horizon (2010).

The politics of Arctic oil and gas has been contentious in the U.S. for many years. However, things have gotten even more heated under the Trump administration. Trump has managed to do what has eluded Republicans in the White House and Congress for four decades: to open a section of the coastal plain of the Arctic National Wildlife Refuge (established in 1960) for petroleum exploration. He did

so by including an ANWR amendment in his Tax Cuts and Jobs Act of 2017. Trump has also reversed Obama's decision from late 2016 to ban oil and gas drilling in federal waters of the Arctic Ocean. The ban essentially affected 115 million acres in the Chukchi Sea and most of the Beaufort Sea. Trump's decision (Executive Order) has since been struck down in court and a lengthy legal battle is likely to ensue. The opposition to petroleum activity, in the U.S. Arctic and elsewhere, has hardened over the last few years as the demand for climate action grows, such as the increased influence on the left of the *Leave it in the ground* movement.

The rhetoric and action of the Trump administration about climate change are also causing polarization (no pun intended) within the Arctic Council, although more at the political level than at the level of experts. At last year's Arctic Council ministerial meeting in Rovaniemi, Finland, for example, it proved impossible to reach agreement among the eight member states on a final joint declaration because the United States insisted on omitting any references to climate change in the document. Secretary of State Pompeo also made headlines by giving an address (Looking North: Sharpening America's Arctic Focus) very much in line with the "false or partial narrative" challenged above. In a polite, consensus-seeking forum that usually avoids or downplays high politics, Pompeo chose to focus on disruptive geopolitics in the Arctic and the negative role played by China and Russia (in that order).

According to Pompeo, China is likely to use investments in critical infrastructure and participation in civilian research activity to increase its military and security presence in the Arctic. Beijing's pattern of aggressive behavior elsewhere in the world

should inform how we view China in the Arctic and what we do about it. China's track record of economic development with wanton disregard for health, safety and the environment ought to give us pause. It is not what is needed in the Arctic. Pompeo also decried Russia's military build-up and "pattern of aggressive behavior" in the Arctic. With reference to Russia's annexation of Crimea and proxy war in Eastern Ukraine, he reminded the audience that Moscow's territorial ambitions could turn violent in the Arctic as well.

Pompeo's clarion call notwithstanding, it remains to be seen whether his words will be followed by action. The United States is widely regarded as the least engaged of the Arctic states. Washington has treated the Arctic as somewhat of a backwater, paying relatively little attention to its own northern areas. Successive U.S. administrations have, for example, proved unable to secure substantial financing for new icebreakers to protect its interests in the Arctic.

Great Powers: China in the Arctic

The return of Asia, led by China, to its relative historical importance in the world economy has also impacted the Arctic. China's stated ambition is to become a "polar great power" (both the Arctic and the Antarctic). It calls itself a "near-Arctic state" and became an observer to the Arctic Council in 2013. Over the last 15 years, China has gone from an outsider in Arctic affairs to its current position as one of the leading players, and by far the most important observer state. China's budgets, programs and plans for an expansion of its political, economic, scientific and military presence in the Arctic have increased significantly during this period. Beijing considers the Arctic to be a strategically important area from which China will draw

the resources needed for its continued rise. China's real competitive advantage in the region is its unmatched capacity to make investments in new economic and transportation infrastructure. Beijing has adopted a China Inc. approach to the Arctic, encouraging and assisting in the expansion of Chinese commercial interests. As of today, China has rather limited polar-relevant military capabilities.

While China's rise clearly has the potential to upend the current order in the Arctic, much of its regional influence today comes from constructive cooperation and participation in existing governance structures. Beijing has been particularly eager to find ways to work cooperatively with mineral-rich Arctic states. It will likely also be the main user of trans-Arctic shipping lanes, especially the Northern Sea Route. Russia and China have agreed to link the NSR to the Maritime Silk Road. 11 of the 27 vessels transiting through the NSR in 2017 were going to Chinese ports and Beijing has expressed interest in developing port infrastructure along the route. China's preference for the NSR, once it is regularly navigable, is both commercial and strategic. The NSR is the only significant international waterway that is not controlled to some extent by the U.S. Navy.

China has sought to increase its level of engagement in Arctic governance by calling for new forms of scientific and economic cooperation in the region. China has also been a leading advocate for a global Arctic, seeking recognition that Arctic issues are global issues that cannot be left exclusively to the Arctic coastal states (A5) or the members of the Arctic Council (A8) to manage. This argument resonates among stakeholders who care deeply about the climate crisis. Yet, Beijing's perspective has been that while climate change brings many

challenges for the Arctic and the world, it creates mostly opportunities for China in the Arctic.

Pompeo's rhetoric in Rovaniemi last year notwithstanding, Arctic nations have cautiously welcomed China's willingness to play a larger role in the Arctic. Their approach has been cooptation, not exclusion. Russian skepticism about China in the Arctic has also diminished. Sino-Russian relations have grown much closer as relations between Russia and the West have deteriorated. A turning point of sorts came in 2016 when China stepped in as an investor in Yamal-LNG, thus rescuing a project that was in trouble because of Western financial sanctions. Yet, China's pursuit of investment opportunities across the Arctic, especially in areas where there is a stark asymmetry in power between investor and host nation/community, will likely trigger more questions and engender more skepticism in the years to come. The post-Cold War era of benign geopolitics is over, also in the Arctic.

Conclusion

Climate change demonstrates that what happens in the Arctic does not stay in the Arctic. It is equally true that what happens in the rest of the world does not necessarily stay out of the Arctic. The region is a known sink for pollutants transported from distant sources. As we have seen, the Arctic is also affected by the turn to disruptive geopolitics following the end of the post-Cold War era. That does not mean, however, that we are back to Cold War-levels of tension and confrontation in the High North. The Arctic has not been conclusively transformed from an arena of cooperation to an arena of conflict, although there is less of the former and more of the latter now than a decade or two or three ago.

THE CHANGING OCEAN: ENERGY AND ITS IMPACT ON THE BLUE ECONOMY

S.K. Avery

President Emerita, Woods Hole Oceanographic Institution

The Ocean and Us

I do not think people fully grasp how astoundingly large the ocean is or how important it is to our weather and climate and to everything that lives on Earth—including humans. It covers more than 2/3 of the planet with a relatively thin skin of water. Its deepest point would swallow Mt. Everest with two kilometers to spare. The ocean holds the longest mountain range on Earth, the highest waterfall, and the tallest mountain. It supports the largest habitat on Earth and contains most of the life we know of on the planet.

The ocean and the atmosphere play a critical role in governing Earth's climate system. We have one atmosphere, one ocean, and these two fluids talk to each other. That communication occurs through the ocean-air interface. The fundamental reason that the atmosphere matters to the ocean, and the ocean to the atmosphere, is that they exchange heat, moisture, momentum, nutrients, and biogeochemical properties. This connection helps determine the rates and regional patterns of land temperature and precipitation.

The ocean is the flywheel of the climate system. This relationship is illustrated in the relaxation time to perturbations (time it takes for a perturbed system to return to equilibrium): in the

atmosphere, the relaxation time scale is 1.5 months, in the upper ocean it is decades, and in the deep ocean, it is centuries. The top three meters of the ocean can hold as much heat as the entire atmosphere. The ocean has taken up approximately 90% of the extra heating in the earth system due to greenhouse gas warming. The warming ocean is, in effect, the true indicator of global warming. A recent study published in *Advances in Atmospheric Sciences* shows that ocean temperatures in 2019 are the highest in modern recorded history.

Warming is not the only climate stressor in the ocean. The excess carbon dioxide that is building up in the atmosphere is dissolving in the ocean. In seawater, it forms carbonic acid, and through a series of chemical reactions, it reduces the amount of carbonate in seawater. Many ocean organisms use carbonate and calcium to build their shells or skeletons. The combined effects of warming and acidification are leading to stressed coral reefs that may not recover in their current (mainly tropical) locations. Perhaps over decades we may see coral reef systems re-established in more poleward locations. In the meantime, there is great concern that the combination of warming and acidification will lead to great biodiversity loss.

The services the ocean provides—and that we often take for granted—range from sources of enjoyment (recreation or a beautiful sunset) to the very air we breathe and the rain that waters our crops. Roughly one-half of the oxygen we breathe and about 80 percent of the water vapor in our atmosphere comes from the ocean. It provides a food resource, cheap transportation of goods and people, an out-of-the-way place to put our waste, as a source for new medicines, precious metals and energy. Its rich biodiversity is an insurance policy for our future aiding in sequestering carbon and providing genetic material that could lead to new products. If the ocean were a nation, it is estimated that it would have the 7th largest economy in the world.

Increased pressure on the ocean has produced cumulative environmental stresses in addition to the previously mentioned climate change effects. These additional stressors include pollution inputs (chemicals, plastics, oil spills), enhanced severe weather systems that affect human security, and overexploitation (e.g. overfishing).

The ocean is likely to become a more important source for humans—increased demand for protein and water, recreational amenities, coastal living, energy and minerals—while at the same time there is demand for healthy marine ecosystems. The challenge is to develop a blue economy—i.e. one in which you enhance conservation as well as economic development through advances in our knowledge of the ocean as well as through technological innovation. In other words the blue economy is a “knowledge economy” not an “extractive economy”.

The Blue Economy

The ocean is a source of economic value because marine resources are an input to human economic activity and because the ocean provides ecosystem services that have economic value. But ocean knowledge also generates economic value because (a) basic ocean science produces new insights into how marine resources (including ecosystem services), and information can contribute to economic activity and (b) because applied ocean science (including ocean observing and forecasting) reduces uncertainty about the consequences of economic decision-making. A knowledge economy that builds upon science and innovation as well as the UN sustainability goals provides the basis for a blue economy. Each nation approaches the development of the blue economy differently—some through a top-down government led initiative and others through grassroots efforts that enhance ocean environmental protection while also promoting economic opportunities. Examples of the blue economy include:

- **Ocean Technology:** robotics, sensors, moorings, navigation, communication, ships, observing networks
- **Ocean Energy and Resources:** Offshore wind and wave energy, oil/gas survey/extraction, environmental monitoring/awareness, incident response, seafloor and continental shelf mining, carbon capture and sequestration.
- **Fisheries and Aquaculture:** stock assessment, bio-economic models, ecosystem-based fisheries management, aquaculture, toxicity

- **Biotechnology/bioprospecting/synthetic Biology/green Chemistry:** Drug discovery, biotoxin detection, anti-fungal crop protection, heavy biofuels, process chemicals
- **Information for Decisions:** any business that is weather/climate sensitive (weather events, safety, human health hazards); outlooks (agriculture, energy management, water management, tourism, shipping, Arctic development); risk assessment and abatement (insurance)
- **Coastal and Urban Resiliency/adaptation:** green infrastructure, habitat restoration, marine protected areas, resilient coastal infrastructure, coastal tourism and recreation

At the heart of the blue economy is the understanding that we are an ocean-connected world and a connected ocean-atmosphere world. We need data to study the connected ocean system—its physics, biology, chemistry, and geology as well as data on how the atmosphere and ocean communicate with each other. The importance of data cannot be underestimated. It provides the basis for decision-making and innovation. How do we obtain that data, assimilate and process it, create the big-databases, and use new computational technologies such as artificial intelligence and data science? What governance is best to oversee this database management of a global commons?" How will our understanding of ocean ecosystems along with new synthetic biology or green chemistry techniques further our abilities to develop plant-based feedstocks to replace petroleum-based feedstocks for products such as plastics or heavy fuels?

The emergent desire to develop renewable forms of energy from the ocean presents a new set of concerns. Whether we extract energy from shore wind, tides, waves or thermo-kinetic transfer, large scale commercial processes may affect the ocean and coastal areas. Understanding where to place installations requires an understanding of the physical, chemical and biological environment. We need to know where tides and thermal gradients are strongest, understand the ecosystem activity, both transient and permanent, and understand the sensitivities to radiation, noise, chemicals and other disturbances.

There are challenges to observing Poseidon's world. Like the atmosphere, the ocean is vast and fluid. However, it is much harder to penetrate. Water is a far more difficult medium to move in. The ocean is corrosive; largely opaque to light and radio waves (hence, limits satellite observations to the near surface). The things we use routinely on land and sky for power, imaging, navigation, command and control, and telemetry do not translate well to working in the ocean. Thus to understand the ocean and develop the blue economy, investments are required in in-situ measurements in the ocean. The ocean observation enterprise requires investments in data coverage, types of data, data quality, informatics systems. It requires the integration into system models (climate, weather, and ocean), prediction and forecasting models, and models that help our understanding of ocean ecosystem connectivity to the ocean environment. Recent testimony in the House, Science, Space, and Technology Committee (January 15, 2020, Richard Murray) details the needs and requirements for an ocean observing investment.

Policies: Circular Economies

“We live in a world designed for an environment that no longer exists.” This quote from Rich Sorkin, CEO of Jupiter Intel illustrates the challenges we have with current economies. Societal forces are increasing demand for adaptation and mitigation to climate change. Yet society has benefited tremendously from the products derived from the carbon-based feedstocks that we take from nature. We have a terrible record of not recycling these feedstocks after a product is discarded. New thinking is required to determine how we use nature in future engineered products.

Every material that is made has a good chance of ending up in the ocean at some point and their fate in the ocean is often unknown but can be devastating to marine life. The use and re-use of feedstocks will have to matter if we are to achieve the sustainability goals we desire. The renewable energy sector (wind, solar, electric vehicles) has a “feedstock” of a variety of rare-earth minerals (neodymium, terbium, indium, dysprosium, and praseodymium)—minerals that are not infinitely abundant and can be challenging to mine. Currently there are no plans to recycle these minerals. If we do not develop circular economies then the solutions of renewable energy and carbon-free cars will falter due to lack of easily available rare-earth minerals.

Policies that will enable circular economies to flourish and satisfy the development of blue economies are required to help stimulate the transition. Investing in the fundamental research in the ocean along with synthetic biology and green chemistry to develop plant-based feedstocks and working with the private sector that understands large-scale systems

engineering processes would facilitate achieving the scaling goals required for a global transition to a sustainable future.

Policies: Enabling a Healthy Ocean and Healthy Blue Economy—A National Ocean Policy

Over the Obama and Trump administrations, a national ocean policy was initiated and then revised. While coastal policies from states and fisheries management from the National Oceanic and Atmospheric Administration have been in place for some years, realizing the importance of a policy that recognizes the national importance of the ocean was a critical step in elevating awareness of the ocean. The impetus for this national policy was the Deep Water Horizon oil spill that began on April 20, 2010. A reflection 10 years later from Chris Reddy (Woods Hole Oceanographic Institution - <https://www.whoi.edu/multimedia/lessons-from-deep-water-horizon/>) is worth watching particularly as countries look to the opening of the Arctic for extractive industries. While the Deep Water horizon accident was a terrible disaster, it occurred in an ocean environment where the biology was helpful to the cleanup and where infrastructure support was available to support the disaster relief response. The Arctic is a different situation and how one would mount a response in waters that may not be as helpful in combating a major oil spill needs development before advancing oil and gas development in the area. The Obama era policy recognized the need for national stewardship of the ocean. The Trump administration replaced it with a policy that focuses on the economy, security, and energy and puts responsibility back on the states to implement action. If the blue economy is to succeed, it will

require stewardship and economic policies to work together.

Policies: Managing Carbon

The Paris Agreement, the Green New Deal, and other policies aim at managing/eliminating greenhouse gases in our atmosphere (and ocean). Implementing these policies has proven to be challenging in part due to political reluctance and in part because it is difficult to do. The best source I have found for analyzing opportunities is the Energy Futures Initiative (<https://energyfuturesinitiative.org/>) which looks at innovation across the energy spectrum (energy technology, business models, and policy). This fact-based group analyzes the opportunities for innovation and implementation. Their work analyzes the array of possibilities to get to a new energy system—many of which would enhance the stewardship of our ocean.

Final Thoughts

This “essay” is by no means comprehensive. However, perhaps it will stimulate some thinking and discussion. One outstanding issue is how to pay for the investment that is needed—made more difficult now in the current pandemic environment. However, perhaps this is the right time—a time when the economy needs rebuilding. Will we choose the same economic path or invest in a future that continues to have an ocean that serves humanity and the planet.

THE CHANGING OCEAN: ENERGY AND ITS IMPACT ON THE BLUE ECONOMY

Michael Conathan

Executive Director, Aspen High Seas Initiative

The ocean acts as the lungs of our planet, producing half of Earth's oxygen and absorbing half of the carbon dioxide humans have pumped into the atmosphere. It acts as the heart of our planet circulating heat and nutrients around the globe and ensuring our climate remains livable at all latitudes. And it acts as our liver and kidneys, filtering and absorbing waste. Just like in our bodies, we must take great care not to overtax these systems lest we put them at risk of collapse.

Ultimately, America's future, and indeed the world's, is irrevocably tied to the health of our ocean. On Christmas Eve 1968, three American astronauts on the Apollo 8 mission became the first humans to orbit the moon. As they circled back around from the dark side, William Anders spotted our home planet seeming to "rise" above the moon's desolate gray surface. He scrambled for the mission camera, loaded a roll of color film, and snapped what has been called the most influential environmental photograph ever taken.

That image, "Earthrise" (figure 1), showed the world two fundamental truths that Anders and his fellow astronauts grasped immediately. First, that Earth is a blue planet—it is one thing to understand intellectually that 70 percent of its surface is covered with seawater; it's another for us

as creatures of the land to see it captured on film. And second, it revealed the immense fragility of our existence on our blue marble, wrapped delicately in an atmosphere as thin as the skin on an apple.



Figure 1: "Earthrise" Image Credit: NASA

Earth's ocean is unique in the known universe. It is the single most vital building block for life as we know it and ensures that our planet remains habitable. It is, quite simply, irreplaceable and fundamental to our very existence. The more we research and explore, the more we understand how human activity is putting our planetary life support system at risk. To reduce that risk, we must reduce our environmental footprint and wean ourselves off destructive behaviors. Humanity has set our climate on the verge of a catastrophic point of no return, decimated fish populations, and put

countless species—from microscopic plankton to blue whales (the largest animals on the planet)—at risk of extinction. We have turned the ocean’s gyres into plastic soup and strewn waste from the poles to the depths of the Marina Trench, the ocean’s deepest point.

And while there can often be a cost to conserving and protecting these resources, the more we study the best scientific projections, the more we learn that the cost of inaction will be significantly higher. In the past few months, the world has faced a pandemic that has killed tens of thousands of people and all but shut down the global economy. Yet barring comprehensive global action to drastically reduce our greenhouse gas emissions, the effects of climate change will be catastrophically worse. We must act now to transition our coastal and ocean economies from single use to sustainable. This is the promise of developing our *blue economy*: prioritizing innovation and development that will create a livable, sustainable future.

For if we fail, it won’t just be our sustainable *blue economy* that will suffer in the long run; it will be our entire planetary economy. If our respiratory, circulatory, and waste filtration systems fail, our entire life support system fails. The underlying principle of the Hippocratic Oath applies here too: we must first do no harm.

This paper is intended to serve as a blueprint, for how congressional leadership can put the U.S. where we belong: in the vanguard of this sustainability revolution, creating jobs, building new industries, and leveraging global innovation. The information contained herein leads to a few recommendations for steps toward expanding our domestic *blue economy* to take advantage of these opportunities for triple bottom line successes that work for

people, profit, and the planet. Those recommendations are briefly summarized here in the order in which they appear in the analysis that follows:

- Establish a national definition of the *Blue Economy* and create the metrics and categories within the existing structure of federal agencies and departments to adequately measure its contributions to U.S. GDP, employment, and other key economic indicators.
- Develop and implement a regional partnership with Mexico and Canada, including expanding use of the North American Industry Classification System to categorize and track change in industries that comprise the *Blue Economy*.
- Increase investment in baseline ocean science and exploration to develop an adequate understanding of how oceanic ecosystems function, catalog marine species, and provide a baseline for future understanding of human impacts on the marine environment, including the ocean’s role in carbon sequestration and how it could be affected by industrial activity.
- Speed the transition from offshore oil and gas development to offshore renewable energy sources in order to reduce adverse impacts on alternative sectors of the *blue economy*, speed the transition away from carbon-based energy, and create new employment opportunities.
- Pursue efforts to understand the global supply chain for strategic minerals that will be critical to

powering a renewable energy future, including establishing an understanding of the risks and potential benefits of minerals extraction and mining in the deep seabed.

- Support ratification of the United Nations Convention on the Law of the Sea in order to give the U.S. a formal role in discussion about regulation of deep seabed mining in areas beyond national jurisdiction.
- Continue and grow federal support for offshore renewable energy policy and technology development that will allow the U.S. to catch up to the rest of the world in offshore wind energy projects and continue developing marine hydrokinetic technology (wave, tidal, and current power) for use in specific circumstances.
- Support the global target of protecting 30 percent of the planet, including the ocean, from development by 2030 as is currently being prioritized for the UN Convention on Biological Diversity which will meet in late 2020 to set new targets for the coming decade.
- Call upon the U.S. delegation to the United Nations to support a new agreement on Biological Diversity Beyond National Jurisdiction that includes strong mechanisms for establishing and enforcing marine protected areas on the High Seas.
- Invest in innovation via “ocean clusters” following the Icelandic

model of bringing entrepreneurs and emerging technology developers together to develop collaborative, creative projects and businesses that leverage the power of sustainability to foster regional economic growth.

This review begins with a summary of how the *blue economy* should be defined and measured, explores some of the threats to future sustainable economic growth, and ultimately addresses some opportunities that a pivot to a *blue economy* presents for American society and the world.

Defining and Measuring the *Blue Economy*

This discussion must begin by calling out an important distinction between two terms that are often used interchangeably: the *ocean economy* and the *blue economy*. The key difference here is that the *ocean economy* is comprised of all activities in the ocean that generate economic activity. Meanwhile the *blue economy* includes only those activities that incorporate an element of sustainability—industries that either contribute to or rely on healthy oceans and coasts. The World Bank defines the *blue economy* to include this element of sustainability (see figure 2), clarifying that it is “sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health.” The United Nations Development Program also adheres to this sustainability element in its definition of the *blue economy*, calling it “the utilization of ocean resources for human benefit in a manner that sustains the overall ocean resource base into perpetuity.”¹ Similar definitions with an

¹ Hudson, Andrew, “Blue Economy: a sustainable ocean paradigm,” United Nations Development Programme, 26 November 2018. Available at:

inherent sustainability component can be found in other UN bodies,² and throughout the current suite of literature on the topic. By these definitions, activities such as oil and gas extraction or sand and gravel mining which are accounted for in the ocean economy should not be thought of as part of the *blue economy*.

Included in the *blue economy* are such sectors as sustainably managed commercial and recreational fisheries, sustainable aquaculture, tourism and other low impact forms of ocean and coastal recreation, coastal resilience and restoration activities, offshore renewable energy development, and some forms of marine biotechnology.

With a definition of the *blue economy* in hand, the next step must be accumulating enough tools and methodologies to measure its size, scope, and influence. Yet our tools for carrying out this critical mission remain inadequate, even compared to other domestic economic sectors. One starting point is the National Ocean Economics Program (NOEP), initially established under the auspices of the National Oceanic and Atmospheric Administration (NOAA) and now housed and maintained at the Center for the Blue Economy at the Middlebury Institute for International Studies at Monterey, California. The NOEP measures ocean-related employment, wages, and gross domestic product contributions from Bureau

of Labor Statistics data in the construction, living resources, minerals, ship and boat building, tourism and recreation, and transportation sectors.³ But its outputs are only as good as its inputs and our national systems simply aren't designed to provide the kind of understanding such an undertaking requires.

This lack of data is an anomaly for sector-based industry accounting. For example, the U.S. Department of Agriculture operates an Economic Research Service (ERS), with a stated mission to "anticipate trends and emerging issues in agriculture, food, the environment, and rural America and to conduct high-quality, objective economic research to inform and enhance public and private decision making."⁴ ERS's annual budget has averaged approximately \$86 million over the past three years.⁵ By comparison, there is no entity charged with a similar mission for the ocean or *blue economy*, and NOAA's total annual investment in this area is estimated to be less than \$1 million. Yet collectively, the U.S. ocean economy, to the extent we are able to measure it, is estimated to provide 3.1 million jobs, more than the crop production, telecommunications, and building construction sectors combined, and this is likely a lowball conjecture.

NOAA is currently amid a two-year process to develop the first ocean economy satellite account through a new program

<http://www.undp.org/content/undp/en/home/blog/2018/blue-economy-sustainable-ocean-economic-paradigm.html>

² United Nations Conference on Trade and Development, "Oceans Economy and Fisheries." undated. Available at: <https://unctad.org/en/Pages/DITC/Trade-and-Environment/Oceans-Economy.aspx>

³ National Ocean Economics Program. Available at: <http://www.oceanoeconomics.org/Market/ocean/oceanEcon.asp>

⁴ United States Department of Agriculture, Economic Research Service, "About ERS," undated. Available at: <https://www.ers.usda.gov/about-ers/>

⁵ FY2019 President's Budget Request: Economic Research Service, see page 16-2. Available at: <https://www.obpa.usda.gov/16ers2019notes.pdf>

called Economics: National Ocean Watch (ENOW).⁶ This program will track statistics across six sectors of activity in the ocean economy, including living resources, marine construction, marine transportation, offshore mineral extraction, ship and boat building and tourism and recreation. While this effort will begin to provide some foundational accounting for the scope of the ocean economy, it includes industries not incorporated into the *blue economy* and thus will not represent a true analysis of the *blue economy*. And if we fail to measure sustainability in our *blue economy* today, we will inevitably fail to predict what it will

Tanzania have prioritized their own *blue economy* assessments. The Aspen High Seas Initiative is working with leadership in the United Arab Emirates, which currently chairs the Indian Ocean Rim Association, to complete *blue economy* assessments throughout IORA member states in order to develop a full perspective on the regional opportunities represented by *blue economy* measurement, growth, and development. In partnership with Duke University's Nicholas School of the Environment, the Center for the Blue Economy, and New York University – Abu Dhabi, we are pursuing these assessments along with establishment of a

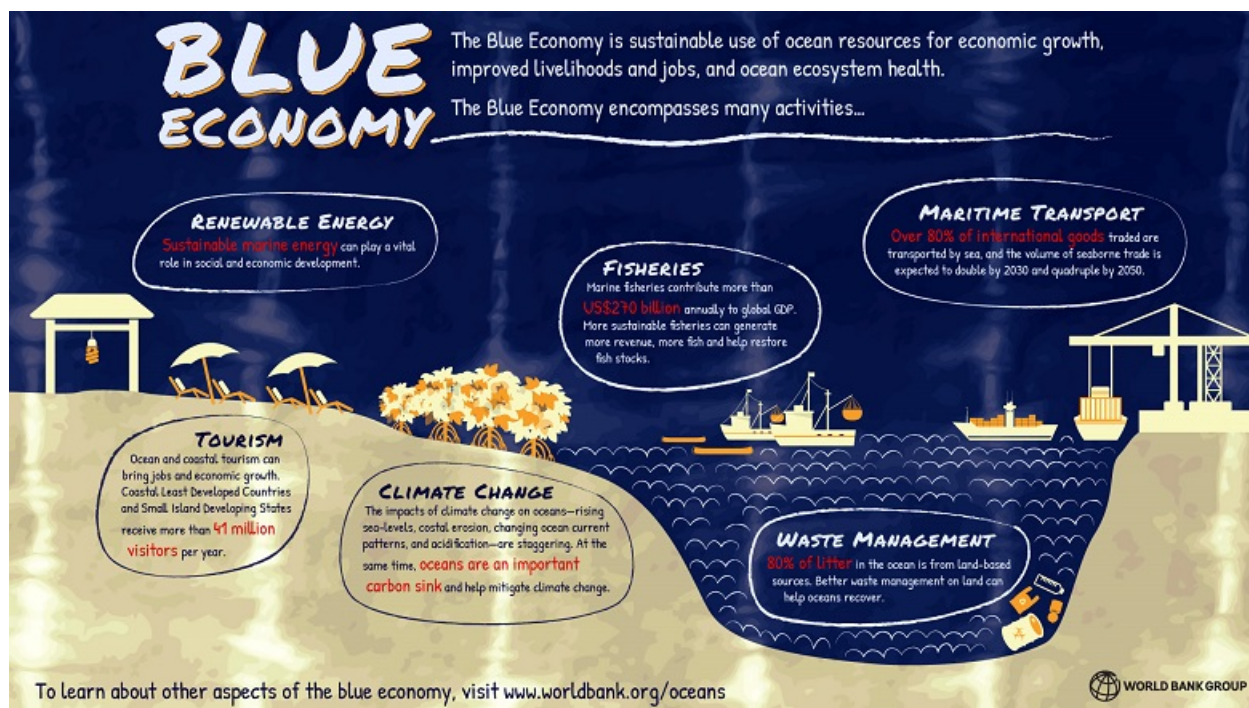


Figure 2: Image Credit: The World Bank Group

be tomorrow.

Meanwhile, other nations are beginning to recognize and fill this gap in their own economic metrics. In the Indian Ocean region, countries such as the Seychelles, Bangladesh, Kenya, and

Blue Economy Center of Excellence to be located in Abu Dhabi to train and educate regional leaders on *blue economy* principles.

The U.S. and our North American allies should follow this model and leverage the numerous initiatives already in

⁶ National Oceanic and Atmospheric Administration, Office for Coastal Management, Digital Coast, "Economics: National Ocean Watch," undated. Available at: <https://coast.noaa.gov/digitalcoast/data/enow.html>

development in various regions of our nations. But to truly be effective, these projects and programs must follow clear, concise guidelines, meet federal standards established in partnership with NOAA, the Bureau of Economic Analysis, and the Bureau of Labor Statistics among other agencies and in partnership with our neighboring countries and be clear about the definition and goals prioritized as part of our regional *blue economy*.

This lack of economic measure is critical, as we cannot manage what we do not understand, nor can we understand what we do not measure. Demand for greater understanding extends beyond economics to the world of ocean science as well. A common trope in ocean circles is the truism that we have higher quality maps of the surface of Mars and the moon than we do of the ocean floor. This is largely because we can map celestial bodies without the visual interference that seawater presents to imaging, but it is also telling that we have invested far more resources and effort into finding answers to the mysteries of our nearest celestial neighbors than we have in solving the riddles of our own deep ocean. In April 2020, the U.S. Geological Survey's Astrogeology Science Center released a new, super high-resolution map of the surface of the moon at a 1:5,000,000 scale.⁷ Meanwhile, NOAA promotes its bathymetric and topographic maps of the ocean floor at a 1:100,000 scale⁸--less detailed by a factor of 50.

The reason for this discrepancy is no secret. Even as our industrial activity expands into the most remote regions of our ocean, we are spending exponentially more on space exploration than investigation of the undiscovered regions of our home planet. A 2013 analysis from the Center for American Progress found that NASA's space exploration budget out-paced NOAA's ocean exploration budget by roughly \$150 to one.⁹ Twelve people have set foot on the surface of the moon while only three have traveled to the Challenger Deep at the bottom of the ocean's deepest point, the Mariana Trench. And while we have yet to find life or other resources in our interstellar exploration that could prove economically recoverable, our ocean continues to be a treasure trove of new life and remarkable discoveries. Some estimates are that our ocean could still hold millions of species that have never been seen or catalogued.

The species discovered in these regions are not just scientific curiosities. As they have in countless instances before, newly discovered marine organisms will provide us with new products, medicines, materials, or inspiration for technologies that could pay unimaginable dividends in any number of ways that benefit human wellbeing. According to UNESCO, "the ocean has already given us compounds to treat cancer, inflammation, and nerve damage," and microbiologists from Woods Hole Oceanographic Institute discovered bacteria in the deep ocean that are

⁷ United States Geological Survey, <https://www.usgs.gov/news/usgs-releases-first-ever-comprehensive-geologic-map-moon>

⁸ https://www.ngdc.noaa.gov/mgg/bathymetry/maps/nos_intro.html

⁹ Conathan, Michael, "Rockets Top Submarines: Space Exploration Dollars Dwarf Ocean Spending," Center for American Progress, 18 June 2013. Available at: <https://www.americanprogress.org/issues/green/news/2013/06/18/66956/rockets-top-submarines-space-exploration-dollars-dwarf-ocean-spending/>

currently being used in diagnostics for Covid-19 and other related viruses.¹⁰

Undiscovered deepsea organisms and phenomena also may hold keys to greater understanding of the ocean's role in the carbon cycle or prove to be pivotal links in the ocean food web. This incredible marine genetic diversity can also provide an insurance policy against environmental disruption, as it offers pathways for evolution. And we need only imagine the great technological and biomedical benefits of understanding how life has adapted in millions of amazing ways to some of the harshest environments on planet Earth. The more we know about the interplay of life, the less likely we are to take yet another misstep and inadvertently disrupt important ecosystem services.

Meanwhile, we do know enough already to understand that human activities pose significant threats to the future health of the world's ocean, the U.S. exclusive economic zone, and our coastal regions. We must now take inventory of these threats before we can talk about our successes or consider opportunities to mitigate and minimize them.

Changing Ocean, Changing Energy

Although there are numerous threats to ocean and coastal ecosystem health that impact our *blue economy*, this paper will focus on the top energy-related priorities: climate change, offshore oil and gas development, and deep seabed mining.

Climate Change

There can be no complete conversation about the *blue economy* and the future of our ocean without addressing the existential environmental challenge of our time: global climate change. Human-caused greenhouse gas emissions are fueling increases in extreme weather events, threatening coastal communities with sea-level rise and salt water intrusion, harming marine life with warming and acidifying waters, and bleaching coral reefs with alarming rapidity. To set the economic tone for what climate change could cost the U.S. economy in general, we can turn to the fourth National Climate Assessment that the Trump Administration released in November 2018. This report suggested that climate change could reduce the overall economy by 10 percent by the end of this century,¹¹ including \$140 billion from the loss of recreational opportunities due to harm to coral reef ecosystems alone.¹²

In its summary on the implications for oceans and coasts, the report states in part:

Rising water temperatures, ocean acidification, retreating arctic sea ice, sea level rise, high-tide flooding, coastal erosion, higher storm surge, and heavier precipitation events threaten our oceans and coasts. These effects are projected to continue, putting ocean and marine species at risk, decreasing the productivity of certain fisheries, and threatening communities that rely on marine ecosystems for livelihoods and recreation, with particular impacts on fishing communities in Hawai'i and the U.S.-

¹⁰ UNESCO, "Covid-19: the ocean, an ally against the virus," 16 April 2020. Available at: <https://en.unesco.org/news/covid-19-ocean-ally-against-virus>

¹¹ Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, undated. Available at: <https://nca2018.globalchange.gov/>

¹² Fourth National Climate Assessment, Chapter 9: Oceans and Marine Resources. Undated. Available at: <https://nca2018.globalchange.gov/chapter/9/>

Affiliated Pacific Islands, the U.S. Caribbean, and the Gulf of Mexico. Lasting damage to coastal property and infrastructure driven by sea level rise and storm surge is expected to lead to financial losses for individuals, businesses, and communities, with the Atlantic and Gulf Coasts facing above-average risks. Impacts on coastal energy and transportation infrastructure driven by sea level rise and storm surge have the potential for cascading costs and disruptions across the country. Even if significant emissions reductions occur, many of the effects from sea level rise over this century—and particularly through mid-century—are already locked in due to historical emissions, and many communities are already dealing with the consequences.¹³

The implications of documented changes in ocean ecosystems are already proving harmful. In 2012, for example, when the Gulf of Maine was hit with an “ocean heat wave.”¹⁴ As a result, lobsters migrated to inshore waters three weeks earlier than expected, leading to a supply glut as processors were not prepared to buy product in the volume that was available, and prices plummeted to their lowest level in 18 years.¹⁵

No region of the country is immune from these effects. From heat waves and drought to the hurricanes and unprecedented torrential rainfall events like the 60 inches of rain that fell on parts of Houston, Texas during Hurricane Harvey in 2017, the effects of our warming climate are wreaking havoc throughout our country and around the globe, and the economic impacts are already adding up. And this is only the beginning.

In the last five years, the frequency of extreme weather events causing over \$1 billion in damages has doubled. In 2018 alone, the U.S. was hit with 14 separate billion-dollar disasters, fueled by climate change, that took 247 lives and collectively inflicted \$91 billion in damages. Still, this figure is less than a third the cost of the prior year, when Hurricanes Harvey, Irma, and Maria combined to cause over \$300 billion in damages.¹⁶ The impacts are real, the causes are becoming clearer with every new study, and it is without question the number one threat to our *blue economy*.

Offshore Oil & Gas Development

Of course, the ultimate source of carbon and other greenhouse gas emissions is the world’s thirst for fossil fuels. And in addition to carbon pollution, offshore oil and

¹³ Fourth National Climate Assessment, Volume II: Impacts, Risks, and Adaptation in the United States, undated. Available at: <https://nca2018.globalchange.gov/>

¹⁴ Pershing, Andrew J., et al. “Fisheries Management in a Changing Climate: Lessons from the 2012 Ocean Heat Wave in the Northwest Atlantic,” *Oceanography*, 2 October 2015. Available at: <https://tos.org/oceanography/article/fisheries-management-in-a-changing-climate-lessonsfrom-the-2012-ocean-heat->

¹⁵ Trotter, Bill, “2012 Maine lobster catch increases by 18 percent, but price continues to decline,” *Bangor Daily News*, 4 January 2013. Available at: <https://bangordailynews.com/2013/01/04/news/hancock/2012-maine-lobster-landings-leap-18-percent-but-price-continues-to-decline/>

¹⁶ Dennis, Brady and Mooney, Chris, “Wildfires, hurricanes, and other extreme weather events cost the nation 247 lives, nearly \$100 billion in damages during 2018,” *The Washington Post*, 6 February 2019. Available at: https://www.washingtonpost.com/climate-environment/2019/02/06/wildfires-hurricanes-other-extreme-weather-cost-nation-lives-nearly-billion-damage-during/?utm_term=.840b8aacb120

gas drilling also causes more direct impacts to ocean and coastal ecosystems from drilling, extraction, and transportation.

April 2020 marked the 10-year anniversary of the BP Deepwater Horizon oil disaster that spewed nearly 170 million gallons of crude from beneath the seabed into the Gulf of Mexico. I was serving as a Republican congressional staffer at the time, and I toured the region with the U.S. Coast Guard in the days afterwards. Often, industrial activities in our ocean suffer from an “out of sight, out of mind” mentality: if we don’t see it, it must not have a negative effect. In this case, all of us who saw the massive harm done by BP and Halliburton’s carelessness will never forget the smell of oil burning on the ocean surface, images of sludge sloshing in the Louisiana marsh grasses, or the shrimp boats and other fishing vessels pressed into duty as impromptu skimmers in a futile attempt to clean up that unmitigated disaster.

Offshore oil and gas disasters harm commercial fisheries, aquaculture, tourism, recreational fishing, boating, and numerous other industries that, when carried out in a sustainable manner, contribute immensely to our *blue economy* and can foster economic wellbeing indefinitely. The irresponsible drilling and expansion of drilling into new areas for short term economic gain puts at risk our natural capital in a way that is unacceptable for long term wellbeing of our nation. While offshore energy development is obviously important to some coastal regions, its harmful effect on other coastal industries such as commercial and recreational fishing, aquaculture, and tourism, must be accounted for.

Deep Seabed Mining

At another end of the energy supply chain, the ocean is facing an emerging threat in the form of a new mining industry targeting mineral resources of the deep and remote ocean. And while it would not qualify as a *blue economy* sector, this new push for deep seabed mining may have a silver lining—or at least a nickel one. The market for the minerals found in the deep ocean in higher concentrations than on land, primarily cobalt and nickel, is driven by demand for them in the building of lithium ion batteries for electric vehicles and as base materials for solar panels and wind turbines.

Much investigation must be carried out before the world can determine whether it’s worth risking the destruction of areas of the deep seabed that have never before been seen by humans, much less explored, categorized, and studied. There is currently no management regime establishing a regulatory structure for exploitation of these resources, most of which lie outside any single country’s ocean territory, in the nearly two-thirds of the global ocean that comprises the High Seas—the area beyond any national jurisdiction. This area is managed by the International Seabed Authority, an arm of the United Nations, established under the UN Convention on the Law of the Sea (UNCLOS). The ISA is currently deep into negotiations for how these regulations should be structured, and ultimately how the economic return on any exploitation of the international seabed should be distributed, given that UNCLOS defines the resources of the area as “the common heritage of [hu]mankind.” One important sidebar on this process, of course, is that the United States has never ratified UNCLOS, and as a result, we do not have a role, or even a vote on the final

outcome when it comes to crafting these regulations.

This possibility of moving ahead with industrial-scale mining in the deep ocean has polarized different elements of society. Ocean conservationists and some scientists insist that we simply don't know enough to proceed with industrial scale mining of the deep ocean. Many environmental groups have called for a ten-year moratorium on commercial mining to coincide with the UN's Decade of Ocean Science that will kick off in 2021. Hitting the pause button would allow scientists more time to understand the role of deep ocean ecosystems in the global carbon cycle and account for biodiversity. The discovery of new species has taken on additional urgency amid the coronavirus pandemic, as past vaccines and cures for other diseases such as MERS have originated from novel proteins discovered in ocean life.

Increasing production of minerals from land-based sources is also problematic. Nearly two-thirds of global cobalt comes from the Democratic Republic of Congo, a country with lax environmental regulation, and a less-than-stellar track record of human rights and child labor abuses, and future production there will require more intrusive practices. Exploration is already underway at sites in the United States, Canada, Australia, and other locations, but recovering these resources would mean destroying forests, grasslands, and other virgin ecosystems—all activities that could actually produce more carbon emissions than what would be offset by the products built as a result.

One other possible source of some of these minerals could be found in the byproducts from another emerging use of seawater: desalination plants. In places like the United Arab Emirates, where fresh

water is scarce but seawater is not, desalination is a critical part of ensuring an adequate water supply. The process results in accumulation of massive quantities of brine—the extract from seawater left behind when the fresh water is piped away to faucets. And this brine is rich in trace minerals, including some that could potentially be recoverable, though it's too early to tell whether the economics of this emerging potential source could be viable.

Manufacturers are working on reducing the amount of these minerals their batteries require, but so far they have been unable to eliminate the material entirely. Elon Musk has pledged that his next generation Tesla vehicles will use cobalt-free batteries, and as of March 2019, Tesla's batteries used 75 percent less cobalt than other manufacturers, but there has been no indication that they are close to rolling out a zero-cobalt battery.

This leaves the world with three choices when it comes to the supply of strategic minerals for battery production: move ahead with deep seabed mining, pursue new and expanded land-based sources, or face a shortfall that will slow the needed transition from internal combustion engines to electric vehicles. The question, from a climate and environmental standpoint then is which or what combination of these options is the best—or perhaps the least bad—choice?

The Aspen High Seas Initiative will convene a series of meetings beginning in late 2020 to initiate an independent review of the relative merits of different sources of the materials that will power our future. This work will bring together scientists, environmental and human rights activists, leaders from the land and ocean based mining industry, regulators, and other key stakeholders for a multi-day forum to get to

the bottom of this critical issue and consider the best path forward on a global scale.

Opportunities to Develop a Sustainable Blue Economy

Even with these serious threats, with adequate investment in sound science, data management, and discovery, the future for our *blue economy* can indeed be full of successes and opportunities, and America is poised to continue leading the world toward a future of healthy productivity for our ocean and coasts. Here is an agenda that can help set the tone for a new era of ocean sustainability and strong growth of the *blue economy*.

Offshore Renewable Energy

As the world looks to pivot away from fossil fuels and toward renewable and alternative energy sources, the ocean holds great potential, particularly in the form of offshore wind energy which is already in wide use in parts of Europe and China. Meanwhile, marine hydrokinetic energy, that harnesses the power of moving water in the form of waves, tides, and currents, remains in development, but still could prove to have valuable contributions, particularly as power sources in some smaller, niche markets. There are roles to play for both of these sources which deserve some further explanation.

Offshore wind is a well-established and growing renewable energy source outside the U.S. with over 27 gigawatts (GW) of installed capacity worldwide, and 2019 saw an increase in new capacity of 24% compared to 2018 with over 5 GW installed last year alone.¹⁷ However, the U.S. lags far behind the rest of the world,

with just a single offshore wind farm installed off Block Island, Rhode Island, with a capacity of just 30 megawatts. The Bureau of Ocean Energy Management has issued 15 active leases for offshore projects and capturing just 1 percent of the available power source off U.S. shores could be sufficient to power 6.5 million American homes according to the Department of Energy. Accelerating this development would be a clear win for coastal regions, provided the permitting continues to be carried out in close coordination with other users of the ocean space, including the commercial and recreational fishing industries.

Marine hydrokinetic energy sits at the other end of this development spectrum. The simple physics and chemistry of motion and corrosion in saltwater environments present massive engineering challenges that have made it extremely difficult to effectively capture the obvious energy of the ocean's moving water. Wave energy has been particularly challenging due to the interactions of so much varying, multi-vector motion and the additional complicating factors of the air-sunlight-seawater interactions. Though it should be noted that one company, OceanEnergy, an Irish company with a base of operations in Oregon, has completed a prototype 500 kilowatt wave energy turbine that is now en route to a testing site near Pearl Harbor.

Tidal and current power have the added benefit of predictability, and its hardware can be installed closer to the seabed where there is less turbulence, but ample current to generate electricity. Tidal projects are showing some promise for use in small, remote coastal communities where

¹⁷ Durakovic, Adrian, "Global offshore wind capacity tops 27 GW as 2019 sets new record," 20 February 2020. Available at: <https://www.offshorewind.biz/2020/02/20/global-offshore-wind-capacity-tops-27gw-as-2019-sets-new-record/>

other sources of electricity can often be prohibitively expensive. For example, the Portland, Maine-based Ocean Renewable Power Company is working with the remote community of Igiugig, Alaska, roughly 240 miles southwest of Anchorage, where electricity was powered by generators fed with diesel fuel that has to be flown into the local airstrip at a cost of over \$7 per gallon. In communities like these, with rapid tidal or river currents and shockingly high electricity costs, marine hydrokinetic energy can be at least a part of the solution to their energy needs.

Establishment of Marine Protected Areas

In 2016, a group of scientists led by Bethan C. O'Leary published a comprehensive review of over 140 studies and found that "results consistently indicate" that protecting 30 to 40 percent of the ocean would be necessary "to protect biodiversity, preserve ecosystem services, and achieve socioeconomic priorities."¹⁸

In recent years, several nations including Chile, the United Kingdom, Palau, the Cook Islands, and others have moved proactively to establish large marine protected areas (MPA) in their waters, affording varying degrees of protection to areas of the ocean comparable in size to entire countries. The U.S. briefly held the title of the world's largest marine protected area following President Obama's 2016 action to expand the Papahānaumokuākea Marine National Monument. The largest is

currently the Cook Islands' Marae Moana area designated in 2017.¹⁹

However, size is not always the most effective measure. Arguably the most critical factor to ensure MPAs achieve their intended goals of increasing ocean health is the level of protection they are afforded. And while Marae Moana includes 50 km no-take zones around 15 islands, the remainder of the area has only limited protections. Current estimates are that approximately 7 percent of the world's ocean has some level of protection, but less than 3 percent is either fully or strongly protected.²⁰

While we may yet be able to achieve the 10 percent by 2020 goal, these will likely not be fully or strongly protected MPAs. And getting to 30 percent or more by 2030 will certainly require a mechanism to safeguard critical areas of the High Seas. There is a need for scientists and research organizations to create data-sharing mechanisms that will enable us to identify the areas of the remote ocean that are most critically in need of protection. Improved governance mechanisms could create mechanisms for the establishment and enforcement of strong High Seas MPAs.

Support for Strong United Nations Action

Of course, ocean issues are inherently international. The world has but one ocean, connected by a perpetual band of currents, tides, and wind. What happens in one basin will inevitably spread to the

¹⁸ O'Leary, Bethan C., et al., "Effective Coverage Targets for Ocean Conservation," *Conservation Letters: a Journal for the Society of Conservation Biology*, 21 March 2016. Available at: <https://onlinelibrary.wiley.com/doi/full/10.1111/conl.12247>

¹⁹ International Union for the Conservation of Nature, "The Journey of Cook Islands: Marae Moana," 26 June 2018. Available at: <https://www.iucn.org/news/oceania/201806/journey-cook-islands-marae-moana>

²⁰ Sala, Enric, et al., "Assessing real progress towards effective ocean protection," *Marine Policy*, vol. 91, May 2018, pp 11-13. Available at: <https://www.sciencedirect.com/science/article/pii/S0308597X17307686>

others. As such, solutions to ocean issues and the pursuit of sustainable economic growth must also be dealt with ultimately at a global scale. The United Nations is currently amid negotiations on a new treaty to manage biodiversity beyond national jurisdiction (BBNJ)—the fourth and final negotiation session had been scheduled for March of this year but was postponed due to the pandemic. Once completed, this new agreement, developed under the auspices of UNCLOS, will for the first time establish a mechanism for the international community to prioritize a holistic approach to the world's deep and remote ocean ecosystems. It contains four major components: 1) creating a mechanism to establish, manage, and enforce marine protected areas on the High Seas; 2) set a process for conducting environmental impact assessments for High Seas activities; 3) develop a management regimen for marine genetic resources of the High Seas; and 4) create an agreement on technology transfer and intellectual property among developed and less developed countries.

The first step the United States can take to ensure a positive outcome from this process is to at long last ratify UNCLOS, the seminal, international agreement that forms the foundation of international maritime law. However, recognizing that such action is unlikely given the current makeup of the U.S. Senate, short of full ratification, the U.S. delegation can still exert significant influence over the ongoing negotiations, and help ensure that the treaty includes strong protections against over-exploitation of marine resources, and establishes a clear path for the world to designate critical areas of the High Seas as

fully- or highly-protected marine protected areas.

In addition to supporting completion and ratification of a robust BBNJ treaty, the U.S. should also support strong ocean protection across a range of international bodies and decisions they will make throughout 2020, a major year for international ocean action. By the end of this decade, international bodies will make major decisions on a suite of topics that will have lasting ramifications for our marine resources. These include working to ensure achievement of key targets in the UN's Sustainable Development Goal 14, "Life Below Water," contains several targets for the international community to meet by 2020, including protecting 10 percent of the ocean; ending harmful fishing subsidies such as those that promote fishing activity on the High Seas; and bringing an end to global overfishing.²¹ The U.S. delegation should support all international efforts to achieve these goals.

Improving Scientific Research Capacity, Data-Sharing, Technology, and Collaboration

The one thing each of these proposed opportunities has in common is the need to rely on improvements in scientific research, data-sharing, and technology. Fortunately, we are living in a time when opportunities to gather data are increasing exponentially, as is our ability to process that data. A piece published by the World Economic Forum in August 2017 asserted boldly that "we have collected more data on our oceans in the past two

²¹United Nations Development Programme, Sustainable Development Goals, Goal 14: Life Below Water. Undated. Available at: <https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-14-life-below-water.html>

years than in the history of the planet.”²² A 2018 blog piece for Scientific American reported that NOAA’s ocean sensors collect 20 million megabytes of data daily.²³

While all the remote sensors, buoys, data tags, satellites, autonomous underwater and sea surface gliders observing, measuring, and reporting back their findings are giving us a better picture of how the infinitely intricate interactions between various aspects of the natural world might actually function, in order to truly unlock the secrets they provide will require not just a data gathering revolution, but a data *management* revolution. What good is your daily 20 terabytes of data if you have no way to sort it and understand what it means?

This is why organizations like the World Economic Forum’s Centre for the 4th Industrial Revolution and XPRIZE are showing an interest in solving this ocean data management puzzle. They recognize that ensuring a fully functioning ocean system is fundamental not just to ocean life, and not just to ensuring we do all in our power to avoid the worst possible outcomes of the climate crisis, but to ensuring a viable future for humanity as our population continues to soar towards 9 billion.

The more we learn about the ocean and its denizens, the more we understand how critical its protection is to the future of humanity and our planet. These physical and scientific explorations also lead to innovations that revolutionize how we can

utilize marine resources in a manner more comprehensive and less wasteful. Creating more value from the same amount of extracted material means a win-win for both the economy and the environment.

Iceland has established an ideal laboratory for this type of innovation and in so doing has become a global leader in the emerging “Blue Tech” movement. This small island nation, which currently ranks 14th in gross domestic product per capita, just one spot behind the United States,²⁴ derives approximately 30 percent of its GDP from ocean-related industries. And it has built this massive economic engine without compromising sustainability, as clearly shown in the massive updates they have made to how they treat one of their oldest and most plentiful commodities: cod. Iceland’s fisheries are among the best managed in the world from a sustainability standpoint, so instead of driving their growth by simply following the old model and catching more fish, they are sticking to scientifically mandated catch limits and creating more value from the same number of cod. Where in previous times, the value of a cod would be equivalent to the price of its fillets, Icelanders have found ways to use previously discarded parts of the fish for commercially viable products—turning collagen into hand sprays and soft drinks, protein enzymes into beauty products, intestines into fishmeal, livers into smoked liver pate, and skin into fish leather. As a result, Icelandic cod are now worth \$3 more

²² Degnarain, Nishan and Adler, Steve, “How data can heal our oceans,” World Economic Forum, 4 August 2017. Available at: <https://www.weforum.org/agenda/2017/08/how-data-can-heal-our-oceans/>

²³ Mulrennan, Matthew and Johnson, Ayana, “7 Award-Winning Apps Launch a Mobile Age for the Ocean Economy,” Scientific American, 16 February 2018. Available at: <https://blogs.scientificamerican.com/observations/7-award-winning-apps-launch-a-mobile-age-for-the-ocean-economy/>

²⁴ Worldometer.info, “GDP per capita,” 01 May 2020. Available at: <https://www.worldometers.info/gdp/gdp-per-capita/>

per fish than their counterparts in other countries.

This infrastructure is all driven by an attitude of collaboration among maritime industry leaders who have banded together both conceptually and physically in an entity called the Ocean Cluster House—a physical, co-working location for small ocean-related start-ups. Buoyed by the Scandinavian ethic of collaboration, these entities fuel one another’s passion, provide sounding boards for emerging ideas, and foster mutual growth—a rising tide that truly lifts all Icelandic boats. The Ocean Cluster model has already been tagged for replication in the U.S.. A Cluster House opened earlier this year in Portland, Maine (though its formal launch has been delayed due to the pandemic), and a Pacific Northwest Ocean Cluster is in development in Seattle, Washington.

Conclusion

With increased knowledge and opportunity comes increased responsibility. When our predecessors made missteps with the natural world, they could at least fall back on ignorance as an excuse for the havoc they had unleashed. Few in Oklahoma in the 1930s could have predicted that uprooting prairie grasses for wheat fields would have led to the wholesale destruction of the Dust Bowl. While nuclear scientists in the 1950s surely understood that radioactive fallout wasn’t healthy for remote Pacific atolls, they failed to fully appreciate the scope and permanence of their actions.

Today we do know what we could not have known before. We know that the ocean is not too big to fail. If we turn away from science and ignore the warnings in order to carry on with our business as usual approach, chasing short-term economic

gain at the expense of long-term environmental health, we will be dooming future generations.

Fortunately, we also have the means to avoid the worst of these possible outcomes. By tracking, measuring, understanding, and managing our ocean and *blue economy*, and making decisions that may cost a little more today but promise a sustainable future and return on our investment tomorrow, we can overcome the challenges that lay before us. The critical life-support system that is the global ocean will support us as long as we take care of it and hold to this one fundamental principle: First do no harm.

GEOPOLITICS OF ENERGY: EXPANDING AMERICA'S GLOBAL COMPETITIVENESS AND ECONOMIC VITALITY

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"The winner of the emerging clean energy race will determine the economic and geopolitical balance of power for decades to come. The United States faces steep competition in this field."

- James A. Baker, III, George P. Shultz, and Ted Halstead, *Foreign Affairs Magazine*

The United States Congress faces the formidable task to create a stimulus plan to restart the U.S. economy in the wake of the coronavirus pandemic and related economic crisis. The temptation will be to focus on restoring the existing economy and preserving existing infrastructure and manufacturing capacity, as the mounting unemployment claims are a pressing and compelling issue. But consideration must also be given to America's future global competitiveness and economic vitality. To address both properly, careful consideration of the changing world of energy will be a necessity. Energy innovation has played a critical role historically in the expansion of U.S. economic and geopolitical power since the early 1900s. It is a vital concern to U.S. national security and therefore deserves special attention.

The U.S. economy has benefited greatly in recent years from advances in energy technologies. Over the last decade

or so, American energy innovation and expanding exports of energy supply and green technology promoted competitive markets and consumer choice, limited the petro-power of authoritarian states such as Russia and Iran, and contributed to a sustained period of global economic expansion.¹ In effect, technology innovation allowed the United States to hit the jackpot twice. U.S.-led innovation in alternative fuels, advanced vehicles, energy efficiency, battery storage, and smart grid solutions gave consumers around the world additional choices for how to meet surging energy needs. At the same time, the U.S. oil and gas industry tapped new, innovative methods to produce oil and gas from unconventional reserves, unlocking a wave of competitively priced oil and gas exports to the global market. By combining hydraulic fracturing and horizontal drilling guided by supercomputing and data analytics, U.S. oil producers were able to increase oil production from shale to reach 9.1 million barrels/per/day, up from virtually

¹ Myers Jaffe, Amy and Ed Morse, "The End Of OPEC," *Foreign Policy*, October 16, 2013, <https://foreignpolicy.com/category/analysis/argument/>

nothing in 2010.² Total U.S. production was 12.2 million b/d in 2019, including shale production, offshore production from the U.S. Gulf of Mexico and Alaska, and traditional oil and gas onshore vertical wells. By leading in energy technologies and exports, the United States enhanced its economy, its global competitiveness, and strengthened economic ties to its important trading partners.

Now in the wake of the coronavirus pandemic, these gains are facing setbacks. Considering how to integrate continued U.S. energy technology leadership into any stimulus to promote the recovery of the U.S. economy will be critical. Unfortunately, zero sum partisan politics surrounding the issue is blocking a huge potential for a win regarding new jobs, continued exports, and revitalization of America's leading role in the global economy. What is needed is a vision that acknowledges the need for fuel to support current infrastructure while at the same time promoting an energy transition that will position the United States for a future economy in the direction that U.S. trading partners are already headed.

Leading in energy innovation ensures that the U.S. military and space programs have a technological edge over geopolitical rivals and lowers the cost of addressing climate change. It has spurred new markets, industries and companies in the United States in recent years. It has also produced more cost-effective supply chains and boosted manufacturing productivity, while lowering the U.S. economy's energy intensity and thereby providing environmental benefits. A new wave of rapid innovation in digital technologies—including advancements in on-demand travel services, automated and

self-driving vehicles, big-data assisted logistics, newly automated, decentralized electricity systems and three-dimensional (3D) printing—are revolutionizing the way we produce, use, and transport energy. Many of these technologies have dual-use applications in the military sphere, meaning that their successful development and launch by U.S. companies is important beyond their economic benefits.

Without public funding and related political leadership to guide optimal outcomes, the United States could fall behind other nations that have well-developed, national energy and digital technology initiatives such as China and Europe. The United States has begun to address the issue by imposing export controls on critical telecommunications and computing technologies. But a supportive policy atmosphere is also needed to foster markets at home and abroad. A U.S. failure to address the challenge of the emerging race in the digital energy future would be analogous to the United States opting to ignore the risks that the Soviet Union's superiority in space in 1957 might have threatened America's national security. Imagine today if the United States had inferior access to satellite and other kinds of sophisticated defense related aerospace technologies. That is, in effect, what it would mean if the United States does not address China's efforts to dominate the new digital energy market with its own brand of smart drones, cyber surveillance technologies, and automated vehicles and electric networks that will not only underpin future economic trade in clean energy products, but also boost their relative capability in asymmetric warfare technology. The U.S. Pentagon has

² Kornfeind, Hunter, "FAQ: A Shale New Deal," Energy Realpolitik, April 15, 2020, <https://www.cfr.org/blog/faq-shale-new-deal>

recognized this future and began funding research in automated machines and vehicles in 2004.

Since then, five U.S. corporate giants, Amazon, Facebook, Apple, Microsoft, and Google/Alphabet, have boosted research and development spending, with totals expected to reach \$160 billion by 2022.³ But private sector focus can diverge from broader national security goals. The U.S. Congress needs to take advantage of a long history of government-directed private sector industrial stimuluses to maintain (and restore where needed) American competitiveness in energy innovation and infrastructure enhancement.

What are some of the key digital energy technologies that are important to future U.S. competitiveness?

There are a host of emerging technologies that will be critical to American economic competitiveness and national defense in the coming decades. These include electricity storage and smart grid networks, quantum computing, Artificial Intelligence, and big data analytics, advanced manufacturing, automation, and small-scale advanced nuclear power, to name a few. As the early stages of the coronavirus pandemic so dramatically demonstrated, many of the components needed for these industries originate in China.

While it is a misconception that China controls the vast majority of rare earth metals used in advanced energy technologies (it is home to only one third of known global reserves) it dominates 85 percent of the world's rare earth ore processing.⁴ There are still U.S. companies with considerable experience in rare earth mining, recycling, and processing as well as experience making permanent magnets.⁵ Only a small percentage of the U.S. wind industry (under 2 percent) use magnets in its turbines. The U.S. military has begun to stockpile rare earth magnets used in missile and jet engine manufacturing. China and Japan are the largest magnet producers of super strength, neodymium industrial magnets. There are other mineral inputs to the alloys and other materials used in jet engines that often come from Chinese processing plants. China also dominates the global lithium processing and recycling industry. In recent years, the United States has also lost its edge in nuclear energy and is taking action to strengthen its uranium mining industry and uranium conversion services. Renewal of the Russian Suspension Agreement (RSA) should be predicated on mechanisms that continue to protect U.S. industry against future uranium dumping practices. Similar limits on import of nuclear fuel fabricated in China may also need to be considered at a future juncture.

The Critical Minerals Policy Act of 2013 provides a starting point to consider

³ Matsuo, Yohei, Daisuke Maruyama, and Tatsuya Goto, "Entire Japan Inc to be outspent by 5 US tech giants in R&D," *Nikkei Asian Review*, February 2, 2020,

<https://asia.nikkei.com/Spotlight/Datawatch/Entire-Japan-Inc-to-be-outspent-by-5-US-tech-giants-in-R-D>

⁴ Webb, Simon, Lisa Shumaker and Jonathan Oatis (eds.), "U.S. dependence on China's rare earth: Trade war vulnerability," *Reuters*, June 27, 2019, <https://www.reuters.com/article/us-usa-trade-china-rareearth-explainer/u-s-dependence-on-chinas-rare-earth-trade-war-vulnerability-idUSKCN1TS3AQ>

⁵ Collins, Gabriel and Andrew Erickson, *Economic Statecraft: Options For Reducing U.S. Overdependence On Chinese-Supplied Materials And Medications*, Rice University's Baker Institute for Public Policy, April 23, 2020, <https://www.bakerinstitute.org/research/economic-statecraft-options-reducing-us-overdependence-chinese-supplied-materials-and-medications/>

additional support for building U.S. domestic capabilities. The United States can also leverage the activities of its allies, such as Japan, which has earmarked funding to repatriate manufacturing activities from China back to Japan. Europe is also spearheading an initiative to build a mining and manufacturing base for clean energy.

The U.S. Pentagon began funding an effort on the development of autonomous vehicles in 2002. Since then a new geostrategic race to dominate critical digital technologies for automation and mobility has begun in earnest. While most Americans think of such products as the latest in experimental commercial endeavors by Waymo to foster ride hailing services in self-driving cars in places like the suburbs of Arizona and efficient drone and mini-robot delivery by Amazon.com or UberEats, major militaries are now competing in the spheres of autonomous vehicles and drones, tapping artificial intelligence, machine learning, and massive data analytics, to gain an edge in asymmetric warfare. The U.S. Congress set a goal that by 2015, "one third of the operational ground combat vehicles of the U.S. military be unmanned."⁶ That deadline has come and gone but now the United States faces intense competition in this space from China.

The COVID-19 pandemic could accelerate the commercial availability of autonomous vehicles and robots in settings where a human driver, delivery person, or medical personnel might be less attractive than a smart machine. The Chinese firm

Baidu has already completed a successful test of 5-G based autonomous driving in the economic development zone of Xiongan in 2018. The Chinese firm WeRide is piloting robotaxi services in Guangzhou while Chinese telecommunications maker Huawei is partnering with several Chinese automakers as well as Audi. To facilitate this industry, China is investing over \$20 billion to launch a national semi-conductor giant that can end its reliance on foreign suppliers. China also offers 5-G companies from India, Japan, and South Korea cheap equipment and free airwaves to jump start their interest in the Chinese self-driving car market.

Autonomous transportation networks could also provide environmental benefits by creating smart networks that allow for efficient traffic flow that can eliminate congestion and accidents. Smart traffic autonomous vehicles (AVs) could reduce stop and go braking and acceleration, which currently accounts for a high proportion of energy use in vehicles. City congestion leads to upwards of 3 billion gallons of wasted fuel a year, according to Texas A&M's Transportation Institute.⁷ In its study, "Digitization and Energy" the International Energy Agency (IEA) found that self-driving vehicles hailed by smart phones had the potential to cut oil use in half from current levels, through efficiency gains and electrification. McKinsey & Co. notes that adding big data analytics to logistics programs of either traditional delivery vehicles or new automated delivery vehicles will be able to shave 25 percent off fuel used for on-road freight as e-commerce

⁶ Brown, Meta, "Driverless Cars, Analytics and Tough Standards for 21st Century Innovation," *Forbes*, August 29, 2015, <https://www.forbes.com/sites/metabrown/2015/08/29/driverless-cars-analytics-and-tough-standards-for-21st-century-innovation/#68cd340445a6>

⁷ Schrank, David, Bill Eisele, and Tim Lomax, *2019 Urban Mobility Report*, Texas A&M Transportation Institute, August 2019, <https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019.pdf>

replaces trips to the store by individual drivers.

In the post-COVID-19 world, governments and corporations alike are reconsidering heavy reliance on complex, extended supply chains. This reevaluation of national vulnerabilities for vital goods has made the advantages of advanced manufacturing clearer. When the United States began searching for solutions to a shortage of medical equipment such as ventilators and protective medical gear, the use of 3D printers offered a ready solution. 3D printing is another important digital technology that has several strategic benefits. It keeps more manufacturing at home in the United States, limits the need for components from other markets, and reduces the use of oil for shipping of goods. The latter is believed to have the potential to eliminate as much as 25 to 40 percent of energy demand for transport of components for construction of heavy equipment.⁸ It is being used successfully in the U.S. aerospace industry and could be a future linchpin to keep U.S. automotive manufacturing competitive to world standards.

Just as digital innovation has contributed to revolutionary improvements in how the United States is tapping its vast unconventional oil and gas reserves, so digital innovation also has the potential to revolutionize U.S. electricity network products and services to make them more resilient to potential sources of outages that can disrupt traditional large-scale

centralized plants such as severe weather events or cyber hacks. One model is to aggregate building systems to integrate rooftop solar, electric cars, and battery storage into a "virtual power plant" that tap smart inverters that use software-assisted programs to manage changes in flows of electricity to and from homeowners and the grid. At times of stress to the grid, surplus capacity from the many household battery systems are used to balance supply and demand, preventing brownouts and smoothing out the intermittency of renewables and time of day demand surges. But to tap these advantages, the United States needs to be a leader in both battery technology, solar inverter technology, and related software. American firms Tesla, First Solar, and Blueprint Power are among the companies leading in the installation of such systems, but China still dominates solar panel manufacturing and over 70 percent of components used in solar panels are currently sourced from China. The electricity storage industry also relies heavily on China for materials processing. Chinese lithium production represents over 60 percent of the world's capacity to utilize the material for battery production.⁹

The United States must also stay the course to ensure its nuclear workforce capabilities remain intact. That means funding for advanced nuclear reactors such as small modular reactors (SMRs) should continue apace via the Nuclear Energy Leadership Act that is now giving life to commercial investigation for a variety of technologies including three molten salt

⁸ Myers Jaffe, Amy, "Will the coronavirus have a lasting impact on carbon emissions?" *The Bulletin of the Atomic Scientists*, April 20, 2020, <https://thebulletin.org/2020/04/will-the-coronavirus-have-a-lasting-impact-on-carbon-emissions/>

⁹ Sanderson, Henry, "The battle for control of world's battery supply chain," *Financial Review*, May 23, 2019, <https://www.afr.com/world/asia/the-looming-battle-for-control-of-battery-supply-chain-20190523-p51qaw>; Sanderson, Henry, "Electric cars: China powers the battery supply chain," *Financial Times*, May 22, 2019, <https://www.ft.com/content/455fe41c-7185-11e9-bf5c-6eeb837566c5>

reactor designs, a gas-cooled reactor and a sodium-cooled design. One promising technology hopes to be able to repurpose stored spent reactor rods in the United States as fuel for a new plant design.

What is China's policy and strategy?

China's industrial policy is aimed to deliver a range of technologies that will dominate the future global economy, including 5-G networks, solar panels, battery storage, electric and autonomous vehicles, drones, and commercial robotics, high performance computing/artificial intelligence applications, and high-speed rail. Many of these technologies are fundamental to superiority of weapons systems. Since Beijing first announced its Science and Technology initiative in 2006, it has launched the world's fastest supercomputer and become the world's largest drone manufacturer. China's unparalleled size as the world's largest consumer country gives the country an economic and strategic advantage. The size of China's online shopping industry now totals over \$1 trillion. Its car market is also the world's largest. China hopes to utilize its consumer spending power to attract innovative companies and to attain top status in critical strategic industries in clean energy. It is no coincidence that U.S. electric car company Tesla saw its stock surge after it successfully opened a manufacturing plant in Shanghai. Similarly, other innovative U.S. companies from those that with technologies to 3D print cars to makers of advanced materials have shifted to China after failing to find public funding or private venture capital champions in the United States.

China has been particularly aggressive targeting smart, connected vehicles technology including self-driving cars and has engaged in espionage against U.S. companies to gain access to American technological knowhow. China is focused on winning the race to install 5-G networks in its major cities, in part so it can attract self-driving automotive industries that might be reluctant to miss out on the opportunity to pilot their wares more quickly at scale. However, China is constrained by its current inability to surpass the United States in semi-conductor design and manufacturing.

To the extent that China eventually overcomes its deficits in leading edge chips innovation and manufacturing and surpasses the United States in launching 5-G and clean energy networks with linked automated energy storage, transport, and e-commerce capabilities, it could not only dominate export markets for the technologies but also establish its own rules for cyber intrusion that could become contrary to U.S. values and interests. Already, China has shown a willingness to export its system that combines authoritarianism and digital surveillance that could lead to an erosion of democratic governance and principles.¹⁰ The use of artificial intelligence, sensors, automated vehicles and drones, as well as smart, computer-assisted household electric and appliance systems will come with strings attached that require an ethical and moral element that will greatly determine the future in almost every sphere of daily and political life.

¹⁰ Campbell, Kurt and Jake Sullivan, "Competition Without Catastrophe," *Foreign Affairs*, September/October 2019, <https://www.foreignaffairs.com/articles/china/2019-08-01/competition-without-catastrophe>

Europe's trillion-dollar clean tech initiative

The European Union, worried about future dependence on China for its clean energy future, has committed to a \$1 trillion initiative to create an internationally competitive battery supply chain, including mining, recycling, and manufacturing to its own shores. France and Germany have announced a \$5 billion to \$6.7 billion consortium of automobile and energy firms to enhance Europe's electric car battery manufacturing capability. The European Union will be providing public subsidies. Even with the COVID-19 pandemic, European leaders are emphasizing European stimulus packages will support the planned shift to clean energy. The European Council reaffirmed that the roadmap for economic recovery will feature the green transition and digital transformation with a "central and priority role in relaunching and modernizing our economy."¹¹

Paradigms for U.S. approaches

The Trump administration's latest budget request would slash federal funding for applied energy programs. Such budget cuts would move the United States in the wrong direction in terms of long-range U.S. competitiveness and economic vitality.

There is no question that the private sector has an important role to play in energy innovation and technology development, and many of the U.S. technology firms that are leading the future energy landscape have been both drivers to jobs, economic prosperity, the rising U.S. stock market, and U.S. national security. It is not sufficient to close the door to Chinese intellectual property theft or to impose

tighter restrictions on the technologies coming out of these American firms that have dual use applications. What is needed is an affirmative strategy that paves a positive response to how the public sector can promote the superiority of America's technological edge and broader the participation of more American workers in the process. The United States also needs to be a leader in regulating digital technology so that it promotes democracy instead of weakening it by enhancing the rights and benefits to the individual, instead of creating a greater network of surveillance techniques that threaten individual privacy and liberty.

Rather than cutting the DOE's budget, the U.S. Congress should study how to expand DOE's regional centers of innovation program to new areas of the country where jobs are most needed such as regions with underused factories and skilled workforces, working together with state and local government to promote new business clusters and incubators that also draw in private sector finance. As part of that effort, stimulus packages need to include funding for re-skilling at trade schools, community colleges and public universities to train workers for new fields. A new scholarship program should be established for American-born students who agree to serve in our national labs upon graduation for a set number of years.

The Congress should also investigate creating public-private partnerships modeled after the Semiconductor Manufacturing Technology (SEMATECH) consortium that restored vital U.S. leadership in the semi-conductor industry in the late 1980s and reestablished supply

¹¹ A Roadmap For Recovery: Towards a more resilient, sustainable and fair Europe, <https://www.consilium.europa.eu/media/43384/roadmap-for-recovery-final-21-04-2020.pdf>

chains and materials infrastructure. The United States needs to put in a similar effort in batteries and advanced nuclear power, as well as consider how to promote advanced manufacturing and 5-G networks in the United States.

It is important as the Congress initiates new programs to restore the U.S. economy in the aftermath of the COVID-19 pandemic that it consider not only how to restore existing jobs that were lost, but also to focus on future workforce revitalization and creating new industries that will enhance U.S. economic competitiveness and vitality in line with emerging industries of the future. Digital technologies that drive energy innovation must be part and parcel of that effort if the United States is to maintain its economic, military, and diplomatic stature as a global world power.

GEOPOLITICS OF ENERGY SECURITY AND CLIMATE CHANGE

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Even before the world was thrown into disarray by the global Coronavirus pandemic, things were in flux. Power structures within and among nation-states were shifting. A decade ago, Zbigniew Brzezinski foreshadowed the upheaval as the result of a “global political awakening” in which “for the first time in history almost all of humanity is politically activated, politically conscious and politically interactive” and the result is a “quest for cultural respect and economic opportunity in a world scarred by memories of colonial or imperial domination.”¹ Much of this awakening has been enabled by technology, which has connected and informed society in ways previously not possible.

Today, this struggle is playing out at multiple levels, including the great power politics of nation-states. In 2016, Henry Kissinger spoke about the nature of the changing world order, saying that for the first time in decades: “Practically all the actors in the Middle East, China, Russia, and to a certain extent Europe are facing major strategic decisions to settle some

fundamental directions of their policies. China, about the nature of its place in the world. Russia, about the goals of its confrontations. Europe, about its purpose, through a series of elections. America, about giving a meaning to its current turmoil in the aftermath of the election.”²

The balance of power is shifting, the global order is being renegotiated. The culmination of both has led to an era of intense competition. Within countries, political competition has brought new parties to power. Widespread displeasure over inequality and an unlevel playing field threaten to disrupt the global trading regime and have led to intensified economic competition among firms and strategic economic competition among states. The advent of new technological horizons and the rise of developing countries have sparked new frontiers of competition. Against this backdrop, great powers are looking to expand their reach and refresh their strategies to achieve geostrategic gains.

¹ Zbigniew Brzezinski, “The global political awakening,” *New York Times*, December 16, 2008, <https://www.nytimes.com/2008/12/16/opinion/16iht-YEbrzezinski.1.18730411.html>.

² Jeffrey Goldberg, “The Lessons of Henry Kissinger,” *Atlantic*, December 2016, <https://www.theatlantic.com/magazine/archive/2016/12/the-lessons-of-henry-kissinger/505868/>.

As countries look to expand their spheres of influence, energy can play a role as both a target and tool of that expansion. Although much of the world's energy development and trade occurs in the sphere of normal commerce, energy infrastructure, investment, and control over resources can also play a role in establishing or challenging the relationships between and among countries. For the first time since the end of the Cold War, there is genuine strategic rivalry among the world's great powers. China's rise has created a web of economic and political relationships in all continents. Russia is reasserting itself in places from which it had retreated. The United States is aggressively renegotiating its existing relationships with allies and adversaries. New areas of strategic competition have opened up in resource-rich areas like the Arctic and the emerging economies of Africa.

At the same time, the energy sector is experiencing several important upheavals with the potential to reorder the world's energy markets. The current energy system predominantly comprises fossil fuels—oil, coal, and natural gas—though in recent years, renewables (wind, solar, and bioenergy) have grown the most (albeit from a lower base). The mix of fuels in the power sector varies among countries, with some now experiencing a high (more than 25 percent) share of renewables in the generation mix. Coal still dominates the power sector and oil has almost entirely been worked out of the mix except for a few countries where it is still used for power generation. Transportation is dominated by oil, but efficiency gains and the declining cost of batteries mean that electric and more efficient vehicles will limit oil use, even though demand for oil for heavy-duty vehicles, shipping, planes, and petrochemicals will remain robust. Nuclear

power, once the domain of developed economies in Europe, North America, and Japan, as well as Russia, has experienced a resurgence in China and will grow in parts of the Middle East. Elsewhere nuclear energy has struggled to maintain cost-competitiveness for its existing plants, restart operations in the wake of post-Fukushima security concerns and build new plants on budget and on time.

In geopolitical terms, the energy map has changed a great deal as well. Developing economies assumed the largest share of energy demand several years ago and currently make up the majority of total energy demand and nearly all demand growth. China, which has had the largest growth in energy demand each year for the last decade and half and is now the largest energy consumer in the world, has seen a slowdown in energy demand growth in recent years because of moderating economic growth, measures to improve energy efficiency, and structural economic reforms. The United States, once the world's largest energy consumer, is now the largest producer of oil, natural gas, and hydrocarbon gas liquids. The rapid rise in U.S. oil and gas production, along with other factors, helped bring about a collapse in oil and natural gas prices in 2014, causing financial stress for the world's oil and gas exporting economies and led to an alliance between the Organization of the Petroleum Exporting Countries (OPEC) and Russia to manage production to stabilize world oil prices.

All of these shifting market and geopolitical dynamics are occurring in the context of important technological and societal change. Greater awareness of global climate change and the need to drive down greenhouse gas emissions in order to stabilize the earth's atmosphere and avoid

catastrophic impacts has given rise to policies and investments designed to accelerate the innovation and deployment processes necessary to decarbonize the global energy system. This has driven down the cost of renewable energy technologies and increased their role in energy systems around the globe. The rising share of renewable energy means that energy systems not only are becoming more diversified but, in some locations, electric power systems are more distributed, flexible, and responsive, incorporating elements like two-way power flow, demand-response, and distributed storage options. The energy system is gradually becoming more digitally enabled even outside the electric power sector, including digital applications for drilling operations, pipeline functioning and maintenance, refinery optimization, and transportation technologies.

From a policy perspective, countries and companies are working to create new strategies to survive and compete in this new market environment while meeting a broader suite of societal goals and commitments. Countries and multilateral organizations have established a number of global and regional priorities, chief among them the United Nations' Sustainable Development Goals, several of which address the provision of energy services to alleviate energy poverty and to meet other development needs like education, health care, and basic nutrition. Many countries and subnational entities continue to orient their policies and regulations to transitioning to a low-carbon and more resilient future for the purposes of combating and withstanding the effects of climate change. These policies would mean a profound transformation for the world's energy system if they were realized.

U.S. policymaking in this landscape is complicated. There are new players and realignments in traditional fuels, chiefly because of the rise of the United States as the largest producer of both crude oil and natural gas, which has led to closer collaboration between the OPEC and Russia on oil, and could, in time, produce a similar response in natural gas. But the United States and the West are retreating or failing to lead in other energy sectors—the nuclear industry in a few decades is likely to be decidedly non-Western, while China has doubled down on new technologies, ranging from solar panels to electric vehicles, and likely will become a leader in the products essential for transitioning to a low-carbon world. There is, in short, a realignment in old markets, just as the battle is intensifying in new ones.

The Future of Energy Security and Climate Change

For several decades, energy security has been defined and pursued in a multilateral world with relatively open markets and technology transfer, where energy relations have become increasingly commodified. But that world may soon disappear—energy relationships might become more political, open trade might give way to friction, and great powers might leverage energy relations or energy technology to gain an edge over each other.

For decades the United States has promoted a rules-based, multilateral order, supported by shared gains from free trade and deeper economic and political integration within and among countries. Energy security, the ability to secure affordable and reliable supplies of energy, has been widely recognized as a common good promoted by this system. As the world's largest consumer and importer of energy, it was squarely in the United States'

national interest to support this approach through domestic and international energy policy as well as foreign policy.

Today, this multilateral order is being challenged. The world is experiencing a new era of competition for greater geographic and economic power driven by the shifting center of gravity of the global economy, the realignment of relationships between and among countries, and rapid technological change. Energy is poised to play an important role in this upheaval and will be affected by these changes. The United States is no longer the largest consumer or importer of energy. Instead, it is now the largest producer of oil and natural gas and was, at least before the COVID-19 economic downturn, a net exporter of both. The energy world also is changing rapidly, with renewable energy resources like solar and wind making up the fastest growing and largest source of new supplies and global imperatives like climate change challenging the role of status quo fuels. These changes have heralded a reexamination of the United States' national interest regarding energy in this changing global system.

So far, the United States has had two approaches, both designed to use U.S. energy policy to influence the actions of other countries. Under the Obama administration, energy was by and large regarded as part of its climate change agenda. Energy security was still a major priority and energy was used as a tool of foreign policy—particularly the economic sanctions enacted on Iran as part of a strategy to lead to the nuclear agreement. But the major thrust of the Obama administration was the creation of domestic and international climate policy that would drive down emissions and spur green growth advantages for the United States

and other countries. This policy focus led to one of the largest investments in clean energy technology ever through the American Recovery and Reinvestment Act, strong domestic regulation designed to reduce greenhouse gas emissions, and the signing of the Paris Climate Agreement, designed to be the final international accord and implementation mechanism for global climate action.

The Trump administration has grappled with these questions by pursuing “energy dominance,” a strategy in which energy represents (1) a tool for gaining geopolitical influence in a given region and (2) an area of competitive and strategic economic advantage for the United States. Energy has featured prominently in its trade-war with China, sanctions against Venezuela, Iran and Russia, and most other trade overtures (positive and negative). Most recently, President Trump played a large role in pulling Russia and Saudi Arabia together to agree to an oil supply cut in the face of the dramatic oil demand downturn resulting from COVID-19 social distancing policies.

Other global powers, such as China and Russia, pose strong competition for the current U.S. strategy. Energy features prominently in the economic, foreign, and national security strategies of all three countries but in different ways. And although all three recognize the importance of maintaining affordable and reliable energy supplies for the good of the global economy as well as their own economic well-being, they also recognize the influence of energy in the execution of foreign policy at the global and regional level. The issue for the international energy community is whether the multilateral approach to shared energy security, supported by the promotion of free and integrated markets, is

breaking down into regional and economic spheres of influence that are more mercantile in nature—and if so, how the United States should respond.

In the near-term, geostrategic competition in the energy space is likely to persist but be different from the past. No longer a story of producer leverage, this world will be shaped by consumers, as producers actively vie for their favor and access to their markets. Policies, strategies, investments, and technologies that shape energy consumption will be of the highest order value. This era of extreme competition will only be interrupted by a series of crises—not all as profound as the global pandemic we are witnessing today, but destabilizing nonetheless, far more common, and many associated with global climate change. Whether cyber intrusions, ongoing trade disputes, ever expanding sanctions regimes, or the sea-level rise, stronger storms, and wildfires we now accompany with a changing climate, the future looks more crisis prone for at least the near-to-medium term future. This environment creates opportunities for some, catastrophic damage for others, and a general drag on productivity and progress for most. For now, it looks to be a bumpy ride.

Lesson from COVID-19 for Climate Change

While it is still too early to tell the longer-term implications of the COVID-19 pandemic on a range of social, economic and political conditions, a few lessons that seem clear reinforce what we already know about the global response to climate change.

- 1) We are Unprepared. Countries are deeply unprepared for a crisis they know will occur, but some countries will fare better than others. Many of

the countries that will do best are the most well-resourced but even in those countries and communities the damage can be long-lasting. Vulnerable populations are hard to protect in the face of a crisis and are often hit hardest.

- 2) Global Cooperation is Weak: If climate change is thought of as a threat multiplier then multilateral cooperation is a capacity multiplier. Unfortunately, the pandemic has shown us that the geopolitical dynamics outlined above have led global governance capacity to fall short of being able to coordinate and lead an effective response. In this world of heightened competition and strong nationalist movements, multilateral muscle memory is weak and trust in government is low.
- 3) Solutions are Hard to Implement: Despite sound policy guidance and the availability of logical solutions, waning trust in government makes it hard to implement solutions at the scale and pace necessary to ward off the worst effects of the crisis. Countries with strong authoritarian tendencies will crack down on domestic freedoms to instill order, whereas liberal democracies will need to work harder to convince their publics to adopt prudent behavior. Local communities, civil society, and the private sector will bear the burden of organizing and finding solutions and those solutions may be replicated elsewhere but very little top down coordination takes place. Even the military is stretched, strained and vulnerable in the face of such a massive and systemic crisis.

- 4) Opportunities are Hard to Take:
Even for those prone to make lemonade out of lemons it is very difficult to mobilize towards long-term solutions during a crisis—and climate change presents its threats to society as a series of ongoing crises. In truth, the Coronavirus pandemic and the threat of global climate change are both excellent opportunities to assess what we as a society are getting right versus getting wrong, what's making us more resilient and less vulnerable, and course correct. But big changes during a time of massive uncertainty can be unsettling. For example, the U.S. government can easily marshal upwards of \$2.5 trillion to help keep the economy afloat during pandemic social distancing but it will be much harder to spend similar amounts of money when the virus is no longer a danger—especially the longer it takes for the virus to be managed. Even if building a resilient, low-carbon economy is in the best interest of the United States and every other country on earth, the opportunity will be hard to take in the face of so many other pressing needs.

CLIMATE CHANGE AS A NATIONAL SECURITY ISSUE

Ray Mabus

Former Secretary of the Navy

Climate change has emerged as one of the most serious, and even existential, national security threats of our time. Although this issue is far larger than the military and its response, this essay looks at how climate change affects the United States military today and the potential effects in the future.

The American military's attention to climate change is not a new undertaking. In the early 2000s, during the George W. Bush Administration, military experts and organizations began writing about and planning for the dangers of climate change to the military. The Quadrennial Defense Review (QDR) is done after each Presidential election and looking to the threats the nation will face in the future. The 2010 QDR specifically called out climate change as one of the trends "whose complex interplay may spark or exacerbate future conflicts." The 2014 QDR was even more explicit: "The impacts of climate change may increase the frequency, scale and complexity of future missions, including defense support of civil authorities, while at the same time undermining the capacity of our domestic installations to support training activities."

Bases

For Americans, the most visible manifestation of climate change to our

military is on bases. As storms, flooding and wildfires become more powerful and occur more often due to the effects of climate change, the destruction inflicted on military bases is stunning in its scope and cost.

A few examples: In September 2018, Hurricane Florence slammed the Marine Corps' Camp Lejeune, North Carolina. Thirty-one buildings were destroyed or damaged beyond repair, seventy percent of homes on base were damaged, and the storm caused an 84,000 gallon sewage spill. The bill to repair just the buildings was \$3.6 billion.

Scarcely a month later, Hurricane Michael struck Tyndall Air Force Base, Florida, with even wider destruction. Nearly every one of the base's 500 buildings were damaged and 300 had to be torn down. Several F-22 fighters costing \$140 million each were casualties and all 11,000 people connected to the base had to be evacuated. Getting Tyndall back to full operational level will cost somewhere in the vicinity of \$5 billion and take years to do.

It's not just hurricanes or places along the coast. In March 2019, Offutt Air Force Base, Nebraska, was inundated with floodwaters from two nearby rivers which submerged a third of the base including much of its runway, causing flight operations to be halted. The cost of

repairing the base will almost certainly top \$1 billion. Offutt is the headquarters of United States Strategic Command which oversees the nation's nuclear arsenal.

There are more enduring problems than storms or isolated weather events. The largest Naval base in the world, Naval Station Norfolk, Virginia, and the shipyards which support it, are already being battered with increasing frequency by "king tides" – tides much higher than normal. The roads leading into the base are often flooded and made impassable so, if the Navy needed to get the ships at Norfolk to sea in an emergency, it's possible that, even today, sailors could not reach their ships. If sea level rise is not arrested, the entire base will go under water in the next few decades. If a major storm hit the base today, projections say the entire area with the base and shipyards could be submerged.

Outside the continental United States, many American bases are threatened: Naval Support Facility Diego Garcia in the Indian Ocean and Army's Ronald Reagan Ballistic Missile Defense Test Site on Kwajalein in the Pacific by rising sea levels; Al Udeid Air Base in Qatar by extreme heat; and Cape Lisburne Long Range Radar, Alaska, by erosion.

In 2019, the Congressionally mandated "Report on Effects of a Changing Climate to the Department of Defense," found that two-thirds of the "mission assurance priority installations" of the American military were threatened by climate change. Even though this report was far from a complete survey (no Marine bases and only 79 of the hundreds of bases were included), its findings were stark and frightening.

Disaster Response/Humanitarian Assistance

Apart from bases, climate change has major implications and impacts on the American military. The United States Navy and Marine Corps are the world's first responders. As storms get more frequent and more intense; as floods get more frequent and more destructive; and as droughts get more frequent and more catastrophic, American Sailors and Marines are the tip of the response spear. During my tenure as Secretary of the Navy from 2009-2017, we got a request for humanitarian assistance or disaster relief an average of once every two weeks, and this trend is accelerating.

When Super Typhoon Haiyan hit the Philippines in 2013 killing more than 6,000, leaving 1.9 million homeless and spurring violence in places, Sailors and Marines were among the first to arrive bringing relief supplies, helping clear the devastation and assisting in restoring order. When Hurricane Matthew dealt a crushing blow to Haiti in 2016 killing nearly 600, displacing hundreds of thousands, causing a cholera epidemic, and destroying many food crops, Sailors and Marines responded with medical care, food assistance and many other forms of help.

Where there are these climate events of ever-increasing frequency and ferocity, instability often follows. Instability can lead to chaos and chaos to conflict. Prior to the Syrian Civil War, a diplomatic cable titled "Potential for Social Destruction and Political Instability" warned that drought could be the catalyst for this prediction.

These types of climate events strike every corner of the planet but Africa is particularly vulnerable. Extreme climate

events ranging the spectrum from droughts to floods have all caused food and water shortages leading to social breakdowns, forced migration and recruiting by terrorist organizations. In early 2109, the United Nations magazine African Renewal said: "Climate change is already considered a threat multiplier, exacerbating existing problems, including conflicts." In March 2019, the most powerful cyclone in history in the southern hemisphere, Cyclone Adai, struck Mozambique, Malawi and Zimbabwe. Soon after, a U.S. Air Force contingency response group arrived to distribute medical supplies, food and water.

These situations are not confined to areas outside the United States. When Hurricane Sandy struck the east coast of the United States, the American military responded in myriad ways. The 26th Marine Expeditionary Unit flew aboard the amphibious ship USS Wasp to provide medical, logistical, engineering, and heavy airlift support. Units from all service branches provided a dizzying array of help ranging from dewatering to fuel deliveries to millions of meals.

In a more permanent situation, there are already internal climate change refugees in the United States. Today, at least 17 communities, mostly Native American or Native Alaskan, are in the process of relocating for climate related reasons. Even if climate change is arrested in its tracks, it is estimated that 414 cities and towns will have to relocate. The only relocation program currently being run by the federal government is the moving of Isle de Jean Charles in Louisiana. Not a buyout program, this effort aims to move the 99 residents together to another location at a cost of \$48 million. Even with this small number of people, it is a complex and daunting task.

As climate events intensify and are more frequent, all the U.S. armed forces, particularly the Navy and Marines, will be increasingly called on to respond and to be put in harm's way because of the conditions following the event or the resulting chaos or conflict. Answering the call of these cataclysmic events is a dangerous undertaking as is any mission into uncertain and unknowable conditions. The more often the military is tasked to provide humanitarian assistance and disaster relief, the more military lives are put at risk.

The Arctic

The Arctic is warming twice as fast as any other part of the Earth. With the ice melting all across the Arctic as a direct result of this much warmer planet, the area is quickly becoming a potential flashpoint. A summer ice-free Arctic opens up possibilities unimagined only a short time ago. Already the fabled Northwest Passage is being used and a previously unreachable treasure of minerals on and beneath the sea floor are becoming available.

I personally saw these effects when, in March 2106, I went to the north pole aboard the submarine USS Hampton. We had been warned that, if the ice was too thick, we might not be able to surface at exactly the pole. When we arrived 800 feet below the surface, radar showed a mile-wide area of thin ice around the pole. We came up through ice only eight inches thick and had to have someone with a long stick go ahead of where we walked to make sure the ice could handle even our weight. According to the civilian "ice pilot" who had done this many times, it was by far the thinnest the ice had ever been.

As new Arctic possibilities open up, the security and military implications increase as quickly. Cruise lines with little or

no experience in the far north and no ships which are ice capable, are advertising cruises to “this magical land.” It is not hard to imagine the international incident and probable tragedy if one of these cruise ships hit an iceberg and became disabled or sank. The search and rescue options available come only from the military and are extremely limited. A case in point: the U.S. Coast Guard has only one more than forty-year-old icebreaker.

Exploring for the mineral riches of the Arctic also involves incredibly high risk. The harsh environment means that much standard equipment does not work and, for example, if there was an oil spill such as Deepwater Horizon in the Arctic, the difficulties in containing such a spill would be far greater than it was in the Gulf of Mexico (and it took several months in far closer and more hospitable conditions to stop that spill) and the damages would be exponentially larger.

In direct military terms, Russia has built or rebuilt almost 500 military facilities across the Arctic many with radars and weapons that work in extreme cold. The only possible explanation for these is, in Pentagon-speak, Anti-Access/Area Denial (AA/AD). Russia wants to be able to control which shipping passes through the Arctic. Because of the increasing traffic through these waters, if it shut down passage to only its ships or those of its allies, it could do great harm to the world’s economy. It claims that the waters to its north are inland waterways and thereby subject to their exclusive control. Under international law, this is not the case but enforcing this international law is a different matter and may not be possible without a military solution.

Even accounting for the nations which border the Arctic (United States,

Russia, Canada, Norway and Denmark—through control of Greenland), a nation far away—China—is making one of the largest plays in the Arctic. Through its “Polar Silk Road” China is investing billions (if not trillions) in energy and mineral projects and in setting goals for Arctic shipping routes. It has and is building icebreakers and is giving a great deal of attention to the region.

The United States’ activity both in commercial and military terms has not been very significant. Every two years, the Navy runs ICEX, a multi-national military training exercise in the Arctic. The last several ICEX’s have been truncated because the thinning ice could not support the base camp. The U.S. Navy put out an “Arctic Road Map” in 2009 which was updated in 2014 and 2019. Among the goals of this Road Map are to ensure the Arctic as a stable and conflict-free region and preserve freedom of the seas. Because of the immense and fast-moving alterations to the Arctic due to climate change and the potential for isolated clashes or open conflict, these goals will add increasing burdens to our military in the near term and will have to be part of America’s national security discussions and policy.

Climate change in these and other ways acts as a threat multiplier and alters the military operating environment impacting our security, our safety, our economy and our ability to remain a global leader. It is an issue which must be at the very top of our national security concerns.

ENERGY TECHNOLOGY INNOVATION LEADERSHIP IN THE 21ST CENTURY

Hal Harvey¹, Jeffrey Rissman, and Sonia Aggarwal

Executive Summary

A rich array of energy options is a critical foundation for enduring prosperity, energy security, and protecting the environment and public health. Smart policy can help fill the pipeline with many energy technology options, bring the best of these to market, and unleash the full power of the private sector in driving down their prices. Energy is a technology business, so it pays to understand which policies work best at stimulating energy technology innovation.

This paper unpacks innovation—from risky science, with only distant potential for application; to the intense work of commercialization, wherein companies drive down costs, increase performance, and learn to deliver reliable products. This paper divides innovation into three stages to illustrate the set of needed policies: research, engineering, and commercialization. It then examines which tools and practices work best for each stage.

Introduction

Energy technology can help meet five goals:

- Energy supplies should be **affordable**.

- Energy delivery should be **reliable**.
- Energy companies should be competitive and should create good **jobs**.
- Energy systems should not unduly harm the **environment**.
- Energy choices should not jeopardize national **security**.

All of these goals are easier to achieve with a steady, strong offering of new technologies—for technology really is the game-changer in energy. Advances in the last two decades have opened up vast new reserves of oil and natural gas, made thermal power plants increasingly efficient and clean, driven down the cost of solar and wind to the point where they are cheaper than most existing coal plants, and made it possible to reduce energy consumption in appliances and buildings by 50 to 90 percent.¹

That's good news. The bad news is that we are starving future generations of the next set of options. Companies in the United States spend less than one-half of one percent of their sales on new

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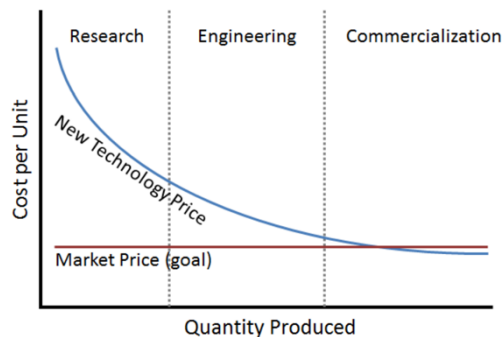
¹ <https://energyinnovation.org/publication/the-coal-cost-crossover/>

technology research and development (R & D), and U.S. government clean energy commitments are at about the same level. This contrasts with information technology (U.S. R&D is 20 times higher as a fraction of sales) and pharmaceuticals (almost 40 times higher). A handful of nations stand out from the rest of the world as they build strong positions on energy R&D; Finland, Japan, and South Korea all make substantial annual energy R&D investments. China has vast new facilities and budgets. The rest of the world lags. If we do not get serious about inventing future energy technologies, energy will become a burden on economic productivity, and we will mortgage our children's futures. Experts in economics, business, energy, and science have all argued that Congress should triple our nation's annual energy R&D budget.²

That said, accelerating technology development without wasting money can be a challenge. Fortunately, proven methods can markedly increase the success rate. This paper describes the best practices that can help energy technologies advance all the way from the laboratory to the marketplace. This work is built upon experience in the field, collaboration with government, reviews of a dozen studies, and many interviews with experts from the private sector, academia, and national labs.

The Phases of Technology Development

The starting point in thinking through technology development is to understand that different strategies are required for different stages of a technology's lifecycle. Schematically, these can be seen as three phases: research, engineering, and commercialization.



Each phase is necessary for success, but each requires its own unique skills, programs, funding approaches, and connections between the public and private sector. Tools that work for one will not work for the others. The next three sections describe strategies for each.

Research

Here, *research* refers to exploration at the boundary of what is known, seeking to achieve new understanding of physical, chemical, or biological systems.

Research fundamentally involves speculation and experimentation. Even with perfect policy incentives, many research projects will never become commercial products. Sometimes technical or scientific issues interfere, sometimes the marketplace changes, sometimes a more innovative approach makes a project obsolete before it can be commercialized. This reality demands that policymakers and investors **tolerate risk** and research failures. Without any failure, you will not find true success.

There are four lessons in organizing successful research:

1. Concentrate efforts in **innovation hubs** to build a critical mass.
2. Use **peer review** to set priorities.

² <https://www.nytimes.com/2019/02/05/opinion/clean-energy-climate-congress.html>

3. Set **long-term** strategies—or else major discoveries are unlikely.

4. Create a set of **gates** for projects to pass at periodic intervals to decide when to stop failing experiments and to continue those that are promising.

1. Concentrate efforts in innovation hubs. Innovation hubs—or “centers of excellence”—are an outstanding machine to accelerate new ideas and products. Alchemy occurs when many academic, private sector, and government researchers work on the same family of problems. Researchers feed off each other’s ideas, students gain technical skills through internships and university-industry partnerships, and businesses have access to talent. Business interests working side-by-side with academia make technologies’ transitions from lab to market faster and more reliable. Venture capital quickly moves in and works as a further accelerant. Intelligent national programs can back up this work with research grants, sophisticated equipment, and public momentum.

2. Use peer review to evaluate potential research project options. Selecting research projects among many competitors is difficult and complex. Peer review, especially when it involves experts from industry, academia, and government, is a critical tool for evaluating the field of options and zeroing in on those most likely to be successful. Peer review panels should include a mixture of government representatives (such as scientists at national labs), industry, and academia. For example, the U.S. Department of Energy (DOE) recently developed a *Quadrennial Technology Review* that considered the potential for breakthroughs in many areas, and overlaid them with national priorities—such as reducing dependence on imported

oil. The work engaged some 600 experts from the private sector, national labs, and academia. The experts were asked to consider the technologies’ leverage against a list of national policy goals and against three explicit measures of potential:

Maturity: Technologies that have significant technical headroom yet could be demonstrated at commercial scale within a decade.

Materiality: Technologies that could have a consequential impact on meeting national energy goals in two decades. “Consequential” is defined as roughly 1 percent of primary energy.

Market Potential: Technologies that could be expected to be adopted by the relevant markets, understanding that these markets are driven by economics but shaped by public policy.

This process helped the U.S. DOE identify issues with its past funding methodology (such as the need to achieve a better balance between projects with near-, medium-, and long-term impacts), and helped identify where to focus efforts to better achieve national priorities.

3. Set long-term strategies. One of the most challenging issues at the interface of legislation and technology development is the need for a **long-term outlook** for technology policy. Private sector companies need consistency and reliability before they make big bets. Federally supported labs must buy equipment, recruit experts, and build and run careful experiments. Policies that promote R&D therefore must match the long time-horizons of technologies, or we will squander opportunities and waste money.

Policymakers, confronted with political and budgetary challenges, tend to fund things a year at a time. But it cannot

be over-emphasized just how deleterious stop-and-start policy is to serious energy innovation. For example, the U.S. R&D tax credit has been repeatedly extended for

and fail fast," before vast quantities of money have been expended.³

Gating Example:

<u>Purpose of the Review</u>	<u>Regular stage gate reviews determine continuation of project</u>	<u>What does a Review Team look like?</u>
<ul style="list-style-type: none"> • To ensure significant progress towards the goals of the R&D project. • To determine changes in priority and direction. • To determine goals for next period. • To stop the project and redirect resources. 	<ul style="list-style-type: none"> • Clear criteria for continuation are established during previous reviews. • An updated business case is very important part of the consideration. • Project goals often change significantly during the toll-gate review. • Projects often stopped for economic rather than scientific reasons. 	<ul style="list-style-type: none"> • Representative of funding department. • Outside technical expertise. • Internal technical expertise. • Representatives of proposed end users. • Representative of financial department. • Members of the R&D team.

short periods of time and allowed to expire. One CEO of an especially research-driven energy technology company told us that, as a result, they "consider the R&D tax credits just to be a windfall, with no impact on the company's R&D choices." By ensuring that credits last for long periods (~five years), companies will have the confidence to rely on the tax credit when making R&D investments.

4. Create a set of **gates** projects must pass to receive continued funding. Finally, there is the difficult question of when to terminate research that is not panning out. Research is more often characterized by failure than success. That means research leaders need great methods to cull the losers. The best method for this is **gating**, which forces research through a series strong, predefined assessments, in which benchmarks are met, and the work proceeds; or they are not, and the work is shut down.

Without a robust gating mechanism, valuable research dollars can be wasted funding a project for years after it becomes clear that it is not valuable, or its time has not come. While some research failures are inevitable, a strong gating procedure helps ensure that when you fail, you "fail early

Funded projects can engender entrenched interests, making it more challenging to remove funding from an existing project than to fund a new project. Therefore, it is critical that gating include independent experts with a combination of **scientific and industrial expertise** in the relevant field. By adding an industry perspective, project funding decisions can be made based on a project's scientific merits and ultimate commercialization potential, not on political considerations.

Engineering

It may be possible to produce a single solar cell with spectacular sunlight-to-energy conversion efficiency, but have no way to cheaply build that cell, or make it robust for decades of continuous operation, or make it reliable, or reasonably priced. Many scientific discoveries fail because they cannot be translated into a practical product.

The engineering phase of the technology lifecycle is the work to make a new discovery into a practical, if not yet market-ready, product. Like research, it is a risky endeavor: Many great ideas, tested in the lab, cannot be made to work at scale.

The German approach suggests a world standard. Fraunhofer-Gesellschaft is

³ http://www1.eere.energy.gov/manufacturing/financial/pdfs/itp_stage_gate_overview.pdf

the largest organization for applied research in Europe. In more than 80 research units across the country, each specialized for a specific technology (e.g., optics, nanotechnology, solar), the Institute undertakes applied research of direct utility to private and public enterprise, and of wide benefit to society. The vast majority of its 20,000 staff members are scientists and engineers, and Fraunhofer operates with an annual budget of about \$2.3 billion.

A review of work in applied research centers around the world reveals three lessons:

1. The research agenda must be set with serious involvement by industry.
2. Research should directly involve industry scientists where possible.
3. Large economies of scale, and new breakthroughs, are possible if government research facilities build the expensive testing and development “platforms” that are beyond the reach of individual companies, and makes them available for industry.

1. The research agenda must be set with **serious involvement by industry.** This will ensure that more of the technology developed by government labs will eventually make its way into commercial products.

For instance, the U.S. DOE ran a program called “Industries of the Future” (IOF). It collected experts from within an industry cluster (e.g., pulp and paper, or steel, or chemicals) and asked them to jointly describe problems they faced, but for which they did not have a solution, nor the technical resources (personnel, facilities, etc.) to come up with one. The DOE then

shopped this list around to the national labs and DOE program managers to see who could make real progress against the problems. This design—with the agenda set by industries, and DOE searching for national assets to help solve their problems—produced significant gains in energy technology, as documented by a National Academy of Sciences study.⁴

2. Research should **directly involve industry scientists** where possible. Collaboration results in superior idea sharing between government researchers and industry personnel, and helps ensure the government researchers understand which work is important to industry on a more detailed, technical level than can be achieved through goal-setting alone.

In 2009, Japan launched the Innovation Network Corporation, a \$1.9 billion collaboration between the public and private sectors to achieve advances in energy, infrastructure, and other high technology sectors. The Japanese government invested more than 90 percent of the upfront capital to create the joint research center, and 27 private companies made up the final 10 percent investment. The program also includes about \$2.5 billion of loan guarantees for the joint research center’s investments.⁵ This structure enables a smooth working relationship between government technicians and private sector players, which has already resulted in a strong pipeline of innovations in energy and other fields.

The U.S. government also has a tool for connecting private-sector industry and national labs: The Cooperative Research

⁴ National Academy of Sciences. Materials Technologies for the Process Industries of the Future: Management. Strategies and Research Opportunities. Washington, DC: The National Academies Press, 2000.

⁵ <http://www.incj.co.jp/english/index.html>

and Development Agreement.⁶ Under these agreements, the lab brings equipment and scientific talent to the project that the industry partner could not afford or justify to its investors, while the industry partner adds product development expertise and deep experience in the relevant market. For example, Cummins Inc. and Oak Ridge National Laboratory (ORNL) have worked together under a series of these agreements to build better catalytic converters for heavy duty trucks. ORNL had great laboratory equipment and deep knowledge of catalytic reactions. Cummins had real-world experience with catalysts, knowledge of on-board diagnostics, and manufacturing talent. Together they built catalysts with far greater efficiency and durability, and lower costs, than existed before.⁷

3. Large economies of scale and new breakthroughs are possible if **the government builds the expensive “platforms”** for testing and development that are beyond the reach of individual companies.

An individual company may not be able to justify the costs of, say, a combustion test facility. A government-run test facility has the potential to benefit the entire sector by providing many private companies with a capability that none of them would have possessed otherwise.

For example, India’s Central Power Research Institute has housed R&D facilities for use by government, industry, and utilities alike over the past 50 years. The

public-private research facilities have helped India make progress on high voltage transmission, power system resilience, and other electricity distribution components.⁸

Meanwhile, the U.S. National Renewable Energy Laboratory has built more than a dozen centralized testing facilities—such as the Energy Systems Integration Laboratory, which studies grid modernization. Similarly, the Plasma Materials Test Facility at Sandia National Laboratories permits researchers from private companies and universities to visit and use the facility, or to contract directly with Sandia to perform their testing. Under this program, the Plasma Materials Test Facility has performed research under 60 different agreements with private industry.⁹

Very few companies can afford this sort of test facility, so making the platform available to the private sector greatly accelerates private development efforts.

Commercialization

The last stage of developing an energy technology focuses on driving down cost and driving up performance. At this stage, the technology is not yet fully market competitive, but it shows promise to ultimately cross that threshold. The policy challenge is to create a demand signal that spurs companies to invest seriously enough, over a sustained time period, to make the new technology market competitive without wasting money or establishing permanent subsidies.

⁶ For an excellent, brief description of CRADAs, see: <http://tinyurl.com/7n7z6sl>

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http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2012/adv_combustion/ace032_partridge_2012_o.pdf

⁸ <http://www.cpri.in/about-us/about-cpri/history.html>

⁹ http://energy.sandia.gov/?page_id=1498

A smart, strong, and consistent policy signal will reward companies that hit ever-more aggressive price and performance goals.

Recommendations to achieve better commercialization:

1. Policy must provide a stable environment for long-term investment decisions.
2. Ensure market signals are large enough to influence the multi-billion dollar energy sector and drive adoption of gigawatt-scale technology.
3. Allow the market to find the price of any subsidy (e.g. via an auction), to ensure the government spends the minimum amount necessary to support any given energy technology.
4. Ensure tax credits are liquid and tradable, or replace them with cash grants, to avoid constraints on tax equity investment and save the government billions of dollars.

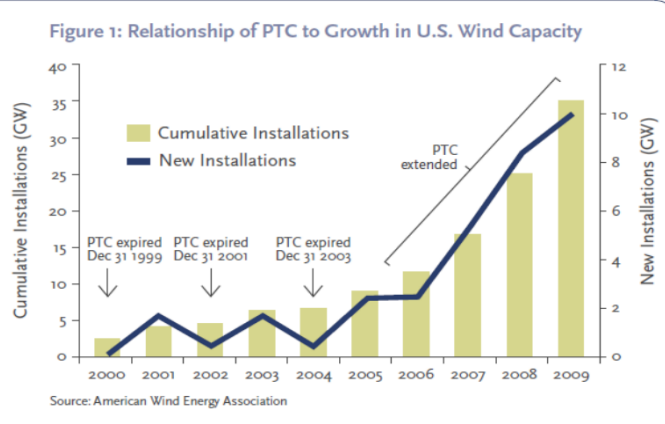
1. Policies must provide a stable environment for investment. Energy generation and transmission facilities often have lifetimes of 40 years or more, so utilities will not be able to take account of

clean energy incentives unless they have confidence that those incentives will exist several years down the road. In a recent set of detailed interviews with R&D directors of 17 large, innovation-driven companies¹⁰, they stated repeatedly that a steady, serious, long-term demand signal was the best possible way to stimulate clean energy innovation. The signal is powerful at driving all stages of research. Energy legislation should make a constant and reliable demand signal a priority. Note that the cost of that demand signal will decline rapidly if it is well-designed (see recommendation 3, below).

For instance, the U.S. Production Tax Credit (PTC) is aimed at supporting the commercialization and deployment of energy technologies that are approaching market competitiveness, but the PTC has been repeatedly allowed to expire and then been extended for short periods, severely limiting its effectiveness.

2. Ensure market signals are large enough to influence the multi-billion dollar energy sector and drive adoption of gigawatt-scale technology. The government cannot afford to purchase all the necessary technology we need. Rather, government

“... every time the PTC has been allowed to expire, renewable energy capacity growth has dwindled to a fraction of the growth that occurred when the tax credit was in place. For instance, when Congress let the program expire in 2000, 2002, and 2004, wind capacity installations in those three years fell 93 percent, 73 percent, and 77 percent, respectively, from the previous year.”
Nate Gorence and Sasha Mackler,
http://bipartisanpolicy.org/sites/default/files/BPC_RE%20Issue%20Brief_3-22.pdf



¹⁰ Rissman, Jeffrey and Maxine Savitz. Unleashing Private-sector Energy R&D: Insights from interviews with 17 R&D Leaders. American Energy Innovation Council, 2013.

spending must ultimately help drive down costs so the market can take over.

Some governments have used **feed-in tariffs** to stimulate new technologies. Germany once offered high payments for solar energy. It is easy to dismiss Germany's policy as having over-rewarded solar providers, but the policy succeeded in dramatically driving down the cost of solar power systems. The benefit the Germans bought was not just the electricity generated from their subsidy: It was the achievement of a dramatic, irreversible price reduction for solar energy—creating an option for Germany and for the world. Getting serious about driving down the cost of energy technologies will have vast long-term rewards.

3. Allow the market to find the price of any subsidy. If the government chooses a fixed price for a subsidy or tax credit, it will almost certainly be too high or too low. Even if a fixed subsidy is right today, it will be wrong in the future, when breakthroughs in energy technology have brought costs down.

The best way to set the price of a subsidy is through the **reverse auction** method. In a reverse auction, the government or a public utility commission offers a subsidy for clean energy and awards that subsidy to the lowest bidder. The funds are delivered when energy is provided. If a company can build a solar plant for seven cents per kilowatt-hour and sell the electricity for five cents, it would bid for a two-cent subsidy. They might lose the bid to someone with a six-cent cost basis. The market will find the lowest required subsidy, saving the government money.

Since energy technology investments are long-term, the prices set at

each auction must last long enough to incentivize the capital investment. For instance, each auction might set the subsidy price for a fixed quantity of electricity produced from that project for the next 10 years. This gives companies an incentive to drive down their costs. The government also benefits, as each subsequent auction costs the government less and less money, until full market competitiveness is achieved, and the subsidy is ended.

5. Lastly, tax credits and subsidies should be made as liquid and tradable as possible. Energy project developers can have difficulty securing investors with sufficient tax liability to take advantage of non-refundable tax credits, so it is far more cost-effective to make them fungible than illiquid. A study by the Bipartisan Policy Center and Bloomberg New Energy Finance found that instead of giving out \$10.3 billion in clean energy tax credits, the same results could have been achieved through \$5 billion in cash grants issued at the time of each project's commissioning.¹¹ By using cash grants rather than tax credits, or making the tax credits refundable, the government can save billions of dollars while achieving the same level of energy technology deployment.

Conclusion

For a modest cost, using best policy practices outlined in this paper, national governments can accelerate their countries' transitions to clean energy. There is no dispute that a broad set of new energy technology options will help achieve security, economic, and environmental goals.

¹¹ <http://bipartisanpolicy.org/library/staff-paper/reassessing-renewable-energy-subsidies-issue-brief>

COVID-19 Addendum

Amidst the COVID-19 public health and economic crisis, we'd like to offer some thoughts on how clean energy innovation directly relates to overcoming the crisis and building resiliency.

Protecting existing jobs and American know-how in companies that have flourished is an immediate imperative. Post-emergency efforts, economic stimulus should prioritize clean energy investment, laying the foundation for strong U.S. position in the next wave of global energy technology. As part of this work, energy technology policy should be aligned to reduce conventional pollutants, which accelerated COVID-19 deaths.¹² The virus underlines the role of science in policymaking, and continued investments in energy R&D, even while much focus is on the virus, remains essential.

Much of the strength of the clean energy sector today dates back to programs and policies borne out of the American Recovery and Reinvestment Act of 2009 (ARRA). This is because policymakers at that time saw the industry as job-intensive and a way to achieve domestic resilience. In fact, one study found that shifting fossil spending to renewable energy and energy efficiency created nearly three times as many jobs and many ARRA studies found clean energy was the most the cost-effective type of spending for job creation.¹³

¹⁴

A broad cross-section of ARRA studies demonstrate that such measures work and deserved to be a priority. The conversion of credits to grants under Section 1603 was directly responsible for saving 50,000 jobs at the height of the Great Recession.¹⁵ Taken together, clean energy investments under ARRA saved 900,000 jobs.¹⁶ The Congressional Budget Office (CBO) concluded that clean energy investments were among top performers for macroeconomic benefits from funding released by ARRA.¹⁷ Beyond the short term stabilization benefits, it is clear these investments did much more, unleashing waves of innovation and learning, and turning solar and wind power into job engines.

Policy Recommendation

Through direct investment in commercial scale application of new technologies, federal policy can ensure American leadership in the next generation of industrial innovation. For example, electric vehicle manufacturing has emerged as California's second most valuable foreign export, valued at \$7.1 billion.¹⁸ Engineers and entrepreneurs deserve the lion's share of the credit, but there is little question that California's policy leadership was a necessary condition for the success of Tesla and other emerging companies—and that in turn was built atop federal Electrical Vehicle

¹² https://projects.iq.harvard.edu/files/covid-pm/files/pm_and_covid_mortality.pdf

¹³ <https://www.sciencedirect.com/science/article/abs/pii/S026499931630709X>

¹⁴ https://www.peri.umass.edu/fileadmin/pdf/published_study/PERI_military_spending_2011.pdf

¹⁵ <https://eta-publications.lbl.gov/sites/default/files/report-lbnl-3188e.pdf>

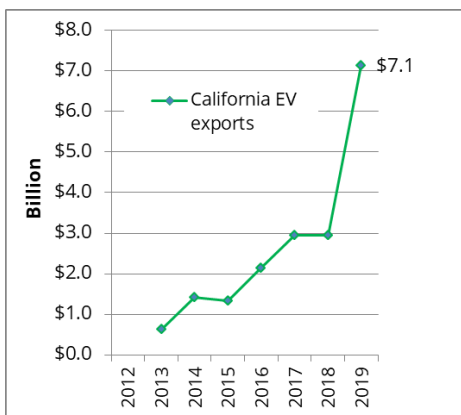
¹⁶

https://obamawhitehouse.archives.gov/sites/default/files/page/files/20160225_cea_final_clean_energy_report.pdf

¹⁷ <https://www.cbo.gov/sites/default/files/113th-congress-2013-2014/reports/45122-ARRA.pdf>

¹⁸ <https://www.census.gov/foreign-trade/statistics/state/data/ca.html>

tax credits and California’s Zero Emission Vehicle mandate.



Direct Investment in Commercial-Scale Demonstrations

In *How Breakthrough Science Can Revive Economic Growth and the American Dream*, Gruber and Johnson show lower public investment in science and to support the commercialization of inventions is at the root of lower GDP growth.¹⁹

Public spending on research and development peaked at nearly 2 percent of our entire economy in 1964. Public support for R&D today amounts to no more than 0.7 percent of GDP. This is equivalent to spending at least \$250 billion per year less than we did during the post-war boom. Since the 1970s, however, U.S. productivity growth has slowed reflected in falling total GDP growth from 4 percent in the post-war years, to under 3 percent from the mid-1970s, and to under 2 percent since 2000. The CBO projects growth in the mid-2020s of only 1.7 percent.

Economic Arguments for Loans and Loan Guarantees

A 2015 Government Accountability Office (GAO) evaluation found the U.S. DOE Loan Programs Office (LPO) have earned the federal treasury more than \$2 billion.²⁰

“Using the \$39 billion in currently available loan and loan guarantee authority, DOE’s loan programs could leverage up to \$100 billion of investments to support innovation and infrastructure investment across the entire energy sector.”²¹

“LPO currently contributes net positive cash flows to the Treasury from its portfolio. For the last full fiscal year (FY 2017), OMB reported that the Advanced Technology Vehicle Manufacturing Program recorded repayments and prepayments of over \$1 billion. The Title XVII program recorded repayments and prepayments of \$360 million, offset in part by new loan disbursements of \$275 million. Budget scorekeepers record these as off-budget transactions that are not counted in budget totals; nonetheless they represent net cash flow to the Treasury. LPO reports that through June 2017 that the Treasury has collected a total almost \$2 billion in interest payments from projects in the LPO portfolio. OMB reports total interest payment collections of about \$450 million in FY 2017 alone. Loans originated through the Federal Financing Bank (FFB) charge LPO project borrowers a premium above the cost of Treasury borrowing, resulting in net interest revenues to the Treasury. The combined government-wide transactions of

¹⁹ <https://www.jump-startingamerica.com/policy-summary>

²⁰ 2015 GAO cites programs costs of \$2.2 billion. Page 41 of the [report](#) includes letter from DOE, commenting that, “LPO-supported companies have made approximately \$4.4 billion in principal and interest payments to the US Treasury,” implying the program provided net cash flow benefits of \$2.2 billion through 2020.

²¹ <https://docs.house.gov/meetings/CN/CN00/20190430/109329/HHRG-116-CN00-Wstate-FosterD-20190430-SD003.pdf>

the FFB contributed net federal deficit reduction of \$334 million in FY 2017.”

RESILIENCE IN THE POST-COVID-19 WORLD: A KEY TO AMERICA'S FUTURE

Leonardo Martinez-Diaz

Global Director, Sustainable Finance Center, World Resources Institute

Climate change has receded from the headlines in recent months as the United States and the world battle the COVID-19 pandemic. Yet, the climate crisis is far from over. Communities across the country and the world will continue to experience the traumatic impact of climate change. Unfortunately, it is only a matter of time before major storms, wildfires, heat waves, and major flooding come back into view. They may materialize even before the COVID-19 crisis is over. For example, forecasters are projecting a "significantly above normal" 2020 Atlantic hurricane season, raising the prospect of communities having to fight both the virus and major storms at the same time.

This is why building resilience against the impacts of climate change is urgent. Resilience in this context means the capacity of a community to reduce, absorb, and recover from the impacts of climate change.¹ To be sure, the best resilience measure remains cutting greenhouse gas emissions to arrest temperature rise. But the same time, all levels of government, the private sector, and communities across the country must take urgent steps to build resilience against climate impacts. Indeed, efforts to build

resilience against climate change could also help the United States rebuild its economy after COVID-19 by helping stimulate employment and innovation.

The rest of this policy note provides policy recommendations for Congress and the federal government, organized around three concepts:

- (1) Empower local communities across the United States to build resilience;
- (2) Rebalance the focus from post-disaster spending to pre-disaster resilience and find better ways to pay for it; and
- (3) Invest in resilience abroad to protect U.S. national security.

The Time for Resilience is Now

Climate scientists have sent a clear message: If we want to keep greenhouse gas emissions below levels likely to cause dangerous and potentially catastrophic warming across the planet, we must reduce them quickly. The 2015 Paris Agreement established for the first time a truly global framework for countries to act together on reducing emissions, but current commitments are not nearly enough to keep the world from warming beyond 2°C,

¹ Alice Hill and Leonardo Martinez-Diaz, *Building a Resilient Tomorrow: How to Prepare for the Coming Climate Disruption* (Oxford University Press, 2019).

not to mention 1.5°C, the Agreement's aspirational temperature goal.

Emissions may slow down temporarily during the economic slowdown brought by the COVID-19 pandemic, but unless we change course, emissions will likely continue their advance once economies get back on track. At the same time, emissions already in the atmosphere have "baked in" a measure of future warming, and the planet's systems are still adjusting to the warming that has already taken place. In other words, we must prepare for some measure of climate change that is now inevitable, even as efforts continue, and hopefully scale up substantially, to cut emissions and put the world economy firmly on a low-carbon path.

If we don't, American economic competitiveness and the lives and livelihoods of millions of Americans will be in jeopardy. The Congressionally-mandated National Climate Assessment, last published in 2018, shows how the impacts of climate change are already affecting, and may affect in the future, communities across the United States, as well as the country's capacity for production and innovation. Economic damage will result from a combination of coastal damage, wilting crops, higher spending on electricity to cool buildings, and more heat-related health impacts, among other factors.

Overall, climate change impacts are projected to cost the United States, on average, 1.2 percent of GDP *per year* for every 1°C of global mean temperature increase.² Just one degree of warming would effectively halve the U.S. rate of economic growth. This average number

hides big regional variations; climate change will harm the economies of southern and lower midwestern states the most, though no state will be spared the second- and third-order impacts.

Empower local communities in the United States to build resilience

One of the most effective ways for Congress and the federal government to help is to empower local communities across the United States to understand their exposure to climate risks and to manage and reduce those risks where possible. **Two policies are particularly important: making weather and climate data accessible and usable, and providing targeted grants that foster innovation in resilience.**

As climate change impacts become more pronounced, more and more communities in the United States will need deeper insight into the future. Decision-makers at all levels of government and business will require information to make high-impact, hard-to-reverse decisions about things like water supply, agriculture, supply chains, and infrastructure. They will demand data to calculate the likelihood of catastrophic events and to figure out how best to plan and pay for defenses. They must model the projected evolution of droughts, heat waves, and wildfires, so they can get people out of harm's way and protect hundreds of billions of dollars in property and other productive assets.

Today, collecting data is not a problem. Satellites, drones, land- and sea-based sensors, and even cell-phone-carrying individuals collect data that can be used for climate resilience purposes. The

² Solomon Hsiang et al., "Estimating Economic Damage from Climate Change in the United States," *Science* 356, no. 6345 (2017).

U.S. National Oceanic and Atmospheric Administration (NOAA) alone collects 20 terabytes of environmental data from its satellites every day—that’s the equivalent of 8,300 ninety-minute Netflix videos daily. And thanks to cloud computing and machine learning, governments and businesses can now store and crunch this information to extract insights more efficiently than ever before. Yet, communities and decision-makers face a paradox. Climate and weather data have never been more plentiful, but many who need this information urgently cannot use it because of cost, because it is not available in decision-relevant formats, or because it is inconvenient to access.

Part of the challenge is the complexity of the current system for climate and weather information. During the Obama Administration, the federal government worked hard to make resilience-relevant data more widely available. But the result was a patchwork of multiple sets of partially-overlapping data hubs run by separate government agencies, including the departments of interior and agriculture, NOAA, and the Federal Emergency Management Agency (FEMA). Farmers, emergency managers, city planners, and others must navigate this unwieldy system to get the information they need, which is difficult even in the best of times.

Even federal policymakers themselves are not getting what they need from the system. In 2015, the Government Accountability Office (GAO) concluded that

the federal government’s climate information “is fragmented across many individual agencies that use the information in different ways to meet their respective missions...[D]ecision makers are vastly underserved by the current *ad hoc* collection of federal climate information services.”³

To address this challenge, Congress and the federal government should establish a nationwide network of resilience hubs, each covering a different region of the United States.

This would involve reorganizing the system of overlapping hubs and consolidating existing field offices and centers from multiple federal agencies into a single set of regional hubs.⁴ This would create a more user-friendly system that enables communities to access vital resources and assistance for climate resilience, including climate and weather data and information. These hubs would do several things:

1. Consolidate multiple government databases into a user-friendly interface with modeling capabilities that enables communities to analyze their exposure and vulnerability to climate change impacts across a variety of dimensions, including infrastructure and public health;
2. Enable communities to invest their scarce resilience resources most effectively and prioritize and coordinate investments in resilience, including for example, how to deploy

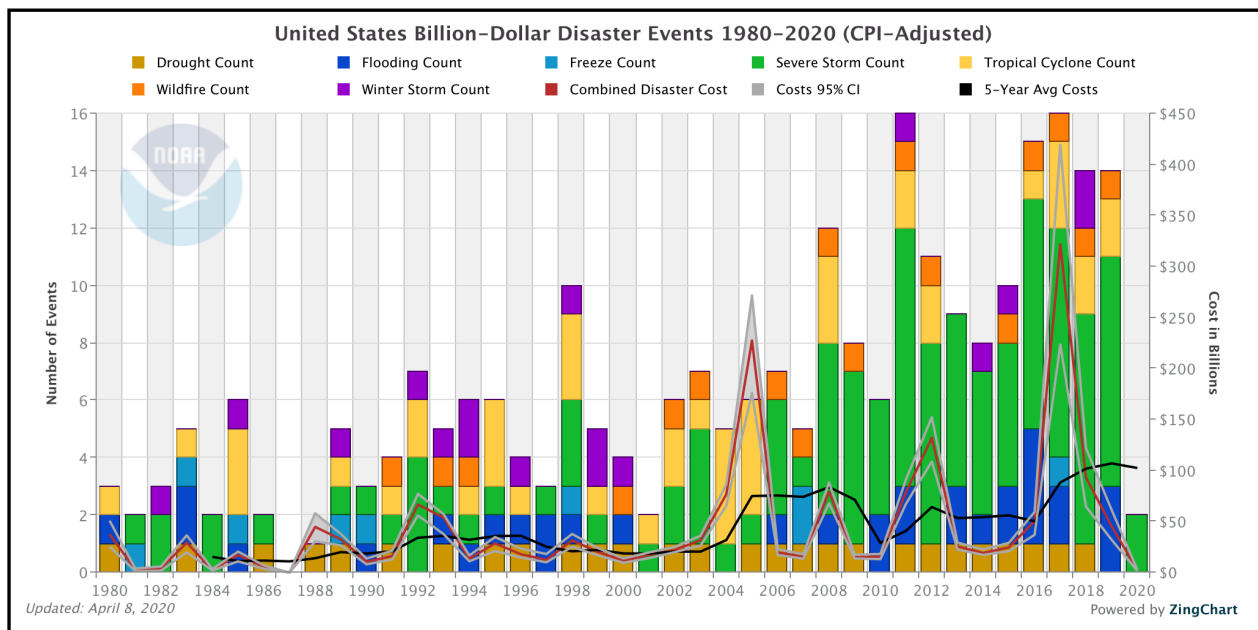
³ U.S. Government Accountability Office, “Climate Information: A National System Could Help Federal, State, Local, and Private Sector Decision Makers Use Climate Information,” GAO-16-37 (Washington, DC: U.S. Government Accountability Office, 2015).

⁴ Alice Hill and Leonardo Martinez-Diaz, “Adapt or Perish: Preparing for the Inescapable Effects of Climate Change,” *Foreign Affairs*, January/February 2020.

nature-based solutions, where to locate new infrastructure, and how to calculate cost-benefit ratios;

3. Collect and analyze information on vulnerable people and groups, including where they are located and how to prioritize their protection through early warning systems and notification to first responders; and

successful post-Superstorm Sandy federal program Rebuild by Design. Grant competitions could be organized along thematic lines, based on each region's top resilience priorities, and grants would be awarded to the solutions with the highest potential for impact. The rest of the grant money would be delivered to communities through block grants that would match local



4. Help strengthen agricultural production, natural resource management, and rural economic development, enabling farmers to access technology and cutting-edge risk management practices.

In addition, Congress and the federal government should establish a system of targeted, small grants for local governments to invest in high-impact resilience measures. Congress should appropriate at least \$10 billion per year for this purpose. The grants would be allocated regionally and be used to finance high-impact investments in resilience. Some grants would be awarded through design competitions, drawing on lessons from the

investments on a 1:1 or 2:1 basis. Grants should leverage cities' existing planned capital investments to make dollars go farther and foster a culture of resilience in state and local governments.

Rebalance the Focus Toward Resilience, and Find Better Ways to Pay for it

Today, the prevailing approach in the United States is to underinvest in resilience and then pay for the damage afterwards. Much of the bill lands with the federal government, which is to say, with taxpayers. This is neither smart or sustainable.

Already, the costs are significant. Congress appropriated almost \$130 billion to pay for damages including from Hurricanes Katrina, Rita, and Wilma. Another \$50 billion federal aid followed Hurricane Sandy. Following devastating wildfires and Hurricanes Harvey, Maria, and Irma in 2017, Congress authorized nearly \$140 billion in emergency aid. As the graph from NOAA below shows, in 2019, there were 14 separate billion-dollar weather and climate disaster events across the United States, with a total cost of \$45 billion. The total cost over the 2017-19 period was \$460 billion, averaging \$153 billion per year.

Climate change is expected to exacerbate extreme weather, as well as slow-onset events, such as droughts. The 2018 National Climate Assessment has observed that the number and cost of disasters are increasing as more and more valuable property and infrastructure are built in risky areas, and as climate change increases the frequency of environmental extremes that lead to billion-dollar disasters. As the impacts grow in frequency and intensity, climate damages threaten to become a constant and escalating drain on the U.S. Treasury, worsening the country's already deteriorating fiscal situation. ***To address this challenge, we must incentivize and finance resilience and prevention--before disaster strikes.*** Preparedness is highly cost-effective. The U.S. National Institute of Building Sciences (NIBS) reviewed several thousand government-funded projects designed to reduce the risk of damage from floods, wind, and earthquakes and concluded that a dollar spent on these resilient investments

saves society an average of \$6.⁵ From an economic perspective, investing in resilience is a no-brainer.

We must therefore shift the balance of spending toward resilience by investing more in preparedness so that communities can avoid damage and economic losses and therefore reduce the costs of post-disaster recovery. In a welcome step, Congress enacted legislation in 2018 requiring that six percent of the post-disaster assistance provided by FEMA go into the agency's Pre-Disaster Mitigation Fund. This should ensure that billions of additional dollars are used to build resilience before disaster strikes. But more needs to be done.

One promising approach is for the federal government to condition, up to a point, some of its disaster assistance on more resilience measures by states. Under this proposal, states would be required to cover a fraction of the cost of a disaster; after that portion was covered, then federal assistance would start paying out. States could buy down this "disaster deductible" by making investments in resilience. The more resilience measures they adopt, the lower the deductible, meaning the sooner federal assistance would kick in. To lower the deductible, states could, for example, improve the effectiveness of building code enforcement, roll out tax incentive programs to encourage residents to retrofit their homes, or bar new development in risky areas. This policy would be a good way to incentivize resilience and lower relief and recovery costs.

At the same time, the question remains of how to raise significant amounts of new money for investing in resilience.

⁵ Multihazard Mitigation Council, "Natural Hazard Mitigation Saves: 2017 Interim Report," (Washington, DC: Multihazard Mitigation Council, 2017).

Some jurisdictions are introducing new taxes. In 2017, with the support of a Republican mayor, voters in Miami approved a referendum to issue \$400 million in “Miami Forever Bonds,” the proceeds of which will pay for coastal protection infrastructure and upgrading flood pumps and storm drains. Other jurisdictions have adopted similar initiatives.

But increases in general taxes will always be politically difficult to secure. In addition, communities will need long-term, reliable streams of revenue for investments in resilience, not one-off cash injections. Governments will need other approaches. Here are three ideas:

5. Use some of the **revenues from carbon taxes and cap-and-trade systems** designed to reduce emissions. This isn't happening yet. The Regional Greenhouse Gas Initiative (RGGI), has raised at least \$2.6 billion through the sale of permits. Yet, only Delaware appears to have used a portion of its share to build climate resilience. California's cap-and-trade mechanism generated \$4.5 billion between 2012 and 2016. Some of the revenues paid for activities indirectly related to resilience, but the state has not traditionally designated a share of the revenues exclusively for resilience. To generate stable revenues for resilience, this will have to change, especially as new carbon-pricing mechanisms are introduced at the state and perhaps even federal level.
6. Communities should **experiment with a measure known as "value capture"** to pay for climate resilience projects. This approach has been used to finance certain

kinds of public infrastructure, such as new subway lines and stations. In the case of resilience, it would work like this example: The value of a property protected from storm surge by a new seawall should be higher than the value of a similarly-situated property without such protection. The value difference between comparable properties with protection and those without it can be calculated. Some of that difference in private benefit can then be "captured" through increased taxes (or lower tax breaks) on the benefiting properties.

7. Insurance markets are critical to help businesses and homeowners recover from climate-related damage and incentivize them to embrace resilience; **reforms can enable insurance markets to work better for resilience.** A key example is the National Flood Insurance Program (NFIP). The program does not always charge insurance premiums that reflect the true risk of flooding. About 20 percent of properties insured, typically those in risky floodplains, receive subsidized insurance, transferring the risk to the government and reducing incentives for homeowners to move to safer ground or to invest in resilience. NFIP is now billions of dollars in debt, as payouts have exceeded the premium income paid by policyholders. Congress tried to fix the system in 2012 but was forced to backtrack after political backlash ensued. The reform did not provide enough time and support for at-risk households to relocate or retrofit their properties to make them

resilient. Congress should reform the NFIP, but this time phasing out the subsidies over an appropriate transition period and providing adequate assistance to affected homeowners, especially low-income and marginalized households.

Invest in Resilience Abroad to Protect U.S. National Security

Alarm bells have rung throughout the U.S. national security community regarding climate change for years. Recent secretaries of defense, including President Trump's first secretary of defense, James Mattis, concluded that climate change constitutes a national security risk. National security agencies have produced many reports identifying it as such: the Departments of Defense, Homeland Security, and State have each repeatedly enumerated the threats climate change poses to U.S. security in strategic digests. In 2016, the U.S. National Intelligence Council concluded that climate change and its impacts are likely to pose wide-ranging national security challenges for the United States over the next 20 years.

Pakistan offers one of the clearest examples. Whether Pakistan can navigate its climate challenges successfully matters immensely to international security. Climate change could disrupt the international community's efforts to contain terrorism and reduce tensions between the nuclear-armed neighbors, Pakistan and India. Devastating floods in July 2010 demonstrated how this disruption could play out. Almost 12 feet of rain fell in a single

week in a Pakistani province that historically averaged slightly more than 3 feet of rain per year. Pakistan's meteorological department concluded that the severity of the flood could be partially attributed to climate change. The flooding displaced over fourteen million people, left an estimated eleven million homeless, and damaged thousands of miles of railway.

After the government of President Asif Ali Zardari badly bungled the response, groups linked to radical Islamist groups, including the Taliban, moved in to provide meals, water, and medical care. This helped undermine the authority of the legitimate government and allowed violent groups to build support among the local population. When a government fails to protect the basic security of its people in the wake of climate-exacerbated disasters, the resulting vacuum can open spaces for violent groups, undermine alliances, and export extremism.

In addition, climate change will drive large-scale migration. The impacts of climate change—both slow-onset changes, such as sea-level rise and drought, and sudden-onset events, such as extreme storms and wildfires—push people from their homes. According to the U.S. National Intelligence Council, the “net effects of climate change on the patterns of global human movement and statelessness could be dramatic, perhaps unprecedented.”⁶ And a recent study by the World Bank projected that by 2050, climate change could create over 140 million internally displaced people in developing regions across the globe.⁷

⁶ Office of the Director of National Intelligence, “Implications for U.S. National Security of Anticipated Climate Change,” (Washington, DC: National Intelligence Council, 2016), 7.

⁷ Kumari Rigaud et al., “Groundswell: Preparing for Internal Climate Migration,” (Washington, DC: World Bank, 2018).

This challenge will require strengthening climate resilience abroad, particularly in strategic but weak or fragile states, to prevent years of development gains from going into reverse. Two policies can begin to address the problem immediately:

- 8.** Congress should enact legislation that **requires the executive branch to identify and consider current and future climate change impacts in the development and implementation of relevant national security doctrine, policies, and plans.** The legislation should require the federal government to establish a policy group made up of senior officials from multiple government agencies to analyze the most urgent climate-related national security concerns, gather existing climate data scattered across the government, and make climate information available to intelligence experts and policymakers. Agencies should identify the countries and regions most vulnerable to climate change and identify ways the U.S. government can assist other countries in their efforts to build resilience. U.S. agencies should adopt detailed work plans to consider priority areas, such as the implications of climate change for mass migration, global food and water security, global health security, economic strength, and critical infrastructure.

- 9.** In addition, Congress should ensure that all direct and indirect **international development assistance provided by the United States accounts for climate risk and resilience.** Using its voice and vote in the multilateral development banks (MDBs), including the World Bank, the United States should ensure that these institutions factor climate considerations into all project design and project selection. MDB investments should be climate resilient and, where appropriate, they should contribute to strengthening the resilience of the communities where the project will be implemented. The same standards should be applied to U.S. bilateral development assistance, including from USAID. Finally, the United States should double its pledge to the Green Climate Fund (GCF), which is the primary global financial vehicle to support climate mitigation and adaptation plans of developing countries.

Even as we confront COVID-19, we must keep our eye on the climate crisis slowly advancing around the world. Building resilience against the impacts of climate change is a necessary investment to safeguard America's future, including its economic competitiveness and the lives and livelihoods of its people. Many policies can advance resilience, but they will take time to be implemented. The time for resilience is now.

ENERGY, SECURITY & THE ARCTIC: Keys to America's Competitiveness

Agenda overview as of 5/21/20 THE ASPEN INSTITUTE CONGRESSIONAL PROGRAM
May 27-31, 2020 Reykjavik, Iceland

PROPOSED CONFERENCE AGENDA

WEDNESDAY, May 27:

Participants travel to Reykjavik

THURSDAY, May 28:

Site Visits

COMMERCIAL-SCALE GEOTHERMAL POWER STATION

We will visit the third-largest geothermal powerplant in the world, which provides renewable geothermal heating to 7 out of 10 homes in Iceland. This plant, which opened in 2006, is the most recent addition to Iceland's fossil fuel free energy production. This visit will help participants understand the significance of geothermal heating and power generation that was initiated some 45 years ago and now puts Iceland in the forefront of using renewable energy. Participants will have opportunities to engage with the Hellisheidi Power Station staff to assess whether there are any applicable lessons that could be put to use in the U.S.

INNOVATIVE CARBON CAPTURE AND MINERALIZATION

Participants will visit:

- CarbFix, a unique carbon removal operation, which extracts carbon dioxide from a geothermal power plant, mixes it with water, pumps it underground, where it bonds to porous basalt rock and becomes a solid. This project was originally partially supported with research grants from the Department of Energy and the National Science Foundation and it is seen as one potential solution for mitigating the impacts of climate change by reducing the amount of carbon in the atmosphere. We will also see two private carbon removal applications linked to CarbFix;
- Climeworks, a Swiss clean technology company, operating a pilot project to test the viability of extracting carbon dioxide from air. Climeworks captures CO₂ from air with the world's first commercial direct air capture carbon removal technology. Their plants remove CO₂ from the atmosphere to supply customers for e-fuels and materials. This technology allows the world to become independent of fossil CO₂ feedstocks and become climate-neutral or even to unlock a negative emissions future via geological storage of atmospheric CO₂; and
- Algaenovation, founded by an MIT scientist, is converting clean energy to sustainable food via vertical cultivation of microalgae. This process converts CO₂ emissions from the adjacent geothermal powerplant to edible organic carbon (essential amino and fatty acids in algae edible for livestock) using less than 1% of the land and water of conventional agriculture in a controlled indoor growing environment.

All three of these approaches are demonstrated at the commercial-scale geothermal power station at Hellisheidi, Iceland. The U.S. currently has 10 large-scale carbon capture and sequestration facilities based on similar scientific principles as CarbFix. Seeing these examples in Iceland is a convenient way to demonstrate that carbon sequestration is one method of reducing the amount of CO₂ in the atmosphere.

Bergur Sigfússon, *Geochemist, Orkuveita Reykjavíkur*
(*Reykjavik's energy utility*)

Kristinn Hafliðason, *General Manager, Algaenovation Iceland*

Christoph Beuttler, *Carbon Dioxide Removal Manager, Climeworks*

Pre-Dinner Remarks

ICELAND'S INNOVATIVE APPROACHES TO ENERGY CHALLENGES

Iceland has a plan to become carbon neutral. Approximately 85% of its primary energy currently comes from renewable sources—geothermal and hydropower. It has charging stations for electrical vehicles throughout the country, as well as filling stations for hydrogen fuel cars powered by fuel cells. Iceland remade itself from one of Europe's poorest into a nation that is financially and environmentally secure. Former Iceland President Olafur Grimsson said "Its about the economic transformation of the country to realize that the move from fossil fuels over to clean energy is fundamentally good business—the road to prosperity and economic achievement." Iceland is an inspiring example of what is possible.

Ólafur Ragnar Grímsson, *former President of Iceland,*
Chair, the Arctic Circle and Chair, International
Renewable Energy Agency's Global Commission on
the Geopolitics of Energy Transformation

FRIDAY, May 29:

Roundtable Discussion

THE CHANGING ARCTIC:

CHALLENGES FOR SECURITY, GOVERNANCE, CLIMATE AND TRADE

The Arctic is warming two to three times faster than the global average, which has environmental, economic and geopolitical implications. In the last five years, Arctic air temperatures have exceeded all previous records since 1900. The amount of Arctic ice has shrunk from 3 million square miles to 2 million square miles since 1980. Climate change could make it easier to tap Arctic energy resources—13% of the world's undiscovered oil and 30% of its undiscovered natural gas. Melting ice makes the viability of the Northern Sea Route across Russia's northern coast 5,000 miles shorter to ship goods from China to Europe with two weeks less transit time. Much of this new traffic along the NSR will be energy exports of Russian Liquid Natural Gas. Expanded activity in a melting Arctic highlights the disparity of U.S. preparedness to deal with an expanding Arctic potential in terms of icebreakers (Russia has 53, China 4, and the U.S. only 2 with Arctic capacity). The changing Arctic opens up a fourth maritime border for the U.S., all along Alaska's northern coastline, with new international security concerns. Governance issues will become more challenging in an area of undefined borders with 8 countries on three continents all laying claims. Even China, which labels itself a "near-Arctic state," is increasing its Arctic involvement: It has invested \$154 million in Iceland

since 2012 and launched a China-Iceland Arctic Science Observatory in northern Iceland. The U.S. Department of Defense issued a “Defense Arctic Strategy” paper in June, 2019 highlighting growing security concerns brought on by the changing Arctic. Making communities resilient in the face of the changing environment is a challenge that will be faced worldwide. For example, the Army Corps of Engineers has identified 31 Alaskan communities that need to be relocated because of environmental change.

- What are the implications of an opening Arctic Ocean to commercial use and shipping?
- What are the impacts of Arctic warming on the ecological and human environment?

***Sherri Goodman**, Senior Fellow, Polar Institute, The Wilson Center
Geir Westgaard, Vice President, Equinor Energy, Oslo*

Roundtable Discussion

THE CHANGING OCEANS:

ENERGY AND ITS IMPACT ON THE BLUE ECONOMY

Over the past decade, the world has come to value and better understand the concept of the Blue Economy, which the World Bank defines as the “sustainable use of ocean resources for economic growth, improved livelihoods and jobs, and ocean ecosystem health.” For countries like the United States or Iceland, which have significant marine resources and where majorities of our populations live within 50 miles of the coast, maintaining and growing our Blue Economy with the implied need to balance sustainable use with environmental protection will be fundamental to our future prosperity, particularly in light of the major challenges energy policy and climate change inflicts upon our global ocean including warming, acidification, and sea level rise.

- What do we need in order to create a full accounting of the economic and societal benefits of our Blue Economy in terms of GDP contribution, job creation, and other economic metrics?
- How can we balance current and future demand for marine goods and services—fisheries, ecosystem services provided by healthy natural resources, tourism and recreation, and extractive industries—with a responsibility to protect biodiversity and the natural environment?
- What will be the future opportunities to develop renewable energy and other sustainable maritime industries?
- How can we follow Iceland’s example of creating added value from the resources we currently harvest?

***Susan Avery**, President Emerita, Woods Hole Oceanographic Institution
Michael Conathan, Executive Director, Aspen High Seas Initiative*

SATURDAY, May 30:

Roundtable Discussion

GEOPOLITICS OF ENERGY:

EXPANDING AMERICA'S GLOBAL COMPETITIVENESS

Market forces and technological development compel international commerce of energy resources. The trans-shipment of energy across international boundaries—cross-border pipelines and powerlines, as well as maritime commerce of oil and Liquid Natural Gas—has geo-strategic economic and security consequences which are further compounded by climate change. Energy supply and demand are the drivers of global commerce. Progress in addressing climate change requires new technologies that offer opportunities for American ingenuity to develop low carbon sources—which can enhance international competitiveness. With the U.S. now a net exporter of energy, the energy sector has greater potential for employment and economic vitality. Competitiveness also grows with the America's increasing role in the global energy supply chain.

- What are the investments required now to ensure international competitiveness in a low carbon future?
- What kinds of carbon pricing mechanisms are there, and what are their advantages and disadvantages? Which are politically viable?
- What kind of energy mix best positions the U.S. economy going forward?
- Are there economic challenges faced from a growing renewable energy mix?

*Amy Myers Jaffe, Director, Energy Security & Climate Change
Council on Foreign Relations*

Chris Midgley, Head of Analytics, S&P Global, London (tentative)

Roundtable Discussion

GEOPOLITICS OF ENERGY:

THE NEXUS OF SECURITY, CLIMATE, AND ECONOMIC VITALITY

The security of the United States is inextricably linked to the global supply and demand of energy sources. Between geopolitical chokepoints of fuel transportation, and the importance of maintaining a reliable source of energy, there is a need to stay abreast of emerging threats and opportunities for cooperation. Climate change enhances the risk by creating national security threats with energy flow disruptions. Warmer average temperatures can lead to the spread of pandemic diseases, forced migration and unforeseeable collateral impacts. America's newfound status as a global energy superpower provides greater flexibility in foreign policy decisions and can allow decision makers to redirect foreign policy strategy. Advancements in renewables and energy efficiency impact consumption patterns with implications for producers, consumers and government policy. Multilateral action is also required because climate change does not limit its impact to national boundaries.

- What are the global strategic implications of the U.S. having achieved "energy independence"?
- Does climate change impact economic growth?
- Is the anti-elite backlash to well-intentioned green energy policies, as evidenced in the protests in France, an exception or indicative of wider trends?

- How will human and animal migrations from climate change impact the international order?
- Is the United Nations the best organization for managing international climate agreements?
- What is the benefit of the U.S. adopting renewable energy strategies if the rest of the world doesn't?

Ray Mabus, former Secretary of the Navy, former Mississippi Governor,
former U.S. Ambassador to Saudi Arabia

Sarah Ladislaw, Director, Energy and National Security Program, CSIS

SUNDAY, May 31:

Roundtable Discussion

INNOVATION AND RESILIENCY AS THE KEY TO AMERICA'S FUTURE:

SORTING THE RESPONSIBILITIES OF GOVERNMENT & INDUSTRY

The need for resiliency from impacts of climate change are increasingly apparent in every state, from coastal flooding in Texas to wildfires in California to widespread excessive heat and drought causing soaring demand for high-cost energy-consuming air conditioning. Adapting to these challenges requires innovating methods of retrofitting building and energy infrastructures, emergency preparation, and dramatic reforms to the insurance industry—all with implications for policymakers and the marketplace. Bringing electric grids up to a high standard of efficiency, reliability and performance is a core building block in having a greater mix of energy sources to meet our electrical demand. Climate change can impose damage to unprotected infrastructure which can have detrimental economic consequences if resiliency strategies are not deployed to minimize the impact.

- How is research and development properly sorted out between the public and the private sector as it relates to finding innovation solutions to energy and climate challenges that will ultimately be used for the public good?
- How can government best promote continued technological improvements that provide reliable, safe, resilient energy at an affordable cost without heavy intervention in the marketplace?
- Is a charging infrastructure for widespread use of electrical vehicles a public or private responsibility, and how will it efficiently come about?
- How should the U.S. best prepare for the future in light of irreversible climate change impacts, continued growth in demand for energy, and a constantly changing mix of energy sources?

Hal Harvey, CEO, Energy Innovation

Leonardo Martinez-Diaz, Global Director,
Sustainable Finance Center, World Resources Institute