

THE BLUE WAVE

**Investing in BlueTech Clusters to
Maintain Leadership and Promote
Economic Growth and Job Creation**

 THE OCEAN FOUNDATION





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“CLUSTERS”:

the industrial ecosystems that have begun to spring up around the globe.

THE BLUE WAVE MISSION

The Ocean Foundation and TMA BlueTech’s mission calling for innovative technology and services to promote sustainable usage of the ocean and freshwater resources.

EXECUTIVE SUMMARY

Water, the vast preponderance of which is found in the ocean, makes our planet habitable. Water is fundamental to our existence. Yet most of the time, humanity takes it for granted.

We must understand and interact with the ocean and water in a deeper, more sustainable way to promote smart global economic prosperity while addressing climate change. The United States should be a world leader in developing BlueTech solutions for both ocean and freshwater environments that can be exported globally. Every great civilization throughout history has been an ocean tech powerhouse, yet the U.S. is losing its historic BlueTech edge to countries with greater focus and funding for these economic development opportunities.

The Ocean Foundation¹ and **TMA BlueTech**² have joined to co-sponsor this white paper calling for a U.S. Apollo-style “Blue Wave Mission,” focused on innovative technology and services to promote sustainable usage of the ocean and freshwater resources.³ Essential elements of this effort are to:

1. support BlueTech clusters to promote innovation, protect critical supply chains, and mobilize “Triple Helix”⁴ Blue Voices region by region;
2. massively increase federal funding available for BlueTech innovation and for BlueTech companies and
3. coordinate integrated U.S. government investment to address ocean and freshwater problems in developing countries as well.

The Blue Wave Mission has bi-partisan, national implications that include defense, economic growth, education, environmental protection, export promotion, finance, good paying jobs across traditional and BlueTech sectors, homeland security, innovation, supply chain preservation, workforce development and more.

This paper includes an overview of the global importance of the ocean economy, including its vast growth potential, and the scientific mandate to ensure our interactions with both ocean and freshwater ecosystems include an underlying element of sustainability. It proceeds to an overview of the industrial ecosystems that have begun to spring up around the globe—known collectively as “clusters”—that take advantage of these economic development opportunities and particularly so-called “innovation clusters.” It defines and subscribes a subset of them that are the primary focus of this work: BlueTech clusters, that is innovation cluster organizations that bring together stakeholders from across the Triple Helix⁵ comprised of 1) academia and education; 2) business and industry and 3) government and policy makers. The paper concludes with key policy recommendations and an overview of examples of BlueTech clusters abroad and here in the United States.

INTRODUCTION

The ocean covers 71% of our planet by surface area and includes 96% of the water on earth by volume.

According to the National Oceanic and Atmospheric Administration (NOAA), “the ocean produces over half of the oxygen we breathe and absorbs 50 times more carbon dioxide than our atmosphere.”⁶ It represents our first line of defense against runaway global climate change, regulates heat around the globe to control our weather patterns, circulates nutrients, provides the primary source of protein for over a billion people and serves as a highway that carries more than 90% of the goods and materials that move internationally. It is a resource unique in the known universe and represents the fundamental building block without which life as we know it could not exist.

Figure 1 shows blue spheres representing all the water on earth in comparison to the size of the Earth. The volume of the largest sphere represents all water on, in, and above the Earth. The middle-sized sphere over Kentucky represents all fresh water in groundwater, lakes, rivers and swamps. The third, much smaller sphere above Atlanta represents the fresh water in all lakes and rivers.⁷ The image demonstrates how little ocean water there is compared to the mass of the earth and, in particular, how little easily accessible fresh water is available. It also does not demonstrate the *distribution* of fresh water. For example, Small Island Developing States typically suffer from lack of water, a problem that will be exacerbated as climate change dramatically increases the frequency and intensity of storms while also creating more drought and floods.

Mission Starfish,⁸ a proposed project of the European Commission’s Mission Board on

Healthy Oceans, Seas, Coastal and Inland Waterways, captures it well:

“Restoring and protecting our ocean and waters is one of the urgent and defining tasks of our time... [They] are taken for granted. Despite their fundamental importance to humanity’s existence, public and political attention has not corresponded to the urgency.”⁹

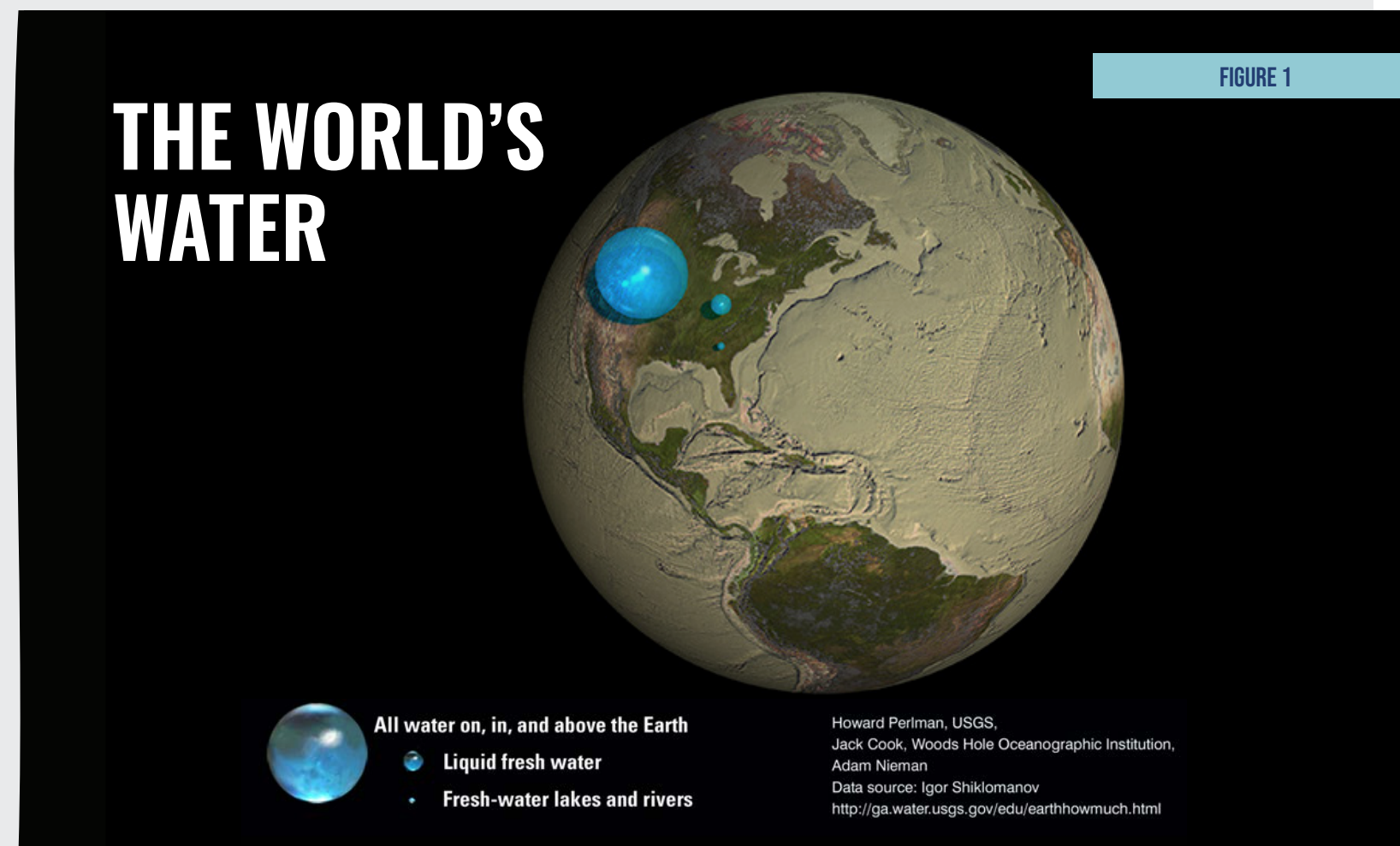
As our understanding of the ocean’s systems and rhythms deepens, and available space and resources on land contract, the world is increasingly looking offshore for solutions and opportunities. Coastal countries, states and communities have begun to recognize that collaboration and coordination of activities will be key to maximizing the opportunities and benefits from expanding development in the ocean. Likewise, there is growing awareness of the need to better understand, monitor and manage water resources that have been stretched or over-utilized in many places, a trend that is accelerating with longer periods of drought.¹⁰

In a number of cities across America, public-private partnerships have sprung up, intended to ensure that marine, maritime, and freshwater-focused businesses and industries can develop and grow quickly and equitably. These partnerships have evolved using different models and means of support and coordination, and are typically referred to as BlueTech clusters—particularly when they focus on innovation. This is the term this paper will use when referring to and making the case for implementation of policies to accelerate economic growth in this critical sector.

While there is often differentiation between salt water and fresh water when it comes to science, policy and advocacy among key stakeholder groups, BlueTech clusters cross these traditional boundaries because the activities and technology developed by their members is agnostic when it comes to relative levels of salinity in the liquid medium in which they operate. TMA BlueTech, for example, includes ocean, freshwater and wastewater technology in its area of focus, though other BlueTech clusters are more narrowly focused on just one of these components, typically related to the focal points of economic activity in their geographic region.

The federal government has an opportunity to dramatically accelerate sustainable economic growth nationwide by stimulating the collaboration, innovation and entrepreneurship in BlueTech clusters, all of which are significant byproducts of

the cluster model of business development that has proven successful in other fields. As Bill Gates says in his new book, *How to Avoid a Climate Disaster*, big breakthroughs in technology “wouldn’t even exist without government spending tax dollars on research.”¹¹ Bringing small innovators together with larger established entities working on an aligned set of issues and priorities spurs growth—and makes the resulting business ecosystem far greater than the sum of its individual parts. This paper will show how government action, including funding and data prioritization, can accelerate development of America’s blue economy via these partnerships. It is also important to protect the vital supply chain needed for America to remain a BlueTech power.



Specific policy recommendations from this overview are included in greater detail in Appendix A and listed here for consideration:

- 1** Launch an Apollo Project-style “Blue Wave Mission” for the ocean, to align with the priorities of the National Academies of Science’s U.S. National Committee for the U.N. Decade of Ocean Science¹² and ensure ocean and freshwater projects and technological development opportunities are given prominence in consideration under DARPA and ARPA-E, and are specifically called out in the proposal to develop an ARPA-Climate as announced in March 2021 by the Biden administration.¹³
- 2** Prioritize funding opportunities within the Department of Commerce, including NOAA and the Economic Development Administration, the Department of Defense, the Export-Import Bank, the National Science Foundation, the Small Business Administration and other agencies, to provide on-going funding for BlueTech clusters focused on small-to-medium-sized-enterprises—the critical innovators that typically cannot pay enough in membership fees to sustain clusters. This SME funding should ensure diversity, equity, inclusiveness and justice are a goal.
- 3** Establish or utilize existing benchmarking systems for clusters to create an objective way to evaluate and promote the progress of clusters from regional start-up to national focus to mature internationally active clusters and promote cluster collaboration.¹⁴
- 4** Increase investment in existing federal programs that manage ocean and Great Lakes observing systems and exploration to provide greater clarity and baseline understanding of marine and freshwater ecosystems.
- 5** Promote private sector access to investment capital and to excess capacity in high-level testing facilities managed or funded by federal government agencies.
- 6** Develop enhanced metrics of tracking and accounting for the blue economy, including the subset related to BlueTech innovation, and prepare a national ocean economy study to understand and track contributions to national economic metrics.
- 7** Reinvigorate the public-private National Oceanographic Partnership Program (NOPP) and an interagency coordinating entity such as the National Ocean Council that was replaced in the Trump administration by the Ocean Policy Committee.

It’s critical to our national security, human health and well-being and the future of economic development and innovation that we recognize the overarching fact that there is one single water system on earth, and it’s imperative to promote sustainable use of this unique and life-sustaining resource. This paper will describe select examples and identify specific opportunities for innovation and economic growth that can bring America into a leadership role with policies and systems that promote U.S. BlueTech globally. In doing so, it will also describe how government investment in the clusters will accelerate development of the sustainable Blue Economy, and improve life for all Americans and, in turn, all of humankind.

A NOTE ABOUT THE BLUE ECONOMY

There are many definitions of the blue economy. Some include all forms of water, some include the ocean and select freshwater resources (e.g., the Great Lakes)¹⁵, and some focus only on freshwater.¹⁶ A number of organizations include a sustainability component as a key criterion. For example, the World Bank and some United Nations programs define the blue economy as “the utilization of ocean resources for human benefit in a manner that sustains the overall ocean resource base into perpetuity.”¹⁷ This paper is not focused on definitions, rather it is focused on promoting BlueTech clusters—which for this discussion are assumed to include ocean and freshwater tech clusters.

THE POWER OF THE OCEAN ECONOMY



The ocean economy is huge—and growing.

The 2016 OECD report entitled “The Ocean Economy in 2030” reported that conservative estimates pegged the global ocean economy in 2010 at \$1.5 trillion and projected it to grow to \$3 trillion by 2030. “Surprisingly perhaps, given its primordial role, the ocean economy has only recently begun to garner attention and move up the international policy agenda.”¹⁸ The global water economy was estimated to be \$500 billion in 2010, so the Ocean and Water Economies would have been \$2 trillion together.

“Surprisingly perhaps, given its primordial role, the ocean economy has only recently begun to garner attention and move up the international policy agenda.”

THE OCEAN ECONOMY IN 2030 | 2016 OECD REPORT

Meanwhile, the United Nations Conference on Trade and Development estimated the ocean economy as even larger at \$3 trillion based on 2015 numbers, which ranked it equivalent to the fifth largest economy in the world (see **Figure 2**).¹⁹

The large discrepancies between estimates from reputable organizations underline that we don’t know enough about the size and growth of these critical ocean and freshwater economies, because neither is captured in detail by government economic data globally. For example, the North American Industry Classification System codes used to track and measure industrial growth do not include subcategories for ocean or water-based industries. As a result, these figures should simply be viewed as ballpark estimates. And society must recognize that as with all “economies,” the ocean economy has challenges and opportunities when it comes to sustainability. We need a just transition into choices that foster and expand environmental sustainability and inclusion of principles of social equity, so that the costs and benefits are shared across all communities and population segments.

Regardless of how we measure the size of the ocean and coastal economy, we know that they are expanding rapidly. For example, NOAA has been

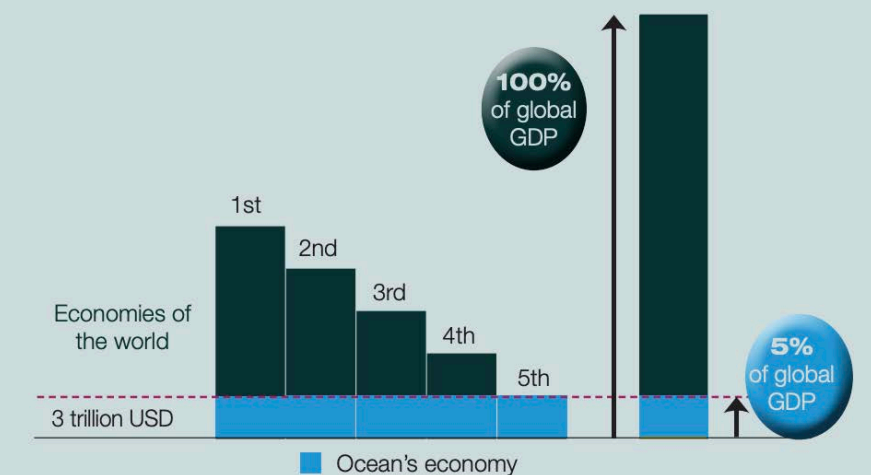
able to track growth in recent years in the U.S. Ocean Economy, and in 2020 it released a report on the U.S. Ocean and Great Lakes Economy that found, “GDP from the ocean economy grew 5.7 percent between 2014 and 2015, more than twice as fast as the U.S. economy as a whole, which grew by 2.7 percent.”²⁰

On a more local scale, these benefits can be more tangible. TMA BlueTech co-sponsored a 2012 Maritime Economy study for San Diego county that identified 1,431 organizations with 45,778 direct jobs and over \$14 billion in annual direct revenue. This included BlueTech as a sub-segment encompassing 18,948 jobs and \$6.2 billion in annual revenue.²¹ NAICS codes, by comparison, capture economic data about six maritime related industries: marine construction, living resources, offshore mineral extraction, ship and boat Building, tourism and recreation and marine transportation. Excluding the tourism and recreation sector, which was not included in the TMA BlueTech study, these five sectors accounted for just \$2.1 billion of GDP—meaning a true assessment of the economic clout of the maritime economy was actually 6.7 times greater than the comparable U.S. government statistics.²²

FIGURE 2

The value of the oceans economy

The value of the oceans economy sectors, such as fisheries, maritime transport, coastal tourism, off-shore energy and marine bio prospecting, has been estimated at about 3 trillion USD annually. These would equal the size of the fifth economy in the world. The top fifth economies in the world, according to GDP size in 2014 were the United States of America, China, Japan, Germany and the United Kingdom.



Source: UNCTAD (2015) and United Nations (2015). Sustainable Development Goals fact sheet.

THE RATIONALE FOR FEDERAL INVESTMENT IN THE OCEAN ECONOMY

“The government’s role is to invest in R&D when the private sector won’t because it can’t see how it will make a profit... This is in fact exactly how we got products you probably use every day, including the internet, lifesaving medicines, and the Global Positioning System that your smartphone uses to help you navigate around town. The personal computer business — including Microsoft — would never have been the success that it was if the U.S. government hadn’t put money into research on smaller, faster microprocessors... Investing in research has another benefit: It can help create businesses in one country that export their products to others.”

BILL GATES | Founder, Microsoft

It is no exaggeration that the ocean and water resources are fundamental to life on earth. They also represent enormous global market opportunities for U.S. BlueTech innovators who struggle to secure private and public sector finance. Meanwhile, other countries, particularly in Europe and China, and increasingly across Asia, are making strategic, targeted investments in their BlueTech sectors. This underlines both the opportunity and the need for a global power like America to make a concerted effort to invest in and prioritize this space. This is particularly true given that the U.S. controls economic activity in an area of the global ocean encompassing over 11.3 million square kilometers—an area larger than all the land within our borders—that we have largely not explored enough to understand how to use sustainably.²³

As a global leader in control of ocean area and in the fields of technology and innovation, the U.S. federal government should take the initiative to promote smart growth across the blue economy. Opportunities for dynamic, sustainable, economic expansion exist in many sectors including aquaculture and fisheries, marine biotechnology, maritime robotics, maritime

transportation, offshore renewable energy and ocean-based climate change solutions such as coastal habitat restoration and water and wastewater management. The key to unlocking these opportunities will be found in collaborations and partnerships, and BlueTech clusters should be the cornerstones.

British Economist Maria Mazzucato made waves throughout the late 2010s by shifting the dialogue around the history of government investment in emerging technologies. Her work recognized that innovations—from green tech to microchips to pharmaceuticals to space travel—all benefited from massive government investment at the earliest stages of development. The narrative that many of our largest corporations are exclusively the result of individual, bootstrap entrepreneurs belies the reality that many of their industries were built on a foundation of public funding. Elon Musk’s companies, for example, have benefitted from a reported \$4.9 billion in government funding.²⁴ Mazzucato reminded the world that Apple received early funding from a U.S. Small Business Investment Company (SBIC), and Google’s search algorithm was initially funded by the National Science Foundation.²⁵ SBICs in

particular have served as launch pads for many of America’s biggest name brands, including Federal Express, Apple, Intel, Costco, Tesla, Whole Foods and Callaway Golf.²⁶

Microsoft Founder Bill Gates encapsulated this reality as well:

*The government’s role is to invest in R&D when the private sector won’t because it can’t see how it will make a profit... This is in fact exactly how we got products you probably use every day, including the internet, lifesaving medicines, and the Global Positioning System that your smartphone uses to help you navigate around town. The personal computer business — including Microsoft — would never have been the success that it was if the U.S. government hadn’t put money into research on smaller, faster microprocessors... Investing in research has another benefit: It can help create businesses in one country that export their products to others.*²⁷

Mazzucato’s work has been instrumental in influencing the European Union to approve Horizon Europe, a seven-year (2021-2027), €100 billion initiative to strengthen the foundations of science and technology and boost innovation across the EU.²⁸ Launching in 2021 as part of

Horizon Europe are five “moon shot” efforts called EU Missions (2022-2030). They are: Conquering Cancer: Mission Possible; A Climate Resilient Europe; 100 Climate-Neutral Cities by 2030; Caring for Soil is Caring for Life; and, of greatest relevance to this work, Mission Starfish 2030: Restore our Ocean and Waters.²⁹

Inspired by the shape of the sea star, the Mission Starfish 2030 has five major objectives:

1. filling the knowledge and emotional gap,
2. regenerating marine and freshwater ecosystems,
3. zero pollution,
4. decarbonizing the ocean and waters and
5. revamping governance.³⁰

This is a bold effort and European BlueTech clusters and companies are gearing up to participate with major funding across many targeted programs. The EU and European BlueTech clusters are looking at the blue economy as a key driver to rebound out of the COVID-19 crisis with good paying blue jobs and new industries.

THE IMPORTANCE OF INNOVATION CLUSTERS

There is considerable research on the importance of business or economic clusters across industries and geographies. One of the leading U.S. proponents is Professor Michael Porter at Harvard Business School, who defined clusters as “geographic concentrations of interconnected companies and institutions in a particular field. Clusters encompass an array of linked industries and other entities important to competition.”³¹

However, not all clusters are created equal. As discussed earlier, this white paper focuses on a subset of Porter’s cluster definition; specifically, organizations focused on innovation, comprised of independent entities that have home-base operations within a defined geographic range and managed by a legal entity with distinct funding and leadership. These are typically referred to as cluster organizations or innovation clusters, of which BlueTech Clusters are but one example. One observer notes:

*Globally, there are some 7,000 innovation clusters. In many countries, these clusters fuel a critical part of the national competitiveness, future growth industries and a large percentage of GDP. Yet, leadership in these critical innovation networks is poorly understood and little researched. Countries like Denmark, Norway, Germany and Spain have invested significantly over the past few decades in building out high-performing national cluster programs.*³²

There is growing international recognition of the importance of harnessing the potential of innovation clusters. One example, the TCI Network, is a global entity based in Spain with a stated vision to “expand the power of collaboration toward more inclusive and sustainable societies.” It has over 500 active members and 9,000 practitioners in 111 countries, all focused on development of clusters and innovation ecosystems globally.³³

Given that there is great diversity in the structure, scope and reach of innovation clusters, not all are equally deserving of government intervention. The European Union has been focused on clusters for developing industrial sectors for years,³⁴ and ocean, coastal and freshwater sectors have been no stranger to this movement. One 2014 study found 117 maritime clusters around the Mediterranean Sea, yet only identified six as providing a “balanced package” that set them apart from smaller, less-mature clusters. According to the

study, “building and developing successful maritime clusters is complex. It requires a large number of actors to cooperate, both public and private. It requires a good policy framework, critical mass [and] a willingness to work together... It is important to recognise that not all maritime clusters can be ‘world class,’ as many will be successful at a lower geographical scale, at sea-basin, national or regional level... Policy makers should know when to support maritime clusters (and when not).”³⁵

Just as innovation clusters bring individual companies, organizations and entrepreneurs together to learn from one another and foster collaboration, there are also entities that support innovation clusters. The mission of the European Cluster Collaboration Platform (ECCP) “is to be the European online hub for clusters... and the reference one-stop-shop for stakeholders in third countries aiming to set up partnerships with European counterparts.”³⁶ It defines clusters as “regional ecosystems of related industries and competences featuring a broad array of inter-industry interdependencies... both as a concept and a real economic phenomenon.”³⁷ It defines cluster organizations as “the legal entities that support the strengthening of collaboration, networking and learning in innovation clusters and act as innovation

support providers... to stimulate innovation activities.” In other words, cluster organizations are the actors that facilitate strategic partnering across clusters. ECCP profiles over 1,200 cluster organizations.³⁸

One way to assess the effectiveness of clusters is to engage an independent third party. The European Secretariat for Cluster Analysis (ESCA) was established in November 2010, with support from the E.U., to create more world-class clusters across the Europe by strengthening cluster management excellence. ESCA “is the one-stop shop for promoting Cluster Management Excellence through benchmarking and quality labelling of cluster management organisations worldwide. The Berlin-based organisation coordinates a network of around 200 cluster experts from more than 30 countries, which offer benchmarking and labelling services on behalf of ESCA.” It also supports cluster managers and developers with direct guidance. ESCA has extensive cluster benchmarking data to determine how successful individual innovation clusters have been, and it offers three levels of certification: bronze, silver and gold.³⁹

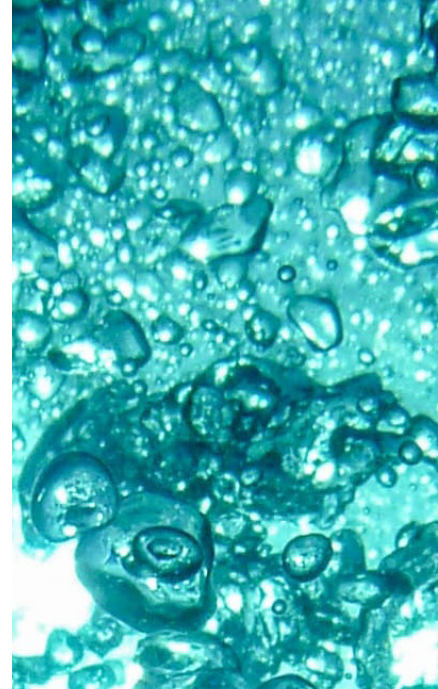
Globally, there are some

7,000

innovation clusters



BLUETECH CLUSTERS – A DEEPER DIVE



BlueTech clusters are innovation cluster organizations that bring together stakeholders from across the Triple Helix⁴⁰, comprised of:



Academia and education



Business and industry



Government and policy makers

By bringing entrepreneurs together, BlueTech clusters serve as hubs of innovation for development, and the economic benefits extend throughout the economy. Blue jobs are good paying jobs, whether traditional jobs like crane operators, stevedores, tugboat operators or in BlueTech, because the ocean is not forgiving of mistakes and imperfections.

BlueTech clusters are almost always not-for-profit organizations that act as specialized industry associations for companies, particularly those that may operate within a discrete geographic location but sell their products and services globally and as such, typically do not belong to the local Chamber of Commerce or Regional Economic Development Corporations (REDC). Unlike companies in most other industries, many BlueTech companies sell the vast majority of their goods and services outside the region in which they are headquartered, and much of that amount regularly involves export sales.

This can be problematic when it comes to accessing government funding, particularly at the state level. In California, for example, the Governor’s Office of Business and Economic Development injects state funding into programs and innovation that is typically coordinated through traditional regional organizations such as Chambers of Commerce or REDCs. Since there is limited overlap with Chambers and REDCs, BlueTech companies do not benefit from high visibility and, therefore, lack equivalent access to state funding.

Industry stakeholders typically organize and lead BlueTech clusters. In 2017, TMA BlueTech helped create the BlueTech Cluster Alliance (BTCA), which gathers ten of the world’s leading ocean tech clusters from eight countries—Canada, France, Ireland, Norway, Portugal, Spain, the U.K. and the U.S.—all of which are not-for-profit cluster organizations focused on the Triple Helix with active educational and workforce development efforts. One of the criteria to join BTCA is that the applicant “be a formal, industry-oriented, BlueTech ‘cluster’ organization (not a general association, government entity, university or the like).”⁴¹

Corporate members of BlueTech clusters are overwhelmingly small- and medium-size enterprises (SME) that sell across freshwater and saltwater opportunities globally. While they contribute membership fees, SMEs cannot afford to pay enough to sustain the operations and personnel required to manage an effective BlueTech cluster. This is one of the reasons that governments support BlueTech clusters in Europe on an on-going basis: the SMEs that clusters help sustain are the innovators and growth companies of the future. They are developing the products that boost understanding of the world around us and create new economic opportunities, including good paying jobs, while addressing and often reversing environmental degradation and ecosystem decline.

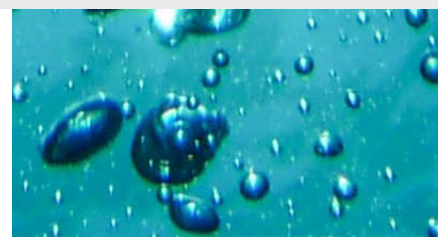
There is overlap and duplication of effort when both a freshwater tech cluster and an ocean tech cluster operate in the same geographic area. Both will be soliciting companies to join as members, and as

a result, both will likely struggle financially. If SME membership fees in BlueTech clusters struggle to support even one such entity, they certainly will be unable to support two—nor would such a system be efficient operationally. As a result, a growing number of BlueTech clusters address the whole water cycle.

One challenging factor about bringing this shared freshwater and saltwater model into the policy arena is that the U.S. federal government, like most governments around the world, typically divides jurisdiction over activities. By extension, it also separates many of its investments into these two different hydrological ecosystems. Thus, pursuing enhanced investment in this model will require significant interagency collaboration.

Between the fact that the U.S. government gathers little economic data about ocean and freshwater industries and that BlueTech companies don’t belong to traditional regional organizations, they have been largely invisible, under-funded and under-supported. One stark example is that ocean clusters were not included in the U.S. Cluster Mapping Project established under U.S. Secretary of Commerce Penny Pritzker during the Obama administration. Ironically, the Department of Commerce is also home to NOAA, the nation’s ocean management agency, yet this institutional relationship did not help ocean industries to rise to prominence within the Mapping Project. While the ocean is frequently an afterthought,⁴² the situation was exacerbated because the vast majority of industry companies are not aggregated in categories under the North American Industry Classification System (NAICS) codes on which the project based its findings.⁴³

Despite this lack of recognition, a limited number of ocean and water clusters have sprung up across the country. Most U.S. BlueTech clusters have not benefited from government funding opportunities such as those in Europe or Canada, the latter of which established a large Ocean Supercluster funding program to promote collaboration between companies and existing BlueTech clusters.⁴⁴



In recent years, various U.S. government agencies have endeavored to launch and support BlueTech clusters. This includes the Economic Development Administration's "Build to Scale" grant program, which recognized the blue economy as a key focus area for 2020, resulting in several grants to early-stage ocean cluster efforts—but this effort was intended to be limited period funding to get them launched. Additional efforts have been project-oriented and required significant match-funding, which is not available to all clusters whether start-up or mature, successful or not. The domestic industry could clearly benefit from a much larger, sustained funding model, since the companies being helped are predominantly SMEs that cannot afford to pay significant member dues. One case study for how this can be executed comes from Norway, which has one of the best cluster support programs in the world and is described in greater detail below.⁴⁵

There are other ways government can assist industry such as the 2018 announcement by the Norwegian government that it would invest \$700 million in ocean research labs in a plan it calls Ocean Space Laboratories. These assets will be used for educating students, for research and for companies that need to test products or equipment.⁴⁶ China is actively developing its ocean testing facilities and BlueTech sector, including Oceantec Valley near Qingdao with 7 million square meters of space (75.4 million sq. ft.).⁴⁷

By comparison to these concerted efforts to provide fundamental research facilities for industrial use, U.S. BlueTech companies struggle to get access to specialized indoor tanks and outdoor testing facilities. The U.S. is home to numerous state-of-the-art government research facilities, such as the Ocean Technology Development Tank at the La Jolla Laboratory of the Southwest Fisheries Science Center, "a 2 million liter seawater tank that allows scientists to test new survey technologies in a controlled environment."⁴⁸ A program allowing this facility and others like it to be accessible to tech developers at cost when not in use by government programs and scientists would serve the double benefit of providing a source of innovation to the

private sector, and a modicum of revenue to the science center itself to enhance its own work if it is allowed to retain usage fees.

By comparison to a number of leading counterparts overseas, there is no overarching strategy or entity charged with promoting a government-wide domestic BlueTech policy in the United States. NOAA has in recent years promoted the blue economy. In January 2021, NOAA released its 2021-2025 Blue Economy Strategic Plan, aimed at strengthening the agency's commitment to enhancing data services and technological resources, cultivating public-private partnerships and supporting the growth of sustainable industries to accelerate America's recovery from the economic downturn resulting from the Covid-19 pandemic. This report found that in 2018, "the American Blue Economy—including goods and services—contributed about \$373 billion to the nation's gross domestic product, supporting 2.3 million jobs, and grew faster than the nation's economy in its entirety."⁴⁹

The 2021 strategic plan included sections dedicated to five agency-wide initiatives: maritime transportation, ocean exploration, seafood competitiveness, tourism and recreation, and coastal resilience. It also called for enhanced monitoring and tracking of economic indicators and "leveraging cross-cutting external opportunities." All of these and more can benefit from the collaborative opportunities presented by BlueTech cluster models, and this collaboration was recognized in the strategic plan. Specifically, Action 7.1.10 calls for NOAA to:

*Collaborate with organizations and principals from Blue Technology clusters nationwide, such as the Gulfport, Mississippi, Blue Economy Innovation District (BEID) and others in New England, San Diego, and Seattle, to gather user requirements and demonstrate the return on investment in [uncrewed systems] data collections.*⁵⁰

It remains to be seen how the Biden administration will move ahead on these recommended actions. This paper's recommendations for policy action, initially listed in the introduction, are described in greater detail in Appendix A.

CONCLUSION

American's ocean and freshwater resources represent a massive and growing segment of our economy.

As the global population continues to rise, pressure on land-based resources and the need to increase productivity will grow exponentially. Yet as those pressures increase, so will the risk of unintended consequences, already compounded by the growing threat of global climate change. BlueTech clusters allow us to interact with the ocean and water resources in ways that were unthinkable 10-20 years ago, leveraging the power of innovation, data collection and processing capacities, hardware and revolutionary thinking and above all, a collective approach that allows entrepreneurs and emerging leaders to balance stakeholder needs across the Triple Helix, promote innovation across a vibrant supply chain, create good paying blue jobs and solve global challenges while developing a sustainable blue economy. This sustainability component must be fundamental in this equation. Again, to quote Bill Gates from his most recent book about how the world can solve the climate crisis, "policy makers need to be clear about the goal they're trying to achieve and aware of the technologies they're trying to promote."⁵¹ There is no win in promoting unsustainable development.

Other countries, from Canada to China to Europe, have recognized this opportunity and are already investing heavily in development of their own

BlueTech clusters, and the U.S. risks being left behind without a similar infusion of investment targeted to this large economic sector. NOAA has measured growth of the U.S. blue economy at 5.7 percent from 2014-2015, the most recent data available. Meanwhile, a 2020 report from the European Union pegged its blue economy growth at 11.6% from 2017-2018⁵²—more than twice the rate of growth in the United States. Expanding our blue economy to match the growth rate of our counterparts across the Atlantic would mean adding tens of thousands of jobs and hundreds of billions of dollars to our gross domestic product. Providing ongoing support for BlueTech clusters focused on SMEs is the key to achieving this goal.

America controls the second largest exclusive economic zone in the world (narrowly edged out by France due to numerous island territories and protectorates), as well as the largest gross domestic product. If we fail to focus our attention on alignment between our natural resources and national economic dominance, we will fail to capitalize on this unique and manifest opportunity to shore up our potential, buoy our coastal communities, and invigorate our blue economy with steady, well-paying jobs and massive return on investment.

“Technology will offer the potential to mitigate problems, such as climate change and disease, and to create new challenges, such as job displacement. Technologies are being invented, used, spread, and then discarded at ever increasing speeds around the world, and new centers of innovation are emerging. During the next two decades, the pace and reach of technological developments are likely to increase ever faster, transforming a range of human experiences and capabilities while also creating new tensions and disruptions within and between societies, industries, and states. State and nonstate rivals will vie for leadership and dominance in science and technology with potentially cascading risks and implications for economic, military and societal security.”

GLOBAL TRENDS 2040: A MORE CONTESTED WORLD PG. 7 | National Intelligence Council

DETAILED POLICY RECOMMENDATIONS

1. Launch an Apollo Project-style “Blue Wave Mission” for the ocean, to align with the priorities of the National Academies of Science’s U.S. National Committee for the U.N. Decade of Ocean Science,⁵³ and ensure ocean and freshwater projects and technological development opportunities are given prominence in consideration under DARPA, ARPA-E, and are specifically called out in the proposal to develop an ARPA-Climate as announced in March 2021 by the Biden administration.⁵⁴

We are in an “ocean race” already with both economic and military competitors. With the vast majority of the global ocean and the U.S. Exclusive Economic Zone still unexplored, there is much to be discovered and utilized as we prove that we can do so in a way that does not add to the panoply of adverse effects industrialization has already visited upon our marine resources. It is, quite literally, the largest opportunity for discovery remaining on Earth, yet we cannot allow this pursuit to become a race to the bottom that perpetuates our history of charging ahead with insufficient regard for economic externalities and unintended consequences of development. The time has come to leverage the research and development potential of the federal government to partner with industries and innovators on a new mission on the scale of a Manhattan or Apollo Project—in this case, a Blue Wave Mission—to excite popular imagination, reestablish the United States as a global leader in science and innovation, address the climate crisis, strengthen our BlueTech supply chain and discover the secrets of the world’s depths.

The Advanced Research Projects Agency model has proven successful in the nation’s history at jump-starting not only the projects it was initially intended to address, such as Cold War and Space Race technologies in the case of DARPA or reducing the cost of renewable energy generation in the case of ARPA-E, but also spinning off some of America and the world’s biggest industries and economic drivers. The recent call from the Biden administration for an ARPA-Climate⁵⁵ provides the right opportunity to leverage the necessary scale of investment in innovations that will contribute solutions to the existential crisis of global climate change that leverage the power of BlueTech clusters and our marine and water resources.

2. Prioritize funding opportunities within the Department of Commerce, including NOAA and the Economic Development Administration, the Department of Defense, the Export-Import Bank, the National Science Foundation, the Small Business Administration, and other agencies to provide on-going funding for BlueTech clusters focused on small-to-medium-sized-enterprises—the critical innovators that typically cannot pay enough in membership fees to sustain clusters. This SME funding should ensure diversity, equity, inclusiveness and justice are a goal.

In 2020, the EDA identified the Blue Economy as one of its key focus areas for the Build to Scale grant program authorized by the Stevenson-Wydler Technology Innovation Act of 1980. The program authorizes the EDA to issue grants that “further technology-based economic development initiatives.”⁵⁶ Both the Alaska Ocean Cluster and the Maritime Blue Initiative in Washington received matching grants of \$600,000 under this program in 2020, however the Blue Economy is not currently supposed to be an annual focus area of the program.

Specific legislation to authorize the Secretary of Commerce through the EDA and NOAA to provide support to U.S. BlueTech clusters on an annual basis in a model akin to that established in Norway would be an ideal first step towards promoting sustained BlueTech cluster and growth of innovative small and medium-sized entities as a priority for the country. These awards could include a tiered structure to ensure BlueTech clusters develop the capacity to handle an increased flow of funding efficiently over time and a system that encourages speed-to-market of new technologies and innovations with multiple on-ramps to help businesses that need the most support and are the least able to afford it compete for funding with larger companies and organizations that have built-in capacity for identifying and pursuing government funding opportunities and have typically high overhead rates affiliated with such a business model.⁵⁷

3. Establish or utilize existing benchmarking systems for clusters to create an objective way to evaluate and promote the progress of clusters from regional start-up, to national focus to mature internationally active clusters and to promote cluster collaboration.⁵⁸

One way to ensure government funding is being allocated effectively is to establish a system of benchmarking for clusters to qualify for increasingly large grants as their operations expand and prove successful and efficient. The European Secretariat for Cluster Analysis (ESCA) provides an excellent model of an objective third-party benchmarking and certification organization.⁵⁹ The Norwegian Innovation Clusters program is an example of this method that provides on-going financial support to encourage clusters to collaborate cross-cluster and expand nationally and internationally.⁶⁰

4. Increase investment in existing federal programs that manage ocean and Great Lakes observing systems and exploration to provide greater clarity and baseline understanding of marine and freshwater ecosystems.

The U.S. Exclusive Economic Zone (EEZ) covers 3.4 million square nautical miles of ocean: larger than the combined land area of all fifty states. U.S. states also have jurisdiction over a significant portion of the Great Lakes, which represents the largest reservoir of fresh surface water on the planet with a U.S. coastline that borders eight states and is roughly the same length as the entire Atlantic Coast.⁶¹ Yet we know little about the resources of our EEZ. NOAA’s ocean exploration and observing budgets are very small in relation to the value these ecosystems provide and the potential for economic growth. We should create a strategy with funding for NOAA and to enlist the assistance of industry particularly to test new technologies and services.

DETAILED POLICY RECOMMENDATIONS

5. Promote private sector access to investment capital and to excess capacity in testing facilities managed or funded by federal government agencies.

The United States is home to numerous state-of-the-art research facilities paid for by federal funding. Some of these are at military, university and non-military research institutions and some are at federal organizations such as the Ocean Technology Development Tank at a NOAA research facility, which is a one-of-a-kind “2-million-liter seawater tank that allows scientists to test new survey technologies in a controlled environment.”⁶² However, most of these facilities, are inaccessible to industry and project developers. A program allowing federally funded facilities to be accessible to tech developers at cost when not in use by government programs and scientists would serve the double benefit of providing a source of innovation to the private sector, and a modicum of revenue to the science center itself to enhance its own work.

6. Develop enhanced metrics of tracking and accounting for the blue economy, including the subset related to BlueTech innovation, and prepare a national ocean economy study to understand and track contributions to national economic and sustainability metrics.

We know there is tremendous potential in development of the Blue Economy, however, we lack the information to establish a baseline and thus how to measure its growth, including tracking the return on investment for programs such as those that will be necessary to spur economic growth. We also lack a standard definition of sustainability and thus an ability to measure how these policies contribute to a transition away from industries that are fundamentally unsustainable or harmful to marine (or terrestrial) ecosystems in a way that will compromise biodiversity or cause unintended harm to other segments of the economy or nature itself.

NOAA’s Blue Economy Strategic Plan includes as Objective 6.1.1 a call to “develop metrics that quantify agency-wide economic impacts.”⁶³ This provision should, in fact, be expanded across the federal government, as NOAA is far from the only agency with jurisdiction over ocean industries or ecosystems. One concrete step that should be taken to enhance Blue Economic data collection would be through establishment of North American Industry Classification Systems codes (or whatever comes with the USMCA as successor to NAFTA) that specifically track ocean and water economy industries, leading to measurable growth. Both of our North American neighbors would likely be willing partners in this effort.

7. Reinvigorate the public-private National Oceanographic Partnership Program (NOPP) and an interagency coordinating entity such as the National Ocean Council that was replaced in the Trump administration by the Ocean Policy Committee.

Ocean issues cross the jurisdiction of numerous government departments and agencies. In 1997 the National Oceanographic Partnership Program (NOPP) was established to “facilitate partnerships between federal agencies, academia, and industry to advance ocean science research and education.”⁶⁴ The NOPP provides funding to support a variety of ocean-based research projects in public-private partnerships and could be used as a home base for developing funding mechanisms referenced in earlier recommendations.

The National Ocean Council (NOC) was an interagency body established in the National Ocean Policy created by President Barack Obama via Executive Order. When President Donald Trump took office, he reviewed and ultimately rescinded the National Ocean Policy, while replacing the National Ocean Council with the Ocean Policy Committee. It is sensible to establish an interagency council or working group dedicated to helping agency leadership coordinate and understand what is taking place across our nation’s vast Exclusive Economic Zone, and in land-based activities that affect coastal, ocean and freshwater ecosystems.

A challenge to bringing this shared freshwater and saltwater model into the policy arena is that the U.S. federal government, like most governments around the world, typically divides jurisdiction over activities, and by extension, it also separates many of its investments into these two different hydrological ecosystems. Thus, pursuing enhanced investment in this model will require significant interagency collaboration.



SELECT BLUETECH CLUSTER EXAMPLES

The following is a selective list describing different examples of BlueTech cluster models, showcasing geographically distinct entities of varying sizes and stages of development in order to illustrate the potential for a benchmarking process for potential government support as discussed above.

It is not exhaustive, rather intended to illuminate some of the different approaches that entities have taken to capitalizing on the cluster model. The list focuses exclusively on not-for-profit BlueTech cluster models that operate based on the Triple Helix principle, as these are the most likely to be eligible for many of the policy recommendations this paper proposes.

UNITED STATES-BASED CLUSTERS

The United States has examples of BlueTech clusters that fit different models:

- **The Alaska Ocean Cluster** is a 2-year-old, early-stage, Triple Helix-oriented ocean tech cluster that has been actively supported by fishing associations in the state during a time that the State's funding capability has been limited. It is actively promoting educational, informational and workforce development activities. It received a Build to Scale grant from the EDA.⁶⁵
- **The Cleveland Water Alliance** is a not-for-profit freshwater cluster established in 2014, with the mission to "build upon Ohio and the Great Lakes' assets and resources to create a clean water innovation ecosystem that harnesses technology, spurs the economy, enhances education and drives research." Its programs focus on strategic funding collaborations and development of water-based environmental technologies.⁶⁶
- The mission of the **Mississippi Enterprise for Technology (MSET)** is to facilitate regional economic development by leveraging the resources of Stennis Space Center, the state of Mississippi, and the Gulf coast region to foster business opportunities among public and private entities. Representing the industry base at Stennis, from the smallest company to the largest federal agency or prime contractor, it provides a number of mechanisms to identify economic development and business opportunities. MSET received a \$1.5 million SBA grant to create an ocean tech cluster.⁶⁷
- **The New England Water Cluster** is evolving following a merger of two organizations: the New England Water Environment Association and the Northeast Water Innovation Network's to focus on fresh water in the Northeast.⁶⁸
- **TMA BlueTech** was established in San Diego in 2007 and is one of the oldest and largest BlueTech clusters in the U.S. and globally. It has approximately 100 members (90 across the U.S. and about 10 international), it is a Strategic Partner with the U.S. Dept. of Commerce, received

funding to organize the first ever US Maritime Technology Export Initiative, and is a founding member of the BlueTech Cluster Alliance, the only international BlueTech alliance. TMA funds itself via memberships dues, revenue from its events and from grants.⁶⁹ However, it has a President that has worked for no salary for 14 years, which is not sustainable, and has not been able to apply for federal cluster funding because it has not had access to multi-year match funding.

- **Washington Maritime Blue** is a Triple Helix-oriented ocean tech cluster in Washington State. It has developed quickly in just over two years building on several years of development work. It was conceived and supported out of the Governor's office and has accessed state funding to match federal cluster development funds,

INTERNATIONAL CLUSTER MODELS

- The French government has always recognized the role of innovation clusters to promote sustainable economic growth. In 2005, it launched a national call to create Triple Helix clusters (also called competitiveness clusters in France) in most major and strategic French industrial areas. The maritime sector has been granted two ocean clusters, **Pôle Mer Bretagne Atlantique** and **Pôle Mer Méditerranée**, both supported by national and regional funds. Additional funds are also specifically dedicated to R&D projects that require to be certified by these competitiveness clusters. This mechanism ensures the quality of the selected projects and allows members of academia, industry and professional organizations to finance their R&D activities and ultimately generate innovation. Since 2005, both Pôle Mers have certified more than 900 projects, leveraging €704 million in public funds into €2.4 billion in research.⁷¹
- **Forum Oceano** is the national BlueTech cluster in Portugal recognized and supported by the government. It was established, based on the French model, and initially supported with national funding, without which, it "would not have been born in 2009."⁷² Government funding lapsed from 2015-2017 before a change of administration brought renewed focus on the blue economy with financing that has allowed it to grow.
- **The Norwegian Innovation Clusters** program provides on-going financial support to encourage clusters to improve. By making the funding contingent on collaboration, the goal of this program is to help companies find common interests, develop experts domestically, and pursue innovative programs while keeping Norway at the forefront of the global blue economy. The clusters are supported with partial funding, as well as advisory services, cluster development support, networking activities and profiling services. There are annual evaluations of each cluster to determine whether they are on the right track according to their strategies and whether they deliver at a quality sufficiently high to continue as part of the program.⁷³
- **GCE Ocean Technology** is an example of an entity that has worked its way up through the program, and now benefits from the highest level of the three funding levels provided:
 - Arena early-stage clusters receive up to 2.5 million Kroner (roughly \$300,000) per year for 3-5 years.
 - The next level up is a National Center of Excellence designation for clusters active nationally, which can receive 5 million Kroner (\$600,000) for 10 years.
 - The third and highest level is Global Center of Expertise, which means they are working internationally and receive 10 million Kroner (\$1.2 million) annually for 10 years.
- Canada has three established ocean tech clusters with one more currently in formation. Through an **Innovation Superclusters Initiative**, the Government committed nearly Can\$1 billion over five years from 2017-2022 to provide national funding for cooperative programs to strengthen five of Canada's most promising economic clusters. One of those chosen was the Ocean Supercluster, which is not a traditional BlueTech cluster but rather a funding source, to promote "sustainable ocean innovation by building a robust ecosystem that is well-connected and well-equipped to rapidly innovate, commercialize solutions, and deliver on the growing ocean opportunity."⁷⁴ It requires organizations interested in funding to become a member and works with existing BlueTech clusters such as OceansAdvance in St. John's, Newfoundland. The central government has set aside up to Can\$153 million to the Ocean Supercluster with an expected GDP impact over 10 years of Can\$14 billion and projected creation of over 3,000 jobs.⁷⁵

BIBLIOGRAPHY

¹The Ocean Foundation is a public, international philanthropy and the only community foundation for the ocean – it is dedicated to reversing the trend of destruction of ocean environments around the world.

²TMA BlueTech is one of the largest, oldest and best-known ocean and freshwater tech clusters in the world. It is unusual in that it includes both ocean and water/wastewater.

³Research and Innovation. (2020, September 22). Mission Starfish 2030: Restore our Ocean and Waters. European Commission. https://ec.europa.eu/info/publications/mission-starfish-2030-restore-our-ocean-and-waters_en. "...the Mission Board on Healthy Oceans, Seas, Coastal and Inland Waters proposes a Mission Starfish 2030: Restore our Ocean and Waters by 2030. Inspired by the shape of the starfish, the Mission has five overarching objectives for 2030: (i) filling the knowledge and emotional gap, (ii) regenerating marine and freshwater ecosystems, (iii) zero pollution, (iv) decarbonizing our ocean and waters, and (v) revamping governance. These five objectives are mutually supportive and...will enable the restoration of the water cycle as a whole."

⁴Volume 5 (2016). Triple Helix Association. (2016, December 28). <https://www.triplehelixassociation.org/helice/volume-5-2016>. "The Triple Helix (university-industry-government relationships) is an established model. One of the practical instruments of the model are innovation clusters." BlueTech defines it as academia/education-industry-policy makers (Policy Makers include elected officials, economic development organizations, military, NGOs and press).

⁵The Triple Helix Association (THA) is a not-for-profit, non-governmental association to advance the scientific knowledge and practical achievements related to all aspects of the interaction between academy-industry-government (Triple Helix).

⁶US Department of Commerce, N. O. and A. A. (2017, May 24). *Why should we care about the ocean?* NOAA's National Ocean Service. <https://oceanservice.noaa.gov/facts/why-care-about-ocean.html>.

⁷How Much Water is There on Earth? https://www.usgs.gov/special-topic/water-science-school/science/how-much-water-there-earth?qt-science_center_objects=0#qt-science_center_objects.

⁸Op. cit. note 3. Mission Starfish 2030.

⁹Op. cit. note 3. Mission Starfish 2030, p. 5, 17.

¹⁰Borenstein, S. (2021, March 18). *Forecast for spring: Nasty drought worsens for much of US*. AP NEWS. <https://apnews.com/article/drought-spring-forecast-united-states-b24a2a60ae320df2fb245e4f215aeb5e>.

¹¹Gates, B. (2021). *How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need*, p. 181.

¹²Ocean-Shot Concepts. The National Academies of Sciences, Engineering, and Medicine. <https://www.nationalacademies.org/our-work/us-national-academy-committee-on-ocean-science-for-sustainable-development-2021-2030#sl-three-columns-e33ae106-08bc-49e3-8baf-078797861e38>.

¹³The United States Government. (2021, April 8). *FACT SHEET: The American Jobs Plan*. The White House. <https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan/>.

¹⁴The European Secretariat for Cluster Analysis (ESCA). ESCA. <https://www.cluster-analysis.org/>. "The European Secretariat for Cluster Analysis (ESCA) is the one-stop shop for promoting Cluster Management Excellence through benchmarking and quality labelling of cluster management organisations worldwide."

¹⁵NOAA finalizes strategy to enhance growth of American Blue Economy. National Oceanic and Atmospheric Administration. <https://www.noaa.gov/stories/noaa-finalizes-strategy-to-enhance-growth-of-american-blue-economy>. "Our ocean, coastal, and Great Lakes resources are critical to our security and well-being..."

¹⁶Buss, D. D. (2014, December 5). *Water: The New Blue Economy?*. Area Development. <https://www.areadevelopment.com/sustainable-development/December-2014/the-blue-economy-water-scarcity-2727110.shtml>. "Meanwhile, in Michigan, state officials have launched a "Blue Economy" initiative to prioritize water technology as a high-growth sector for the state. Moving water around the world in various ways represents a \$50 billion market over the next 20 years."

¹⁷Oceans Economy and Fisheries. United Nations Conference on Trade and Development. (2021, April). <https://unctad.org/en/Pages/DITC/Trade-and-Environment/Oceans-Economy.aspx>.

¹⁸The Ocean Economy in 2030. OECD. (2016, April 27). <https://www.oecd.org/environment/the-ocean-economy-in-2030-9789264251724-en.htm>. p. 5

¹⁹The Oceans Economy: A Formidable Asset for the Advancement of Sustainable Development. United Nations Conference on Trade and Development. https://unctad.org/system/files/official-document/ditc2015misc5_en.pdf.

²⁰US Department of Commerce, N. O. and A. A. *U.S. Ocean Economic Sectors Growing Twice as Fast as Overall Economy*. NOAA's National Ocean Service. <https://oceanservice.noaa.gov/news/may18/ocean-economy-report.html>.

²¹San Diego Maritime Industry Report. San Diego Workforce Partnership. (2018, June 28). <https://workforce.org/reports/2012/09/18/san-diego-maritime-industry-report/>.

²²NOAA Economics: National Ocean Watch. <https://coast.noaa.gov/digitalcoast/data/enow.html#:~:text=The%20Economics%3A%20National%20Ocean%20Watch,a%20wide%20variety%20of%20formats>.

²³Migiro, G. (2018, June 29). *Countries with the Largest Exclusive Economic Zones*. WorldAtlas. <https://www.worldatlas.com/articles/countries-with-the-largest-exclusive-economic-zones.html>.

²⁴Medeiros, J. This economist has a plan to fix capitalism. It's time we all listened. WIRED UK. <https://www.wired.co.uk/article/mariana-mazzucato>.

²⁵Taxpayers Helped Apple, but Apple Won't Help Them. Harvard Business Review. (2014, August 7). <https://hbr.org/2013/03/taxpayers-helped-apple-but-app>.

²⁶About the SBIC Program. Small Business Investor Alliance. (2021, April 14). <https://www.sbia.org/sbic/>.

²⁷Op. cit. note 11. *How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need*, p. 185.

²⁸Horizon Europe programme analysis. European Commission. (2021, March 31). https://ec.europa.eu/info/research-and-innovation/strategy/support-policy-making/shaping-eu-research-and-innovation-policy/evaluation-impact-assessment-and-monitoring/horizon-europe_en.

Ghosh, J. (2021, January 19). *Lessons from the Moonshot for fixing global problems*. Nature News. <https://www.nature.com/articles/d41586-021-00076-1>.

²⁹Missions in Horizon Europe. European Commission. (2021, March 1). https://ec.europa.eu/info/horizon-europe/missions-horizon-europe_en.

³⁰Directorate-General for Research and Innovation (European Commission). (2020, September 21). *Mission Starfish 2030: Restore our Ocean and Waters*. Publications Office of the European Union. <https://op.europa.eu/en/web/eu-law-and-publications/publication-detail/-/publication/672ddc53-fc85-11ea-b44f-01aa75ed71a1>.

³¹Porter, M. (1998, November-December). "Clusters and the New Economics of Competition", Harvard Business Review

³²Rangen, C. *Leadership in Clusters and Networks*. LinkedIn. <https://www.linkedin.com/pulse/leadership-clusters-networks-christian-rangen/>.

³³About. TCI Network. <https://www.tci-network.org/about/>.

³⁴P54. (2016) *Smart Guide to Cluster Policy*. European Commission DG-GROW. <https://www.cluster-analysis.org/downloads/smart-guide-to-cluster-policy>. "Cluster policy should...be focused on developing new industrial sectors of this type by encouraging correspond-

ing cross-sectoral collaboration and transforming existing industrial sectors”.

³⁵Directorate-General for Maritime Affairs and Fisheries (European Commission). (2015, January 29). *Support activities for the development of maritime clusters in the Mediterranean and Black Sea areas: Final Report*. Publications Office of the European Union. <https://op.europa.eu/en/publication-detail/-/publication/0cf48e00-7bc9-46d1-a15e-5507cbb775db>.

³⁶*Mission*. European Cluster Collaboration Platform. <https://clustercollaboration.eu/vibrant-platform-service-cluster-organisations>.

³⁷*Cluster Definitions*. European Cluster Collaboration Platform. <https://clustercollaboration.eu/cluster-definitions>.

³⁸*Homepage*. European Cluster Collaboration Platform. <https://clustercollaboration.eu/>.

³⁹Op. cit. note 14. The European Secretariat for Cluster Analysis (ESCA).

⁴⁰Op. cit. note 5.

⁴¹*Join*. BlueTech Cluster Alliance (BTCA). <https://www.bluetechclusters.org/join>.

⁴²Because current U.S. Secretary of State Gina Raimondo was formerly the Governor of Rhode Island, “the Ocean State,” there’s hope that her time in office will present a unique opportunity to marry blue economy initiatives with economic development.

⁴³*About the project*. U.S. Cluster Mapping Project. <http://www.clustermapping.us/about>.

⁴⁴*Annual Report 2019-2020*. Canada’s Ocean Supercluster. (2020). https://oceansupercluster.ca/wp-content/uploads/2020/09/COSC-2020-Annual-Report_Public_WEB.pdf.

⁴⁵Norwegian Innovation Clusters. <http://innovationclustersno-dev.azurewebsites.net/english/>.

⁴⁶Gemini News. *Norway’s Government Invests \$700 Million in Ocean Research Labs*. The Maritime Executive. <https://maritime-executive.com/editorials/norway-s-government-invests-700-million-in-ocean-research-labs>.

⁴⁷*Full steam ahead for Oceantec Valley*. China Daily. https://www.chinadaily.com.cn/m/qingdao/2016-09/07/content_26724895.htm.

⁴⁸*Ocean Technology Development Tank*. NOAA Fisheries. (2020, August 4). <https://www.fisheries.noaa.gov/west-coast/science-data/ocean-technology-development-tank>.

⁴⁹National Oceanic and Atmospheric Administration. *Blue Economy Strategic Plan*. NOAA.gov. <https://aambpublicoceanservice.blob.core.windows.net/oceanserviceprod/economy/Blue-Economy%20Strategic-Plan.pdf>.

⁵⁰Ibid. p. 15-16.

⁵¹Op. cit. note 11. *How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need*, p. 192.

⁵²*Press Corner*. European Commission. https://ec.europa.eu/commission/presscorner/detail/en/IP_20_986.

⁵³Op. cit. note 12. *Ocean-Shot Concepts*.

⁵⁴Op. cit. note 13. *FACT SHEET: The American Jobs Plan*.

⁵⁵The United States Government. (2021, February 11). *Biden-Harris Administration Launches American Innovation Effort to Create Jobs and Tackle the Climate Crisis*. The White House. <https://www.whitehouse.gov/briefing-room/statements-releases/2021/02/11/biden-harris-administration-launches-american-innovation-effort-to-create-jobs-and-tackle-the-climate-crisis/>.

⁵⁶*Build to Scale (B2S) Program*. U.S. Economic Development Administration. <https://www.eda.gov/oie/buildtoscale/>.

⁵⁷Op. cit. note 5.

⁵⁸Op. cit. note 14. The European Secretariat for Cluster Analysis (ESCA).

⁵⁹Op. cit. note 34. *Smart Guide to Cluster Policy*.

⁶⁰Op. cit. note 5.

⁶¹*Map of the U.S. Exclusive Economic Zone*. NOAA.gov. https://www.gc.noaa.gov/documents/2011/012711_gcil_maritime_eez_map.pdf.

⁶²Op. cit. note 48. *Ocean Technology Development Tank*.

⁶³Op. cit. note 49. *Blue Economy Strategic Plan*.

⁶⁴*Promoting Partnerships for the Future of the Ocean, Coasts and Great Lakes*. National Oceanographic Partnership Program. <https://www.nopp.org/>.

⁶⁵*Promoting Maritime Industry Growth and Prosperity in Alaska*. Alaska Ocean Cluster. <https://www.alaskacluster.com/>.

⁶⁶*About Us*. Cleveland Water Alliance. <https://clevelandwateralliance.org/about-us>.

⁶⁷Mississippi Enterprise for Technology. <https://www.mset.org/programs/mist-industry-cluster/>.

SBA Announces Four New Regional Innovation Cluster Awards. Small Business Administration. (2014, September 30). <https://www.sba.gov/about-sba/sba-newsroom/press-releases-media-advisories/sba-announces-four-new-regional-innovation-cluster-awards>.

⁶⁸*About Us*. New England Water Environment Association. (2020, June 3). <https://www.newea.org/about-us/>.

⁶⁹*Promoting Sustainable Science-Based Ocean and Water Industries*. TMA BlueTech. <https://www.tmablue.tech.org/>.

⁷⁰*What is Blue?* Washington Maritime Blue. <https://maritimeblue.org/what-is-blue/>.

⁷¹Provided by Phil Monbet, PhD, Deputy Director of Pôle Mer Bretagne Atlantique on April 23, 2021.

⁷²Interview with Frederico Ferreira on March 24, 2021.

⁷³Norwegian Innovation Clusters. <http://innovationclustersno-dev.azurewebsites.net/english/>.

⁷⁴Op. cit. note 44. *Annual Report 2019-2020*.

⁷⁵*Sector, I*. (2020, December 1). Canada’s Ocean Supercluster. Innovation Superclusters Initiative. <https://www.ic.gc.ca/eic/site/093.nsf/eng/00013.html>.