



# ALASKA RESOURCES AND OPPORTUNITIES IN THE RESPONSE TO GLOBAL CLIMATE CHANGE

## Discussion Paper

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# Key Terms and Acronyms

## Key Terms

**Additionality** - The concept that a carbon or other greenhouse gas intervention provides a positive effect over baseline.

**Blue carbon** - Carbon that is removed from the air or water by marine organisms such as mangroves and seaweed.

**Cap and trade** - A regulatory system that creates a cost for greenhouse gas emissions by setting a cap for how much carbon can be emitted across industry. Individual companies are able to buy and sell government allowances that allow them to emit greenhouse gases.

**Carbon offsets** - Pieces of projects that reduce greenhouse gases in the atmosphere in one location to compensate for emissions elsewhere, sold as an alternative to government allowances in regulatory cap and trade markets or to companies that make voluntary commitments to reduce their emissions. The unit of one carbon credit equates to avoided emission or removal of one ton of carbon dioxide.

**Carbon capture and sequestration** - A mechanical approach to removing carbon dioxide from the atmosphere and keeping it from escaping back. This technology can be used at the location of pollution source such as a fossil fuel power plant or can be applied to the atmosphere more generally.

**Carbon tax** - An alternative regulatory system to cap and trade for putting a price on greenhouse gases. Under this system companies pay taxes based on their greenhouse gas emissions, making carbon-intensive goods and services more expensive and incentivizing low-carbon alternatives.

**Green bonds** - Fixed rate financial instruments that are designed to support projects with environmental benefits.

**Environmental impact bonds** - Financial instruments that provide capital to project owners and employ a differential pay-back structure based on project outcomes.

**Irrecoverable carbon** - Stores of carbon in natural systems such as forests and peatlands that, if lost, could not be reversed on a timescale required to limit significant global warming over pre-industrial temperatures.

**Natural climate solutions** - Approaches to conserving, restoring, or managing natural ecosystems in order to increase their capacity to absorb carbon dioxide.

**Negative emissions technologies** - A broad term for climate solutions that actively remove carbon dioxide from the atmosphere, rather than merely reducing emissions. Negative emissions technologies can include both natural climate solutions and carbon capture and sequestration.

## Acronyms

GHG	greenhouse gas
UNEP	United Nations Environment Programme
IPCC	Intergovernmental Panel on Climate Change
UNFCCC	United Nations Framework Convention on Climate Change
NGO	non-governmental organization(s)
NET	negative emission technology
CCS	carbon capture and storage
NCS	natural climate solution(s)
ANC	Alaska Native corporation(s)

# A Pathway for Alaska

Governments, businesses, non-governmental organizations (NGOs), and individuals are increasingly focused on global climate change and the challenges it presents to populations and natural systems across the world. The measures required to slow the global temperature increase and hold overall warming to within best-case realms (1.5° to 2.0°C or less) demand a wholesale effort from a spectrum of actors. Necessary steps range from reduction of carbon and other greenhouse gases (GHG) releases to long-term sequestration of carbon and GHG from Earth's atmosphere.

Alaska faces significant climate-related challenges, with temperatures rising at rates far greater than those in lower latitudes and impacts felt already throughout all regions of the state. At the same time, the global pivot to climate change mitigation creates opportunities. With massive current stores of GHG throughout the state's intact ecosystems, valuable energy resources that can power carbon removal and sequestration, and a giant land-base and marine zone in which carbon solutions can be engineered, the state is positioned to drive meaningful impact in climate response and stabilization. Billions of dollars (and in some markets, in excess of a trillion dollars) are moving to respond to climate change, with additional commitments and further reorientation of global capital occurring on a near-weekly basis.

To position itself as a global player in climate response, and to orient the economy of tomorrow toward the opportunities presented by this global imperative, Alaska's political, business, and tribal leaders must act boldly to:

- 1 Attract investment in testing and deployment of climate-responsive tech, ranging from renewable energy solutions to climate capture and sequestration.**
- 2 Lead in the development and deployment of natural climate solutions, building on the extraordinary terrestrial and marine resources of the state. This must include the quantification and monitoring infrastructure necessary to position Alaska for investment.**
- 3 Use strategic partnerships and homegrown capacity to create novel market tools and stake out a leadership role in the "financialization" of greenhouse gas sinks.**
- 4 Aid municipal, tribal, and other local scale projects in identifying and capturing capital market opportunities; and drive federal programmatic dollars toward climate-linked opportunities in communities across the state.**
- 5 Exert the necessary political influence so that federal investments in climate are scaled for Alaska's opportunities, and drive benefit to Alaskans.**

Absent a significant, proactive focus on these opportunities, Alaska stands to be passed by during the most significant realignment of global capital priorities in generations. Climate change is a **humanitarian and ecological crisis**. Science has built a framework for understanding it and identifying possible solutions. **Action will occur where capital and governmental funding flows.**

Alaska's policymakers, business community, and university system, among other key actors, have clear roles to play in a path toward climate leadership. These roles include:

- Building **awareness and visibility of economic opportunities** in Alaska related to climate change.
- Establishing a **shared vision of opportunity and a strategic orientation** toward climate-driven economic opportunities.
- Developing **the next generation of climate leaders**, including those who will work at the intersection of capital markets and climate.
- **Identifying and removing regulatory barriers** that prevent Alaska from realizing its maximum potential as a major GHG natural resource base.
- Accelerating the climate economy by **attracting new businesses and investors** hungry for climate-responsive innovation.

These recommendations are informed by key informant interviews and a literature review – both of which are further elaborated in the report that follows. Other jurisdictions – nations, states, and economic blocs – are already building new economic power around the climate change imperative. Alaska can position itself to be part of this transition.



# Capital + Climate: Considerations for the 49<sup>th</sup> State

## Background

Climate change impacts, on people and natural and built environments, are becoming a major driver of policy, private investment, capital flow, entrepreneurial activity, and research and development. Participation in economic and business initiatives that are part of this response presents opportunities for Alaska's people and regional economies, while also contributing to the global imperative for robust and rapid climate action.

Alaska's varied landscapes and freshwater and marine regions support rich ecosystems, and land management choices have the potential to contribute significantly to climate stabilization and emissions reductions. Ecosystems in the state also presently support functioning natural carbon and greenhouse gas (GHG) capture mechanisms. Additionally, natural resource industries such as oil and gas and mineral extraction are active in the state, offering possibilities to consider climate in their operations. Combined, such climate change mitigation opportunities in Alaska are at a scale that warrants attention from Alaska-based and outside business and policy makers.

The purpose of this paper is to identify climate-related opportunities for leadership and economic opportunity in Alaska. Alaska Venture Fund contracted with McKinley Research Group (formerly McDowell Group) to examine whether Alaska might realize financial benefits from use of its existing, relatively intact GHG-rich natural systems for climate stabilization. We gave particular attention to the possible development of financial tools that could help incentivize land management choices for climate-stabilizing management of irrecoverable carbon in the state. The work also explored the intersection of global capital and climate change more broadly, including mechanisms by which mobilization of financial resources to address climate change might present economic opportunity for Alaska.

Research for this report included a broad literature review and interviews with key informants from a variety of public and private sectors and non-governmental organizations (NGOs), including representatives from finance, conservation finance, green technology startups, private equity, and investment.

## Current Context

The 2015 Paris Climate Agreement aims to limit global warming to well below to 2° C, preferably 1.5° C.<sup>1</sup> To reach that goal, the world is faced with a multi-faceted challenge that includes reductions in carbon emissions, retention of existing carbon stores within current ecosystems, use of “natural climate solutions” (restoration, conservation, or management of lands and waters to maximize carbon uptake), and technological removal and long-term sequestration of carbon currently in the earth’s atmosphere or at the point of emission (carbon capture and storage or CCS). This variety of needs is driving a proliferation of businesses, policy tools, novel partnerships, and new technologies.

Part of this effort includes reducing greenhouse gas emissions in the United States by half by 2030 (compared to a 2005 baseline) and reaching net-zero by 2050.<sup>2</sup> The United Nations Framework Convention on Climate Change (UNFCCC) is a significant driving force behind this effort. This framework has already begun to transform the global economy, driving new markets for projects that reduce greenhouse gas emissions or remove carbon from the atmosphere, while incentivizing research into new technologies. Changes to global spending patterns are also forecast to accelerate as climate goals established by the Paris Agreement approach.

## Climate Stabilization and Finance

Financial patterns are changing globally as people seek to respond to climate change. As noted by the IPCC, “Limiting warming to 1.5°C requires a marked shift in investment patterns,”<sup>3</sup> and these changes are already occurring:

- Spending in world regulatory carbon markets was estimated at \$277 billion in 2020, most of it through the European Union Emissions Trading Scheme.<sup>4</sup> Though smaller than government mandated markets, voluntary carbon markets are expected to grow rapidly, with a 15-fold increase by 2030 as corporations continue to make commitments to reduce emissions.<sup>5</sup> Spending on the global renewable energy transition, alone, was estimated at \$500 billion in 2020.<sup>6</sup>

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<sup>1</sup> United Nations Framework Convention on Climate Change. [“What is the Paris Agreement?” webpage](#). Accessed July 2021.

<sup>2</sup> White House Briefing Room, 2021. [“FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies.”](#)

<sup>3</sup> IPCC, 2018. [“Special Report: Global Warming of 1.5°C.”](#)

<sup>4</sup> Refinitiv, 2021. [“Carbon Market Year in Review 2020.”](#)

<sup>5</sup> Taskforce on Scaling Voluntary Carbon Markets, 2021. [“Final Report.”](#)

<sup>6</sup> [“Spending on Global Energy Transition Hits Record \\$500 Billion,”](#) 2021. Bloomberg Law.



- Annual climate finance flows (focused on projects that assist in mitigation or adaptation to climate change or with linked GHG benefits) are estimated to exceed \$570 billion, of which about \$37 billion is government grants and loans.<sup>7</sup>
- Further evidence exists in changes in venture capital deal flow,<sup>8</sup> where deal flow to climate tech as of the end of June 2021 (just over \$14 billion) was already at 88% of total deal flow for 2020, and 80% of the all-time high of \$17.9 billion.
- The issuance of green bonds has grown to over \$1 trillion.<sup>9</sup> Corporations from Pepsi to Amazon are issuing green or sustainability focused bonds. Some, like Amazon, are pairing that with a commitment to the goals of the Paris climate agreement.
- Corporate sustainability commitments are proliferating, with new commitments rolled out regularly.<sup>10</sup> It is notable that corporate commitments do not necessarily have identified mechanisms for spending in place.

## What Kind of Investors are Moving Toward Climate?

- Individual and institutional investors in private companies and in equity and bond markets
- Venture capitalists
- Corporations
- Philanthropies and impact investors
- National governments, economic blocs, state, and local governments
- Inter-governmental agencies
- Sovereign wealth funds

<sup>7</sup> Climate Policy Initiative, 2020. "Updated View on the Global Landscape of Climate Finance 2019."

<sup>8</sup> Pitchbook, 2021. "[Why Investors Are Raising Climate Tech Funds at a Torrid Pace.](#)"

<sup>9</sup> Nasdaq, July 2, 2021. "[Green Bonds on the Rise.](#)"

<sup>10</sup> Greenbiz, January 8, 2021. "[Companies made climate commitments – now it's time to stop making climate chaos.](#)"

## A New Economic Frame for Alaska

With oil production tapering off in Alaska, so is the source of nearly two generations of wealth in the state. As this driver of the Alaska economy wanes, global climate responses may play an increasingly important role in the state's economic future.

As in the past, Alaska's future economy will likely depend on the state's natural resources. Now, in addition to extraction, some value may come from the global significance of the state's natural resources as storehouses of greenhouse gases as well as natural biodiversity. It may also hinge on the ability of actors in the state – from policymakers to businesses – to pivot to the opportunities presented by decarbonization.

The pace at which Alaska reorients to respond to climate change opportunities will impact the ability of Alaska interests to assume a leadership role and gain advantage in attracting investment relative to other jurisdictions. Creation of a shared understanding and language around global climate investment flows and Alaska's relevant assets is one key initial step that will help business and policy leaders in the state lean into these new opportunities.

### A Foundation of Natural Resources

Alaska has more than 1.5 million km<sup>2</sup> in landmass – more than 17% of the total area of the United States – of which around 1.3 million km<sup>2</sup> is in state or federal ownership and another 178,000 km<sup>2</sup> is held by Alaska Native corporations. Terrestrial ecosystems across that range include temperate rainforests, boreal forests, and arctic and subarctic tundra.

The economic value of temperate rainforests for their GHG has already been demonstrated: large landowners (both village and regional Native corporations) have produced revenue by establishing carbon programs built largely upon preserving timber resources.

Despite receiving less attention, much more of Alaska's landmass and stored carbon is in boreal biomes, which include forests as well as peatlands.

Alaska's boreal biomes extend from the Coast Range to the Brooks Range.<sup>11</sup> Globally, boreal forests biomes are second only to tropical and subtropical forests in terms of sequestered carbon. One reason for their significance is that more carbon has been found to be stored in peat than in trees within some boreal forests. Nonetheless, the importance of the boreal region to global carbon efforts, and of peat in particular, remains underappreciated in many climate mitigation schemes.<sup>12</sup>

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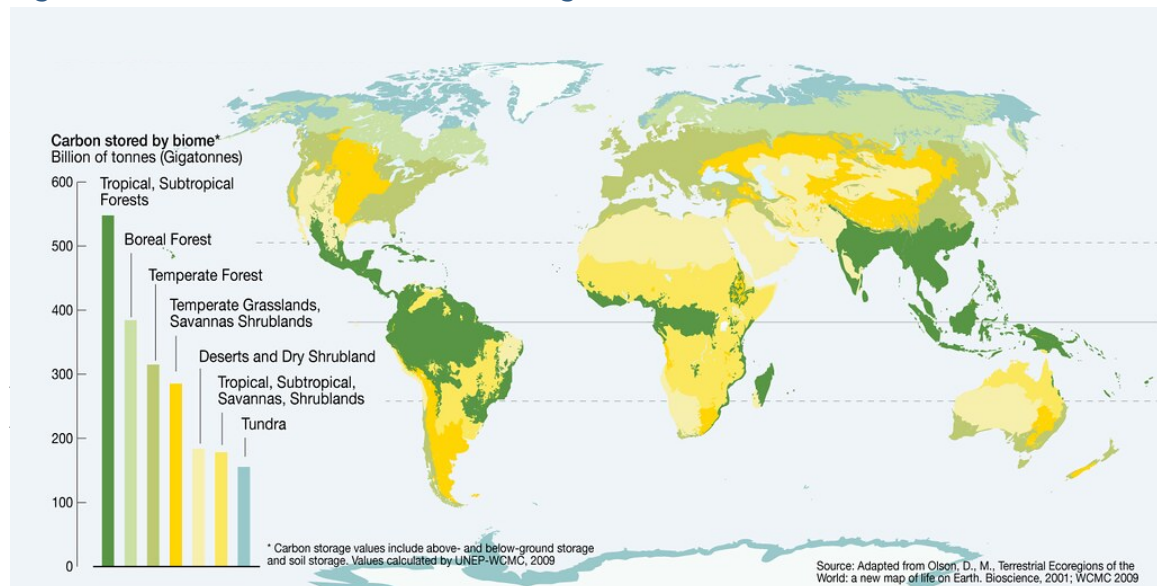
<sup>11</sup> Alaska Department of Fish and Game. "[Where is the Boreal Forest?](#)" Retrieved July 2021.

<sup>12</sup> Nature Communications, 2018. "[The underappreciated potential of peatlands in global climate change mitigation strategies.](#)"

Arctic peatlands represent the largest carbon storehouse in the state and are a major global carbon sink despite covering less than 3% of the earth's surface.<sup>13</sup> Arctic peatlands also store carbon for particularly long periods of time, though a continued scientific debate about how a warming climate is releasing long-buried carbon in frozen peat soils is a major source of uncertainty in global climate change projections.<sup>14</sup>

In addition to its lands, Alaska's natural resources include the state's more-than 46,000 miles of tidal shoreline, nearly half that of the entire United States. Globally more than half the biological carbon captured on earth is from marine organisms.<sup>15</sup>

**Figure 1. World Biomes and Carbon Storage**



alkaline rocks (that pull carbon dioxide from the air and water through a chemical reaction).

Seven of the main categories of NET are<sup>17</sup>:

1. Afforestation and reforestation.
2. Land management to increase and fix carbon in soils.
3. Carbon Capture and Storage (a requirement for the next two technologies)
4. Bioenergy production with carbon capture and storage (BECCS).
5. Direct capture of CO<sub>2</sub> from ambient air with CO<sub>2</sub> storage (DACCS).

<sup>13</sup> Nature Communications, 2018. "[The underappreciated potential of peatlands in global climate change mitigation strategies.](#)"

<sup>14</sup> IPCC, 2018. "[Global Warming of 1.5°C: An IPCC Special Report.](#)"

<sup>15</sup> United Nations Environment Programme, 2009. "[Blue Carbon: The Role of Healthy Oceans in Binding Carbon, a Rapid Response Assessment.](#)"

<sup>16</sup> European Academies Science Advisory Council, 2018. "[Negative Emission Technologies: What Role in Meeting Paris Agreement Targets?](#)"

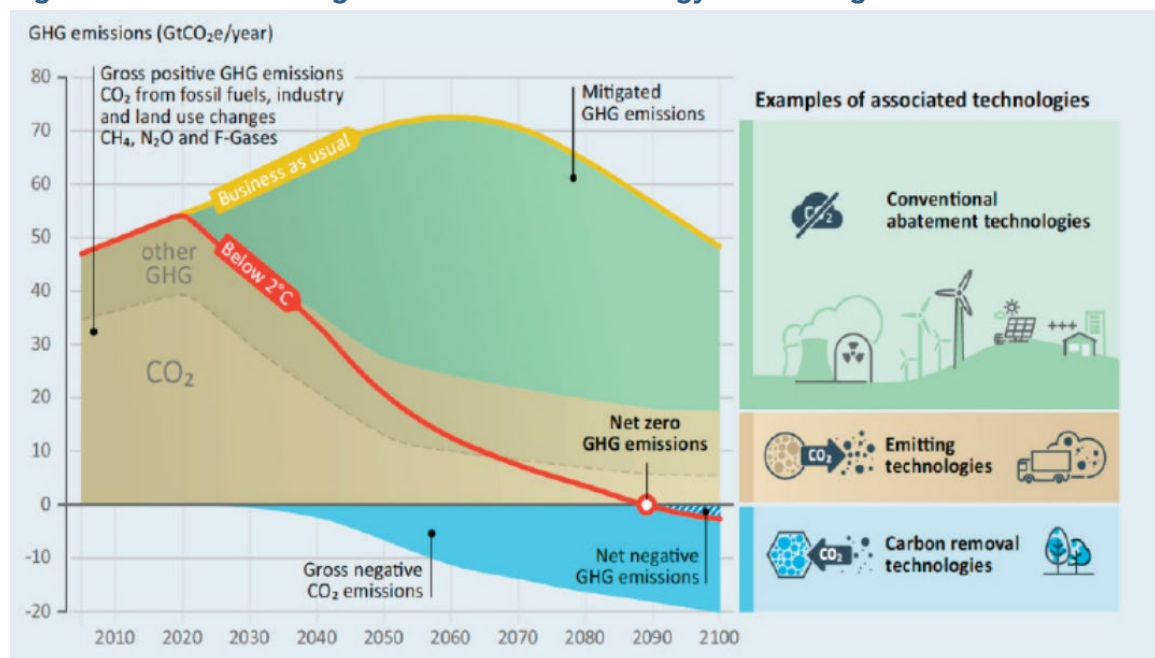
<sup>17</sup> *Ibid*, 2018.

6. Enhanced weathering (carbon mineralization of CO<sub>2</sub>).
7. Ocean fertilization to increase marine life and fix more carbon in oceans.<sup>18</sup>

Among the many possible NET opportunities, those that are directly relevant to Alaska because of its natural landscapes include afforestation, land management, and carbon capture and storage. Opportunities may, in fact, exist across all categories.

As seen in Figure 2, negative emission technologies (in blue), are critical for achieving net zero emissions without completely reducing emissions (in brown). Note: this graphic shows a carbon budget for keeping global warming below 2°C, a less-ambitious target than the 1.5°C Paris Agreement goal.

**Figure 2. The Role of Negative Emissions Technology in Reaching Net Zero**



Source: National Academies of Sciences, Engineering, and Medicine 2019. Negative Emissions Technologies and Reliable Sequestration: A Research Agenda

<sup>18</sup> The European Academies' report observed that carbon capture technology is years behind where it was expected to be a few years ago. Although attention in these technologies has increased in the years since the report's publication, the paper identifies insufficient government and industry support as the main reason for this lag in technology development. Meanwhile the report concluded that, while reforestation and land management are potential sources of negative emissions, current forest and soil policies are presently adding to total greenhouse gas emissions rather reducing emissions.

# Alaska Resources and Opportunities

Alaska opportunities within the global climate change response run a spectrum from local-and-practical to global-in-scale. One interviewee summed them up as “wide open spaces, moon shot ideas, and premium carbon credits.” Alaska opportunities are summarized in the following key areas:

- **A test and deployment space for climate-responsive technology**, including negative emissions technologies, building on the unique characteristics of the state’s energy generation systems, natural resource base, and potential policy incentives.
- **Support for natural climate solutions** (NCS), which increase greenhouse gas sequestration or avoid their release through land management, land restoration, and conservation. This opportunity **extends to employment and business activities** in science and monitoring that would be needed to support NCS.
- **Staking out a leadership role in the “financialization” of natural greenhouse gas sinks** (irrecoverable carbon), such as forests (both temperate rainforest and boreal) and peatlands.
- **Local-scale climate infrastructure investments** and land management strategies, leveraging investment tools (such as green or environmental impact bonds) or overall reorientation of the financial sector toward ESG).
- **Policy leadership** that drives federal programmatic support and directed funding to the place-based solutions, including those in Alaska, that will be necessary to mitigate climate change.

Additional opportunities may exist in Alaska’s existing natural resource development industries, including the extraction of **rare earth minerals and other industrial inputs** required for the carbon transition, and the deployment of **carbon capture and storage** in the existing oil and gas industry.

## Test and Deployment of Emerging Technologies and Services

As noted earlier, significant capital is being deployed to climate technologies, as well as to technologies (such as renewable energy or energy efficiency) that have positive implications for the climate. Opportunities linked to climate response include not only the technologies that could directly reduce carbon emissions or sequester carbon or other GHG, but also the supporting technology, such as monitoring software, microgrid control software, and operations

and maintenance systems.<sup>19</sup> Alaska offers a research and development (R&D) space for these technologies, as well as a potential space for their scaled deployment. As one interviewee noted, Alaska presents many of the same challenges present in some developing nations – with more than 250 islanded and diesel-dependent energy grids, rural sanitation challenges, and front-line climate impacts – with a “first world wrapper” that includes U.S. currency and U.S. rule of law.<sup>20</sup> This combination makes it an ideal test space for many companies.

Opportunities that are currently being tested in the Alaska space include electrified aviation, hydrogen production (using existing Alaska resources such as geothermal, wind, or natural gas), and numerous renewable electrical generation and microgrid management technologies.<sup>21</sup>

## Natural Climate Solutions, including Blue Carbon

Natural Climate Solutions (NCS), described as “conservation, restoration and improved land management actions that increase carbon storage or avoid greenhouse gas emissions” in oceans, landscapes, and wetlands, is an opportunity for proactive management of natural resources to enhance or preserve climate mitigating functions.<sup>22</sup> Opportunities for NCS in Alaska include forest and peatland management as well as mariculture and other blue economy contributors.

- **Management of standing forests and areas that have been harvested for timber to maximize their function in carbon sequestration.** To date, three regional Alaska Native Corporations and four village corporations have registered forestry carbon credit projects through the State of California’s cap and trade system.<sup>23</sup> With significant increases in demand for carbon credits forecast, these opportunities present potential value to Alaska landowners. As extreme temperature shifts in some regions of the globe increase, along with the risk of forest fires, temperate and coastal Alaska may be able to position itself as a domain for “premier” carbon offsets that are less likely to burn.
- **Development of a blue carbon economy, building on opportunities in seaweed and kelp mariculture.** Seaweed presents a variety of climate mitigation possibilities. In particular, seaweed farming may be able to mitigate as much as 3,800 tons of carbon

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<sup>19</sup> Personal interview, July 2021.

<sup>20</sup> Personal interview, July 2021.

<sup>21</sup> Several interviewees noted that Alaska has had, through the long presence of the oil industry, significant human capital and technological and business sophistication around resource development and associated fields (pipeline construction and maintenance, well operations, remote field construction, advanced logistics, and more). This hypothetically represents a talent field and workforce that could be mobilized to some of the technological challenges in the climate response, and people who could be engaged in startup companies. By the same token, though, much of that talent is here *because* of oil and in service to current oil operators. Whether this workforce is available to other kinds of projects and employers, as well as how to engage with the oil companies on long plays around climate, particularly where carbon capture and storage is concerned, will be important questions for the future.

<sup>22</sup> TNC. “[Natural Climate Solutions](#).” Accessed July 2021.

<sup>23</sup> California Air Resources Board. “[ARB Offset Credit Issuance Table](#).” Accessed July 2021.

dioxide per square mile per year if economically feasible technology can be developed to convert the seaweed into biofuel.<sup>24</sup> Business startups, NGOs, and governmental entities are currently either investigating or implementing kelp and seaweed projects that address climate change in myriad ways, ranging from replacement of proteins currently derived from GHG-intensive meat production, to replacing bioplastics currently produced using petroleum, to capturing and sequestering carbon in ocean environments. With more than 46,000 miles of tidal shoreline<sup>25,26</sup> Alaska coastal marine areas are prime for climate-related investments in seaweed and kelp. One study estimated that seaweed mariculture in less than 4% of offshore waters of California, Washington, and Oregon could offset the carbon emissions from California's entire agricultural industry.

We have identified and communicated with numerous businesses already investigating carbon-linked seaweed and kelp investments in Alaska. Business models include bioplastics and protein replacement, as well as carbon sequestration and offsets. In addition, the U.S. Department of Energy ARPA-E program is investigating the effects of kelp on carbon dioxide in marine waters, a potential strategy for localized reduction of CO<sub>2</sub> to minimize ocean acidification.

## "Financialization" of Carbon and Other GHG Resources

Alaska's vast reserves of intact, functioning natural systems are an asset, overall, in global efforts toward climate change mitigation. Natural systems in the state are part of the background systems making critical contributions to overall carbon and GHG sequestration in global natural climate systems. However, it is presently difficult to place an economic value on their functions. As described in one paper, the "forgotten assumption" is that "both the ocean and terrestrial [GHG] sinks will continue to absorb a combined 50% of annual emissions," as part of the pathway to Net Zero by 2050.<sup>27</sup> The carbon and other greenhouse gases already sequestered through natural cycles in Alaska's forests, peatlands, and oceans are part of the background functioning of the world's natural cycles, and are a critical component of the total pathway toward addressing GHG and keeping global warming at target levels.

Included in the assumptions about these background functions is the role of "irrecoverable carbon." Irrecoverable carbon is carbon present in intact ecosystems, the loss of which (through

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<sup>24</sup> Duarte, Carlos et al, 2017. "[Can Seaweed Farming Play a Role in Climate Change Mitigation and Adaptation?](#)" *Frontiers in Marine Science*.

<sup>25</sup> National Oceanographic and Atmospheric Administration, Office of Response and Restoration. "[Alaska ShoreZone: Mapping Over 46,000 Miles of Coastal Habitat](#)." Accessed July 2021.

<sup>26</sup> Alaska Department of Fish and Game. "[Federal Partners webpage](#)." Accessed July 2021.

<sup>27</sup> International Emissions Trading Association and Wildlife Conservation Society Canada, 2020. "[Carbon Markets and Finance to Protect Canada's Land Carbon Sink: Concept Paper & Options for Discussion](#)."



land conversion) “will not be recoverable on timescales required for avoiding dangerous climate impacts.”<sup>28</sup> In Alaska, irrecoverable carbon exists in ecosystems such as rainforests, boreal forests, and boreal peatlands. While conservation of carbon sinks such as temperate/northern peatlands are likely essential for achieving net zero goals on the 2050 timeline,<sup>29</sup> absence of immediate threat of conversion makes it difficult for funders and conservation finance deal developers to prioritize carbon/GHG projects under current schemes.

Presently, the focus of conservation finance or climate finance efforts is on projects that either a) respond to a threatened land conversion or provide “additionality” over current land uses, or b) yield a revenue stream through changes in land use, such as improved agriculture practices, or land restoration and added ecotourism. Designing and implementing climate finance, biodiversity finance, or other alternative financing deals is labor and time intensive, and typically come together at scales of millions or tens of millions of dollars.<sup>30,31</sup> The level of effort and focus needed prejudices interest away from projects that incorporate intact – and vital – landscapes.<sup>32</sup>

Currently, mature opportunities to “financialize” irrecoverable carbon in Alaska – that is, to identify or create financial mechanisms that generate revenue streams linked to conservation of irrecoverable carbon resources – are absent.<sup>33</sup> Our research revealed that financial innovations are not yet in place to address irrecoverable carbon in Alaska, and particularly not in vast landscapes where there is no immediate threat or no degradation that could be remedied through a change in land management.<sup>34</sup>

Despite the absence of near-term tools, interviews suggested that assessing and attaching a value to Alaska’s carbon and other GHG resources will be necessary over time in order to continue to participate in the global economy. As one interviewee with a long history in finance, venture capital, and business investing noted, “we will need to place a [value] on carbon just to remain internationally competitive.” That the additional cost of carbon on Alaska’s industries could be a competitive advantage may at first seem counterintuitive. However, the business

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<sup>28</sup> International Emissions Trading Association and Wildlife Conservation Society Canada, 2020. “Carbon Markets and Finance to Protect Canada’s Land Carbon Sink: Concept Paper & Options for Discussion.”

<sup>29</sup> *Ibid*; personal interview, July 2021.

<sup>30</sup> Personal interview, June 2021.

<sup>31</sup> “How Much Is a Tree Worth? Investors Seek to Build a Market for Nature,” 2021. *Financial Times*

<sup>32</sup> Specific to northern peatlands, one interviewee who specializes in climate finance noted a concern that the perception that the risk of methane emissions with rising temperatures could cancel out possible benefits of conserving them from a carbon standpoint. While this is not an argument against the value of the carbon in peatlands, *per se*, it does highlight the challenge of attracting interest to one group of assets (boreal forests and peatlands) over others that may be perceived as less risky.

<sup>33</sup> There are some political actors in the state who are looking into carbon opportunities across Alaska lands, particularly those in Alaska Native Corporation (ANC) holdings or on Bureau of Land Management (BLM) lands. These may hold promise, over time, for irrecoverable carbon.

<sup>34</sup> One possible exception to this conclusion is the relatively recent development of the “environmental impact bond” – a performance-based bonding mechanism that can incorporate the contributions of natural capital such as forests or waterways into the financing of infrastructure projects. With costs of capital and other financial incentives potentially tied to a set of predicted (and subsequently measured) outcomes, projects can be designed in ways that maximize the contribution of natural systems to environmental goals.

imperatives and, in some jurisdictions, governmental mandates toward tracking environmental, social and governance (ESG) impacts will drive financial resources toward projects and investment environments that have created structures to measure these impacts.

In July 2021, the European Commission adopted a package of measures “intended to help improve the flow of money towards financing the transition to a sustainable economy.”<sup>35</sup> The “EU taxonomy” describes a set of reporting requirements that will affect financial and other EU businesses, with a focus on environmental impacts of business activities, including lending by financial institutions. The adoption of the EU taxonomy is another major lever and signal in the reorientation of business and finance toward climate- and biodiversity-responsive business practices. As the same interviewee noted, Alaska can work toward “professionalizing and financializing all of its [natural capital] assets” in order to participate domestic and international economies. This includes the assets that will be extracted and used, as well as those that may be conserved.

## ESG Trends in Capital Markets, Governmental Resources for Local Projects

As the paradigm shift in investor priorities continues to move toward ESG investing, opportunities for favorable financing for local-scale projects in Alaska may continue to develop. The green bond market has grown to a total of \$1 trillion and is anticipated to continue to grow rapidly. Municipalities and corporate actors can anticipate a marketplace that is hungry for projects that have climate, biodiversity, and other impacts, whether through green bond offerings or more complex environmental impact bond projects. Similarly, companies and startups working in climate and related spaces can anticipate investor interest in these areas to increase. Alaska’s ability to effectively access these resources, however, is not a given. Actors at many levels, including municipalities, utilities, financial intermediaries, and in policymaking bodies will need to increase awareness and understanding of these opportunities and trends.

A rapid reorientation of federal spending priorities is also underway. Some available funds or soon-to-be available funds are likely generational in scope and availability. Targeted support for Alaska communities seeking to attract federal dollars, to use as a building block or an anchor for climate adaptation or mitigation will be invaluable at this time.

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<sup>35</sup> Travers Smith LLP, 2021. [“The EU’s new sustainable finance strategy.”](#)

## Additional Opportunities in Established Resource Development Industries

### RARE EARTH AND OTHER METALS NECESSARY FOR CLIMATE TRANSITION

Over 3 billion tons of minerals and metals will be needed to deploy wind, solar, geothermal, and energy storage technologies required for achieving a below 2°C global warming future, increasing demand for materials such as graphite, lithium, and cobalt by nearly 500% by 2050.<sup>36</sup> However, even though clean energy technologies will require more minerals, the carbon footprint of their production – from extraction to end use – will account for only 6% of the greenhouse gas emissions generated by fossil fuel technologies, according to a recent World Bank Group report. Further, even if recycling rates are scaled up for minerals like copper and aluminum by 100%, recycling and reuse would still not be enough to meet the demand for renewable energy technologies and energy storage.<sup>37</sup>

The International Energy Agency offers similar growth trajectories for supplies of critical minerals essential to support key clean energy technologies.<sup>38</sup> In climate-driven scenarios, mineral demand for use in batteries for electric vehicles and grid storage is a major force, growing by at least 30 times by 2040. The rise of low-carbon power generation to meet climate goals also means a tripling of mineral demand from this sector by 2040. Wind takes the lead, bolstered by material-intensive offshore wind. Solar PV follows closely, with the sheer volume of capacity being added. The expansion of electricity networks also requires a huge amount of copper and aluminum.<sup>39</sup>

Production and processing of many minerals such as lithium, cobalt, and some rare earth elements are highly concentrated in a handful of countries, with the top three producers accounting for more than 75% of supplies.

Alaska's known mineral endowment includes some of the largest and highest-grade deposits of various metals, including gold, copper, and zinc.<sup>40</sup> Alaska has also been active in the worldwide search for sources of rare earth elements to replace exports now being limited by China. There are more than 70 known occurrences of rare-earth elements throughout Alaska.<sup>41,42</sup>

Development of rare earth minerals in the Alaska landscape will result in releases of irrecoverable carbon currently stored in intact ecosystems. Efforts to advance rare earth mining

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<sup>36</sup> World Bank Group, 2020. "[Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition.](#)"

<sup>37</sup> *Ibid.*

<sup>38</sup> International Energy Agency, 2021. "[The Role of Critical Minerals in Clean Energy Transitions.](#)"

<sup>39</sup> *Ibid.*

<sup>40</sup> Barker, James et al., 2012. "[Alaska's Rare Earth Deposit and Resource Potential.](#)" *Mining Engineering.*

<sup>41</sup> Alaska Department of Natural Resources. "[Fact Sheet: Alaska Strategic Minerals/Rare Earth Elements.](#)"

<sup>42</sup> Alaska Department of Natural Resources. "[Rare-Earth Elements: A Brief Overview Including Uses, Worldwide Resources, and Known Occurrences in Alaska.](#)"

will require careful accounting of the potential impact on GHG. Alaska could distinguish itself globally through establishment of a robust framework and world-class standard for responsible mining of critical minerals that incorporates impacts of proposed mines on existing GHG sinks.

## **CARBON CAPTURE AND SEQUESTRATION IN ALASKA OIL AND GAS PRODUCTION**

Perhaps counterintuitively, some opportunities for reducing emissions can be found in Alaska's oil and gas industry, and not only through reduced production.

The carbon capture and sequestration technology of removing and securely storing carbon dioxide from the atmosphere is most efficient when done at the source of the pollution. Lacking much heavy industry, Alaska has limited applications for this technology. However, globally the oil and gas industry to date has been one of the main applications for carbon capture technology. A global inventory of 17 large-scale operational CCS projects in early 2017 found that 13 (10 of them in North America) used the captured carbon for enhanced oil recovery.<sup>43</sup> Carbon dioxide for enhanced oil recovery, the so-called "huff-n-puff" method, uses captured carbon to pressurize wells and recover more oil.<sup>44</sup>

It should be noted that when used to extract additional fossil fuels from the ground, CCS technology is more accurately described as "carbon storage and utilization" and can no longer be considered a negative emission technology because it produces a fuel that will produce new greenhouse gases. However, if massively scaled-up CCS is needed to meet carbon budget goals, current applications that help the technology advance may be part of the solution. Oil and gas fields have also been proposed as good geological formations for the long-term storage of carbon captured by CCS.

A final opportunity in Alaska's oil and gas industry is to further reduce the carbon intensity of oil, the amount of greenhouse gas emissions needed to produce each barrel.

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<sup>43</sup> European Academies Science Advisory Council, 2018. "[Negative Emission Technologies: What Role in Meeting Paris Agreement Targets?](#)"

<sup>44</sup> Dogah, Banabas, et al., 2021. "[Enhanced Oil Recovery Using CO2 in Alaska.](#)" *Geosciences*.

# Next Steps for Alaska Leaders

This research identifies trends at the intersection of global finance and the response to climate change. There is tremendous potential for Alaska to play a meaningful role in the global climate response. Key insights and opportunities for the state are identified, along with next steps to advance Alaska participation in and potential economic benefit from the global reorientation to address climate change.

- It is important to **build awareness and visibility of economic opportunities in Alaska related to climate change**. Alaskans will be able to engage more meaningfully and think more creatively in policy and business with a **common vernacular** that includes both **implications of climate change** and **opportunities it may present**. Ideas may be as simple as a communications strategy that highlights key concepts (such as the importance of boreal biomes) or relevant projects (including carbon offset deals, blue carbon opportunities, or other strategies). **Increased climate literacy**, specific to Alaska's resources, will help the business community, municipal leaders, and others orient toward opportunities.
- Alaska's institutions must reorient around climate opportunities. The University of Alaska system has a key role to play in framing the conversation around climate change and **building the next generation of leaders** in the climate response, including those who can lead **at the intersection of capital markets and climate**. Similarly, the State of Alaska must elevate climate opportunity as well as climate response. **The state has a key role as convener and can frame conversations around economic potential**, while also aligning programs and personnel to position Alaska for a leadership role.
- A **thorough assessment of regulatory barriers** or structures that hamper Alaska efforts to mobilize a response to climate change and monetize natural resources in the climate response is needed. Examples of barriers and related agencies are likely myriad and scattered across a variety of jurisdictions. Such an assessment may also **highlight new regulatory structures** to hasten the climate response.<sup>45</sup>
- The time may be ripe for business and policy influencers to come together in Alaska and **identify the most impactful ways to accelerate the climate economy** in the state. To be most effective, this effort should target businesses and people with the ability to **bring meaningful capital and policy pressure** to bear on the state. While broader

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<sup>45</sup> Examples could include exclusion of carbon from the natural resources for which the U.S. Bureau of Land Management can manage lands; regulatory restrictions on strain selection in Alaska seaweed mariculture that will restrict investors' ability to maximize carbon uptake in blue carbon schemes; and the potential beneficial contribution of a renewable portfolio standard (RPS) in speeding renewable projects to market.

convenings may help with climate literacy, the timeline for action and complex nature of solutions and opportunities demands participation of high-level actors.

- **National and international experts** may be consulted to bring them and their knowledge to Alaska. Each interview for this project yielded new leads and insights. The ability of the state's businesses, NGOs, and policymakers to rise into the economic opportunities presented by climate change will require **new and purposeful relationships**.

## Appendix A: Key Insights from Literature Review and Interviews

Capital is moving to meet the challenge of climate change. With a growing understanding of and orientation toward the imperative of climate response, businesses and capital are orienting towards solutions, and the financial sector is seeking to build new tools and approaches to match demand. As one informant noted, “Financial markets are realizing this play of investing in climate is going to render some profound returns. The greed is harnessed and pulling in the direction of the mission.” Interviews and the literature review revealed the following key insights.

- **Changes in financial patterns will happen at huge scales.** As noted by the IPCC, “Limiting warming to 1.5°C requires a marked shift in investment patterns.”<sup>46</sup> Global spending on climate stabilization comes in many forms, including money spent in carbon credits markets (both regulated and voluntary), money spent on climate change research and projects by governments, corporations, and charitable organizations, and spending and investments in a whole host of climate response approaches (from technology development to the transition to green energy to research and development). Spending on the global renewable energy transition, alone, was estimated at \$500 billion in 2020.<sup>47</sup>
- **Green bonds and environmental impact bonds are financing projects that wrap in natural capital as well as brick and mortar infrastructure.** These debt tools support or directly incentivize activities or target outcomes, creating new ways to bring ecosystem services and risk mitigation into on-the-ground investments such as utility operations or infrastructure development.<sup>48</sup> Environmental impact bonds, in particular, are creating new, blended approaches that make room for natural assets to contribute to the success of infrastructure investments, and to align financial incentives with those outcomes.<sup>49</sup>
- **The financial innovations and novel instruments that will align capital with climate goals are proliferating, though the scale remains modest.** Financial institutions and

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<sup>46</sup> IPCC, 2018. “[Special Report: Global Warming of 1.5°C.](#)”

<sup>47</sup> Bloomberg Law, 2021. “[Spending on Global Energy Transition Hits Record \\$500 Billion.](#)”

<sup>48</sup> World Resources Institute, March 2021. “[Why Investors Bought the First Certified Green Bond to Protect Forests for Drinking Water.](#)”

<sup>49</sup> Center for American Progress, March 2021. “[A Framework for Strengthening Municipal Market Green Bond Labeling](#)”



their partners are moving to create financial tools that will help move capital to climate-related investments and projects.<sup>50</sup> However, real challenges around scale and pace of the creation of these tools remain.

- **The oceans and “blue carbon” are increasingly understood to play a potentially powerful role in reducing GHG.** More than half of biological carbon in the world is captured by marine organisms<sup>51</sup>, though conservation finance flows have historically gone mostly to terrestrial ecosystems. Most existing blue carbon efforts are focused on mangroves, seagrass meadows, and tidal marshes.<sup>52</sup>
- **Negative Emissions Technologies (NET, or carbon capture and storage) are gaining significant traction and attracting public and private sector investment.** Driven by imperatives for carbon, efforts to develop carbon capture and sequestration technologies are booming. Venture capital is increasingly seeking climate-focused investments, with more than \$16 billion in venture capital deals in climate tech in 2020 (up from less than \$2 billion at the start of the decade) and more than \$14 billion as of midyear 2021.<sup>53</sup>
- **The market for carbon offsets will continue to grow.** Spending in world regulatory carbon markets was estimated at \$277 billion in 2020, most of it through the European Union Emissions Trading Scheme.<sup>54</sup> Voluntary carbon markets are much smaller than government mandated markets. However, they are expected to grow rapidly as corporations continue to make voluntary commitments to reduce emissions, with a 15-fold increase by 2030.<sup>55</sup>
- **“Climate finance” represents a major international commitment,** but most of that funding will move to developing countries. National governments have pledged \$10.2 billion total since 2010 to the Green Climate Fund, the United Nations’ signature climate fund dedicated to both climate change mitigation and adaptation in the developing world. Multilateral development banks (such as the World Bank and the Inter-American Development Bank) are also major climate finance participants, spending \$66 billion in 2020.<sup>56</sup> Total annual climate finance flows are estimated to exceed \$570 billion (an

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<sup>50</sup> See [HSBC/Pollination Climate Asset Management](#) as one example of two firms’ efforts to create tools that connect capital with nature-based solutions, with investment themes that include blue carbon, biodiversity protection and restoration, and carbon credits.

<sup>51</sup> United Nations Environment Programme, 2009. [“Blue Carbon: The Role of Healthy Oceans in Binding Carbon, a Rapid Response Assessment.”](#)

<sup>52</sup> *Ibid.*

<sup>53</sup> Pitchbook, 2021. [“Why Investors Are Raising Climate Tech Funds at a Torrid Pace.”](#)

<sup>54</sup> Refinitiv, 2021. [“Carbon Market Year in Review 2020.”](#)

<sup>55</sup> Taskforce on Scaling Voluntary Carbon Markets, 2021. [“Final Report.”](#)

<sup>56</sup> [“Development Bank Climate Finance Spending Hit \\$66 Bln in 2020 – Report,”](#) 2021. Reuters.

average of the years 2017 and 2018) as of the most recent estimate of which about \$37 billion is government grants and loans.<sup>57</sup>

- **Corporate financial commitments to respond to climate and other environmental challenges are beginning, but radical increase in scale is needed.** The UNEP estimates that a total investment of \$8.1 trillion in nature-based solutions alone (such as peatland and mangrove restoration and forest-based solutions) is needed by 2050 “if the world is to meet its climate change, biodiversity, and land degradation targets.”<sup>58</sup> This would require an investment of more than \$530 billion per year. By contrast, private investment in these solutions is still modest, currently accounting for only 14% of investments in nature-based solutions. Unilever’s commitment of €1 billion for use over 10 years represents a significant investment by a private company.<sup>59</sup>
- **By all reports, the drumbeat around ESG investing, climate finance, climate-related investment opportunities, and related trends is getting louder and louder.** Interviewees and literature suggest a “paradigm shift” in the scale and interest in ESG or impact orientations for capital. How effectively that paradigm shift can scale and whether the results will be meaningful on the timeline of the climate challenge has yet to be determined, with international investors and activists pointing to the risk of “window-dressing”<sup>60</sup> and “greenwashing”<sup>61</sup> at current levels of real effort and commitment.

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<sup>57</sup> Climate Policy Initiative, 2020. [“Updated View on the Global Landscape of Climate Finance 2019.”](#)

<sup>58</sup> United Nations Environment Programme, 2021. [“State of Finance for Nature.”](#)

<sup>59</sup> World Economic Forum, 2021. [“5 Things You Need to Know About the New Global Framework to Manage Nature.”](#)

<sup>60</sup> Devex, 2021. [“Devex Invested: Climate finance that’s more than ‘window dressing.’”](#)

<sup>61</sup> The Hill, 2021. [“Gore Warns Of ‘Yawning Gap’ Between Long-Term Climate Goals And Near-Term Action Plans.”](#)

## Appendix B: Further Reading

*"[Alaska Governor Seeks Green Bank for Microgrids, Clean Energy](#)," 2021. Microgrid Knowledge.*

*One advantage of Alaska in a de-carbonizing economy is its use as a testbed for renewable energy and microgrid technology. This news article describes a bill (not passed into law) that sought to create a fund, seeded with \$10 million from the state, to finance clean energy projects.*

Bloomberg L.P., 2020. "[Bloomberg Impact Report: 2020](#)."

*Bloomberg L.P.'s most recent impact report was one of several corporate sustainability documents reviewed to better understand corporate approaches to meeting climate goals. Bloomberg's goals include achieving net-zero emissions by 2025 and obtaining 100% of its energy from renewable sources the same year.*

BSR, 2021. "[Six Things Business Should Know About the EU Taxonomy](#)."

*Starting this year, the European Union is classifying companies by six environmental categories under the new EU Taxonomy regulation. This brief blog post explains the program and its role in the context of global ESG investment metrics.*

Conservation Finance Network, 2020. "[Mainstreaming Blue Carbon to Finance Coastal Resilience](#)."

*This brief article explains some of the continuing challenges of financing blue carbon initiatives, projects that protect coastal carbon sinks such as mangroves, tidal marshes, and seagrass meadows. These projects were historically hard to finance because of a lack of carbon accounting methodologies although that has started to change (see Verra, 2020 below). Other challenges include the fact that these ecosystems are vulnerable to climate-change-caused sea level rise and can be expensive to conserve because of the high value of other land uses such as tourism in the coastal locations where these ecosystems are found.*

Climate Policy Initiative, 2020. "[Updated View on the Global Landscape of Climate Finance 2019](#)."

*This report is one of the main efforts to quantify global capital flows related to climate change mitigation and adaptation. The report concludes global climate finance flows in 2017 totaled \$608 billion, and \$540 billion in 2018.*

ClimateWorks Foundation. "[Ocean Carbon Dioxide Removal](#)" webpage. Accessed July 2021.

*This webpage from U.S.-based philanthropy ClimateWorks Foundation explains the organization's support of research into potential ocean carbon dioxide removal technologies such as ocean alkalinity enhancement, which would involve adding material from alkaline-rich rock like limestone to the oceans.*

Conservation Finance Alliance, 2020. "[Conservation Finance: A Framework.](#)"

*This whitepaper defines a broad definition for conservation finance as "mechanisms and strategies that generate, manage, and deploy financial resources and align incentives to achieve nature conservation outcomes," and organizes all climate finance mechanisms into seven categories.*

"[Conservation Finance: Can Banks Embrace Natural Capital?](#)" 2019. Euromoney.

*This thorough introduction to the concept of natural capital from the director of the Green Finance Institute explains the importance of accounting for all environmental costs in business (biodiversity and water pollution impacts among others) in addition to just climate. The article profiles the contributions of more than a dozen influential people working to raise the profile of natural capital.*

Conservation through Reconciliation Partnership, 2020. "[Nature Based Solutions: Indigenous-led Conservation and Carbon Storage in Canada.](#)"

*This project examined the role indigenous communities can play in nature-based climate solutions in Canada through a historical review of the often-negative relationship between conservation movements and indigenous rights, a forum held in Ontario in 2019, and an effort to map both carbon storage and indigenous protected areas in Canada.*

Credit Suisse, WWF, and McKinsey & Company, 2014. "[Conservation Finance: Moving Beyond Donor Funding Toward an Investor-Driven Approach.](#)"

*This key conservation finance paper addresses the opportunities for conservation finance from the for-profit sector. One finding is that there would be sufficient financial capital available to meet conservation investment needs if the main investor segments (such as high net worth individuals, institutions, and retail investors) globally allocated 1% of their capital to conservation. The paper provides a blueprint for creating a mainstream conservation finance asset class.*

Duarte, Carlos et al, 2017. "[Can Seaweed Farming Play a Role in Climate Change Mitigation and Adaptation?](#)" *Frontiers in Marine Science.*

*This journal article quantifies the potential carbon dioxide mitigation potential of seaweed farming, estimating that seaweed farms could potentially mitigate as much as 1,500 tons of carbon dioxide per cubic kilometer per year if used to produce biofuel that replaced fossil fuels.*

Ecosystems Marketplace, 2020. "[Voluntary Carbon and the Post-Pandemic Recovery.](#)" and "[The Only Constant is Change: State of the Voluntary Carbon Markets 2020 Second Installment.](#)"

*The Ecosystem Marketplace survey is a window into the voluntary carbon market, where an estimated \$320 million in transactions took place in 2019. Most carbon offset projects are in the renewable energy and forestry/land use categories. However, renewable energy projects are in the process of being phased out as costs for solar and wind energy become competitive with fossil fuels in more cases, making carbon financing increasingly unnecessary for these projects.*

European Academies Science Advisory Council, 2018. "[Negative emission technologies: What Role in Meeting Paris Agreement Targets?](#)"

*This report reviews the availability and challenges of seven negative emission technologies, highlighting the need to invest in these technologies and the perils on depending on unproven methods to meet carbon budget goals. The report devotes special attention to carbon capture and storage, which is part of two other negative emission technologies and has developed much more slowly than anticipated.*

Friedlingstein, Pierre, et al., 2020. "[Global Carbon Budget 2020.](#)" *Earth System Science Data.*

*This article and ongoing research efforts help to predict the pace of climate change and guide climate policy. The carbon budget is based on five factors: fossil fuel emissions (based on energy statistics and cement production data), land use change, atmospheric carbon dioxide concentrations, the ocean carbon sink, and the terrestrial carbon sink.*

Froehlich, Halley, et al., 2019. "Blue Growth Potential to Mitigate Climate Change through Seaweed Offsetting." *Current Biology.*

*This journal article reviewed the feasibility of farmed seaweed as a carbon offset. It found that it would be possible to offset the global aquaculture industry by growing seaweed and that it might be possible offset the emissions of the agricultural sector within regions like California that have strong climate policy. However, the report concluded it would be "extremely unlikely" to offset global agriculture with seaweed aquaculture, "in part due to production growth and cost constraints."*

Goldstein, Allie, et al., 2020. "[Protecting irrecoverable carbon in Earth's ecosystems.](#)" *Nature Climate Change.*

*This paper analyzes different ecosystems to estimate irrecoverable carbon stocks, natural stores of carbon that if lost could not be recovered in time to help prevent catastrophic global warming. The author argues that ecosystems with high concentrations of irrecoverable carbon that respond to human management decisions need special protections. These include all peatlands, all mangroves, and old-growth forests.*

*["How Much Is a Tree Worth? Investors Seek to Build a Market For Nature,"](#) 2021. Financial Times.*

*This summary article describes emerging nature capital instruments, including the new HSBC Pollination Climate Asset Management and the €500m natural capital fund launched by Mirova.*

*["HSBC, RRG are Reaching for The Canopy in Nature-Based Investments,"](#) 2021. GreenBiz.*

*This article examines two examples of natural capital investments: the first is HSBC Pollination Climate Asset Management a joint venture which has announced an intention to raise up to \$3 billion towards natural capital and carbon abatement-focused investments. The second natural capital investment profiled is the Sustainable Water Impact Fund, a \$927 million fund created by The Nature Conservancy and RRG Capital Management.*

Intergovernmental Panel on Climate Change, 2018. *["Special Report: Global Warming of 1.5°C."](#)*

*This key report from the United Nations addresses the probabilities of keeping global warming to 1.5° C and pathways for lowering emissions to meet this climate goal.*

International Emissions Trading Association and Wildlife Conservation Society Canada, 2020. *"Carbon Markets and Finance to Protect Canada's Land Carbon Sink: Concept Paper & Options for Discussion."*

*Like Alaska, Canada has large intact boreal forest and peatland ecosystems that are important carbon sinks. This paper addresses the challenges of using financial markets to incentivize the conservation of these lands.*

Griscom, Bronson, et al., 2017. *["Natural Climate Solutions."](#)* PNAS.

*This frequently cited paper attempts to quantify the potential greenhouse gas removal that can be achieved through nature climate solutions, specifically 20 conservation, restoration, and/or improved land management actions. The report concludes that natural climate solutions can provide 37% of cost-effective carbon dioxide mitigation needed through 2030 in order to reach the goal of having a more than 66% chance of holding warming to below 2°C.*

McKinsey & Company/Taskforce on Scaling Voluntary Carbon Markets, 2021. *["Final Report."](#)*

*This report estimates that voluntary carbon markets will need to grow 15-fold by 2030 to meet the 1.5°C climate goal. The report makes 20 recommendations for how to grow the voluntary credit market to meet this expected spike in demand.*

Shopify, 2020. *["How to Kick-Start the Carbon Removal Market: Shopify's Playbook."](#)*

*As outlined in this playbook, Shopify's sustainability fund focuses on investing in emerging negative emissions technologies, based on the premise that negative emissions will be needed*

*to meet climate change goals and that these technologies need investment now in order to be deployed at scale in the future.*

The Biodiversity Finance Initiative, 2020. "[Moving Mountains: Unlocking Private Capital for Biodiversity and Ecosystems.](#)"

*Much like climate finance, biodiversity finance can be difficult to unlock. This paper outlines strategies for attracting private capital to projects that protect biodiversity.*

United Nations Environment Programme, 2021. "[State of Finance for Nature Tripling Investments in Nature-Based Solutions by 2030.](#)"

*This report estimates current global spending on nature-based solutions as well as the pace of growth in spending needed to meet climate and biodiversity goals. The report finds \$133 billion currently flows into nature-based solutions, most of it from governments. The report calls for annual investment of \$536 billion by 2030, including \$203 billion for forest-based solutions and \$7 billion for peatland restoration.*

United Nations Framework Convention on Climate Change. "[Introduction to Climate Finance](#)" [webpage](#). Accessed July 2021.

*This United Nations webpage explains climate finance in the context of international climate agreements and describes several important climate finance funds that have come out of these agreements including the Green Climate Fund, the Special Climate Change Fund, the Least Developed Countries Fund, and the Adaptation Fund.*

United Nations Framework Convention on Climate Change, 2021. "[New Financial Alliance for Net Zero Emissions Launches.](#)"

*This announcement of the creation of the Glasgow Financial Alliance for Net Zero in April, shows the scale of global climate finance and its growing mainstream acceptance. The 43 banks from 23 countries that signed into the alliance include major institutions like Bank of America, Citigroup, and Morgan Stanley. In all, these banks manage more than \$28.5 trillion. The banks agreed to "align operational and attributable emissions from their lending and investment portfolios with pathways to net-zero by 2050 or sooner" among other requirements.*

United Nations Framework Convention on Climate Change, 2021. "[UN Secretary-General Calls for Exponential Growth in Global Coalition to Achieve Net-Zero Emissions.](#)"

*This statement from UN Secretary-General António Guterres ahead of the UN Climate Change Conference of the Parties in Glasgow, Scotland illustrates ongoing challenges of meeting the 2015 Paris Agreement goals. Guterres urged countries to make commitments ahead of the November 2021 meeting including phasing out the use of coal by 2030 for OECD countries (and*



2040 for the rest of the world). He said developed countries need to mobilize \$100 billion per year for climate finance in developing nations.

Verra, 2020. "[First Blue Carbon Conservation Methodology Expected to Scale Up Finance for Coastal Restoration & Conservation Activities.](#)"

*Despite their importance to sequestering carbon, coastal ecosystem conservation projects could not until recently be used as carbon offset projects for major carbon trading systems. As explained in this announcement from carbon accounting standard organization Verra, a methodology for forest carbon projects known as REDD+ was expanded in 2020 to blue carbon projects in tidal wetlands. According to Verra, blue carbon received just 3% of total climate investment in 2020, despite having the potential to deliver a third of the emissions reductions needed to keep global warming below 2°C.*

Vynne, Carly, et al., 2021. "[The Importance of Alaska for Climate Stabilization, Resilience, and Biodiversity Conservation.](#)" *Frontiers in Forest and Global Change.*

*This paper describes why Alaska's public lands play an important role in global climate stabilization efforts, as well as for biodiversity and resilience. It describes Alaska's contribution to total terrestrial ecosystem carbon on U.S. federal lands and the importance of Alaska to a strategy for climate stabilization and biodiversity conservation.*

Watson, James, et al., 2018. "[The Exceptional Value of Intact Forest Ecosystems.](#)" *Nature Climate Change.*

*This paper argues that intact forests provide more environmental and social values than forests that have been degraded by human activity, and that within 100 years there may be few large areas of intact forest left on the planet. It states that the tools needed to preserve the remaining forests are well understood (such as "well-located and managed protected areas, indigenous territories that exemplify sound stewardship, regulatory controls and responsible behavior by logging, mining, and agricultural companies and consumers"), but these tools are not now being used sufficiently.*

"[Where Climate Cash is Flowing and Why it's Not Enough,](#)" 2019. *Nature.*

*This broad summary about the challenges in climate finance breaks down climate finance funding sources by country, sector, and mitigation/adaptation approach. It describes challenges related to insufficient total spending and not enough funding crossing international borders.*

White House Briefing Room, 2021. "[Executive Order on Tackling the Climate Crisis at Home and Abroad.](#)"

*This executive order from the first week of the Biden Administration outlines the climate commitments of the new government, including the United States' intention to re-join the 2015 Paris Agreement.*

White House Briefing Room, 2021. ["FACT SHEET: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies."](#)

*A subsequent White House announcement made in April during the Leaders Summit on Climate established a climate target of reducing U.S. greenhouse gas pollution by 50% (from 2005 baseline), by 2030.*

## Other Works Reviewed

Better Nature, 2021. ["The State of Conservation Finance: A Better Nature Long Read."](#)

*Biodiversity as a stand-in for climate finance. In some cases you can get the same results if you manage for biodiversity if you manage for climate. Possible delete?*

Conservation International. ["Conservation Finance" webpage](#). Accessed July 2021.

["Development Bank Climate Finance Spending Hit \\$66 Bln in 2020 - Report,"](#) 2021. Reuters.

Duke Nicholas Institute for Environmental Policy Solutions, 2011. ["Financing Options for Blue Carbon Opportunities and Lessons from the REDD+ Experience."](#)

Ecosystem Marketplace, 2014. ["Carbon Rights and Tenure: The Debate Continues."](#)

["Explainer: 10 Ways 'Negative Emissions' Could Slow Climate Change,"](#) 2016. Carbon Brief.

Forest Trends, 2020. ["Building Carbon in America's Farms, Forests, and Grasslands: Foundations for a Policy Roadmap."](#)

Government of Canada. ["Inventory and Land-Use Change" website](#). Accessed July 2021.

["Hannon Armstrong Announces Closing of \\$400 Million Senior Unsecured Sustainability-Linked Revolving Credit Facility,"](#) 2021. Businesswire.

["Infrastructure, Green Finance and Net Zero,"](#) 2021. GreenBiz.

International Emissions Trading Association, 2019. ["The Economic Potential of Article 6 of the Paris Agreement and Implementation Challenges."](#)

Key-Log Economics, 2014. ["Payments for Ecosystem Services: Cases from the Experience of U.S. Communities."](#)

Ksapa, 2021. "[The EU Green Taxonomy: A Game-Changer for Business and Investors.](#)"

Mack, Michelle et al., 2021. "[Carbon Loss from Boreal Forest Wildfires Offset by Increased Dominance of Deciduous Trees.](#)" *Science*.

McKinsey & Company, 2021. "[A Blueprint for Scaling Voluntary Carbon Markets to Meet the Climate Challenge.](#)"

Microsoft, 2021. "[Microsoft Carbon Removal: Lessons from an Early Corporate Purchase.](#)"

National Academies of Sciences, Engineering, and Medicine, 2019. "[Negative Emissions Technologies and Reliable Sequestration: A Research Agenda.](#)"

"[Nature is next: Q&A with Finance for Biodiversity's Simon Zadek,](#)" 2020. *Mongabay*.

Organisation for Economic Co-operation and Development, 2018. "[Climate-related Development Finance Data.](#)"

Qiu, Chunjing, et al., 2020. "[The Role of Northern Peatlands in The Global Carbon Cycle for the 21st Century.](#)" *Global Ecology and Biogeography*.

Seddon, Nathalie, et al., 2019. "Grounding Nature-Based Climate Solutions in Sound Biodiversity Science." *Nature Climate Change*.

Stripe, 2019. "[Decrement Carbon: Stripe's Negative Emissions Commitment.](#)"

United Nations Framework Convention on Climate Change. "[What is the Paris Agreement?](#)" [webpage](#). Accessed July 2021

United Nations Intergovernmental Panel on Climate Change (IPCC), 2020. "[Climate Change and Land.](#)"

United States Forest Service, 2011. "[Giving Credit Where Credit Is Due: Increasing Landowner Compensation for Ecosystem Services.](#)"

"[Using Microfungi & Melanin, This Soil Carbon Startup Just Raised \\$6.9m In a Round Led By Li Ka-Shing's VC,](#)" 2020. *AgFunder News*.

World Bank Group, 2020. "[Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition.](#)"

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