BEYOND PATENTS: INCENTIVE STRATEGIES FOR OCEAN PLASTIC REMEDIATION TECHNOLOGIES

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ABSTRACT

With a garbage truck's worth of plastic being dumped in the ocean each minute, there is a dire need for effective technological solutions aimed at mitigating the marine plastic pollution problem. However, the reliance of the U.S. patent system on market demand to incentivize this type of innovation has proven insufficient in light of the peculiarities of "green" technologies. To remedy this, this article proposes a multi-faceted incentivization approach that looks beyond the U.S. Patent and Trademark Office to stimulate the development of remediation technologies through comprehensive regulatory interventions, the establishment of prize funds and other alternative incentive mechanisms, and targeted reforms to patent procedures.

INTRODUCTION

The world's oceans are among the most valuable natural resources on the planet.[1] Economies of all scales depend on the sea for food, transportation, energy production, and more.[2] However, both ocean habitats and the marine life within them face an immense threat – plastic pollution.[3] Despite widespread public recognition of the harmful externalities posed by plastic waste,[4] more than eight million tons of

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[1] *Ocean Resources*, MARINEBIO CONSERVATION SOC'Y, https://www.marinebio.org/conservation/ocean-dumping/ocean-resources/ (last visited Dec. 1, 2021).

[2] *Id.*

[3] Douglas McCauley, *Here Are 5 of the Biggest Threats To Our Oceans, and How We Can Solve Them*, WORLD ECON. F. (June 8, 2018), https://www.weforum.org/agenda/2018/06/5-ways-we-can-improve-ocean-health/.

[4] *Public Opinion Surrounding Plastic Consumption and Waste Management of Consumer Packaging*, A Report to World Wildlife Fund (2020), at 7-8, https://www.merkley.senate.gov/wp-content/uploads/imo/media/doc/Public%20Opinion%20Research%20to%20WWF%202021.pdf.

discarded plastics enter the world's oceans each year.[5]

A broad range of technical solutions should be developed and employed to mitigate the harmful effects of ocean plastics. The United States heavily relies on the patent system to incentivize this type of innovation.[6] However, the U.S. patent system's implicit reliance on market demand to drive innovation may fail to adequately incentivize the development of green technologies,[7] including technologies directed to plastic waste remediation. Current efforts to spark these innovations may ignore the nature of the problem and do little to accomplish their aims.[8] Instead of relying solely on the existing patent system, the U.S. government should encourage the development of ocean plastic pollution remediation technologies through regulations aimed at increasing demand, alternative incentive mechanisms, and, eventually, changes to patent system procedures.

I. DETAILED DESCRIPTION OF THE PROBLEM

Innovation relating to ocean plastic waste reduction is essential for improving ocean and coastal health, but the existing system designed to encourage this innovation – the U.S. patent system – is ill-suited for the unique characteristics of green technologies.[9]

A. The Value of Oceans, Marine Life, and Ecosystems

The ocean is a true jack of all trades. It stores carbon dioxide and generates more than 50% of the world's oxygen.[10] It regulates our climate by relocating excess heat from the equator to the poles, shaping the frequency and severity of weather events.[11] Oceans are home to an abundance of known marine life, which provide vital sources of food and

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[5] Gwen Ranniger, *How Is Plastic Pollution Affecting the Ocean?*, ENV'T. HEALTH NEWS (Aug. 11, 2021), https://www.ehn.org/ocean-plastic-pollution-2654378379/plastic-pollution-in-the-ocean.

[6] Ofer Tur-Sinai, *Patents and Climate Change: A Skeptic's View*, 48 ENV'T. L. 211 (2018).

[7] *Id.* at 226–27.

[8] Sarah Tran, *Expediting Innovation*, 36 HARV. ENV'T. L. REV. 123, 153 (2012).

[9] Tur-Sanai, *supra* note 5, at 211, 221; see also Reto M Hilty et. al, *Potential and Limits of Patent Law to Address Climate Change*, 72 GRUR International 9 (2023), at 821-839.

[10] Sean Fleming, *Here Are 5 Reasons Why The Ocean Is So Important*, WORLD ECON. FORUM (Aug. 29, 2019), https://www.weforum.org/agenda/2019/08/here-are-5-reasons-why-the-ocean-is-so-important/.

[11] *Why Should We Care About the Ocean?*, NAT'L OCEAN SERV. (Feb. 26, 2021), https://oceanservice.noaa.gov/facts/why-care-about-ocean.html.

nutrients, and may harbor millions more organisms awaiting discovery.[12] Additionally, oceans drive both local and national economies. Ocean-based industries will provide jobs for over 40 million people worldwide within the next decade.[13] As of 2020, America's "blue economy" accounted for $361 billion of our nation's gross domestic product (GDP).[14] For developing countries, which encompass over three billion of the world's inhabitants, ocean resources may be even more essential. In these regions, oceans and marine-based resources provide nourishment, a means of transportation, and a gateway to economic opportunities, playing a pivotal role in supporting livelihoods and fostering sustainable development.[15]

B. The Threat Posed by Plastic Waste

Despite the unique benefits it offers, the ocean faces constant attack from all angles. Human-made climate change may raise ocean temperatures, promote acidification, and create a more hostile environment for marine life.[16] Ocean resources are also threatened by overfishing, tourism, and many other types of human activity.[17] While some environmental impacts of human activities may be less observable than others, one of the greatest threats to ocean health is also one of the most obvious – plastic pollution.

Every year, the world's oceans are forced to make room for over eight million metric tons of new plastic pollution.[18] In addition to well-known impacts on marine life, plastic waste poses numerous threats to overall ocean health as well as economies relying on the sea.[19] Delicate ecosystems may be impacted by invasive marine organisms transported by

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[12] Fleming, *supra* note 9.
[13] *Id.*
[14] *Marine Economy Continues to Power American Prosperity Despite 2020 Downturn*, NOAA (June 9, 2020), https://www.noaa.gov/news-release/marine-economy-continues-to-power-american-prosperity-despite-2020-downturn#:~:text=File&text=America's%20marine%20economy%20contributed%20about,gross%20domestic%20product%20in%202020.
[15] Fleming, *supra* note 9.
[16] McCauley, *supra* note 3.
[17] *Id.*
[18] *Id.*
[19] Megan Lowry, *U.S. Should Create National Strategy by End of 2022 to Reduce Its Increasing Contribution to Global Ocean Plastic Waste, Says New Report*, NAT'L ACAD. (Dec. 1, 2021), https://www.nationalacademies.org/news/2021/12/u-s-should-create-national-strategy-by-end-of-2022-to-reduce-its-increasing-contribution-to-global-ocean-plastic-waste-says-new-report.

floating plastics.[20] Plastic waste crowds shorelines and discourages tourism, decreasing revenue and creating massive cleaning and maintenance costs.[21] Larger pieces of plastic break down into small fragments called microplastics and nanoplastics, which may increase the toxicity of ocean water and are often ingested by unsuspecting sea creatures.[22] Humans who eat microplastics-contaminated seafood have been found with plastic throughout their bodies: in their brains, bloodstreams, kidneys, and more.[23] Researchers recently discovered microplastics in 62 of 62 placentas tested and, while the future health implications are largely unknown,[24] microplastics have been linked to endocrine disruption, weight gain, insulin resistance, decreased reproductive health, and cancer. [25]

Plastic pollution comes from a variety of sources, increasing the complexity of the issue. While the aquaculture industry, fisheries, and other ocean-based sources certainly contribute their fair share, land-based sources account for most of the plastic waste entering the world's oceans each year.[26] Single-use items like shopping bags, cups, and straws are obviously problematic.[27] In addition, nearly invisible microplastics may enter the ocean through more discrete sources like tap water or beer.[28] The simple act of washing a shirt made of synthetic materials may cause microparticles to enter oceans through water systems.[29] Other land-based sources include urban and stormwater runoff, industrial production, illegal dumping, and inadequate waste disposal.[30]

Campaigns aimed at increasing public awareness have been

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[20] *Issues Brief: Marine Plastic Pollution*, IUCN (Nov. 2021), https://www.iucn.org/sites/default/files/2022-04/marine_plastic_pollution_issues_brief_nov21.pdf.

[21] *Id.*

[22] *Id.*

[23] Joseph Winters, *Detergent pods are only the start of clothing's microplastic pollution problem*, Grist (Mar. 11, 2024), https://grist.org/regulation/detergent-pods-are-only-the-start-of-clothings-microplastic-pollution-problem/

[24] *Id.*

[25] *Microplastics on Human Health: How Much do they harm us?*, United Nations Development Programme (June 5, 2023), https://www.undp.org/kosovo/blog/microplastics-human-health-how-much-do-they-harm-us#:~:text=Different%20chemicals%20can%20leach%20from,decreased%20reproductive%20health%2C%20and%20cancer.

[26] *Issues Brief: Marine Plastic Pollution*, supra note 20.

[27] *Id.*

[28] *Id.*

[29] Ranniger, *supra* note 5.

[30] IUCN, *supra* note 20.

largely successful in familiarizing consumers with the issue.[31] An image of a dead seagull with a stomach full of plastic bottle caps is a hard one to shake, and many individuals have at least a passing familiarity with the Great Pacific Garbage Patch.[32] However, some may still fail to understand just how much plastic is in the ocean:

- The amount of plastic waste entering each year is "the equivalent of dumping a garbage truck of plastic into the ocean every minute."[33]
- Ocean plastics are expected to outweigh all of the fish in the ocean by 2050."[34]
- The Great Pacific Garbage Patch is nearly 5 times the size of Germany, and there are now plastic patches growing in every ocean."[35]
- Humans "trade" two pounds of plastic for every one pound of tuna derived from the ocean.[36]
- There are more than five trillion (5,000,000,000,000) pieces of plastic waste floating in the ocean,[37] but the majority of ocean waste is actually below the surface.[38]

C. The Role of Technological Innovation

Over the last decade, international, national, and regional efforts to deal with ocean plastic waste have increased.[39] These efforts are often policy-focused and may seek to use bans, taxes or fees, and voluntary programs such as "reduce and reuse" campaigns to reduce plastic pollution.[40] However, the rate of plastic pollution continues to grow

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[31] McCauley, supra note 3.
[32] *Id.*
[33] Lowry, *supra* note 19.
[34] Ranniger, *supra* note 5.
[35] *Id.*
[36] McCauley, *supra* note 3.
[37] *Ocean Trash: 5.25 Trillion Pieces and Counting, but Big Questions Remain*, National Geographic (last accessed 2024), https://education.nationalgeographic.org/resource/ocean-trash-525-trillion-pieces-and-counting-big-questions-remain/6th-grade/.
[38] *Ocean Pollution: 11 Facts You Need to Know*, CONSERVATION INT'L, https://www.conservation.org/stories/ocean-pollution-11-facts-you-need-to-know (last visited Oct. 5, 2022).
[39] Emma Schmaltz, et al., *Plastic Pollution Solutions: Emerging Technologies To Prevent And Collect Marine Plastic Pollution*, ENV'T INT'L, Nov. 2020, at 2.
[40] *Id.*

despite the implementation of such policy-oriented strategies.[41] To increase the effectiveness of these efforts, technological innovations should serve alongside strategies focused on policy.[42]

Marine plastic reduction technologies can take many forms. For example, consider a consumer-oriented plastic prevention technology – the "Cora Ball."[43] This product may be placed in a washing machine and captures plastic-containing microfibers produced when synthetic clothing items are washed, preventing these materials from reaching oceans.[44] Another example is the "Hoola One," a large vacuum that filters plastic waste from sand.[45] In addition to technologies that prevent or collect plastic waste, other helpful innovations may involve biodegradable materials, surveillance schemes, and more.[46]

A new report from the National Academies of Sciences, Engineering, and Medicine, which urged the United States to develop of a national strategy to reduce plastic pollution by the end of 2022, left substantial gaps in its recommendations that could only be filled by technological innovations.[47] The recommendations included developing plastic-substitute materials, improving waste management systems, implementing new waste-capture mechanisms, and increasing enforcement of illegal dumping prohibitions.[48]

There is widespread agreement across political aisles on the need for green innovation.[49] While the Democratic party is well known for focusing on environmental issues, a consensus of Republican policymakers recognized the essentiality of these technologies as early as 2019.[50] While environmental regulation is still the subject of considerable debate, many policymakers agree, as Senator John Barrasso stated, that

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[41] *Id.*
[42] *Id.*
[43] *Id.* at 11.
[44] *Id.*
[45] *Id.* at 12.
[46] Emma Bryce, *Twenty plastic-busting inventions to clean our rivers and seas*, CHINA DIALOGUE OCEAN (May 10, 2021), https://chinadialogueocean.net/17153-twenty-plastic-busting-inventions-to-clean-our-rivers-and-seas/.
[47] *See* Lowry, *supra* note 19 (suggesting there are gaps in the recommendations due to lack of technological innovation).
[48] *Id.*
[49] Dana Nuccitelli, *Needed For Clean Tech: Policy Incentives*, YALE CLIMATE CONNECTIONS (Jan. 8, 2019), https://yaleclimateconnections.org/2019/01/needed-for-clean-tech-policy-incentives/.
[50] *Id.*

"Innovation … is the ultimate solution."[51]

D. The Aims of the U.S. Patent System

Considering that our nation produced more plastic waste than any other country in 2016, the United States has a strong interest in encouraging the development of technologies that reduce plastic pollution.[52] Technological development often requires significant research and development (R&D) expenditures, and few innovators would engage in R&D if opportunities to recoup their investment were lacking.[53] Perhaps recognizing this underlying incentive problem as early as the 1800s, the Constitution's framers drafted Article I, Section 8 and granted Congress the power "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."[54] The Patent Act of 1790 was passed a few years later, and the U.S. patent system began to take shape.[55]

While the minutia of the patent system has changed through the years, the current system relies on the same property- and incentive-based rationale that served as the foundation for its inception.[56] Under the current system, inventors who create a new and useful "machine, manufacture, or composition of matter" may be granted a patent, which confers a right to exclude others from practicing that invention for a certain period.[57] The limited monopoly conferred by this exclusive right suppresses competition from "free riders," who seek to exploit the work of other inventors despite making no investment themselves, and thus encourages the R&D necessary for the production of socially valuable inventions.[58] There is no separate patent system for "green" technologies, and these innovations are generally treated equally to other inventions during patent prosecution and thereafter.

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[51] *Id.*

[52] Lowry, *supra* note 19.

[53] Baron et. al, *Joining Standards Organizations: The Role of R&D Expenditure, Patents, and Product Market Position*, OECD (Nov. 2018), https://www.oecd.org/site/stipatents/programme/ipsdm-2018-4-2-baron-li-nasirov.pdf.

[54] Lowry, *supra* note 19.

[55] *Id.*

[56] Jessie Kratz, *Inventing in Congress: Patent Law since 1790*, National Archives (Mar. 11, 2015), https://prologue.blogs.archives.gov/2015/03/11/inventing-in-congress-patent-law-since-1790/ (noting that "[t]he framers of the Constitution believed that patent law encouraged innovation by protecting private property").

[57] Lowry, *supra* note 19.

[58] Tur-Sinai, *supra* note 6, at 226.

E. Why the Current System May Not Provide Adequate Incentives

The current patent system implicitly relies on the assumption that market demand adequately incentivizes innovation.[59] However, the exclusive right granted by patents is only worth something if consumers actually want to purchase the good or service. While a market-based approach may generally be adequate to incentivize innovation, this strategy may crumble when faced with the peculiarities of "green" technologies.[60] Thus, the current patent system may be inadequate to incentivize the development of marine plastic remediation technologies.

These technologies may be best described as "nonmarket" goods.[61] Because the patent system relies on consumer preferences to "signal" areas of innovation worth pursuing, the incentive to invest may disappear when the goods are difficult to value in standard markets.[62] This may discourage researchers from performing the foundational research necessary to develop these innovations.[63] Green technologies, such as innovations directed to ocean plastics, may not be properly valued by markets for several reasons.

First, not all consumers can be trusted to make environmentally conscious choices.[64] Even though the public is generally more aware of environmental issues than they were in the past, some skepticism persists.[65] Even individuals who are conscious of these issues may still fail to fully appreciate the impact of the individual's own, personal actions.[66] For example, a coffee enthusiast may be aware that discarded plastic straws pose risks to ocean health, but he may view his own use as insignificant, considering the millions of tons of plastic waste produced by industry giants. Consumers also routinely exercise influence on each other, which limits demand for technologies that have not yet reached widespread use.[67] For example, many consumers adopt a "wait to see" approach before switching to green products and processes, hindering

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[59] *Id.*

[60] *Id.* at 226–27.

[61] *Id.* at 227.

[62] *Id.* at 226–27; Amy Kapczynski & Talha Syed, *The Continuum of Excludability and the Limits of Patents*, 122 YALE L.J. 1900, 1905 (2013).

[63] Tur-Sanai, *supra* note 6, at 214.

[64] *Id.* at 243.

[65] *Id.* at 238.

[66] *Id.* at 239-40 (noting that "[e]ven when fully aware of the link between consumption and climate change, an individual consumer may fail to make choices that sufficiently account for environmental concerns…" due to "the human propensity for self-interest").

[67] *Id.* at 241.

diffusion in early stages.[68]

Although consumers look to cues from others to when choosing whether to adopt green products, they simultaneously doubt the collective commitment of society to achieving significant environmental progress, leading to a "collective action" problem.[69] In other words, because consumers do not trust that other individuals will make equally environmentally responsible choices, they might avoid making these choices themselves.[70] Finally, green technologies present an interesting paradox: their use creates positive externalities that significantly undercut their own demand.[71] Significant progress in reducing ocean plastic might still be years away, yet as new technologies curb or prevent waste, their success ironically diminishes the demand for the very technologies solving the problem.

Technological solutions designed for businesses, rather than individual consumers, may also be improperly valued by market demand.[72] The social value of green technology is largely a function of the public benefit it provides.[73] In choosing to use an environmentally friendly product or process, a business is essentially choosing to offer a benefit to all while bearing the cost by itself.[74] A for-profit firm will rarely consider the indirect benefits of third parties when making business decisions and will instead focus on an internal cost-benefit analysis.[75] Thus, a business will rarely "green its operations" on its own accord.[76] Firms may justify a switch to satisfy consumer preferences, but this consideration is often

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[68] *Id.*

[69] *Id.* at 242

[70] *Id.*

[71] *Id.* at 214.

[72] *Id.* at 233.

[73] *Id.*

[74] *Id.* (noting that "[t]he reason why a systematic gap between market demand and social value exists in this context has to do with the fact that a cleaner environment constitutes a public good, from which we all benefit, whether we contributed to it or not").

[75] *Id.* at 233-34.

[76] *Id.* (noting that "a profit maximizing firm is <u>likely to focus predominantly on its direct costs and benefits, while failing to account for such indirect or benefits to others</u>" but that "despite these costs, a firm could still find it beneficial to green its operations… [such as] to comply with regulation or reduce its environmental costs and liabilities") (emphasis added) ; *id.* at 235 (stating that "in most cases, a profit-maximizing firm is <u>not likely to assign a significant weight to the indirect benefits that others may derive</u> from the positive impact of its actions on the state of the environment") (emphasis added).

outweighed by profit-maximizing goals.[77]

Because the market itself consistently undervalues green products and processes, the patent system's reliance on market demand to drive innovation may fail to incentivize the development of marine plastic remediation technologies. A systematic review conducted in 2020 identified only 52 discrete technologies directed to plastic pollution prevention or collection.[78] While these technologies may offer a reasonable starting point, today's recycling and waste management infrastructure is "grossly insufficient" to address the plastic waste problem.[79] Thus, there is an urgent need for more innovations to address challenges associated with scale, deployment location, prohibitive costs, and microplastics in particular.[80]

II. CURRENT ACTIONS

The United States has taken a few actions to address these challenges. The federal government largely focuses on changes to Patent Office procedures and direct federal funding through research subsidies or grants to incentivize green innovation. State and local regulatory efforts may indirectly encourage the development of ocean plastic remediation technologies as well.

A. Basic Overview of the Patent System

Many U.S. efforts are directed at the United States Patent and Trademark Office, the federal agency charged with granting patents.[81] For an inventor to receive U.S. patent protection on her invention, she must start the process by filing an application with the USPTO.[82] This begins a back-and-forth between the applicant and the assigned patent examiner, who sends the applicant "Office Actions" containing the examiner's conclusions regarding the patentability of the invention.[83] The applicant may respond to these Office Actions, for example, by amending the invention's claims to limit them to patentable subject matter, or by raising

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[77] *Id.* at 234–35.
[78] Schmaltz, *supra* note 35, at 5.
[79] Lowry, *supra* note 18.
[80] Schmaltz, *supra* note 35, at 10.
[81] *About Us*, UNITED STATES PATENT AND TRADEMARK OFFICE (Feb. 9, 2021), https://www.uspto.gov/about-us.
[82] *Patent process overview*, UNITED STATES PATENT AND TRADEMARK OFFICE (July 29, 2021), https://www.uspto.gov/patents/basics/patent-process-overview#step6.
[83] *Id.*

legal or technical arguments to counter the examiner's reasoning.[84] The process generally concludes when the claimed invention receives a "final rejection" or an "allowance" from the examiner.[85] If the examiner issues a Notice of Allowance on a utility application, the inventor is granted a patent, which confers a 20-year exclusive right to prevent others from practicing the invention.[86]

The structure and nature of the patent process leads to many headaches for applicants and inventors. First, applicants must pay a variety of fees, including fees for filing, examination, search, issuance, and more.[87] Even before filing, inventors often seek the help of a patent agent or attorney in drafting the application, and many choose to retain counsel to handle the entirety of the prosecution of the application. Second, the patent-granting process may be excruciatingly slow. As of January 2024, applicants must wait an overage of over twenty months before receiving a substantive response from the Patent Office.[88] Patents are generally "pending" for around two years, and the USPTO has a current backlog of over 775,000 unexamined patent applications.[89]

B. USPTO Efforts to Incentivize Green Innovation

To spark development of green technologies, the United States has taken measures designed to alleviate some of these patent office inconveniences. In 1983, Congress amended existing patent rules to speed up the application process for certain inventions.[90] When a patent application is directed to an invention that "materially enhance[s] the quality of the environment or materially contribute[s] to the development or conservation of energy resources," the invention may be granted special status under this "accelerated examination program."[91] Because patent applications are generally examined in the order in which they are filed,[92] this program offers an opportunity for applicants to receive faster

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[84] *Id.*
[85] *Id.*
[86] *Id.*
[87] *Id.*
[88] *Patents Pendency Data January 2024*, UNITED STATES PATENT AND TRADEMARK OFFICE (Jan. 2024), https://www.uspto.gov/dashboard/patents/pendency.html.
[89] *Patents Production, Unexamined Inventory and Filings Data January 2024*, UNITED STATES PATENT AND TRADEMARK OFFICE (Jan. 2024), https://uspto.gov/dashboard/patents/production-unexamined-filing.html.
[90] 37 C.F.R. § 1.102(c).
[91] Pilot Program for Green Technologies Including Greenhouse Gas Reduction, 74 Fed. Reg. 64, 64666 (Dec. 8, 2009).
[92] Tran, *supra* note 8, at 125.

decisions on their inventions. For qualifying applications, the USPTO strives to complete the entire examination process within twelve months of the application's filing date.[93]

While the procedure was relatively lenient following its creation, the USPTO set out additional requirements for this accelerated examination program in 2006.[94] Under the revised framework, applicants aiming to fast-track their green applications must meet several stringent requirements.[95] Applicants must complete an extensive pre-examination prior art search, include a detailed examination support document ("ESD"), and limit the number of claims included in their application.[96] The pre-examination search and ESD are particularly burdensome, requiring the applicant to compile a huge volume of relevant information and present an analysis of the information at a painstaking level of detail.[97] Additionally, these requirements limit the applicant's ability to amend or add new claims during prosecution.[98]

Given the many idiosyncrasies of the accelerated examination process, the Green Technology Pilot Program was a welcome addition to the patent system. Implemented by the PTO in 2009, this program offered another avenue for patent applications to be examined out of turn.[99] The Green Technology Pilot Program covered a broader range of technologies than the accelerated examination program, including applications directed to energy conservation, renewable energy, greenhouse gas reduction, and environmental quality.[100] Importantly, this program did not require any pre-examination search or examination support document, which significantly reduced the workload for applicants and inventors.[101] Unfortunately, the Green Technology Program had an application limit, and the program was discontinued in 2012 after the limit was reached.[102]

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[93] Changes to Practice for Petitions in Patent Applications to Make Special and for Accelerated Examination, 71 Fed. Reg. 36, 363323 (June 6, 2006).
[94] *Id.*
[95] *Id.* (noting that applicants seeking to take advantage of the program were required to perform preliminary searches, pay various fees, limit claims, and more).
[96] *Id.*
[97] Tran, *supra* note 8, at 141.
[98] *Id.*
[99] Jeffrey M. Kaden, *The Death of Green Technology at the U.S. Patent Office*, GOTTLIEB, RACKMAN, & REISMAN, https://grr.com/publications/the-death-of-green-technology-at-the-u-s-patent-office/ (last visited Dec. 2, 2021).
[100] *Id.*
[101] Pilot Program for Green Technologies Including Greenhouse Gas Reduction, *supra* note 85.
[102] Kaden, *supra* note 99.

It was not renewed.[103]

Nearly a decade later, however, the Green Technology Pilot Program was replaced with the "Climate Change Mitigation Program" in 2022.[104] The USPTO expanded the Climate Change Mitigation Program in 2023 to allow "qualifying applications involving technologies that reduce, remove, prevent, and/or monitor greenhouse gas emission [to] be advanced out of turn (made special)," similar to its predecessor. [105] Notably, to qualify under the Climate Change Mitigation Program, "[a]pplications must contain … claims to a product or process that mitigates climate change by being designed to: (a) remove greenhouse gases already present in the atmosphere; (b) reduce and/or prevent additional greenhouse gas emissions; and/or (c) monitor, track, and/or verify greenhouse gas emission reductions." [106]

It is not entirely clear whether ocean plastic remediation technologies would qualify for accelerated examination under the definitions provided. Arguably, the USPTO's repeated emphasis on "greenhouse gas" suggests a preference for technologies that directly interact with the carbon cycle or influence the processes of energy production and consumption.[107] Examples such as renewable energy sources (e.g., solar, wind, hydroelectric power) and carbon capture and storage (CCS) methods may align more closely with technologies "designed to … reduce and/or prevent additional greenhouse gas emissions" as compared to ocean plastic remediation innovations which, while critically important for marine health and capable of indirectly influencing lifecycle greenhouse gas emissions through the reduction of plastic degradation, for example,[108] typically do not directly address the sources of greenhouse gas emissions or their sequestration from the

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[103] *Id.*

[104] *Climate Change Mitigation Program*, UNITED STATES PATENT AND TRADEMARK OFFICE, https://www.uspto.gov/patents/laws/patent-related-notices/climate-change-mitigation-pilot-program.

[105] *Id.*

[106] *Id.* (emphasis added).

[107] *Id.* (noting that the Climate Change Mitigation Program "aligns with and supports Executive Order 14008"); see also Executive Order 14008, *Executive Order on Tackling the Climate Crisis at Home and Abroad*, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/, (containing multiple mentions of "greenhouse gas" but no mention of "plastic" or "plastics").

[108] Sarra N. Dimassi, et. al, *Degradation-fragmentation of marine plastic waste and their environmental implications: A Critical Review*, 15 Arabian. J. Chem. 11 (Nov. 22).

atmosphere.[109] This distinction may place ocean plastic remediation outside the primary scope of the USPTO's Climate Change Mitigation Program and limit its effectiveness in encouraging such innovations.

The USPTO's Climate Change Mitigation Program was set to be short-lived from the start, with a hard cap of 4000 applications and a sunset date of June 7, 2027, whichever occurs sooner. [110] It is unclear why the USPTO ostensibly recognizes the need for additional green patenting incentives by establishing such programs, only to constrain them in both breadth and duration and potentially limit the programs' effectiveness in achieving their stated goals. Regardless, this pattern suggests a need to look beyond temporary measures for lasting environmental innovation support, and to measures beyond the USPTO entirely.

C. Why USPTO Efforts, Alone, Are Not Enough

While other U.S. efforts may provide some incentives for green technology development, Patent Office reforms are considered a primary mechanism for addressing the issue head-on. In announcing the initiation of the Green Technology Pilot Program in 2009, the Secretary of Commerce confidently stated that the Program would "encourage our brightest inventors to invest needed resources" and "fuel further innovation of clean technology."[111] Unfortunately, this shows that even U.S. leaders may misunderstand the nature of the incentive problem.[112] Efforts like the Green Technology Pilot Program and Climate Change Mitigation Program may occasionally enable applicants to commercialize their inventions at an earlier date but often fail to provide adequate incentives for innovation from the outset.[113] These programs are not entirely meritless, as early commercialization may allow patent applicants to license their inventions sooner and help environmental start-ups raise necessary capital.[114] However, by limiting their reach to streamlining the examination process, these programs ignore the underlying market value problem that plagues green innovations.

Under the current system, the economic incentive to invest in R&D is proportional to the value the market assigns to any invention that may follow.[115] Because the market routinely undervalues green inventions, the time of commercialization is essentially irrelevant – inventors still lack

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[109] *See infra* notes 43-48 and accompanying text.
[110] *Climate Change Mitigation Program*, *supra* note 104.
[111] Tran, *supra* note 8, at 153.
[112] *Id.* at 154.
[113] *Id.* at 152.
[114] Kaden, *supra* note 99.
[115] Tur-Sanai, *supra* note 6, at 226.

adequate incentives to develop these technologies in the first place. There is little point in pursuing an exclusive right to practice an invention if the value of that right is minimal, even if the process for obtaining it is made slightly less inconvenient. To analogize, these programs essentially promise shorter lines for an amusement park attraction that patrons have little interest in actually riding. Accordingly, USPTO efforts may be limited in effect, and there remains a broad consensus that much more green innovation is needed.[116] Thus, the U.S. should look to solutions beyond the USPTO to provide adequate incentives for the development of marine plastic pollution technologies.

D. Other Actions

The U.S. government offers a few federally funded grant opportunities to directly incentivize green innovation relating to marine plastics. For example, the Department of Energy announced a $14.5 million dollar investment for R&D of plastic reduction technologies in 2021.[117] Other federal agencies employ competitive funding opportunities as well, including the NOAA's "Marine Debris Research Grants," which offers funding for research related to ecological risk assessment, exposure, and transportation of marine debris.[118] Even though federal agencies commit substantial funds to R&D grants, these efforts may be less effective than corporate-sponsored research in producing valuable innovations.[119] Thus, government-funded research efforts cannot be regarded as a "close substitute" for market-driven incentives.[120]

Regulatory efforts may have an indirect effect on market demand for green innovations. Environmental regulations can direct businesses towards green technologies, thereby increasing demand for technologies that help these businesses comply.[121] However, because governance is "fragmented" across jurisdictions, corporations may exploit "regulatory gaps" to avoid compliance and deflect the costs of plastic pollution onto

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[116] *Id.* at 223–25.

[117] *DOE Announces $14.5 Million to Combat Plastics Waste and Pollution*, ENERGY.GOV (May 25, 2021), https://www.energy.gov/articles/doe-announces-145-million-combat-plastics-waste-and-pollution.

[118] *Marine Debris Program,* NOAA (Dec. 4, 2021), https://marinedebris.noaa.gov/resources/funding-opportunities.

[119] Daniel Spulber, *Prices versus Prizes: Patents, Public Policy, and the Market for Invention*, NORTHWESTERN UNIV. 17 (Aug. 2014), https://wwws.law.northwestern.edu/research-faculty/clbe/innovationeconomics/documents/spulber_prices_versus_prizes.pdf.

[120] *Id.*

[121] Tur-Sanai, *supra* note 6, at 234–36.

third parties.[122] As a result, state and local regulations may have only a limited effect in increasing market demand, and there is a pressing need for comprehensive federal legislation directed to plastic pollution.

III. RECOMMENDATIONS

The urgency and complexity of the marine plastic waste problem necessitate a multi-faceted approach to incentivize the development of remediation technologies. In seeking to fulfill the constitutional mandate of "promot[ing] the Progress of Science and useful Arts," the USPTO should not attempt to tackle this incentive issue independently, but should instead take an active role in advising the President, the Secretary of Commerce, and other relevant government agencies on potential solutions,[123] including the recommendations listed below.

A. Alternative (Non-Patent) Incentive Schemes: The government should establish a prize fund that grants monetary rewards to inventors delivering specific marine plastic innovations.

Prizes have been recommended by many leading scholars to encourage innovation in situations where the patent system fails.[124] Because these mechanisms provide an incentive distinct from market demand, prizes may encourage the development of green technologies despite the market's tendency to underrepresent the social value of these innovations.[125] The recommended prize fund should offer rewards for a wide range of remediation technologies so that a "full toolbox" of innovative solutions may be developed. Recent trends suggest that members of Congress have begun to recognize the value of prize-based incentive mechanisms. In 2017, for example, Senator Bernie Sanders introduced the Medical Innovation Prize Fund Act.[126] This bill proposed the creation of a prize fund of over $100 billion to reward medical innovations based on various criteria.[127]

Some argue that, because government actors lack the private information that generates market prices, government-led prize funds

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[122] Schmaltz, *supra* note 39, at 2.
[123] *About Us*, *supra* note 76.
[124] Joseph Stiglitz, *Prizes, Not Patents*, PROJECT SYNDICATE (Mar. 6, 2007), https://www.project-syndicate.org/commentary/prizes--not-patents?barrier=accesspaylog.
[125] Tur-Sanai, *supra* note 6, at 216.
[126] KNOWLEDGE ECOLOGY INT'L, *Sen. Sanders Introduces Medical Innovation Prize Fund Act*, DELINKAGE.ORG (Mar. 2, 2017), https://delinkage.org/sen-sanders-introduces-medical-innovation-prize-fund-act/.
[127] *Id.*

allocate resources less efficiently than the patent system.[128] Sanders' proposal seems to mitigate these concerns by establishing a diverse board (made up of consumers, R&D entities, health insurance companies, and more in addition to government officials) to administer the fund.[129] While market-value input is less important in the green innovation context, as discussed previously, stakeholder input is certainly encouraged.

Despite its introduction over four years ago, the Medical Innovation Prize Fund Act has not been passed. This may be a result of the composition of Congress at the time, the size of the proposed fund, or its controversial effect of removing certain innovations from patent protection entirely. Thus, a proposal for a prize fund for ocean plastic pollution technologies should request a more modest fund size and offer the prize money in addition to existing patent opportunities.

Finally, the government should continue to directly fund the development of ocean plastic remediation technologies through research subsidies and grants even after the prize fund has been established. Both prize-based mechanisms and direct research subsidies may incentivize innovation, but each reaches the goal through different means.[130] Thus, existing research grants should be used as a complement to the new prize fund for remediation technologies.

In an encouraging development announced in 2023, the USPTO recently expanded its "Patents for Humanity Program" to provide a variety of "business incentives" for "patent applicants, holders, and licensees whose inventions are addressing the challenges of climate change through green energy innovations, including wind, solar, hydrogen, hydropower, geothermal, and biofuels technologies." [131] Winners will receive only a modest prize: "a certificate to accelerate USPTO processing for one eligible matter (such as an ex parte reexamination proceeding or a patent application), as well as public recognition of their work." However, this expansion is a step in the right direction and, notably, a powerful acknowledgment by the USPTO of the need for creative strategies to incentivize the development of green tech. Future programs could

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[128] Tur-Sanai, *supra* note 6, at 226–27.

[129] *See* KNOWLEDGE ECOLOGY INT'L, *supra* note 114.

[130] QIANG FU ET AL., CENTRAL UNIVERSITY OF FINANCE AND ECONOMICS, HOW TO MOTIVATE INNOVATION: SUBSIDIES OR PRIZES?, at 4 (Sept. 2008), https://citeseerx.ist.psu.edu/viewxdoc/download?doi=10.1.1.584.9208&rep=rep1&type=pdf.

[131] *USPTO announces new Patents for Humanity Green Energy category*, UNITED STATES PATENT AND TRADEMARK OFFICE (Mar. 6, 2023), https://www.uspto.gov/about-us/news-updates/uspto-announces-new-patents-humanity-green-energy-category.

continue to explore non-monetary business incentives as an addition or alternative to cash-based prize funds.

B. Establishing the Prize Fund: While the U.S. Federal Government should be the primary source of funding, complementary sources should be used as well.

A majority of the funding should be secured via Congressional appropriation. While the need for green innovation is recognized across the political spectrum, opposition may exist depending on the size of the prize fund and terms of its allocation. If more votes from Democrats are needed, the proposal should stress the magnitude and complexity of the marine plastic problem, and public awareness campaigns may be effective in allowing constituents to provide additional pressure to members of Congress. If more Republican votes are needed, the proposal should emphasize its lack of reliance on environmental regulations in mitigating the issue. Additionally, existing subsidies and grants may be partially redirected towards the prize fund. For example, the Department of Energy announced a $14.5 million dollar investment for R&D of plastic reduction technologies in 2021.[132] Part of this grant money could be apportioned to the prize fund, which may better incentivize innovation than direct subsidies to researchers.

Some private individuals, corporations, and non-profit entities have started their own prize-based initiatives to spark green innovation. For example, Elon Musk currently offers $100 million in prize money for the best carbon capture technology.[133] National Geographic recently held the Ocean Plastic Innovation Challenge and awarded $1.3 million for inventors developing novel solutions to address the plastic pollution problem.[134] The government could encourage similar prizes as a complement to a federal prize fund by, for example, granting tax incentives to individuals and organizations offering them.

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[132] DEP'T OF ENERGY, *DOE Announces $14.5 Million to Combat Plastics Waste and Pollution*, ENERGY.GOV (May 25, 2021), https://www.energy.gov/articles/doe-announces-145-million-combat-plastics-waste-and-pollution.

[133] *See* Catherine Clifford, *The Who, What And Where Of Elon Musk's $100 Million Prize Money For Carbon Capture Innovation*, CNBC (Feb. 8, 2021), https://www.cnbc.com/2021/02/08/who-what-where-of-elon-musks-100-million-prize-for-carbon-capture.html.

[134] *National Geographic and Sky Ocean Ventures Award $1.3 Million as the Ocean Plastic Innovation Challenge Winners are Announced*, NAT'L GEOGRAPHIC (Dec. 12, 2019), https://blog.nationalgeographic.org/2019/12/12/national-geographic-and-sky-ocean-ventures-award-1-3-million-as-the-ocean-plastic-innovation-challenge-winners-are-announced/.

C. Increasing Market Demand through Regulation: The government should establish a comprehensive federal scheme on plastic pollution.

Currently, plastic pollution is mainly regulated by states and other local governments due to an absence in national legislation.[135] As a result, governance is fragmented, and corporations can often exploit regulatory gaps and avoid internalizing the costs of their polluting activities.[136] By implementing comprehensive federal regulation, these gaps may be closed. Businesses would be forced to consider costs of non-compliance with plastic pollution regulations, thereby increasing market demand for products aiding in compliance.

In March 2021, policymakers introduced the Break Free From Plastic Pollution Act, a federal bill designed to comprehensively address plastic production, use, and waste management across the nation.[137] The Act includes several regulatory efforts that may increase demand for plastic remediation technologies. First, the Act bans certain non-recyclable single-use plastics,[138] which may incentivize and encourage the development of alternatives. Minimum standards for recycled content in beverage containers, packaging, and food-service products are also detailed in the Act.[139] The Act also protects state and local governments that set stricter standards for plastic pollution,[140] which may further increase demand in those jurisdictions.

Implementation of this Act, or a similar federal scheme, could correct market demand failures involving both individual consumers and businesses. The collective action problem discouraging individuals from choosing green alternatives is mitigated where widespread public action is legally mandated. As a result, early-stage diffusion of emerging technologies may increase, shortening the time consumers spend in a "wait to see" phase.

By allowing market demand to better align with social values, comprehensive federal regulation may increase incentives to develop green technologies. Despite its necessity, the Break Free From Plastic

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[135] Hannah Seo, *The US Falls Behind Most Of The World In Plastic Pollution Legislation*, ENV'T HEALTH NEWS (Oct. 4, 2021), https://www.ehn.org/plastic-pollution-2655191194/u-s-lags-behind-plastic-pollution-regulation.

[136] Schmaltz, *supra* note 35, at 2.

[137] Seo, *supra* note 122.

[138] *The Break Free From Plastic Pollution Act of 2023*, S.3127, 118th Cong. (2023).

[139] *Id.*

[140] *Id.*

Pollution Act (or similar federal schemes) will certainly face opposition from a range of stakeholders, and politicians will consider this opposition during voting. Public awareness campaigns may be used to educate consumers on the extent of the plastic pollution issue, and a focus should be placed on how individuals personally contribute to ocean degradation. Because some of the Act's regulations will not take effect until a few years later, affected industries have a chance to adapt their practices to ensure compliance with the Act's provisions. Industries on the fence may be swayed by further delaying implementation or extending the length of the "phase-out" periods. However, certain corporations, specifically those manufacturing single-use plastics, will likely never support this Act. Even if proponents cannot garner enough votes, portions this Act with bipartisan support may be severed and proposed on their own accord.[141]

D. Shifting the Burden: The government should implement Extended Producer Responsibility schemes for industries producing significant amounts of ocean plastic waste.

If comprehensive federal regulatory efforts lack adequate support, the government should focus on Extended Producer Responsibility (EPR) schemes to incentivize the development of green technologies. EPR schemes hold producers responsible for post-consumer waste stemming from their activities and can effectively shift the economic burden of plastic waste upstream onto producers.[142] In effect, producers in industries generating significant plastic waste would be faced with massive fees and costs. These producers would thus have a substantial need for remediation technologies, creating demand in the market. The government should start by imposing EPR on manufacturers of single-use plastics, as these products generate a significant amount of the plastic waste littering the world's oceans.

EPR schemes may be particularly effective in the marine plastic pollution context for a few reasons. First, by targeting the specific industries generating the majority of plastic waste, EPR policies may gather more widespread support than legislation affecting broader industries. Two-thirds of Americans are already willing to spend more money on sustainable replacements for single-use plastics,[143] so there may

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[141] *See* Seo, *supra* note 122.

[142] Hannah Yang, *Introducing a Voluntary Extender Producer Responsibility Scheme for the New Plastics Economy*, N.Y.U. ENV'T L.J.: ENV'T L. REV. SYNDICATE (Dec. 23, 2020), https://www.nyuelj.org/2020/12/introducing-a-voluntary-extended-producer-responsibility-scheme-for-the-new-plastics-economy/.

[143] Laura Santhanam, *Most Americans Would Pay More To Avoid Using Plastic,*

be less public opposition to this narrowly focused legislation. Next, EPR schemes can reduce the amount of plastic in circulation from its point of production, rather than relying on subsequent regulations involving its use or disposal. This may increase the effectiveness of other clean-up efforts and reduce the load on the nation's existing waste management infrastructure.

E. Patent Office Changes: The USPTO should adopt new standards for applications related to ocean plastic pollution technologies.

While prior USPTO efforts did little to incentivize innovation, these programs may be significantly more effective when paired with alternative incentive mechanisms and regulations aimed at increasing market demand. USPTO efforts may take a wide variety of forms, including: implementing long-term prioritized exam procedures for green innovations, extending the duration of existing programs like the Climate Change Mitigation Program, broadening subject matter requirements to encompass a wide range of green technologies, including ocean plastic remediation technologies; or reducing fees and filing costs.[144] The USPTO may choose to direct these efforts towards green innovations in general, or technologies relating to marine plastic waste specifically.[145]

In adopting new standards, the USPTO should avoid a few of the issues accompanying its past efforts. For example, the Green Technology Pilot Program, in addition to its disregard of the underlying market-demand incentive problem, was riddled with flaws in its design and implementation. In the program's early stages, the USPTO used an overly restrictive classification system that excluded many green inventions from eligibility.[146] While participation increased once this classification system was removed,[147] future USPTO programs should avoid this type of scheme from the outset. The USPTO also limited this program to 3000 applications, [148] but a future program would be wise to avoid an

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Poll Says, PBS (Nov. 26, 2019), https://www.pbs.org/newshour/nation/most-americans-would-pay-more-to-avoid-using-plastic-poll-says.

[144] *See* Tur-Sanai, *supra* note 6, at 223–24.

[145] "Greenwashing" – here, the concern that applicants could attempt to disingenuously characterize their invention as "green" or environmentally friendly to qualify for an accelerated examination program – should be noted. However, applicants have a duty of candor in all dealings with the patent office under 37 C.F.R. 1.156(a). This "Rule 56" obligation does not entirely eliminate the risk of greenwashing but may mitigate it.

[146] Tran, *supra* note 8, at 145.

[147] *Id.*

[148] *Id.* at 144–45.

application limit altogether.

Unfortunately, rather than improving upon the flaws of Green Technology Pilot Program, the USPTO's new Climate Change Mitigation Program perpetuates many of the same issues as its predecessor. [149] The USTPO's newest program is, again, limited in both duration and subject matter eligibility, and it is reasonable to expect the Climate Change Mitigation Program to have only minimal impacts on green patenting outcomes.

There are a variety of mechanisms that may be used to encourage the USPTO to adopt new procedures for ocean plastic pollution technologies.[150] Most directly, Congress could pass federal legislation directing the USPTO to alter its rules, which could include improvements to existing USPTO programs, or the implementation of new programs specifically aimed at plastic remediation technologies. If political support is lacking, Congressional committees or federal advisory committees could recommend these changes. Agencies that already recognize the extent of the plastic pollution problem, such as the DOE, could also prompt USPTO action. Finally, interest groups, corporations, and other members of the general public could also use petitions to encourage the agency to act.

F. Letting the Market Regain Control: Alternative incentive mechanisms should be phased-out once market demand better aligns with social value for green innovations, but these programs should not be eliminated entirely.

Prize funds and direct research subsidies are especially important in early stages. These mechanisms may overcome certain market failures associated with individual consumers by increasing product diffusion,[151] allowing these technologies to reach widespread use at faster rates. Because regulations aimed at increasing demand will require a few years to take effect, alternative incentive schemes are essential to spur immediate development. These programs, however, require extensive federal funding. Thus, it is important that the market itself regains control and provides adequate incentives for the development of ocean plastic remediation technologies.

Fortunately, the need for alternative incentive mechanisms may

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[149] *Infra* notes 104-110 and accompanying text.

[150] *See A Guide to the Rulemaking Process*, OFFICE OF THE FEDERAL REGISTER, https://www.federalregister.gov/uploads/2011/01/the_rulemaking_process.pdf (last visited Dec. 2, 2021).

[151] Tur-Sanai, *supra* note 6, at 241.

decrease as market demand for green technologies increases. These programs may be reduced or limited once market demand for marine plastic technologies accurately reflects the social value of these inventions. However, as the use of plastic remediation technologies increases, and less plastic waste ends up in the world's oceans, the market demand for these green inventions will unfortunately decline.[152] To ensure continuing incentives for development, prize funds and research subsidies should not be entirely eliminated.

IV. CONCLUSION

While new technologies are essential in the fight against plastic pollution, the patent system's reliance on market demand to drive innovation presents a massive hurdle. To incentivize the development of these marine plastic innovations, the U.S. government should focus on alternative incentive mechanisms, federal regulations aimed at increasing market demand, and changes to USPTO practices, before allowing the market to regain control. With more creative incentivizing solutions, comprehensive regulations, and lower barriers to obtaining a patent, a cleaner ocean may finally be on the horizon.

[152] *Id.* at 214.