

Sea of Opportunity

EXECUTIVE SUMMARY



**Supply Chain Investment Opportunities
to Address Marine Plastic Pollution**



Sea of Opportunity

EXECUTIVE SUMMARY

Supply Chain Investment Opportunities to Address Marine Plastic Pollution

Recommended Citation

Moss, E., Eidson, A., and Jambeck J., 2017.

Sea of Opportunity: Supply Chain Investment Opportunities to Address Marine Plastic Pollution, Encourage Capital on behalf of Vulcan, Inc., New York, New York.

Publication Date

February 2017



A Paul G. Allen Company



Acknowledgements



Philanthropist Paul G. Allen funded this report to identify impact investment opportunities for those joining the fight to eliminate plastics pollution as a significant contributor to the rapidly deteriorating health of our ocean. Millions of metric tons of plastic are dumped into our ocean annually, and through this report potential investors will better understand how they can most efficiently and effectively help to disrupt the plastics supply chain and prevent plastics pollution in the first place. Mr. Allen's unique data- and technology-driven approach to some of the world's toughest challenges catalyzes innovation, improves policy, and accelerates change for the better. He believes this report can have the same effect on the future of our ocean.

This report is intended solely as an informational resource for those individuals and organizations seeking to support solutions to the problem of ocean plastics. It is not intended to prescribe specific investment approaches, speculate about potential

risks or returns, or recommend individual companies for investment. And, as always, investors need to conduct their own extensive due diligence on these suggestions before making any investments. This report does not claim to have completed exhaustive due diligence on any of these approaches.

This report has been produced by Encourage Capital who takes full responsibility for the report's contents and conclusions. While our technical advisors and the many organizations consulted have greatly informed the content of this report, their participation does not necessarily imply endorsement of the report's contents or its conclusions. We are very thankful for their contributions.

Principal Authors: Ellie Moss, Alex Eidson, Dr. Jenna Jambeck

Contributors: Ricardo Bayon, Adam Wolfensohn



Foreword

Over the last five years, plastic waste in the ocean has become a more pressing, quantified, and well-publicized problem. Previously considered benign and dilute, increased attention has put ocean plastic on the agenda for many academics, NGOs, governments and companies.

Data now exist that not only establish that this problem requires immediate and significant attention, but also provide insight into various interventions and where to focus intervention efforts. The story of ocean plastics is interwoven with global development challenges such as poverty, sanitation, sustainable cities and communities, responsible production and consumption, women's empowerment and child labor.

Effectively addressing the causes of ocean plastics will directly and significantly contribute to progress on the 2030 Agenda and Sustainable Development Goals as well as other sustainability and development-related objectives set by countries and municipalities around the world. More importantly, addressing this problem

will lead to a better quality of life for millions – if not billions – of people around the world.

While there is continued interest from traditional government and philanthropic sources on issues of plastic pollution, very little investment capital has flowed to directly address this fast-growing and multifaceted problem. And, given the scale of the problem, it is becoming increasingly clear that the problem is not likely to be resolved without significant investment from private capital sources.

The goal of this report is to show how private capital can play a meaningful role in tackling the issues of plastic pollution across the world's ocean. Numerous investment opportunities are highlighted across the risk/return spectrum where investors can gain a return on investment, while also having a meaningful impact on the problem of ocean plastics. While investment is the primary focus of this report, it also highlights the role that catalytic philanthropy, citizen engagement, and government actions can play, working in concert with investment solutions across the value chain.

Together, these efforts can drive significant reductions in plastic waste generation and losses to the ocean environment.

This is a challenge of global proportions, but, if there is good news, it is that the worst effects of ocean plastics can still be avoided with strategic, timely and coordinated actions. There is still time, and there is ample opportunity, for diverse funders to make a series of well-orchestrated, high-impact investments that will meaningfully shift the trajectory our ocean is currently following. However, delayed or diminished efforts will allow a doubling of plastic waste inputs into the ocean, with potentially serious consequences for the ocean, marine life, and human health and wellbeing.

As with many other complex challenges, slowing the flow of plastics into the ocean will require concerted, coordinated and collaborative global action from industry, citizens, non-governmental organizations, governments at all levels, philanthropists and investors. It also touches many large, slow-moving, and interconnected sectors of the economy, everything

from the petrochemical industry to industrial design to waste management. This report focuses on the role of investors and opportunities for greatest impact and most attractive returns, with recognition of the critical interdependencies with the work of other actors in the system, especially the complementary role of philanthropists.

This framework for investment is offered with optimism for the potential to effectively slow the flow of plastic waste into the ocean, and in doing so, speed the course of sustainable development globally.

The Problem

I magine five grocery-size plastic bags filled with plastic waste. In your mind, stack them one on top of the other. Now picture one stack of five bags for every foot of coastline in the world, across North America, South America, Europe, Asia, Africa, Australia and Antarctica. This is what eight million metric tons of plastic waste looks like. And this is how much plastic waste enters our ocean every year. Without intervention, this number is expected to double to 17 million metric tons per year by 2025.^[1]

Our ocean is in crisis. Plastics in the ocean are devastating marine life, damaging ecosystems, burdening fishing and shipping industries with costs of millions of dollars a year, reducing tourism revenue, and accumulating in the food chain for human consumption.^[2-6] And yet, each year another eight million metric tons or more of additional plastic waste enters the ocean.^[1]

Plastics in the ocean are a mix of macroplastics and microplastics. Macroplastics include abandoned or derelict fishing gear, expanded polystyrene foam, single-use wrappers and plastic bottles. Microplastics are less than five millimeters long and are either intentionally produced (e.g., microbeads) or the result of the photodegradation of macroplastics.^[3]

It is estimated that 80 percent of plastic waste in the ocean comes from land-based sources ^[3] and about half of that comes from four countries: China, the Philippines, Indonesia and Vietnam. The other half comes largely from other rapidly developing countries in Asia, Africa, and Latin America, and there is also a contribution from high-income countries with large populations and long coastlines.^[1]

Once they have entered the ocean, plastics end up in nearly every component of the marine environment.

Just where a particular piece will end up is determined partly by its characteristics and partly by the movement of the ocean. Some plastics float, such as polyethylene and polypropylene, while denser plastics sink, ending up as deep as the sea floor.^[4] Plastics have been found in the world's most remote waters, on the ocean floor, in sea ice, in sediment, and littering beaches in uninhabited areas.^[7]

The items most commonly found on beaches and in harbors are single-use plastic items such as grocery bags, food packaging, bottles, bottle caps, utensils, and straws.^[8] This is not surprising considering about 40 percent of plastic produced each year becomes single-use packaging and another 20-25 percent goes to consumer and institutional products.^[9]

Most of the plastic in the ocean is not floating on the surface. The plastic floating in the five gyres, such as what has been termed the "Great Pacific Garbage Patch," is estimated at 475,000 metric tons¹, ^[10, 11] a mere fraction of the total amount of plastic in the ocean, and dwarfed in comparison to the estimated eight million metric tons entering the ocean every year. This means that removing all of the plastic currently floating in these five gyres (if this were economically and physically feasible, which it currently is not), would only remove approximately three percent of the plastics entering the ocean each year.

¹ This estimate sums the top microplastic data from source ^[10] and the large items from source ^[11], which equals 475,000 MT, and then divides by 8 MMT to get the 3 percent value.

Ocean plastics are devastating marine life.

Ocean plastics are the single biggest debris threat to marine life today – 82 percent of the debris threats to marine life were plastic.^[5] Nearly 700 species of fish, birds, sea turtles, sea mammals and other marine animals are known to have been killed by ocean plastic, some in large numbers.^[12] Ocean plastics can also amplify the exposure of marine life to toxic persistent organic pollutants.^[13] The implications for human health are not yet well understood.^[3] Lost or discarded fishing gear is known to damage reefs and other marine environments and it also continues “ghost fishing,” where it traps or entangles fish, turtles, birds and other animals, resulting in injury or death.^[14, 15]

Ocean plastics also exact social and economic costs.

The short-term social and economic costs are being borne primarily by coastal communities, commercial fishing and commercial shipping. Losses on the order of tens to hundreds of millions of dollars have been reported by communities and businesses. The longer-term economic and social costs of ocean plastics have the potential to be much higher.^[2, 16]

The ocean plastics problem does not begin the moment a plastic bag floats out to sea. Rather, that moment is the culmination of a cascade of choices made by fossil fuel producers, materials engineers and producers, product designers, small, medium and multinational corporations, entrepreneurs, governments at all levels, waste management companies, informal waste sector workers, and individual citizens.



The Solutions

It is essential to take a whole-system view to fully understand both the drivers of – and potential solutions to – plastic waste in the ocean. With this approach, it becomes evident that there is no single solution to this problem. Instead, a portfolio of interventions is required to address the problem across the value chain and to achieve results at different scales and in different time periods (i.e., in the near-, medium- or long-term).

The plastics value chain covers the full life cycle of plastic – from design and production through end of life. The plastics value chain begins with the creation of plastics in their many forms. These plastics are then made into products and packaging, which are selected, used and ideally reused by consumers. Once consumers are done with these plastics, they become plastic waste for collection and management. Plastics may then be recycled, composted or repurposed, end up in a landfill or dump, or serve as feedstock for “Waste-to-Energy” (WTE). Finally, plastic that has escaped collection and enters the environment may still be captured prior to entering the ocean through last-chance capture.

Just as the root causes of the ocean plastics problem are found at each stage of the value chain, so too are the potential solutions. Stopping the flow of plastics into the ocean requires rethinking and reworking how plastics are made, used, reused and disposed of in a way that is economically viable. The system view also highlights the interdependency and, at times, tension, between different stages of the value chain. For example, successfully increasing reuse requires products that are designed to be reused, infrastructure that facilitates their reuse, and consumers willing

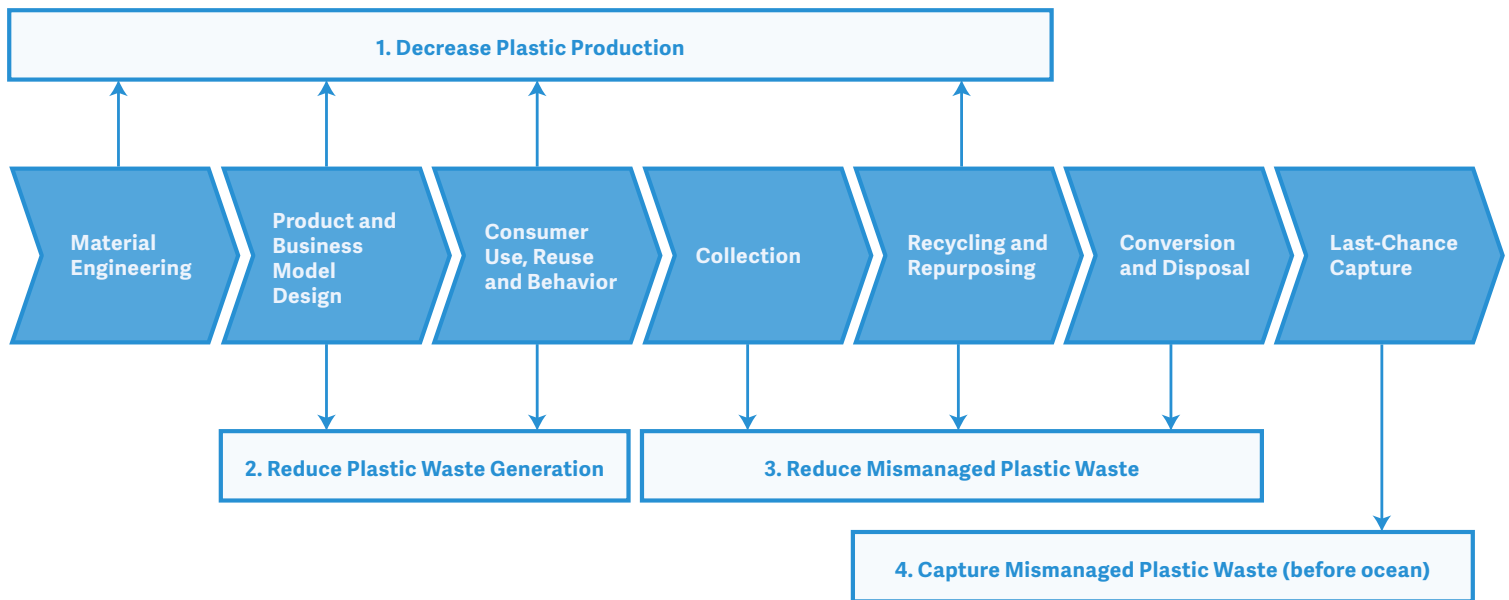
to reuse them. Similarly, when considering waste management solutions, it is essential to consider the entire waste process from collection through recycling, conversion or disposal as an integrated whole.

There are four mechanisms across the plastics value chain for reducing plastic waste entering the ocean (see graphic on page 9):

1. decreasing plastic production,
2. reducing plastic waste generation,
3. reducing mismanaged plastic waste, and
4. capturing mismanaged plastic waste before it becomes ocean plastic.

This report identifies ten intervention strategies to disrupt the trajectory of accelerating plastic pollution in the ocean. Of these, seven are high-impact investment strategies to deploy throughout the value chain (and with a variety of risk/return profiles). The remaining three strategies are for additional levers such as philanthropy, citizen engagement, and government actions and the role they play in solving this problem. These sectors, however, are not the focus of this report. A brief overview of this work has been included where it is most relevant to driving investment.

Four Mechanisms Across the Plastics Value Chain for Reducing Plastic Waste Entering the Ocean



Impact Investments

1. Accelerate and Scale Better Materials: Accelerate the development and scale-up of better (bio-benign or more readily recyclable), commercially viable materials for packaging and single-use plastic applications.

- a. Plastics, additives, and adhesives that emphasize bio-based feedstocks, are less toxic, biodegrade more quickly and/or more easily, and are economically and fully recyclable
- b. Alternatives to current plastics such as wood, bamboo, algae, mushroom, and others

2. Promote Innovative Products and Circular Business Models: Support companies with innovative products and circular economy business models that enable and promote product and packaging reuse, repair and refurbishment, product-as-a-service, recapture and recycling, and reductions in plastic usage.

3. Advance Collection, Tracking and Sorting Innovations: Accelerate the adoption at scale of next-generation collection, tracking and sorting technologies that can lead to greater recycling and circularity.

4. Engage and Support the Informal Waste Sector:

Provide equipment, opportunities and incentives for the informal waste sector in Southeast Asia, Africa, and Latin America (“waste pickers”) to enhance their collection of low and high-value plastic waste.

5. Enhance Recycling, Repurposing and Composting:

Support the development and scaling of materials and products that use reclaimed or recycled feedstock, creating pull in the system to better capture waste at each stage of the value chain (both circular loops like bottle-to-bottle recycling as well as waste repurposing).

6. Develop Responsible Waste-to-Energy Conversion

Solutions: Provide financing for context-driven, environmentally and financially sound advanced Waste-to-Energy (WTE) technologies, such as

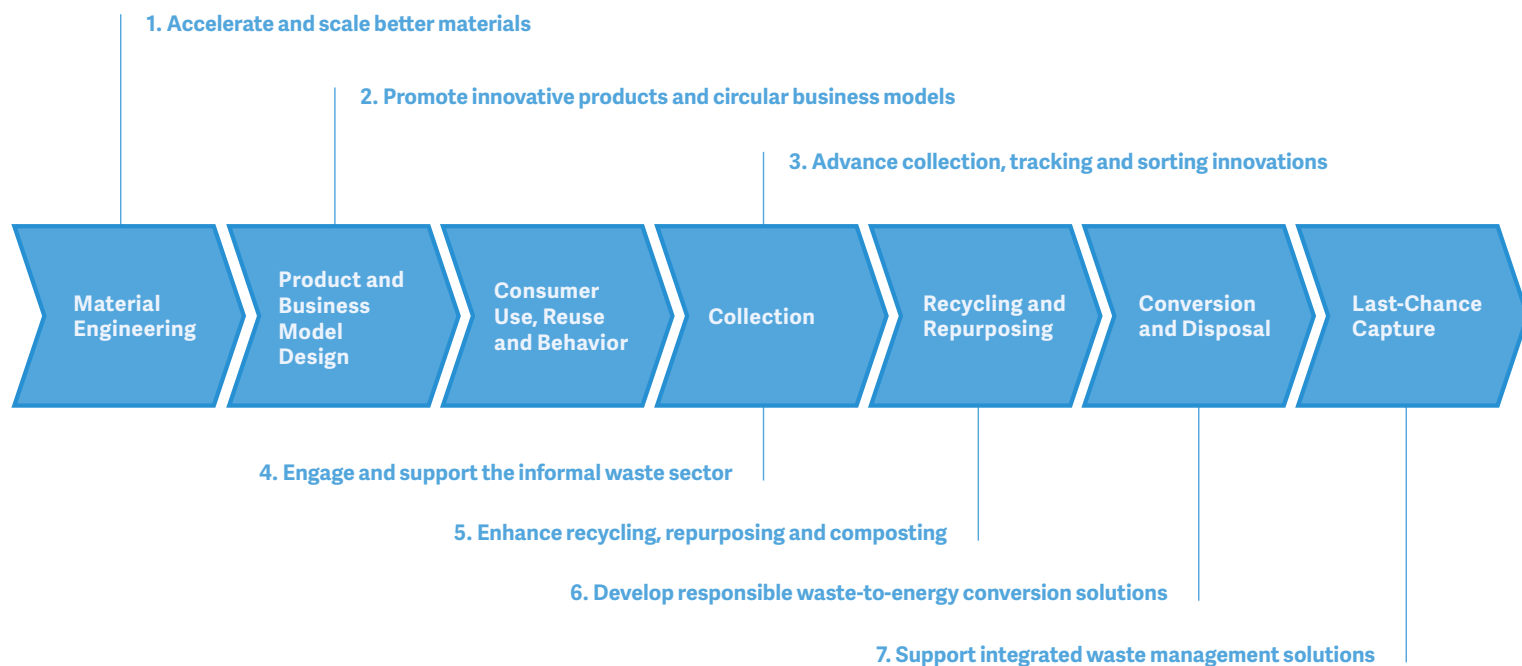
gasification and pyrolysis, to underwrite scale-up risk from pilot to first commercial plant.*

**Please note: WTE investments require extensive due diligence to assure their economic and environmental viability. There is currently much debate on the role of WTE in waste management and it is out of scope for this report to determine exactly where, how and with what existing or new technologies WTE may make sense, but they are considered a potential solution.*

7. Support Integrated Waste Management Solutions:

Provide financing for facilities and/or services that are part of integrated waste management solutions in countries with low rates of waste capture and high leakage in areas of Southeast Asia, Africa, and Latin America.

Seven Investment Strategies Across the Plastics Value Chain



Additional Levers

8. Philanthropy: Use catalytic philanthropy to spur innovation in material design, waste collection, and other sectors.

9. Citizen Engagement: Raise public awareness, facilitate ocean-friendly purchasing decisions, and encourage citizens to make modest behavior changes.

10. Government Actions: Use policy, international action, and government capital expenditures to accelerate change.

Each of these strategies can play a vital part in reducing the flow of plastic into the ocean and, taken collectively, they represent a comprehensive set of priorities for investment that address the problem of ocean plastic.



The Role of Investors

Making this shift to a new, self-sustaining plastic paradigm will require significant investment from businesses, investors, and others. Unfortunately, to date there has been insufficient investment emphasis placed on any of these solutions, even from development finance institutions. In this context, identifying solutions that are both impactful as well as profitable is of paramount importance for mobilizing capital from a broader group of investors.

Investors have an opportunity now to make attractive, strategic, high-impact investments to slow the flow of plastic into the ocean and minimize the damage it can do. There are roles for all types of investors and a diverse group will be needed to individually and collectively pursue these opportunities.

Different strategies lend themselves to different types of investment. Investors seeking opportunities in multiple asset classes will be able to find investment opportunities that meet a wide range of impact and return criteria. This report is focused on those areas that offer a competitive financial return for a given level of risk, but within that context the opportunities represent a very broad range of asset types and risk/return profiles. For example, investments in material, product and business model design can be structured as either venture capital investments in innovative companies, growth equity financing for more established firms, or debt or equity investments in the infrastructure these firms will need to grow their operations.

There are a range of different types of funders who may play a role in tackling the ocean plastics problem: Development Finance Institutions (DFIs), infrastructure investors, impact investors, other private or institutional investors, the private sector, and foundations, philanthropists and other grant funders.

Opportunities From Plastic Source Through Use



Accelerate and Scale Better Materials

The ideal portfolio of plastic and alternative options would include cost and performance-competitive materials meeting these criteria, where the materials were bio-based to the extent possible in the near to medium term:

- Backyard/ocean biodegradable plastics for single-use and packaging applications
- High-value recyclable plastics that are easy to identify/sort and are worth collecting (e.g., not too light-weight, single material, no problematic adhesives or additives)
- Biodegradable / water-soluble non-toxic films
- Additives that exclude substances of concern
- Biodegradable adhesives that exclude substances of concern
- Non-plastic, easily biodegradable materials that are suited to their use

There are promising materials at varying stages of development today that have the potential to be part of the solution. Among the investments considered within the materials innovation section, there are opportunities to deploy venture capital for investments ranging from lab space for the most nascent material science research on the low end to combined debt/equity infrastructure investment for a commercial-scale manufacturing facility on the high end. These materials would be designed to replace the most prevalent and harmful ocean plastics. Individual investments in companies working on the creation of new materials range from \$500,000 to \$50 million for individual investments.

Promote Innovative Products and Circular Business Models

There are six design strategies to inform product and packaging design, with implications for business model design as well:

1. Use less material
2. Design for longer life, repair and refurbishment
3. Enable and promote reuse and refills
4. Improve rates of recapture
5. Design for recyclability
6. Offer product-as-a-service

These innovations present a range of investment opportunities from venture capital investments in innovative companies to growth equity financing for more established firms, to debt or equity investments in the infrastructure these firms will need to grow their operations. This represents a system change, particularly as it relates to delivery systems, reuse, and product-as-a-service models. Additionally, there are also targeted design solutions for fishing gear, which has a distinct set of requirements and constraints. The potential for investment in this area is estimated to range from \$2 million to \$10 million per deal.

There is also an opportunity for investors to demand greater transparency on a range of ocean-plastic-related metrics, such as plastic use per unit of revenue, which would enable all investors to better take these impacts into account in their investment strategies.

Opportunities with Post-Consumer Plastics



Advance Collection, Tracking and Sorting Innovations

Collection is the key to diverting plastic waste from the ocean: waste that is collected has a dramatically higher likelihood of being recycled or properly disposed than that which is not. However, collection typically represents a net cost in the waste management process and must be paid for by citizens, businesses and/or government. Finding and scaling ways to reduce the cost of collection is essential to expanding collection services. Innovations in tracking and sorting can further drive down cost and increase the amount of value that can be extracted from the waste stream. There are a range of companies, from start-up to mature, working on innovations that lower cost and improve quality for collection, tracking and sorting of waste streams, which both brings down the cost of collection and increases the potential for material circularity. Investment opportunities in this area range from \$1 million per deal on the low end to \$30 million per deal on the high end.

Engage and Support the Informal Waste Sector

In countries with inadequate waste infrastructure, the “waste pickers” of the informal waste sector collect a significant amount of the total waste collected. Waste picking provides a way for people with very few options to make what is typically a subsistence living but the conditions can be unsanitary and even unsafe. While, historically, attitudes toward waste pickers had been negative, this is now shifting as their work is being recognized as valuable, especially the collection of

plastic waste before it enters the ocean. Waste pickers in some locales have even successfully organized into waste picker cooperatives or unions, which offer greater economic opportunity and improve working conditions. Waste worker cooperatives and zero waste groups are seeking funding to expand their work in high-impact countries. They seek loans for small amounts so that they can buy hand- or motorized carts for collection, build small-scale sorting facilities, and educate residents on their programs. The opportunity for investment here ranges from \$500,000 to \$15 million per deal globally over the next three years.

Enhance Recycling, Repurposing and Composting

Recycling, repurposing and composting are critical to keeping plastic out of the ocean. Simply put: when post-consumer plastic is seen as having sufficient potential value, it will be captured. While the recycling industry has struggled in recent years from challenges to its economics, there are ways to strengthen it and create pull in the system for plastic waste. Specifically, action is needed to innovate recycling processes and technologies, find ways to recycle or repurpose waste into higher-value products, drive greater use of recycled content in packaging, promote recycling for non-plastics as well. It will also be necessary to increase industrial composting capacity to keep pace with the growth in compostable plastics. There are opportunities to support companies that are advancing the use of recycled materials, finding ways

to repurpose or recycle a range of different plastic feedstocks for a second life in higher-value products. There are also companies investing in industrial composting capacity. The potential for investment here is estimated to range from \$2 million to \$25 million per deal, covering a range of potential investments from a very basic plastic recycling plant to a state-of-the-art recycling/repurposing facility.

Develop Responsible Waste-to-Energy (WTE) Conversion Solutions

Incineration, or the combustion of waste, is currently the most common form of WTE, but this category also includes other forms of thermal conversion of waste, such as gasification, pyrolysis, and plasma arc technologies. Although not directly WTE, byproduct gases generated from waste (e.g., through anaerobic digestion and landfill gas), can be used as a source of energy as well. Responsible WTE facilities may contribute to an integrated waste management solution for ocean plastics, though it must be noted that there are divergent views on the economic and environmental viability of WTE technologies, including concerns about their impact on human health. There is evidence that shows that, in some contexts, WTE facilities may be able to use waste to generate energy in a 'double win' for municipalities. However, in other cases, problems with energy generation, environmental outcomes or financial weakness have led to the failure of some WTE facilities, often with serious consequences for the municipalities that supported them. There are also concerns that WTE discourages waste reduction efforts as waste becomes seen as a needed feedstock. Some observers, however, argue that more advanced technologies hold promise for cleaner, safer and more economically sound WTE, though they will require time and funding to be proven, tested and scaled. Investors interested in WTE solutions should carefully consider all possible benefits, costs, and risks associated with WTE before investing. These facilities can cost anywhere from \$20 million to over \$500 million, depending on their size and technology. In cities that currently lack adequate collection systems to accommodate WTE facilities, the costs of these collection systems must be added to the total and can range from \$5 to \$50 million depending on the size of the municipality.

Support Integrated Waste Management Solutions

The central challenge of waste management infrastructure development is an economic one: the inherent value of the waste does not cover the cost of collection and disposal. There are opportunities to generate revenue throughout the waste value chain by recycling, composting, and possibly WTE technologies, but their economic viability is dependent on a mix of commodity prices and regulated sources of revenue such as feed-in tariffs and tipping fees, and is subject to supply risk (the quantity and composition of the waste they receive), political risk, contract/counterparty risk and risks from corruption. Nonetheless, creative project developers and investors are finding ways to make viable investments by designing vertically-integrated waste management solutions that draw on diverse sources of investment capital and revenue, mitigate the biggest risks, and are designed to work within the unique local context.

These investments can be structured in a variety of ways, allowing diverse investors to play a part in the ultimate solution. For investors interested in debt investments, cities may issue municipal debt to pay for: increased collection; waste worker cooperatives in need of loans; and infrastructure for Material Recovery Facilities (MRFs), Plastic Recovery Facilities (PRFs), composting facilities, and WTE facilities. Equity investors can take ownership stakes in any one of a number of WTE companies or waste collection/management companies. Depending on their geographic focus and their existing track records, these investments could display dramatically different risk/return profiles. Individual deals are estimated to range from \$20 million to over \$500 million each.

It must be acknowledged that for some of these investments it is unrealistic to expect "market rate" returns for the given risks. Of the 500 largest cities in developing countries, for example, only 4 percent have sufficient credit to access municipal debt markets. [17] Many of these cities are located in the countries that leak the greatest amount of plastic waste into the ocean, making it imperative to expand their access

to financing for urgently needed improvements and infrastructure. Today's low price of oil and petroleum-based polymers present similar challenges to waste-to-fuel companies and bio-benign plastics producers seeking financing for their first commercial facilities. In these instances, it will be necessary to layer in concessionary capital from mission-oriented organizations such as foundations, the World Bank, FMO, USAID, and other philanthropic or development-finance institutions together with private investment capital seeking more commercial rates of return. These groups, along with impact investors, may value the environmental benefits and public health outcomes associated with their investment enough to make catalytic but otherwise sub-commercial investments in order to spur innovation and progress.



Additional Levers

A discussion of the investment opportunities to reduce the flow of plastics into the ocean would be incomplete without recognizing other key levers for change and their ability to amplify the impact of investment. Philanthropy, citizen engagement, and government policies and actions can complement and strengthen the investment opportunities outlined in this report.

Philanthropy can be used catalytically in many ways to unlock new investment possibilities. In particular, philanthropy has potential to uncover new solutions through research and development; support higher-risk, high-impact investments; and offer market-altering prizes that may spur new innovations.

Citizens globally can and must begin to make choices that can reduce the problem of ocean plastics. As individuals across the world make choices today that contribute directly to the ocean plastics problem, they also have significant power to stop the flow of plastic into the ocean. Citizens have two main ways to affect change on ocean plastics: 1. change their purchasing choices, and 2. change their own behavior around plastic use and end-of-life waste management. Before they will do either of these things, however, they first have to understand and care about the problem, emphasizing the importance of raising awareness of this issue globally.

Governments are critical actors in the fight against ocean plastics. They can use policy to create the conditions for successful action from material development through the waste management system, engage internationally to support global collective action, and fund efforts that stop the flow of plastic waste into the ocean. In many cases, policies can impact the viability and ultimate success of an investment, either directly or indirectly. Interested investors would be wise to carefully consider the policy landscape relevant to a particular investment opportunity.

This report provides current and potential investors with a solid understanding of the problem, a clear set of actionable solutions, insight into possible investment approaches, and ultimately a compelling framework for coordinated action against ocean plastics.

Conclusion



The time to act on ocean plastics is **now**. This investment roadmap provides opportunities for diverse investors to get involved: there are opportunities across the plastics value chain, across asset classes, at different levels, and with different time horizons that meet a broad range of interests and requirements. In addition to being attractive, strategic investments, these opportunities hold tremendous potential for impact on a problem with global implications for the environment and for people. With swift action to invest in these many solutions, the amount of plastic waste entering the ocean can be slowed from a torrent to a trickle.



Intervention Strategies	Timing of Initial Impact	Total Potential Impact	Range of Individual Investment Size (Min/Max)	Type of Investment	Geographic Focus
1. Accelerate and Scale Better Materials: Accelerate the development and scale-up of better (bio-benign or more readily recyclable), commercially viable materials for packaging and single-use plastic applications	5-10+ years	High	\$500,000 to \$50 million	Early Stage Project or Company Equity	Global Opportunities
2. Promote Innovative Products and Circular Business Models: Support companies with innovative products and circular economy business models that enable and promote product and packaging reuse, repair and refurbishment, product-as-a-service, recapture and recycling, and reductions in plastic usage	3-5 years	Medium	\$2 million to \$10 million	Early Stage and Growth Equity, Project Equity	Global Opportunities
3. Advance Collection, Tracking and Sorting Innovations: Accelerate the adoption at scale of next generation collection, tracking and sorting technologies that can lead to greater recycling and circularity	3-8 years	Medium	\$1 million to \$30 million	Early and Growth Stage Corporate Equity	Middle- and High-Income Countries
4. Engage and Support the Informal Waste Sector: Provide equipment, opportunities and incentives for the informal waste sector in Southeast Asia, Africa and Latin America ("waste pickers") to enhance their collection of low and high-value plastic waste	1-3 years	High	\$500,000 to \$15 million	Microfinance, Pay-for-Performance Impact Bond	Asia, Africa and Latin America

Intervention Strategies	Timing of Initial Impact	Total Potential Impact	Range of Individual Investment Size (Min/Max)	Type of Investment	Geographic Focus
5. Enhance Recycling, Repurposing and Composting: Support the development and scaling of materials and products that use reclaimed or recycled feedstock, creating pull in the system to better capture waste at each stage of the value chain	3-8 years	High	\$2 million to \$25 million	Early Stage and Growth Equity, Project Equity	Global Opportunities
6. Develop Responsible Waste-to-Energy (WTE) Solutions: Provide financing for context-driven environmentally and financially sound advanced WTE technologies, such as gasification and pyrolysis, to underwrite scale-up risk from pilot to first commercial plant*	3-5 years	Medium	\$20 million to \$500 million+	Project or Corporate Equity, Tech-Focused Loan Guarantees	High-Income Countries
7. Support Integrated Waste Management Solutions: Provide financing for facilities and/or services that are part of integrated waste management solutions in countries with low rates of waste capture and high leakage in areas of Southeast Asia, Africa, and Latin America	3-5 years	High	\$20 million to \$500 million+	Project Equity, Stacked Financing with DFIs/ First-Loss Investors	Asia, Africa and Latin America
* Please note: WTE investments require extensive due diligence to assure their economic and environmental viability. There is currently much debate on the role of WTE in waste management and it is out of scope for this report to determine exactly where, how and with what old or new technologies WTE may make sense, but they clearly are a potential solution.					

Intervention Strategies	Timing of Initial Impact	Total Potential Impact	Type of Funding	Geographic Focus
8. Philanthropy: Use catalytic philanthropy to spur innovation in material design, waste collection, and other sectors	2-4 years	High	Philanthropy and Concessionary Capital	Global Opportunities
9. Citizen Engagement: Raise public awareness, facilitate ocean-friendly purchasing decisions, and encourage citizens to make modest behavior changes	1-2 years	High	Philanthropy	Global Opportunities
10. Government Actions: Use policy, international action, and government capital expenditures to accelerate change	3-5 years	High	Policy and Government Spending	Global Opportunities

References

1. Jambeck, J.R., et al., Plastic waste inputs from land into the ocean. *Science*, 2015. 347(6223): p. 768-771.
2. Valuing Plastics: The Business Case for Measuring, Managing and Disclosing Plastic Use in the Consumer Goods Industry. 2014, United Nations Environment Programme.
3. Microplastics in the ocean: A global assessment. 2015, United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP), Working Group 40.
4. UNEP, Marine plastic debris and microplastics – Global lessons and research to inspire action and guide policy change. United Nations Environment Programme, 2016.
5. Rochman, C.M., Browne, M.A., Underwood, A.J., van Franeker, J.A., Amaral-Zettler, L.A., Thompson, R.C., Perceived and demonstrated ecological impacts of marine debris. *Ecology*, 2016. 97(2): p. 302-312.
6. Hardesty, B.D., T.P. Good, and C. Wilcox, Novel methods, new results and science-based solutions to tackle marine debris impacts on wildlife. *Ocean & Coastal Management*, 2015. 115: p. 4-9.
7. Bergmann, M. and M. Klages, Increase of litter at the Arctic deep-sea observatory HAUSGARTEN. *Marine Pollution Bulletin*, 2012. 64(12): p. 2734-2741.
8. Ocean Conservancy. Top 10 Items Found. 2015 January 23, 2017]; Available from: <http://www.oceanconservancy.org/our-work/international-coastal-cleanup/top-10-items-found-1.html>.
9. Plastics – the Facts 2016. 2016, Plastics Europe.
10. van Sebille, E., et al., A global inventory of small floating plastic debris. *Environmental Research Letters*, 2015. 10(12): p. 124006.
11. Eriksen, M., et al., Plastic Pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. *PLOS ONE*, 2014. 9(12): p. e111913.
12. S.C. Gall, R.C., Thompson, The impact of debris on marine life. *Marine Pollution Bulletin*, 2015. 92(1-2): p. 170-179.
13. Rochman, C., The Complex Mixture, Fate and Toxicity of Chemicals Associated with Plastic Debris in the Marine Environment, in *Marine Anthropogenic Litter*, L.G. Melanie Bergmann, Michael Klages, Editor. 2015, Springer.
14. Good, T.P., et al., Derelict fishing nets in Puget Sound and the Northwest Straits: Patterns and threats to marine fauna. *Marine Pollution Bulletin*, 2010. 60(1): p. 39-50.
15. Wilcox, C., et al., Using expert elicitation to estimate the impacts of plastic pollution on marine wildlife. *Marine Policy*, 2016. 65: p. 107-114.
16. Chris Leggett, N.S., Mark Curry and Ryan Bailey, , Assessing the Economic Benefits of Reductions in Marine Debris: A Pilot Study of Beach Recreation in Orange County California. 2014, Industrial Economics Inc. for the NOAA Marine Debris Program.
17. Global Waste Management Outlook. 2015, United National Environment Programme.

Learn more about
Paul G. Allen's initiatives at:

www.paulallen.com

Download the full version
of this report at:

www.vulcan.com/seaofopportunity



A Paul G. Allen Company