



# **A new perspective on plastic waste in Israel: A circular economy**

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Since entering the commercial market in the middle of the 20th century, plastics have become a seemingly inextricable part of everyday life. Their unrivaled functional properties, versatility, and affordability make them suitable for a wide range of applications<sup>6, 7, 29, 67, 81</sup>, leading to their near ubiquity in modern society<sup>71</sup>. Despite the numerous benefits plastics offer, the take-make-waste mentality of today's society has created a system characterized by poor resource efficiency, mass waste production, and ecological deterioration. Plastic use has created extensive negative economic and environmental outcomes including greenhouse gas emissions, accumulation of marine plastics, dangers to human health, and substantial material losses<sup>81, 127</sup>.

Israel's rising production and consumption of single-use plastics (SUPs) combined with inadequate waste management infrastructure have contributed to alarming quantities of plastic waste and pollution. Of the OECD countries, Israel has the highest rate of landfilling, and produces nearly 30% more waste (675.08 kg) per capita annually than the OECD average of 524.66kg<sup>89</sup>. Furthermore, on average,

OECD countries have decreased their landfilling of municipal solid waste from 63% in 1995 to 42% in 2018. Some countries, including Switzerland, Germany, Finland, Sweden, and Belgium, have even stopped landfilling operations almost entirely. Yet, Israel continues to landfill almost 80% (76% in 2018 according to OECD sources) of its municipal waste, with less than 7% recycled and 1% incinerated for energy recovery<sup>89</sup>. This state of latent development indicates the inefficient and consumptive nature of Israel's current plastic economy.

A circular plastic economy presents an opportunity to diverge from this trajectory. As outlined by the Ellen MacArthur Foundation and supported by the UNDP and OECD, creating a circular plastic economy retains the material value of plastics in the economy while improving overall economic and environmental outcomes. This optimization of the plastic economy for higher material efficiency, productivity, and circularity requires Israel to rethink the way plastics are currently produced, used, and discarded.

This report explores the economic, social, and behavioral facets of plastic production and consumption in Israel and identifies opportunities for policy makers to influence environmental, social, political, and legal conditions to drive sustainable development in the country. Also contained in this report is a review of Israel's efforts towards plastic circularity and identification opportunities to streamline Israel's transition towards a more prosperous and resource efficient plastic economy. This transition aligns with Israel's commitments to the UN Sustainable Development Goals, the OECD, and the Barcelona Convention. In addition, a strong commitment to a sustainable plastic economy can have far-reaching impacts, as Carter et al. found with small states in Europe's environmental policy impacting EU policy to an extent disproportion to their size.

This report focuses on single-use plastics as a significant contributor to the deleterious and inefficient nature of today's plastic economy and reviews Israel's most recent efforts to reduce consumption of single-use plastics. As a foundation, this report draws from an interdisciplinary selection of literature from experts around the world and is intended to contribute to the comprehensive global perspective upon which the recommendations of this report are based.

Included in this report is a review of salient challenges and barriers impacting the efficacy of previous regulatory and legislative efforts to reduce the impacts of plastic waste and pollution in Israel, an exploration of the structural, contextual, and societal factors reinforcing the overconsumption of single-use plastics, and insight into the attitude-behavior gap. This report concludes with systemic, collaborative, and accessible approaches to overcoming it. The aim is to offer decision-makers within

the Ministry of Environmental Protection (MoEP) the tools necessary to streamline Israel's transition to a more efficient and circular plastic economy.

This report promotes more sustainable patterns of plastic production and consumption through policy plans addressing the intricacies of the plastic economy. These changes will increase efficiency and productivity, improve circular material flows, and promote more sustainable patterns of plastic production and consumption.

## Scope

This report addresses for the most part Israeli consumer use of plastic with an emphasis on single-use plastic, and the socioeconomic and political factors that have produced the issue that the current generation must grapple with for its very survival.

Much more research is needed, and should be funded, to continue to disentangle and to adequately address the full complexities of the plastic problem in this region and in the world at large.

# The Case for Reconstructing Plastic Usage

As in most of the world today, plastics are a commodity prevalent in Israeli society. Plastics are an incredibly valuable material with unique functional properties that offer countless societal benefits. However, current plastic production, usage, and waste have produced numerous negative economic and environmental outcomes that are ultimately unsustainable and require government intervention to improve<sup>66</sup>.

Plastics are widely used at both an industrial and individual scale. This synthetic material is appealing for human use for the same reason that is devastating to the environment and to human health: durability<sup>45</sup>. Plastics are comprised of organic polymers adapted to suit the needs of modern society<sup>5, 67</sup>. Since the invention of modern plastics in the early 1900s, they have been adapted to be more durable, flexible, and transparent, and the production costs have become ever cheaper<sup>5, 6</sup>. Years of scientific development were devoted to making plastics more affordable, durable, and suitable for a wide array of applications. The value of plastics is largely attributed to its longevity<sup>5</sup>, but this material specifically engineered to last is increasingly being used only once or twice before being discarded<sup>71, 80</sup>. This durability, however, persists long after consumption; as plastics persist in the environment for an indefinite amount of time as a recalcitrant environmental pollutant<sup>80</sup>. It is estimated that of all the plastic waste produced up until 2015, which amounts to approximately 6300 million tons, only 9% has been recycled<sup>45</sup>. As for the rest, 12% was incinerated, and 79% has accumulated in landfills or the natural environment<sup>45</sup>.

## Benefits of Plastic

Plastics are a lightweight, strong, durable, and corrosion-resistant material with high thermal and electrical insulation properties<sup>113</sup>. Low production costs have made plastics universally accessible and facilitated its commoditization around the world<sup>87</sup>. Between 1950 and 2015, annual production of plastics increased nearly 200-fold, reaching 381 million tonnes in 2015, and 415 million tonnes in 2017<sup>93</sup>. The combination of functional properties and affordability makes plastics suitable for a variety of industry applications and it has often replacing traditional materials

such as concrete, glass, metals, wood, natural fibers, and paper<sup>87</sup>. This report does not unilaterally oppose plastics, but rather aims to highlight the issues in current production and consumption models and identify steps to optimize and ameliorate negative outcomes of plastic usage in Israeli society.

In 2014, Israel consumed about 1 million tons of raw plastic material, 30% of which derived from domestic production, and 70% was imported<sup>105</sup>. In addition to creating job opportunities for 25,000 people, Israel's plastic industry accounts for 5-6% of the country's GDP, turning over 5 billion Euros per year<sup>50</sup>. Without denying the societal benefits of plastics in Israel, a situation of growing concern is the mass-production of unmanageable amounts of plastic waste resulting from plastic usage.

## **Drawbacks of Plastic Use**

The way we produce, use, and dispose of plastics has extensive economic and environmental consequences<sup>66, 71, 81</sup>. Growing demand and reliance on single-use plastics only exacerbates this problem<sup>6</sup>, leading to massive amounts of plastic waste, which largely ends up in landfills.

This section highlights the negative environmental, economic, health, and societal impacts of single-use plastic consumption, and shows how the current linear economic model is inferior to a more circular approach to plastic production and consumption.

## **Greenhouse Gas Emissions**

Plastic production and consumption has contributed to climate change by releasing approximately 400 million tonnes of greenhouse gas emissions per year from energy consumed throughout the plastic supply chain<sup>87</sup>.

## **Use of Unsustainable Fossil Fuel Resources**

The overwhelming majority of modern plastics are derived from fossil feedstocks, with petroleum-based products accounting for approximately 99% of the plastic industry in 2015<sup>45</sup>. In 2018, with around 359 million metric tons of plastic produced worldwide, the environmental cost of the inputs to produce such massive amounts of plastic is undeniable, and how much ends up wasted and harming ecosystems, people, and the economy certainly warrants action. As of 2009, plastic production accounted for 6% of oil consumed globally, and expected to rise to 20% by 2050<sup>81, 129</sup>. This reliance on depleting fossil fuels is undeniably unsustainable, with growing scientific consensus and public concern over the irreversible environmental pressures associated with resource extraction and production<sup>90, 114</sup>.

## **Material Value Loss**

Plastics are engineered to last through water-resistance, corrosion-resistance, and high thermal and electrical insulation<sup>45, 67, 113</sup>. These assets are not being optimized as they are increasingly thrown away after one or two uses, leading to enormous losses in material value and a substantial loss in economic opportunity.

While plastics' durability and versatility make it a superior material substitute in many scenarios, when produced as low-residual value products or packaging, their intrinsic value is often overlooked due to their low cost and perceived replaceability<sup>71</sup>. The subsequently short-use phase of single-use plastics presents a major economic concern. According to the OECD, "Nearly half of all plastic products littering the world today were created after 2000<sup>124</sup>. This issue is only decades old, and yet over 75 per cent of all plastic ever produced is already waste"<sup>125</sup>. The majority of single-use plastics are disposed of long before their intrinsic value deteriorates, such as plastic bags, tableware, and

water bottles, which Israelis often throw away immediately after use<sup>100, 132</sup>. This habit of premature plastic disposal results in the unnecessary loss of around 95% of its material value<sup>81</sup>, resulting in an immense loss in economic opportunity corresponding to an estimated \$80–120 billion of annual global losses<sup>81</sup>. Herein lies an opportunity for Israel's economy by strengthening the recycled plastic market. The circular approach that this report recommends "can deliver several benefits having untapped business potential. Globally, replacing only 20% of single-use plastic packaging with reusable alternatives offers an opportunity worth at least USD 10 billion"<sup>47</sup>.

### **Landfill Waste Accumulation**

As a result of this growing take-make-dispose mentality characterizing today's economy, rapid growth in plastic production has led to mounting quantities of plastic waste stemming from an increased demand for single-use plastics<sup>64, 71</sup>. This is evident in Israel, where single-use plastics make up a significant portion of the municipal solid waste stream. Plastics make up 41% of the volume and 18% of the weight composition of Israel's municipal waste stream, but less than 7% of waste plastic value is recovered through material, chemical, and energy recovery processes<sup>76, 78</sup>. Therefore, between 90-95% of consumer plastics that enter Israel's waste stream end up in the landfill, along with nearly 80% of Israel's municipal solid waste<sup>30</sup>.

### **Leakage**

In addition to accumulation of landfill waste, single-use plastics often escape the human technosphere and enter the natural environment as a result of improper disposal and inadequate waste collection and management systems<sup>4, 81, 93</sup>. This phenomenon is widely known as leakage, which significantly contributes to marine litter<sup>93</sup>. Global estimates suggest plastic leakage occurs at an approximate rate of 10 million metric tons per year, with 8 million tonnes entering the ocean<sup>93</sup>. In the absence of meaningful intervention, this number is predicted to rise to 17.5 Mt per year by 2025, by which time there will be more plastic than fish in the ocean<sup>81, 93</sup>.

Plastics are prone to leakage due to their lightweight and low residual value, thereby easily escaping collection systems<sup>71</sup>. Single-use plastics are especially susceptible to leakage when garbage bins, collection vehicles, and disposal sites are uncovered and exposed to the elements<sup>119</sup>, which is often the case in Israel. Globally, 32% of single-use plastics leak out of the collection system; these plastics are either never collected or lost after collection through illegal dumping or mismanagement<sup>81</sup>. Current estimates suggest mismanaged waste accounts for the loss of approximately 73.4% of macroplastics<sup>119</sup>.

### **Microplastics in Wastewater**

Microplastics in wastewater are a major concern<sup>38</sup> that is outside the scope of this paper. Further investigation into this area is urgently warranted.

### **Marine Plastic Pollution**

As explained above, large quantities of plastic leak into the environment, specifically into marine ecosystems<sup>71</sup>. Most commonly used plastics are highly resistant to physical and chemical degradation and are not biodegradable<sup>88</sup>, and can only be permanently eliminated by destructive thermal treatment, such as combustion or pyrolysis<sup>45</sup>. When deposited into the environment, plastics accumulate rather than decompose, persisting as recalcitrant pollutants, and remaining in the environment for hundreds of years<sup>1, 12, 45, 80</sup>. Over time, plastics break down into minute fragments of plastic debris, known as microplastics<sup>7</sup>. Studies on marine plastics have shown that under marine conditions, where degradation is severely stunted, certain plastics may even persist for an indefinite period of time<sup>7</sup>.

Plastics consist of organic polymers formed into synthetic resins with enhanced properties, specially designed for the benefit of human application. Modern plastics' high strength-to-weight ratio results in its high-resilience to physical and chemical degradation pathways<sup>87</sup>. These properties become especially problematic once plastics enter the waste stream and the environment<sup>73, 87</sup>.

A large fraction of leaked plastics end up accumulating in marine environments, which is a natural plastic sink. Today, plastics are found to be ubiquitous in marine environments<sup>127</sup>, with current estimates suggesting global oceans have accumulated an upward of 150 million metric tons of plastics<sup>71</sup>. In the absence of significant intervention, this number is expected to rise to nearly 250 million metric tons of plastic by 2025<sup>71</sup>. With roughly 8 million tons of plastic waste entering the world's oceans each year, marine plastic pollution has become a global concern, deemed "one of the great environmental challenges of our time"<sup>121</sup>. Plastics have accumulated in every compartment of the environment, reaching even the most remote regions of the planet, with debris found in all major ocean basins<sup>12</sup> as well as reaching both poles of the Earth. Microplastics have penetrated areas widely considered to be pristine, including the terrestrial ecosystem of Antarctica<sup>7, 18, 45</sup> as well the Arctic's beaches, sea ice, water column, sea surface, and sea floor<sup>19</sup>.

Plastics reach these environmental compartments via transfer pathways such as wastewater, road runoff, uncollected or poorly managed waste, or directly from human activity into the ocean. In addition to the common distribution pathways such as rivers and ocean currents, recent discoveries have found evidence of aerial mechanisms of transporting plastic particles such as via wind and rain pathways<sup>20, 19</sup>. Plastics' intrinsic properties of buoyancy and durability have contributed to plastic's global distribution, and the issue is further complicated by the reality that leakage occurs at every stage of the plastic lifecycle<sup>33</sup>. Due to the abundance, global distribution, and ubiquity of microplastics in the environment<sup>3</sup>, scientists have even started using microplastics as a key geological indicator of the Anthropocene<sup>128</sup>.

### **Plastic Pollution in the Mediterranean Sea**

The Mediterranean Sea is considered to be one of the most impacted regions by marine plastic pollution<sup>2, 57</sup> with concentration densities of microplastics in some locations greater than in the Great Pacific Garbage Patch<sup>2</sup>. Approximately 0.57 million tonnes of plastic enters the Mediterranean Sea each year; equivalent to dumping 33,800 plastic bottles into the water every minute<sup>126</sup>. Indeed, of the countries on the perimeter of the Mediterranean Sea, Israel's coastline is the third largest hotspot for beached plastics, of which single-use plastics constitute a significant fraction<sup>126</sup>. Israel is one of the most densely populated countries in the world<sup>10</sup>. Considering that the majority of marine plastics derive from coastal populations living within 50 km of the shore<sup>93</sup>, as one of the most densely populated countries in the world<sup>10, 11</sup>, Israel's growing population and highly concentrated coastal regions is immensely disconcerting. Each kilometer of Israel's coastline accumulates approximately 21 kg of marine plastics each day, which is over four times higher than the Mediterranean average (5.1 kg/(km day))<sup>152</sup>. On a global scale, microplastics (defined as plastic fragments <5 microns) in Israeli coastal waters were found to be 1-2 orders of magnitude higher than those reported in other parts of the world<sup>52</sup>. Due to a natural phenomenon termed the "rebound effect", approximately 90% of the marine debris littering Israel's Mediterranean coastal waters is derived from local land-based origins<sup>52</sup>. The accumulation of marine plastics reflects high rates of plastic leakage in Israel. Furthermore, a recent study has also found evidence of alarming quantities of microplastics ingested by aquatic organisms in the Gulf of Aqaba off the coast of Eilat in the South of Israel<sup>122</sup>.

In the 1960s, only decades after modern plastics' invention, microplastics had already been consumed by 10% of fish off Israel's Mediterranean coastal waters<sup>135</sup>. Microplastic pollution has

since risen exponentially, found within 80% of fish in the 1990s, and 92% in 2016<sup>53</sup>. Microplastic abundances in Israeli coastal waters were found to be 1-2 orders of magnitude higher than those reported in other parts of the world <sup>52</sup>. The short timeframe between the introduction of plastics into society and the emergence of observable impacts of plastic leakage is incredibly disconcerting. These findings elucidate how plastics, from their inception, prove to be inherently unsustainable. This present moment is critical, and demands an uncompromising approach.

### **Beach Deterioration Costs**

Plastic leakage also results in significant economic losses and health risks to coastal regions. Plastic litter diminishes the aesthetic appeal of tourist destinations, causing subsequent revenue reductions <sup>92, 127</sup>. In the context of Israel, where tourism is a major revenue stream, this is a major concern<sup>108</sup>. Additionally, accumulation of plastic in the food chain threatens the fishing industry. Furthermore, substantive losses are associated with the cost of remediation of environmental and infrastructural damages and enforcement efforts<sup>81</sup>. Clean up requires an estimate of \$3,300-33,000 per tonne of marine plastic per year <sup>14</sup> with annual damages of at least \$13 billion<sup>81</sup>. In Israel, the MoEP tripled its investment from the previous budget in the Clean Coast Program to NIS 8.6 million<sup>131</sup>.

Further research in this field is required, but the impacts are significant. This finding, along with the environmental and climactic unsustainability, demands an intervention to save ecosystems, costs, and people<sup>25</sup>.

### **Recycling Shortcomings**

Recycling can effectively prolong the life of plastics and keep the value of plastic in the economy by removing plastics from the waste stream and facilitating their re-entry into the human technosphere. That being said, recycling only extends the usage of plastic; the value still diminishes, resulting in a lower value recycle. Due to this diminished value, the products that are produced are often not recyclable, and end up entering the waste stream soon after use. In addition, effective recycling requires adequate infrastructure, and even so, only certain types of plastics can be recycled. While increasing the recycling rates is necessary to divert plastics from the landfill and the natural environment, recycling is not a sufficient solution for the overall plastic problem.

There is a low incentive to recycle single-use plastics due to their low residual value. It is often cheaper to buy new plastics than to invest in recycling infrastructure. The incentive to recycle SUPs is even lower for individual consumers, who don't see the direct benefits of recycling. That being said, recycling provides an economic opportunity to repurpose waste that would otherwise be taking up landfill space or littered across the environment.

### **Waste-to-Energy Shortcomings**

Israel's most recent waste management action plans include plans to develop a large-scale waste-to-energy facility. Energy recovery is an alternative method to retain the value of plastics in the economy. However, concerns regarding energy recovery treatment processes include the loss of embedded efforts and labour invested in producing the material, redeployment due to the "lock-in" effect and hindering the market for higher-value mechanisms such as recycling, pollution, and byproduct production<sup>81</sup>. Additionally, there are concerns that incinerators will be chosen as a short-term solution to deal with stockpiling of plastic waste<sup>111</sup>. This has the potential to "lock in" demand for incinerators for years to come, rather than focusing on reducing usage and scaling recycling to build a circular value chain <sup>125</sup>. This process is also highly sensitive to contaminants including plastic additives. Space requirements for the size of the machine are also predicted to be a concern given previous issues with residents related to the NIMBY (Not In My Back Yard) phenomenon.

## Alternative Feedstocks

Increasing demand for more sustainable alternatives has led many plastic producers to turn to bioplastics. The emergence of the biopolymer industry presents a promising direction for the plastic industry. However, this transition is only in its infancy. While there is increasing interest in bioplastic production, it currently accounts for just 1% of plastics produced globally<sup>59</sup>. Despite growing investment into this new industry, the biopolymer industry is still in the research and development stage and will take time to fully evolve. In the meantime, plastic use is predicted to double in the next 20 years<sup>72</sup>. The shift from fossil fuel-based plastic to biopolymer plastics, while promising, perpetuates a throwaway culture that has been stated to be unsustainable and harmful for human health and the environment. It is urgent, then, to curb reliance on plastic in the long term, while in the short term, to invest in more sustainable processes such as bioplastic production.

## Human Health Concerns

Plastic pollution does not only risk marine ecosystems, but contaminates marine food chains, and poses significant human health consequences. Plastics are both an environmental pollutant and a transport vector for toxic chemicals<sup>25</sup>. As more fish ingest recalcitrant pollutants resulting from plastic leakage, microplastics find their way into the human body through consumption of fish, but also in everyday items like salt, sugar, alcohol, and fruits and vegetables<sup>25</sup>. Microplastic consumption by marine biota facilitates the synthetic polymers' entry into the food web, and ultimately into human diets. Aside from marine sources, humans can inadvertently consume microscopic pieces of plastic that are shed from food and water containers or even through inhaling of airborne microplastics fibers<sup>28, 40</sup>. Humans are estimated to consume more than 74,000 microplastic particles each year<sup>28</sup>. While the health risks are still unclear, potential effects include, and are not limited to, damage to the lungs, skin, liver, bladder or gastrointestinal tract, reproductive toxicity, disruption of the nervous system, breast cancer, and neurodegenerative disorders<sup>40, 128</sup>. More research is needed in this field to ascertain true costs of toxic accumulation of plastic in the human body.

Now that the many drawbacks of plastic production and consumption have been laid out, the report will turn to a proposed solution, transitioning to a circular plastic economy that benefits the public, the environment, and the market.

**The notion of a circular economy is a strategy to achieve zero waste in an effort to reduce environmental impacts and create significant economic benefits.**

How can we maximize the value captured from plastics while minimizing waste production and leakage? Today's linear model of single usage, resource consumption, and waste production are inevitable and unavoidable outcomes of economic development. However, the consequences are being felt, thereby forcing leaders to reckon with their impacts. Growing awareness of the deleterious, inefficient, and costly nature of the current plastic economy has led to the development and adoption of more resource-efficient and circular models of production and consumption.

Creating a "circular economy is becoming a central issue in sustainable development strategies at international, regional, and national level." <sup>109</sup>. The circular economy framework has been widely accepted as an opportunity to simultaneously benefit society, the economy, and the environment by keeping the material value of plastics in the economy, while minimizing the negative impacts associated with the current take-make-dispose economy. The circular economy framework is an opportunity to improve the overall economic benefit of Israel's plastic economy while minimizing economic losses, harm to the environment, and other negative externalities<sup>109</sup>.

The foundation of the circular economy is a closed loop, regenerative plastic system where plastics never become waste, are utilized at their highest value, and are reused or made from renewable resources<sup>81</sup>. In contrast to other sustainability concepts, the circular economy approach aims to optimize systems rather than components<sup>60</sup>.

The recent upsurge in activism and public concern over plastic waste and pollution has provoked global attention. Government agencies, academic institutions, industries, and non-governmental organizations around the world have responded with strong commitments for reform. As a result, government agencies and international organizations around the world have launched circular economy plans of action <sup>21, 66, 117, 118, 123, 125</sup> many of which isolate single-use plastic as a primary area of focus, or have developed their own plastic action plans. Considering the position of Israel, a country with a small surface area slated to be severely impacted by climate change and a leader in innovation worldwide, urgent and aggressive action is needed.

A strategic circular economy plan for plastics, with a focus on plastic packaging (used synonymously with single-use plastics in this report), was envisioned by the Ellen MacArthur Foundation. In 2016, the World Economic Forum published their report called "The New Plastics Economy: Rethinking the Future of Plastics", which proposes a new approach to society's current economic relationship with plastics, with a particular focus on plastic packaging<sup>81</sup>. The report describes the unsustainable nature of the present-day linear plastic economy, identifying the substantive monetary losses associated with the short life span of plastic packaging and the degradation of marine ecosystems<sup>81</sup>. A circular economy inspired approach is presented as a more efficient systemic alternative, estimated as a

\$706 billion economic opportunity<sup>81</sup>.

In 2018, the Ellen MacArthur Foundation and the UNEP jointly launched the “New Plastic Economy Global Commitment”, to unite businesses, governments, and organizations around the globe behind a common vision of a future where plastics never become waste. Targets were set to address plastic waste and pollution at its source by 2025<sup>48</sup>. There are currently over 450 signatories, including “companies representing 20% of all plastic packaging produced globally, as well as governments, NGOs, universities, industry associations, investors, and other organisations”<sup>48</sup>. Israel should unquestionably be a part of this global movement.

To achieve this vision, three actions are proposed:

- 1) Eliminate problematic and unnecessary plastic items,
- 2) Innovate to ensure that the plastics we do need are reusable, recyclable, or compostable, and
- 3) Circulate all plastic items we use to keep them in the economy and out of the environment<sup>72</sup>.

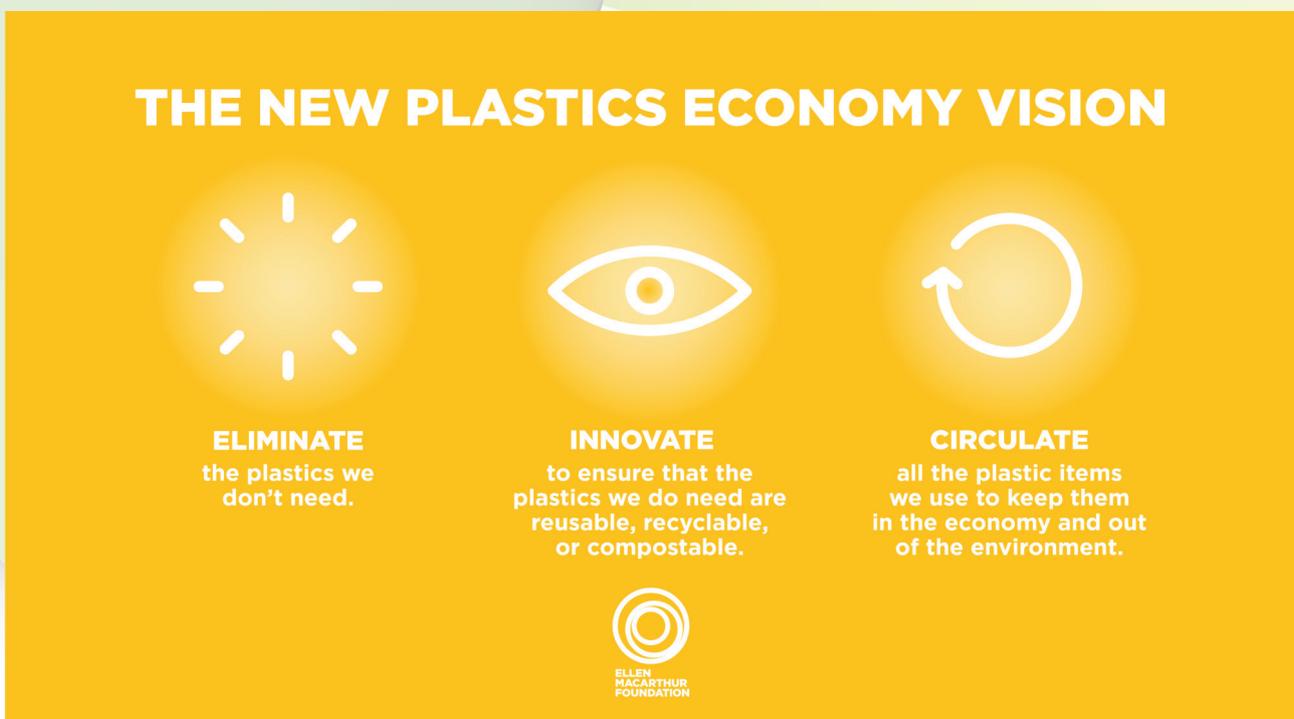


Figure 1: Vision of a New Plastic Economy<sup>72</sup>

## Israeli Progress Towards a Circular Economy

Government efforts to achieve a circular economy in Israel have largely been driven by the Ministry of Environmental Protection, with additional contributions from the Ministry of Economy & Industry (MoE&I). These efforts have consisted of regulatory and legislative efforts to reduce landfilling and increase recycling rates, including a plastic bag law introduced in 2017<sup>30</sup>. By the summer of 2018, the plastic bag fee brought about an 80% drop in consumption of plastic bags. Through this legislative action, it became clear that government intervention does work, when used strategically. More recently, in 2018, the MoEP and the MoE&I jointly developed “a national program for streamlining resources and a circular economy in the industry”<sup>47</sup>. However, the legislative framework necessary to support these plans is still lacking<sup>47</sup>. According to SwitchMed, a European initiative that supports social and eco-innovations in the Mediterranean, circular economy development in Israel has been driven by academic institutions, industry partners, civic society, and entrepreneurs<sup>63</sup>. These groups have led Israel’s progress towards a circular economy. Stronger government intervention is required to achieve these lofty and necessary goals. Transitioning to a more circular plastic economy

is essential to the sustainability and security of Israel, while also further aligning with the UNDP and the OECD, and helps Israel better fulfill its commitment to the Barcelona Convention, Paris Climate Change Accord, and the UN's Sustainable Development Goals, specifically Goal 12: Ensure sustainable consumption and production, and Goal 14: Conserve and sustainably use the oceans, seas, and marine resources for sustainable development.

The Ministry of Environmental Protection, and the Ministries of Finance and of Economy and Industry have made several efforts towards resource efficiency and a circular economy. The majority of these efforts have been directed towards waste management<sup>47</sup>, with the MoEP attempting to raise recycling rates and reduce landfilling since 1993<sup>63</sup>. In 2018, the MoEP created a national plan for streamlining resources and a circular economy in industry<sup>56</sup>. However, according to an assessment of Israel's "Circular Economy Situation" published in 2020, despite the numerous plans consolidated in the past years, Israel's progress is still in its infancy<sup>47</sup>.

The country has planned to recycle 50% of its total waste by 2050, but the current actual rate of recycling is only 25%. For plastic recycling, it is only 6%<sup>73</sup>. Considering that plastic makes up 41.1% of Israel's solid waste composition by volume, creating circularity and continuity in plastic usage will go far to help the waste and the environmental goals set out by the MoEP. The 2011 "Packaging Law" was meant to address this issue by requiring manufacturers of importers of packaged products to recycle the waste, incentivizing the establishment of sorting and recycling infrastructures, and creating new jobs in the process. The law did not meet its goal for many reasons, including inadequate enforcement and inexpensive substitutes for packaging production.

The Aviv plant, the only factory in Israel to recycle PET (polyethylene-terephthalate, from which plastic bottles are made), is now closed due to the decline in prices of raw materials for plastic production, which made it more worthwhile for manufacturers to purchase new materials than to recycle. Now, all of Israel's plastic waste is transported overseas. This is a significant business opportunity, to incentivize plastic recycling within Israel and catalyze the creation of new industry and jobs.

Funding research to further innovate the products and technology in Israel around plastic consumption and recycling is needed in order to achieve circularity and reach the sustainability goals of the nation while also stimulating the economy. Within Israel are some very promising technologies that should be empowered through government action to expand and spread.

For example, Plastic2Nrg is an Israeli venture that converts plastic waste into electricity through a unique oxidation methodology developed at the Hebrew University of Jerusalem<sup>136</sup>. Plastic2Nrg produces 6KWh of clean energy from 1kg of plastic at low temperatures, efficiently<sup>86</sup>, and without pollution. Tel Aviv-based UBQ converts household waste into sustainable bio-based materials that can serve as feedstock for new products.

Along with supporting these innovative post-plastic usage innovations, it is essential to raise public awareness, create regulations, and use political leadership to make a lasting change in our socioeconomic relationship to plastic. While commendable, the findings of this report make clear that the plastic crisis must be solved by treating the root cause, that is, excessive use of disposable plastic products.

To achieve circularity, single-use plastics must be phased out entirely in Israel. **Single-use plastics in particular are a major challenge for the development of a circular economy and have thus become a major focus of international intervention efforts.** Due to the numerous economic and environmental concerns associated with the use of SUPs, government agencies, academic institutions, nongovernmental organizations, industries, and activists around the world are advocating for SUPs to be phased out of the plastic industry entirely.

## **Overview of Plastic-Related Interventions by the Israeli Government**

### **International Interventions**

#### **Paris Climate Accords**

As a member of the Paris Climate Accords, Israel must lower its plastic consumption in order to reach the goals of limiting global warming to 1.5 degrees above pre-industrial levels. According to a new report by ODI, an independent global think tank, states that on current trends of emissions from plastic, there is no hope to reach the goal. In order to abide by the commitment to the Accords, plastic consumption must be cut.

#### **Barcelona Convention**

As a member of the Barcelona Convention, Israel is committed to the Regional Plan on Marine Litter Management, a plan aimed at protecting the Mediterranean from Marine and Coastal Waste, as part of a broader program to reduce marine pollution from land sources (NAPs)<sup>77</sup>.

#### **United Nations Environment Agency's Clean Sea Program**

MoEP is a partner in the United Nations (UNEP) Environment Agency's Clean Sea Program<sup>77</sup>. This program aims to bring together governments, the public, and the private sector to fight against marine plastic pollution.

### **National Interventions**

#### **Israel's Clean Beach Program & Clean Coast Index**

Israel's Clean Coast Index "is a tool used to assess the cleanliness level of the coast and to assess the effectiveness of education, information and enforcement activities"<sup>10, 76</sup>. The program involves cleaning and surveying of beaches along the coasts of the Mediterranean Sea and in the Gulf of Eilat once every two weeks, including undeclared beaches<sup>78</sup>. The tool is used to measure the success of the Clean Beach Program, which has been operational since 2005<sup>77</sup>.

Plastic is used as a cleanliness indicator because it is the main component of marine debris littering the Mediterranean Coast<sup>10, 76</sup>. Already a decade ago, at the time of the MoEP's report on the state of the environment in Israel in 2010 (and for at least 5 years prior), plastic constituted 80% of all waste that washes up on Israel's Mediterranean shoreline. According to the most recent index from June 2020, this remains true today<sup>78</sup>.

The Clean Coast Index also serves as an enforcement effort, aimed to ensure that local authorities fulfill their duties to maintain the cleanliness of beaches within their municipalities<sup>780</sup>. Content previously on the MoEP website included background information regarding the impact of beach litter and microplastics, as well as a budget for the Clean Beach Program. There is presently no such information on the MoEP website<sup>131</sup>.

Financial support for these activities has fluctuated over the years, from around NIS 1.5 million in 2009-2010, rising to NIS 2 million in 2011 before dropping to NIS 0.4 million in 2012. Financial constraints and limited accompanying activities prevented the program from operating at full capacity in 2008<sup>10, 76</sup>. However, in 2017, the MoEP tripled the funds allocated to support coastal local authorities with cleaning of undeclared beaches, with NIS 8.6 million allocated in 2017, compared to NIS 2.3 million allocated the prior year<sup>131</sup>.

## Municipal Solid Waste Management

**Table 2.** Waste and recycling legislation in Israel, 1984–2016.

Year	Legislation	Purpose
1984	Maintenance of Cleanliness Law	Prohibits littering or the disposal of waste, building debris, and vehicle scrap in the public domain
1993	Collection and Disposal of Waste for Recycling	Provides the principles and the legal framework for recycling in Israel. It authorizes local authorities and obliges them, when required by the Minister of Environmental Protection, to allocate sites for recycling centers and to install recycling facilities and containers
1998	Obligation of Waste Disposal for Recycling-Regulations	These regulations require local authorities to reduce their waste for disposal by means of recycling, in accordance with graduated recycling targets as per the following timetable: at least 10% by December 1998; 15% by December 2000; and 25% by December 2007
1999	Deposit on Beverage Containers	Required manufacturers, importers, and retailers to collect a deposit on beverage containers larger than 0.1 liters and smaller than 1.5 liters, with the exception of bags or paper containers. A recycling corporation was established under the law to institute a refund, bottle collection, and recycling system, which was required to comply with graduated targets for collecting empty beverage containers
2007	Amendment to Maintenance of Cleanliness Law, 2007: Landfill Levy	In effect since 1 July 2007; requires landfill operators to pay a levy for every ton of waste landfilled. The aim is to internalize the full and real costs of waste treatment and disposal
2007	Tire Disposal and Recycling	Aims to reduce the environmental nuisance caused by improper tire disposal in Israel, while promoting tire recycling. The law makes tire producers and importers responsible for the disposal and recycling of used tires at graduated rates each year, with recycling totally replacing disposal after July 2013
2011	Packaging Law	This law imposes direct responsibility on manufacturers and importers in Israel to collect and recycle the packaging waste of their products
2012	Electrical and Electronic Equipment and Batteries Law	Environmental treatment of electrical and electronic equipment and of batteries and accumulators, in order to encourage the reuse of electrical and electronic equipment, reduce the quantity of waste created from electrical and electronic equipment and from batteries and accumulators, prevent the burial of such waste, and mitigate the negative environmental and health effects of electrical and electronic equipment, of batteries and accumulators, and of the waste from these products
2016	The Law for the Reduction of the Use of Disposable Carrying Bags	Reducing the use of carrying bags to reduce the amount of waste generated by their use and the negative environmental effects of this waste, <i>inter alia</i> by restricting the distribution of disposable bags by dealers without payment and by imposing a duty to sell them

**Table 1** Waste and recycling legislation in Israel, 1984-2016<sup>30</sup>

**Table 3.** Municipal solid waste (MSW) recycling targets versus actual recycling rates, 1998–2017.

Source	Recycling target	Actual MSW recycling rate
Obligation of Waste Disposal for Recycling-Regulations, 1998 (Ministry of Environmental Protection, 1998)	(1) At least 10% by 31 December 1998; (2) at least 15% by 31 December 2000; and (3) at least 25% by 31 December 2007	
The State Budget for 2011–2012 (Ministry of Environmental Protection, 2010)	50% of total household waste by 2015	20%
The State Budget for 2013–2014 (Ministry of Environmental Protection, 2012)	50% of the total MSW by 2020	20%
The State Budget for 2015–2016 (Ministry of Environmental Protection, 2014)	50% of the total MSW by 2020	20%
The State Budget for 2017–2018 (Ministry of Environmental Protection, 2016)	35% of the total MSW by 2020	Not yet published

**Table 2:** Municipal solid waste recycling targets versus actual recycling rates, 1998-2017 30.

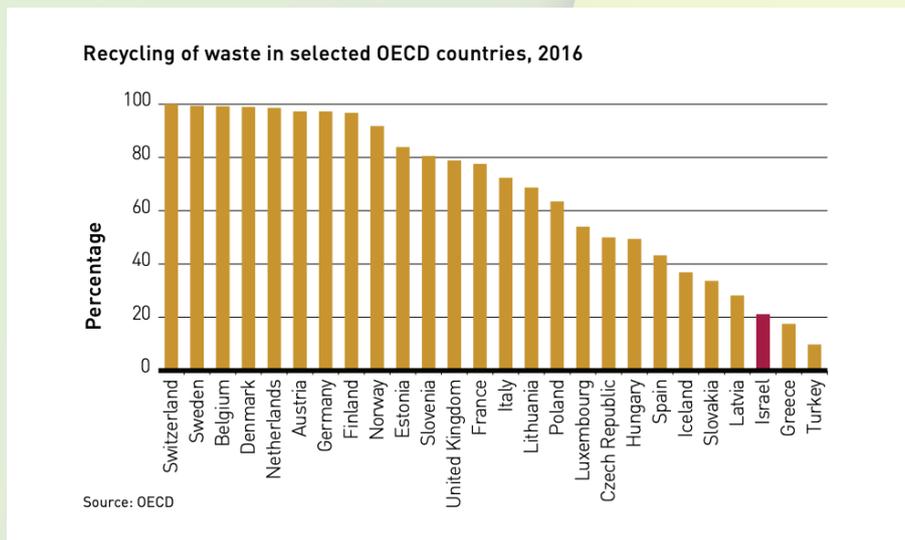


Figure 2: Recycling of waste in selected OECD countries, 2016<sup>134</sup>

According to the OECD, a “resource-efficient and circular economy is critical from both supply security and environmental perspectives and provides a basis for a sustainable and competitive economy”<sup>89</sup>. Currently, plastics represents about 41% of the volume composition of MSW in Israel<sup>30</sup> with supermarket plastic bags alone making up 25%<sup>77, 100</sup>.

### Plastic Bag Law

Plastic bags are one of the most common single-use plastic products. Their use is widespread throughout the world due to their affordability and convenience.

Many countries around the world have begun implementing plastic bag laws, with the aim of mitigating their environmental effects. Widespread use of plastic bags has led to their visible accumulation in natural environments, causing a variety of adverse effects. In addition to the environmental impacts, leakage of plastic bags into the environment can cause costly structural damages as a result of clogged drainage pipes and subsequent flooding. Furthermore, there are reduced tourism revenues as a result of the negative aesthetics effects of plastic debris.

Of macroplastic litter items, plastic bags have been identified as the most harmful to marine biota<sup>127</sup>. Along Israel’s Mediterranean coastline, plastic bags were found to be among the most common marine debris categories<sup>92</sup>. While marine debris can be of foreign origin, 90% of the marine debris along this coast is assumed to be of local origin. The plastic littering Israel’s coastline is thus a reflection of local behavior.

To address this, a plastic bag law was introduced restricting the distribution of disposable bags. The law was introduced on January 1, 2017, requiring 20 of Israel’s largest supermarkets to charge a levy of at least NIS 0.10 for plastic bags with widths between 20-50 microns<sup>77</sup>. The law also included a complete ban on the distribution of plastic bags that are less than 20 microns at the specified supermarkets. The ban excludes the distribution of plastic bags meant for direct contact with food (fresh, frozen or cooked without charge, as long as they do not have handles<sup>77</sup>).

Supermarkets are required to record the number of plastic bags they sell in quarterly reports, which they submit to the MoEP, along with the money they received for those bags. The money is then transferred to the MoEP’s Maintenance of Cleanliness Fund<sup>77</sup>.

According to the MoEP, an aim of the plastic bag law was to motivate Israelis to use environmentally-friendly reusable bags<sup>77</sup>, and it has been effective in some ways. However, as this report has laid out, much more is required to address the issue at hand. While the law has had positive outcomes, they have only been effective in specific retail channels in heavily regulated locations<sup>71</sup>. “Despite good intentions, the increasing number of plastic bag bans aimed at alleviating marine plastic pollution saw a correlated increase in the number of unintended consequences that emerged alongside the bans, suggesting that human behavior towards plastic bag consumption have not changed, but merely shifted, and are feeding into other major international environmental catastrophes”<sup>68</sup>.

Over the past three decades, the MoEP’s efforts towards achieving a circular economy have revolved around the implementation of regulation and legislation, including laws, economic penalties, and financial incentives such as landfill levy and the plastic bag law. The primary objective efforts were to reduce landfilling and raising recycling rates. However, these efforts were largely ineffective, illustrating the limitations of regulatory measures in the development of a circular economy without sufficient buy-in from the government as well as the people<sup>47</sup>. It has additionally been studied that “in the last decade, a number of processes have taken place in the world of environmental regulation in Israel that indicate an erosion of the government’s commitment to the idea of sustainability or sustainable development”<sup>94</sup>.

## Transitioning to a Circular Plastic Economy

The problems associated with overconsumption of plastics have been recognized for decades. Evidence of marine plastic pollution dates back to the early 1960s<sup>5</sup>, and was declared “one of the greatest environmental concerns of our time” by the United Nations in 2005<sup>9</sup>. Yet, over a decade later, the problem has yet to be adequately addressed. Rather, plastic production and marine plastic pollution has since increased exponentially<sup>15</sup>, offering further validation of the previous sentiment.

The problems associated with plastics are widespread, interconnected and cross-cutting, affecting the majority of the world’s population, every sector of the economy, and every component of the environment. Restructuring the current system will require a strategic approach that takes into account these complexities. This section identified the major challenges associated with achieving the vision outlined by the Ellen MacArthur Foundation and adopted by many world leaders driving the transition to a circular plastic economy. This section focuses on the challenges most relevant to Israel, and explores opportunities to overcome them.

### **Addressing the Core of the Plastic Issue**

**Tackling the issues associated with plastic production and consumption requires an understanding that the problem** “is rooted in the production-consumption pattern of our societies and the way countries manage and dispose [of] their waste”<sup>36</sup>. Transitioning to a more resource-efficient and circular system will require a dramatic restructuring of the current plastic economy. To facilitate this transition, policy plans need to take into account the complex interplay of social, economic, and environmental factors influencing the efficacy of intervention efforts. It is our responsibility as the generation consciously identifying, and experiencing the repercussions of industrialization and increased urbanization, to analyze this lifecycle and take steps – we need a permanent revolution.

The problems associated with plastics are interconnected and interdependent, affecting every sector of the economy and every component of the environment. Due to these complexities, a suite of policy instruments is often necessary to effect change in a given area<sup>60, 104</sup>. This section explores ways in which policymakers within the MoEP can effectively address salient areas of concern by promoting more sustainable patterns of plastic production and consumption. By incorporating circular economy principles and other sustainability concepts, along with other supporting resilience thinking, and knowledge from the social and behavioral sciences into the policy planning process, policymakers can improve the overall effectiveness and productivity of the plastic system while benefiting the environment, the economy, and the overall well-being of Israeli citizens.

## Plastics in Israel: A Socioeconomic Analysis

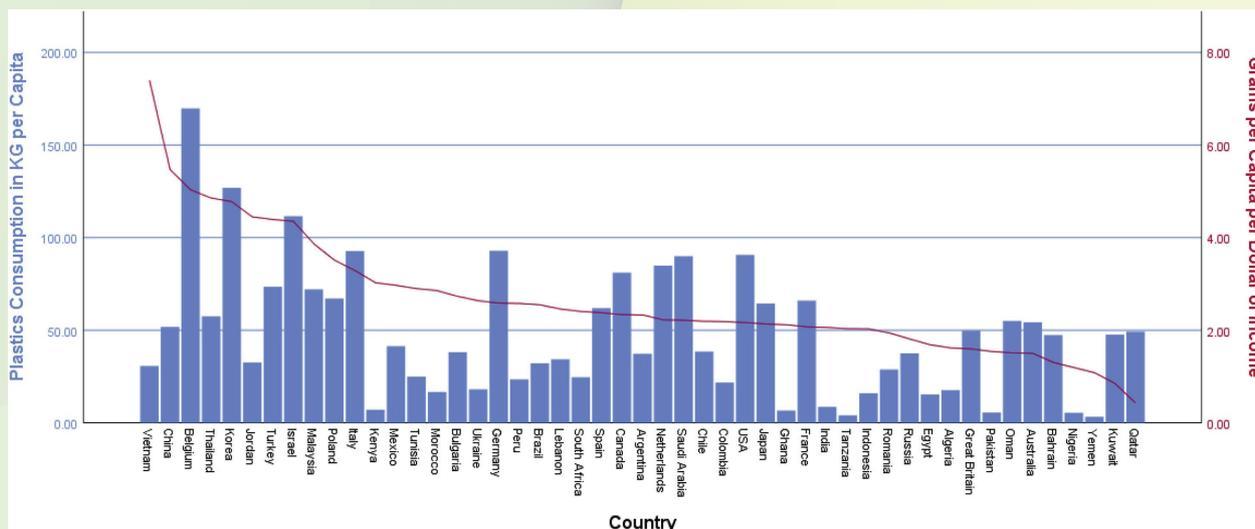


Figure 3: Plastic Consumption (2011-2015) in Israel<sup>13</sup> as compared to other countries

Israelis are among the highest consumers of plastic in the world (see Fig. 3)<sup>13</sup>. Of the 49 countries where data was available, Israel was shown to be the third highest consumer of plastics, with individuals, on average, using 110 kg of plastic per person per year, just below Korea and Belgium<sup>13</sup>.

Israel is renowned for its remarkable ecological achievements, is recognized as a hub for eco-innovation, with notable advancements in sewage effluent reuse, low-cost desalination drinking water technology, renewable energy technology, and countless other cleantech innovations<sup>85, 107, 110</sup>. Because of its location within the water-scarce region of the Middle East, Israel has managed to reduce major risks concerning water resources<sup>107</sup>, and is one of the only countries to significantly reverse desertification, turning semi-arid countryside into highly productive agricultural zones<sup>110</sup>. While these achievements demonstrate Israel's capacity for large-scale environmental reform, such competencies are not present enough in other areas of environmental concern. In particular, high rates of waste production and heavily polluted coastal water are areas of long standing concern, for which plastics are a significant contributor. In contrast to Israel's aforementioned environmental achievements, efforts to address rising plastic waste and pollution have not been so fruitful. At the present state, Israel's waste sector management ranks lowest among OECD countries.

Israel's rising production and consumption of single-use plastics combined with inadequate waste management infrastructure have created alarming quantities of plastic waste and pollution. Some countries, including Switzerland, Germany, Finland, Sweden, and Belgium, have managed to eliminate landfill operations almost entirely and OECD countries, on average, decreased their landfilling of

municipal solid waste from 63% in 1995 to 42% in 2018<sup>95</sup>. Yet, Israel continues to landfill nearly 80% of its municipal solid waste<sup>89</sup>, of which plastics make up a significant proportion. According to the most recent available data from 2012, plastics make up the largest fraction of municipal solid waste, accounting for 41% volume and 18% weight composition<sup>30</sup>; however these numbers are expected to have since risen. Israel's lack of success in this area further divulges the unique complexities surrounding the plastic problem and its seemingly perpetual position as a global crisis<sup>8, 9, 17, 15, 115, 120</sup>, and a major challenge facing Israel.

Many countries in the EU have plastic packaging recycling rates above 35%, with 41% of all plastic in the EU recycled in 2016<sup>95</sup>. Yet, Israel is still struggling to raise plastic recycling rates above 6%<sup>89</sup>. Between 2006 and 2016, Germany managed to almost entirely eliminate post-consumer plastic packaging waste from the landfill, with only 0.1% of plastics landfilled in 2016, a 95% reduction since 2006<sup>95</sup>. Within 10 years, they managed to increase plastic packaging recycling rates by 68%, suggesting a major transition is attainable. The following section explores the barriers preventing such improvements in Israel, and explores opportunities to overcome them.

## **Scenarios Towards a Circular Plastic Economy**

### **Necessity of Consumer Engagement**

Sustainability oriented approaches to development have recognized citizens as active participants and necessary actors for the function of a closed loop economy.

The MoEP's efforts to address plastic waste and pollution have largely overlooked the role of consumers as a major driver of change. However, the problems associated with plastics will require the participation by all stakeholders, including consumers<sup>124</sup>. Increasing engagement inside and outside of industry is one of Plastic Europe's 2018 targets for achieving circularity and resource efficiency<sup>95</sup>.

Previous reports prepared by or for the MoEP have emphasized how understanding and influencing consumer perceptions, attitudes, and behavior is crucial for addressing rising plastic waste and furthering sustainable development<sup>107</sup>.

However, many of the recommendations have never been acted upon, such as the Green Growth Plan for 2012-2020 prepared by the MoEP and the MoE in 2011<sup>63</sup>, and were not included in the most recent SDG review<sup>134</sup>. The Green Growth Plan identified sustainable consumption as one of the three elements critical for sustainable development. Among other things, this plan intended to establish a research center focused on the study of materials and waste management. However, this initiative was never implemented due to a lack of resources and a long legislation process<sup>63</sup>. In 2012, as part of the project, a consultation forum was set up to formulate recommendations on well-being, sustainability, and resilience, which included public participation, however, according to the later published SwitchMed report, these plans never came to fruition<sup>63</sup>.

Current political conditions in Israel exhibit a significant disconnect between citizens and government. This disconnect constrains development on every front. Regardless of where and how this disconnect originated, the consequences constrain the actions of every economic actor. Intervention efforts will thus have to be designed accordingly. Research finds that "interventions to address urgent problems", such as single-use plastic consumption, are "more effective and efficient if they are designed to change a suite of behaviors, rather than a single action"<sup>58</sup>. Systemic transformation will require unified acceptance of alternatives.

## Behavioral Insights

This section provides a review of the most recent literature on behavioral insights as a tool that policymakers can use to drive more sustainable consumer behavior, with a focus on work related to plastics, relevant to the Israeli context, or both.

Since 2011, the OECD Environmental Directorate has conducted countless studies investigating the role of behavioral insights in policies related to the environment<sup>86</sup>. The OECD defines behavioral insights as “an inductive approach to policy making that combines insights from psychology, cognitive science, and social science with empirically-tested results to discover how humans actually make choices”<sup>16</sup>. In 2015, the Knesset published a report further corroborating this point<sup>133</sup>.

Israel participated in the OECD’s Environmental Policy and Individual Choice<sup>91</sup> Project, which included a household survey on people’s attitudes and decisions related to waste generation and recycling. Among the countries included in this survey, Israel’s reported household waste generation was the highest<sup>91</sup>.



Figure 4: Household Waste Behavior Survey 2011<sup>91</sup>

There is increasing interest in using knowledge from the behavioural sciences to enhance environmental conservation efforts<sup>27, 99</sup>. Behavioral interventions are gaining momentum as potential low-cost measures to promote household environmental action<sup>84</sup>. Furthermore, the behavioural malleability of household recycling is high relative to other environmental behaviours and thus more susceptible to change<sup>84</sup>. Behavioural economics first emerged in Israel, and in recent years, has seemed to gain traction as a potential tool for policy-makers within the MoEP. Most recent developments include a report on “Behavioral Insights for Streamlining the Work of Government”, which provides practical recommendations on how the Israeli government can use behavioral insights to improve its function.

As stated before, the introduction of laws and regulations is not sufficient to ensure their objectives are accomplished and intended outcomes are achieved. Effective enforcement of these laws is necessary for environmental policies to be effective<sup>134</sup>. Challenges to the enforcement of environmental laws include unquantifiable infractions and the lack of a direct medium to enforce fines. That being said, an overhaul of the current plastic discourse from both top-down legislative and bottom-up consumer behavioral perspectives, given adequate funding and oversight, will be effective in addressing the problem of plastic pollution.

As of now, there has only been a sampling of behavioral studies conducted on Israeli plastic consumption. The most recent study providing behavioral insights into plastic-related consumer behavior was conducted on Israeli university students<sup>10</sup>. While the study provides some insight into household environmental behaviors, including minimization and both easy and difficult recycling, university students are not a representative proxy of adult behavior.

Despite good intentions, the implementation process presents a prominent challenge contributing to ineffective regulations<sup>65</sup>. For areas of environmental protection, aggressive and disproportionate assimilation processes were identified as an additional issue<sup>65</sup>. Supposedly, “[w]hile the public of business owners complains about excess regulation, the consumer public complains about its absence - a proportion should be obtained”<sup>65</sup>.

Mintz<sup>75</sup> offers recommendations on how normative messaging can be used to promote environmental behavior related to water and energy consumption in Israel, and extending to educational interventions.

### Incentivizing Habit Changes

This section reviews the literature on shifting consumer behavior through social and financial means. There are a number of personal and social influences that can affect an individual’s environmental concern and behavior<sup>46</sup>. Acknowledging and integrating structures of information flows in local communities will help in effectively shifting individual, community, and national behavior.

Habits, norms, and situational factors seem to be especially predictive for plastic consumption behavior<sup>54</sup>. Nudges and social comparisons were suggested to be most effective behavior intervention strategies, while information and social comparison strategies were the most common<sup>84</sup>.

There is a significant gap between awareness levels and plastic-related behavior<sup>86</sup>. This must be addressed with the knowledge that “having the motivation to change is important, but it must be supported by the opportunity and the capability to change”<sup>73</sup>. Raising awareness is simply not enough. For example, a survey conducted in France found that “while 93% of the respondents believed that environmental issues have become a major concern, only 38% of them reported adopting environmentally friendly behaviors (e.g., recycling) or sustainable consumption choices (e.g., buying fluorescent or LED lamps instead of standard incandescent lamps) [2009]”<sup>73</sup>.

Another aspect that challenges effective change in environmental behavior is the lack of immediate positive feedback. Generally, “environmental behaviors suffer from the lack of feedback about the effects of behavior”<sup>32</sup>. In other words, feedback can overcome the “out of sight, out of mind” phenomenon. Incorporating feedback into environmental behavior change has been shown to be effective. This concept is called ‘eco-feedback’, and it provides feedback on individual or group behaviors with the aim of reducing their environmental impact<sup>32</sup>. Smart metering is one technique used to shape water conservation behaviors<sup>101</sup>. It has also been found that “behavior change is most effectively brought about using simple, low-cost [feedback] methods to engage with residents **at the point of service delivery**, i.e. by the collection crews whilst emptying bins”<sup>112</sup>. Therefore, eco-feedback can, and should, be used to illuminate positive impacts, or to recall or draw attention to past transgressions.

The block leader approach, which advocates the empowerment of community leaders and advocates in creating desired social change, has been more influential than other persuasive methods<sup>24</sup>. There is also evidence that the ‘social norms approach’ functions to shift behavior. This concept is guided

from the idea that social norms guide behavior, and that the perception of others' perceptions of behavior powerfully impacts individual decision making. It has been found that behavior change is more likely to be enduring where it involves social identity change and norm internalization. Mols et al. (2014) conclude by urging public policy scholars to engage with the **social identity** literature on '**social influence**', and the idea that those **promoting lasting behavior change** need to engage with people not as individual cognitive misers, but as members of groups whose norms they internalize and enact"<sup>79</sup>.

It has also been found that commitments, be them verbal or written, positively impact engagement. While in most experiments, commitment led to an increase in recycling<sup>32</sup>, "this strategy is not suitable for a large population because it requires face-to-face interaction or phone calls"<sup>23, 32</sup>. Integrating this approach with the community block leader approach might be very effective in getting minority communities in Israel engaged. It also feeds in well to the induced hypocrisy paradigm, which draws on the knowledge that cognitive dissonance is capable of motivating cognitive and behavioral change<sup>37</sup>. The first step entails inviting or encouraging individuals to advocate for a certain socially desirable behavior, by involving them in a commitment of some sort<sup>97</sup>. Commitments can be written or verbal, such as through a speech or petition signature<sup>97</sup>. During the second step, said individuals are prompted to recall prior transgressions, thus subjecting them to hypocrisy<sup>97</sup>. Elucidating the dissonance between cognition and behaviors is intended to stimulate subsequent behavioral changes. In other words, hypocrisy has been shown to increase behavioral intention and promote behavior changes. While similar outcomes can be achieved by illuminating transgressions alone, in absence of evident hypocrisy. Whilst sufficient to promote behavioral change in relation to the environment, this method intends to make "a person aware that he or she knows what is good for the planet, but does not actually do it, can encourage the adoption of ecological behaviors"<sup>97</sup>.

Referencing prompts, many studies have found that they do not provide a lasting change in recycling behavior"<sup>32, 55, 113</sup>. At the same time, however, creative design thinking, or choice architecture, does help. These interventions work by removing external barriers, expediting access or facilitating climate change mitigation behaviors by altering the structure of the environment in which people make choices"<sup>84</sup>. Optimizing recycling bin locations to increase accessibility relative to regular waste is an example of a nudge.

## **Financial Incentives**

Efforts to improve recycling rates in Israel have largely consisted of financial mechanisms. However, financial incentives were not sufficient to motivate local authorities to instigate recycling programs<sup>62</sup>.

Limited effectiveness of market tools, such as price variations or subsidies are leading to the decreased use of price "as an instrument to influence consumers' behavior"<sup>84</sup>. Price incentives, such as financial penalties, can not only be limited at times, requiring supplementary measurements, but can, in certain applications and contexts, be detrimental to their very purpose. Of the applied behavioral economic policies included in the OECD's 2012 catalogue of examples<sup>22</sup> with implications for environmental policy, the Israeli example is one that demonstrates a case where price incentives led to outcomes drastically opposed to their intended purpose<sup>49</sup>. The example was of Israeli daycare centers that began imposing fines on parents who were late to collect their children. While the intention was to discourage tardiness, it resulted in parents picking their children up significantly later than they had prior to the fine's introduction. Furthermore, even after the fine was lifted, the parents' refrained from returning to their prior behavior, highlighting the policy's lasting impact. While many would quickly chalk this up to Israeli obstinance, otherwise known as 'chutzpah', social psychologists and philosophers posit that the parents' increased tardiness denotes the abnegation

of perceived moral obligations, contradicting the homo economicus perspective abstracted by proponents of the neoclassical economic theory, and often attributed to policy-makers.

The daycare example is widely referenced to showcase how “price incentives can sometimes abolish individuals’ intrinsic motivations to engage in prosocial [or moral] behavior”, demonstrating a phenomenon referred to as “moral crowding out” (also termed “motivational crowding out” or “crowding out effect”) <sup>10, 22, 82, 103</sup>. This was defined by Underhill<sup>82</sup>, as “the process by which incentives can interfere with “intrinsic” motivations for behavior” (By 1999, the robust nature of this phenomenon was already established in a meta-analysis of 128 studies<sup>42</sup>).

An explanation attributes crowding out to the “monetization” of social norms<sup>22</sup>. This explanation is based on the assumption that “the fine changes the agents’ perception of the social situation in which they are involved”<sup>49</sup>, illustrating how external interventions can result in internalization; appealing to the notion that shifting perceptions of social norms and subsequently affect behavioral patterns. In this case, financial incentives transform social norms resulting in previously unacceptable behaviors becoming acceptable. This normative dimension of the crowding out effect has been explored further by various scholars<sup>10, 82</sup>.

Schwartz<sup>103</sup> elaborates on this explanation by illustrating the parents’ perspective, “they’re giving me permission to be late. Is it worth \$25? Is that a good price to pay to let me stay in the office a few minutes longer? Sure is!” and further explains how by monetizing the behavior, “it is as though the introduction of fines permanently altered parents’ framing of the situation from a moral transaction to an economic one. When the fines were lifted, lateness simply became a better deal”.

To draw an environmental parallel, a similar occurrence was documented in relation to the “not-in-my-backyard” (NIMBY) phenomenon, which was considered a major obstacle to the development of waste disposal facilities in Israel<sup>96p</sup>. When asked, 51% of Swiss citizens expressed their willingness to have a nuclear waste dump in their community despite subsequently lower property values and widespread acknowledgement (80%) of potential health hazards (this example was also included in <sup>22</sup>)<sup>42</sup>. Whereas, when posed the same question but with an additional offer for financial compensation, only 25% stated their approval. Both examples demonstrate instances where financial incentives undermine intrinsic motivations by framing moral obligations as economic imputations. This interpretation is further supported by the myriad examples of research suggesting individuals employ moral framing to support their altruistic behavior. Further research suggests economic incentives crowd out moral concerns and motivations<sup>43</sup>. More explicitly, a recent quantitative study indicates egoistic framing as an inhibitor to altruistic behavior<sup>44</sup>. The latter study asserts that its findings hold “the potential to inform ongoing conversations regarding organizational citizenship and moral crowding out, namely, how financial incentives can undermine altruistic behavior”<sup>44</sup>. These findings raise questions about financial instruments and their capacity to promote behavior changes in areas enriched in moral fundamentals. Further investigation is required to understand in which areas of economic incentives are critical to the furtherment of environmental objectives, in which areas they are best used in conjunction with moral arguments, and in which areas they may be detrimental to policy objectives due to their impediment on intrinsic motivations.

For habits, financial incentives may be able to induce behavioral changes in the short term, but may reduce intrinsic motivations towards said behavior in the long run after removing the incentive<sup>22</sup>. This likely reflects the superficial nature of such intervention measures. While they may deter the consumer from conducting the habitual behavior, it will not likely suppress the habit. In this case, behavior changes are reliant on, as opposed to influenced by, external interventions.

Environmental actions, under which plastic-related behaviors lie, are generally perceived as moral<sup>61</sup>, and are thus very much susceptible to the crowding out effect. However, monetary incentives will not always result in the crowding out effect, and can, in certain contexts, be highly effective behavior change instruments. This was demonstrated by an empirical study that showed how payment for environmental services (PES) programs can effectively influence behaviors, even after the financial incentive was withdrawn<sup>43</sup>. On the other hand, a study in Australia found non-monetary approaches to be more influential on environmental behaviors and attitudes, also finding that information-based approaches and moral arguments were the approaches best suited to promote water conservation behaviors<sup>98</sup>. These contrasting findings could be attributed to varying contexts, such as different public perceptions of environmental behaviors and intrinsic motivations<sup>116</sup>, public perceptions of legitimacy, traditions, demographics<sup>35</sup>, policy instruments<sup>82</sup>, or policy development schemes. For this reason, it is vital for policy makers to immediately consider the relevance of the crowding out effect when designing intervention measures. Furthermore, these findings emphasize why it is important to thoroughly test predominant assumptions that underlie policy plans that are put forth, and test prototype policy plans prior to scaling implementation.

For incentives to be effective, they have to be “attainable by the majority of participants”, as failure to attain the maximum reward may inflict on the agent’s sense of competence<sup>116</sup>. Therefore, when designing incentive mechanisms, to avoid crowding out, it is essential for policy makers to accurately assess the capabilities of the public to participate. For financial incentives imposed on reduced plastic waste quantities, or increased recycling rates, this could entail measurement of the extant disposal rates and prior testing within smaller regions along with ongoing monitoring to gain insight into what levels of reduction are attainable.

Another method of deterring crowding out, based on the self-determination theory, is through coproduction of incentive structures, such as through surveys or soliciting feedback on proposed plans prior to their finalization<sup>116</sup>. The idea behind this is to convey that the incentive introduced is a means of supporting, rather than controlling the citizens. “Agents who perceive incentives as supportive are likely to experience crowding-in of intrinsic motivations rather than crowding-out”<sup>116</sup>.

### **Public Distrust as a Barrier**

Despite the Israeli government’s considerable devotion of resources and economic investment into environmental restoration, these efforts have often been disproportionate and, at times, simultaneously undermined by extensive depletion of natural resources<sup>110</sup>. Seemingly contradictory governmental initiatives can promote a general distrust towards the government’s intentions, contributing to the poor self-efficacy that drives public inaction and deters sustainable behavior.

A lack of trust can hinder behavior change. “Responsibility [as a category of personal barriers] is where individuals do not engage in virtuous environmental behaviors because of a lack of trust, which leads to a belief that individual behaviors cannot influence the situation”<sup>51</sup>. This phenomenon is also referred to as a sense of self-efficacy, agency, or self-legitimization.

## Designing and Planning

- **Identifying Targets:** Behaviors that contribute to plastic waste and pollution and behavior change objectives.
  - Littering Behavior: Conscious and Subconscious
    - Encourage proper disposal practices
    - Discourage improper disposal practices
  - Minimizing Purchase and Use
    - Deter unsustainable purchases with an emphasis on unrecyclable plastic products intended for quick or immediate disposal
    - Promote sustainable purchases
    - Reduce consumption of quantities of plastic purchased
    - Encourage extended use or reuse
    - Deter quick or premature disposal
- **Disposal: Sorting & Recycling**
  - Provide and encourage waste sorting and recycling
  - Deter unsorted waste
- **Testing**
  - Control groups for policy plans
- **Implementing**
- **Monitoring & Enforcing**
- **Assessing**
- **Improvement**

In the case that there is a clearly apparent issue or obstacle that needs to be addressed, or a salient opportunity or prospective leverage point arises or becomes apparent, start with distinguishing potential instruments or plan accordingly. Then, refine it based on international examples and academic literature before returning to assess its suitability given the local context once again. Test any altered assumptions or potential barriers that may have arisen, and ensure the refined policy plan still aligns with the initial intent and all pertinent factors have been considered.

## Selecting Policy Instruments & Behavior Change Mechanisms

Drawing from international examples, theoretical literature, and empirical studies provides a basis for decision making, providing insight into what has worked and what has not. This narrows down viable and tested intervention methods. The pool of potential instruments can then be narrowed down further by funneling them through the local context. This section includes **concomitant behavioral strategies** that can be applied to a single policy or program to increase the program's influence on behavior. In relation to the environment, policy packages are relevant to policy plans, where the interconnections between different components of a sociopolitical landscape are taken into account to improve the overall efficiency and effectiveness of the entire system.

According to the most recent studies, social influence is shown to have the most significant influence on behavior changes. Therefore, it is recommended for policy-makers to incorporate these factors into policy designs. However, that is not to say other mechanisms are not effective. A combination of multiple approaches will result in a larger effect.

Behavioral interventions have the potential to enhance the impact of other intervention methods, emphasizing the importance of understanding the interactions between intervention measures<sup>84</sup>. For example, "participation in conservation programs could vary by a factor of 10, depending on

**concomitant behavioral strategies**, such as perceived social norms or message framing”<sup>84</sup>.

Effects on behavior depend on the policy or economic forces concurrently in place, or that specific combinations of behavioral interventions with legislation and/ or financial incentives produce better results<sup>33</sup>. Indeed, there is evidence strongly suggesting an interactive effect. For instance, financial incentive programs for home insulation that required prior energy audits were less effective in promoting conservation actions compared to programs that offered similar monetary incentives, but that did not involve requesting an audit”<sup>84</sup>.

## **Public Perspectives**

It is important to understand the socio-demographic and psychological determinants of environmental behaviors<sup>130</sup>. Policies should be designed according to the local context, and adhere to the local population. The behavior change mechanism should take into account structural or design features, community features (cultural, demographic, socio-economic, social networks, community dynamics) and individual features (preferences, attitudes, self-identity, knowledge & awareness). Implementing any policy plan “should be preceded by a detailed assessment and attenuation of barriers that could potentially threaten the outcome”<sup>51</sup>. These barriers include practical, behavioral, or physiological. This can be through existing literature, surveys, or behavioral observations, in addition to local involvement, recalling the community leader approach to behavioral change.

Comparisons with international examples of theoretical concepts or understandings must integrate with significance in local contexts. “The way individuals relate to the natural environment is culturally patterned. In this article we review and discuss cross-cultural differences and similarities in a number of important domains including environmental concern, environmental risk perception, and pro-environmental behavior”<sup>74</sup>. Thus was the primary objective of the OECD’s EPIC study conducted in 2010, as well as the 2009 study on Israeli university students. Given university students are not representative of adult populaces; this cross-country perspective illuminates the significance of the latter study.

## **Collaborative Governance**

A study based in Israel discovered how “the structure of the legal instruments used to regulate environmental behavior can influence the attitudes of the general population toward problematic ecological behavior irrespective of the eco-physical attributes and health impacts of the observed behavior. Because these expressive effects can influence people’s willingness to engage in private enforcement, they can also influence the overall efficacy of the regulatory regime”<sup>34</sup>. Furthermore, the study further demonstrated how requiring private firms, such as recycling companies, to engage the public in the development of regulatory schemes and their objective goals can “increase the perceived legitimacy of these schemes and enhance public willingness to contribute to the enforcement of the scheme provisions, further enhancing its efficacy and credibility”<sup>34</sup>.

These findings both illuminate the need of testing prior assumptions while also illustrating how the allocation of enforcement responsibilities can influence Israeli’s perceptions and compliance behavior. The study further demonstrates how participatory mechanisms can “provide valuable insights for the design of policy measures” while enhancing perceptions of legitimacy and subsequently strengthening the public’s willingness to comply with government policies and adhere to the behaviors that would otherwise require additional enforcement measures<sup>34</sup>. A more recent study on regulation of recycling in Israel supports this recommendation for co-production on a municipal level, on the basis that participatory governance facilitates the development of policies adapted to the localized populace<sup>35</sup>. As for the publications by the Institute of Policy and Strategy in Israel,

there is minimal focus on environmental issues apart from a few papers on R&D policy<sup>106</sup>, electricity consumption, and Israel's partnership with the OECD<sup>106</sup>.

Norway and Denmark are excellent examples of successful co-production where NGOs and stakeholders are involved in and actively implementing knowledge from the behavioral science into the policy-making process, including experimental design, training, and intervention programs<sup>17</sup>. In particular, the Green Nudge grass roots organization, that works to create environmentally sustainable behavior and practices that will lead to a low carbon, zero-waste Singapore by 2030 contributes to government decisions made around environmental issues.

Integrating interdisciplinary perspectives into behavioral interventions is “crucial particularly when implementing interventions that may combine different stimuli e.g., public service announcements, social comparison and government action. Complex, multi-layered interventions from the standpoint of their content and implementation may require the joint work of multiple experts. Also, using advanced technological solutions for data collection may also be more effectively implemented when combining behavioral scientists with technical expertise such as engineers and computer scientists”<sup>84</sup>.

### **Policy Package**

R2Pi, an EU funded project that examines ways to shift from the broad concept of a Circular Economy (CE) to one of Circular Economy Business Models (CEBM), recognizes the limitations of policy instruments, suggesting that a combination of instruments are often necessary to achieve what a single policy instrument is incapable of<sup>104</sup>. Research finds that “a portfolio of diverse solutions – not only technological ones – is likely to have greater technical, political and economic feasibility”<sup>26</sup>. Rather than deciding on a single policy instrument, choosing multiple policy instruments will increase the likelihood of effective outcomes. Scholars and policy-makers have largely focused on downstream solutions to plastic-related problems. However, others<sup>83</sup> recommend decision makers pay closer attention to the relationships between different stages of the life-cycle. Entanglement and interdependencies across different parts of the plastic system should be taken into consideration<sup>83</sup>. A more in-depth understanding of the entanglements and interdependencies across different stages of the plastic system can facilitate more efficient and effective governance. Rather than considering each stage individually, policy makers should incorporate the connections and relationships between elements of the plastic life-cycle into their policy plans. This broader systemic outlook to sustainable development offers decision makers the prospect of extending the impact of interventions. Adding in multiple dimensions better reflects the complexities of the plastic problem. While the complexities of the plastic industry are most often considered a barrier to sustainable development, if mapped and properly incorporated into the decision making process, the interconnections can be used to create “policy spillover”, streamlining efforts towards a circular economy. “Common sense could argue that such a discrepancy is an obstacle to the promotion of ecological behaviors. Social psychological research, however, shows that this kind of discrepancy can be used to enhance pro-environmental behaviors [2015]”<sup>55</sup>.

Traditional sectoral and uncoordinated policy approaches have been criticized due to their inability to effectively address the cross-cutting character of most political issues<sup>41</sup>. Alternatively, horizontal policy approaches can improve the efficacy and coherence of policies aimed at addressing multi-dimensional issues with elements affecting multiple sectors of the economy<sup>41, 124</sup>. One approach is to integrate environmental objectives into existing sectoral policies through intersectoral coordination<sup>41</sup>. This approach is expected to improve the efficacy and coherence of plastic-related policies by

improving alignments across different government departments.

Policy coherence (as a policy attribute), as it is defined by Lenschow et al., is the “synergic and systematic support towards the achievement of common objectives within and across individual policies”<sup>70</sup>. Related concepts include policy interaction, policy integration, policy coordination, coordinative discourse, collaborative governance, and nexus governance<sup>70</sup>. As a policy attribute, coordination, collaboration, and cooperation are thus considered “mechanisms or processes contributing to coherence”, rather than the core focus<sup>70</sup>.

Plastics, as a key component of Sustainable Development Goals 10 and 14, and relevant to a number of other SDGs, present these challenges, along with an additional dimension of complexity. Plastics cut across the three dimensions of sustainable development: the economic, social, and environmental, as is a key challenge to the implementation of the SDGs<sup>39</sup>. This presents further governance challenges due to the complexities associated with “properties of plastic itself, including its longevity, toxicity, malleability, and propensity to disintegrate into microplastics”<sup>31</sup>. Almost paradoxically, while plastic pollution is recognized as a global crisis and despite ongoing research efforts, its global distribution, transfer pathways, and the magnitude, extent, and consequences of its impact remain largely enigmatic. Despite ongoing research efforts, “the array of intertwined sources of marine plastic pollution makes its governance difficult, since we need to envisage the inclusion of a broad range of activities and sectors”<sup>31</sup>.

Therefore, Israel’s action against this critical issue requires cooperation between ministries as well as between the private and public sectors. Bringing the right people and parties together will undoubtedly create change towards a stronger, more sustainable economy and society.

## Recommendations

To effectively address the complicated issue of plastic pollution, it is necessary to build an interdisciplinary task force that can design, oversee, enforce, and assess different governmental interventions into plastic production and consumption. This group should contain members of multiple ministries in the government related to environment, finance, and culture, academics in relevant fields, environmental NGOs, and community leaders.

A crucial intervention is in the phasing out of single-use plastics. Examples of what action might look like in this sector include, but are not limited to, instituting a tax on single-use plastic products and subsidizing companies producing substitute materials. Changes in product design, business models, and consumer behavior to incorporate principles of sustainability and increased reuse of products, are essential. Incentivizing and subsidizing innovative techniques to both produce more sustainable products and to creatively deal with waste, are necessary to address the issue at hand.

An area that could have profound impacts is in the field of design thinking. Research and businesses interested in producing more sustainable forms of plastic, or improving consumer disposal behavior, could be significant in altering consumer behavior. An example of this form of intervention is in the redesigning of public garbage bins. Generally speaking, it is assumed that public authorities are unlikely to put much

thought or effort into designing garbage bins, and presumably even less likely when it comes to public trash cans, such as those found outside grocery stores or at the park or beach. However, behavioral psychologists and those familiar with design thinking would likely conceive this lack of regard as being a lost opportunity. Bins should be creatively covered to prevent plastic leakage, strategically placed at littering hotspots, and should always be accompanied by a clearly identifiable recycling bin to provide the opportunity for sustainable habit formation. Something like a neighborhood art competition to design such a bin could engage everyday citizens in the adoption of sustainable behaviors.

Another possibility for creating social change is through mobilizing trends of gamification and digitization, as the OECD found through testing smartphone apps about plastic. Gamification techniques, as it is defined by Llanos et al.<sup>69</sup>, “are techniques that aim to involve people in certain tasks as if they were a game, taking advantage of emotional and/or physical reward”. Gamification techniques can be used to encourage citizen participation in recycling activities, although they can also be designed to offer additional benefits, such as improved environmental knowledge and waste tracking. Sensors can also be adapted to provide measurements on other parameters, such as potentially-hazardous gas emissions. There are numerous potential awarding mechanics, which can range from sensory stimuli such as emoticons and sounds, to financial incentives such as gift certificates<sup>69</sup> or tax deductions. However, it should be cautioned that the level of difficulty necessary to obtain the reward, for example, if paperwork is necessary, may deter participation. Automated reward systems are thus preferred. As opposed to the conventional utilitarian perspective of recycling behavior, gamification mechanisms address the experiential attributes of recycling. Gamification of recycling in student apartments in Finland improved participation in plastic recycling from 25% to 84% of inhabitants<sup>102</sup>.

The Israeli government, in partnership with the Israeli population, must act fast to reduce the consumption of plastics, use renewable energy to manufacture plastics, and greatly increase the recycling of plastic waste. This is the only way forward, to ensure a clean, safe, and prosperous future for the land of Israel.

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