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Subject: Potential Engineering Solutions for Project 1

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This memo describes our micro plastic problem and outlines the possible solutions. We have identified 5 key solutions: DRS (Deposit Return Schemes), Multi-Stream Recycling, Advanced Sorting and Robotics, Chemical Recycling, WtE (Waste to Energy).

In Qatar, there is a problem more pressing than any, that being Hazardous waste, more specifically micro plastics. Despite Qatar's modernized infrastructure, it is still missing critical waste disposal, especially one that effectively deals with micro plastics. Most waste in Qatar is not recycled but sent to landfills, buried, or burned, which releases harmful waste into the environment. Eventually, this waste breaks down into micro plastics, polymers smaller than 5 millimeters that are almost impossible to remove and process once integrated into the environment due to the durability of plastics. More importantly, they get smaller over time, making it easier to be ingested by animals and humans, which produces great harm, the greater its quantity.

Option 1: Deposit Return Scheme

One of our proposed solutions is the implementation of a Deposit Return Scheme (DRS) for single-use plastic bottles, as currently trialed in Qatar by retailers such as Al Meera and LuLu Hypermarket. Even though our problem is tackling micro plastics, this system recycles the single use plastics so that they are not thrown into landfills or incinerated which creates micro plastics. Under this system, customers receive small incentives (for example Points, Vouchers etc…) when they return used plastic bottles via machines at the stores. Al Meera's[1] initiative allows customers to earn bonus rewards (Al Meera Points) by depositing bottles and cans in their machines.

The main advantage of this solution is that people will start recycling more and there is a higher chance of them returning the plastic bottle instead of throwing it in the trash can, where it is then disposed of harmfully. Some people may think that by introducing such system, the consumer rate for plastic beverages will increase which will reduce the effectiveness of the machine. This is incorrect, as the fluctuation [2] in beverage sales is within a normal variation range and aligns with regional trends, so there is no direct correlation between increase beverage sales and introduction of deposit return scheme.

Option 2: Multi-Stream Recycling

One approach to reducing micro plastic pollution in Qatar is improving source separation. Source separation is the practice of sorting different materials at the point where they are generated. By separating recyclables at the source, plastics can be kept cleaner and properly processed before they degrade into micro plastics. Programs like Education City's Green Island initiative as well as Qkons are showing some potential. One achieves source separation by separating them right after the trash is collected and the other by rewarding those who separate their trash. However, to scale it Qatar must educate and provide its citizens with the resources to improve source separation. Furthermore, people must be willing to put in effort to have a meaningful impact. This human factor is hard to control, which means that this solution is less feasible on a large scale.

Option 3: Advanced Sorting and Robotics

Deploying optical-AI sorting and robotics would cut micro plastics at the source. Faster capture of bottles, trays, and films keeps plastics out of heat and abrasion that fragment them [3]. Inside the plant, enclosed transfers, dust extraction, and fine filters on vents and drains stop shed fragments from escaping [4]. This will not remove micro

plastics already in water or soil, but it shrinks the upstream reservoir that makes them. Compared with awareness campaigns or incineration, advanced sorting raises capture rates and bale quality, and it supports other tools [5]. Trade-offs include capital cost, skilled staff needs, and sensitivity to heavy food waste. A public-private, phased rollout can manage these and offers a practical near-term path.

Option 4: Chemical Recycling

Qatar might utilize chemical recycling as its hidden card against plastic pollution. The process of converting PE, PET, and PP among other polymers by thermal or chemical degradation of the materials to their original monomer or other useful feedstocks provides waste with a second opportunity, turning a landfill issue into a resource. The reward is unbelievable, and with each ton of the plastic which will be chemically recycled, about seven barrels of crude oil will be saved, which will reduce the input of petroleum and decrease greenhouse-gas emissions at the same time.

Option 5: Waste to Energy

Waste-to-Energy or WtE represents one of Qatar's main solutions to the problem of plastic waste. It is the process of converting non-recyclable waste into usable energy by using heat. Qatar generates large amounts of plastic waste and has limited landfill space, and WtE helps in managing waste efficiently while simultaneously producing renewable energy. This initiative is also driven by Qatar's commitment to the QNV 2030 by promoting environmental sustainability and producing efficient energy. An example of this initiative is the Domestic Solid Waste Management Center (DSWMC) located in Mesaieed. The Center is designed to treat up to 2,300 tons of mixed domestic solid waste per day, servicing the whole of Qatar. It comprises state-of-the-art waste sorting and recycling facilities, an Anaerobic Digestion composting plant, a 1,500 ton-per-day incineration plant, and a sanitary landfill satisfying the most advanced standards in the world [6]. However, there is a high amount of carbon dioxide emissions during the process, which is one of the most notable greenhouse gases. Methods like gasification, where the waste is processed at extremely high temperatures without combustion, produce a natural combustible gas called syngas that can be used as a fuel source and can be used to reduce emissions and improve the sustainability of WtE systems [7].

Decision Matrix:

Solution	Feasibility	Environmental Impact	Cost Efficiency	Total
Deposit Return Scheme	**9**	**8**	**9**	**26**
Multi-Stream Recycling	7	8	7	22
Advanced Sorting and Robotics	6	9	5	20
Chemical Recycling	5	9	4	18
Waste to Energy	7	6	6	19

Feasibility: Reflects how realistically the solution can be implemented in Qatar.

Cost Efficiency Evaluates financial practicality, ensuring that the proposed solution offers meaningful benefits relative to its cost of operation and implementation.

Environmental Impact: Measures how effectively the solution reduces micro plastic generation

Conclusion:
Based on our decision matrix Deposit Return Scheme scored the highest total(26/30) and we selected it as the most suitable solution for addressing micro plastic pollution in Qatar.

References:

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