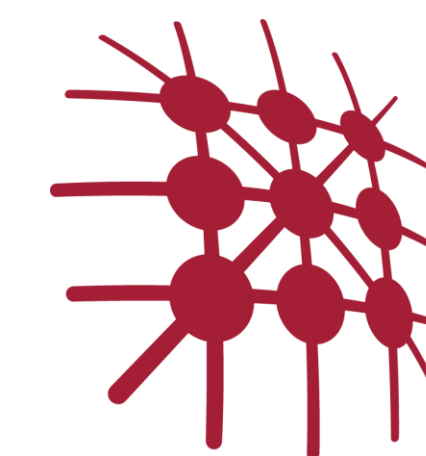
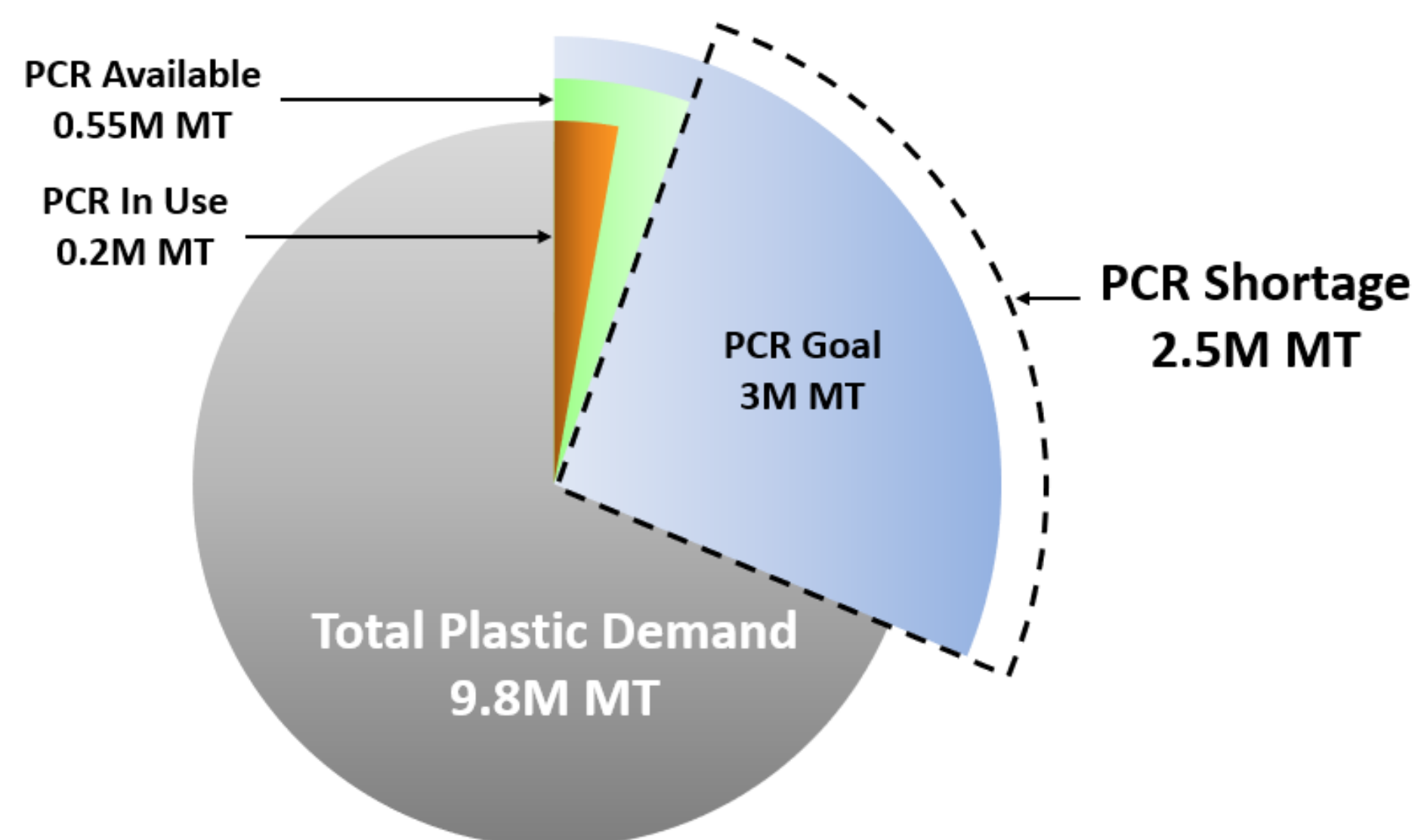


Get Smart: Reinventing Plastic Recycling in a Collaborative, Circular Supply Chain



Motivation / Background

- **CPG industry sustainability commitment:** Reduce demand for virgin plastic by 30-50% and replace with post-consumer recycled (PCR) plastic
- **Problem:** Less than 10% of post-consumer plastic is recovered
- **Action:** Increase the recovery of PCR plastic to meet the collective sustainability goals of the CPG industry



Key Question / Hypothesis

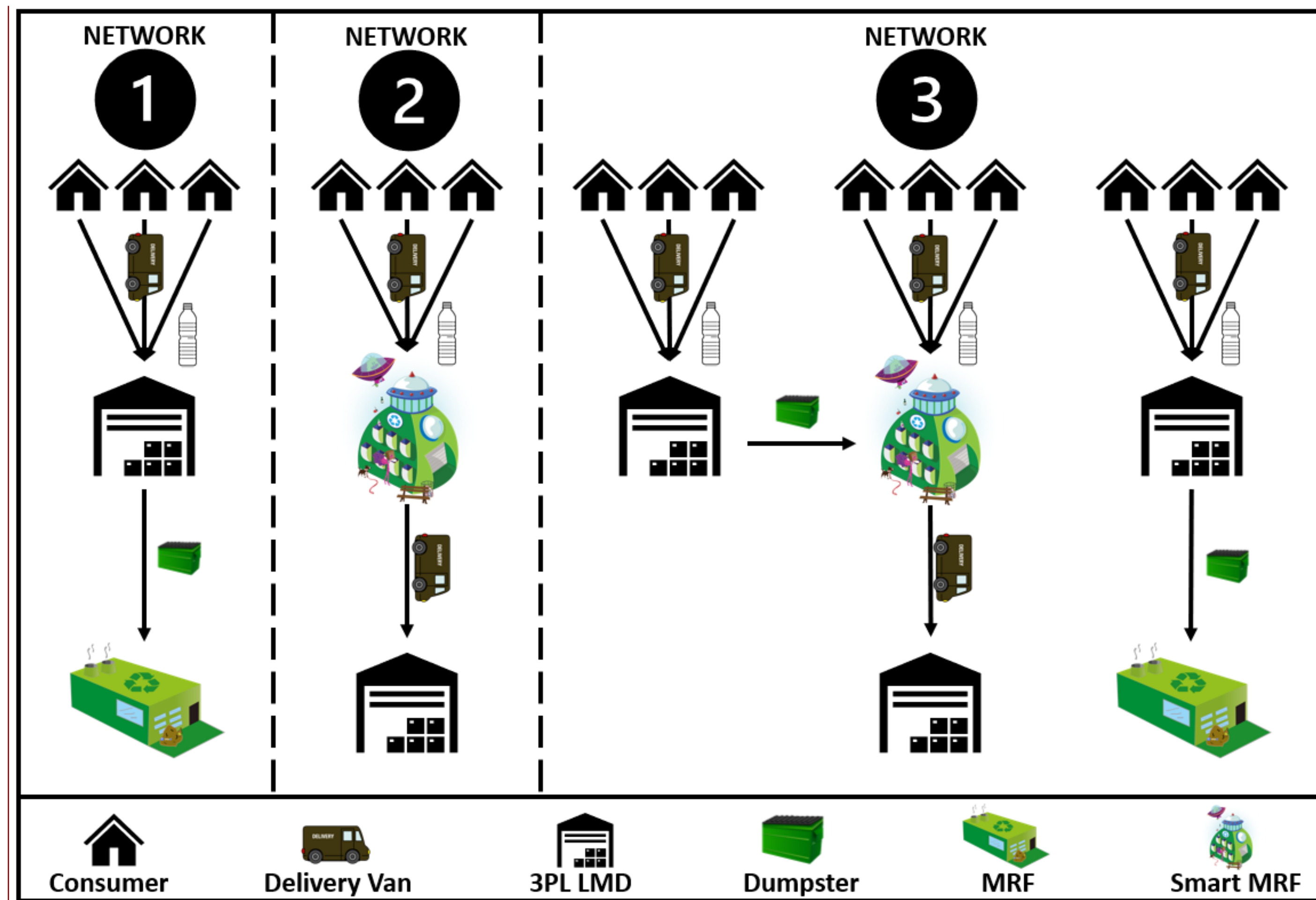
What is the optimal network design for a circular supply chain facilitated by 3PL plastic collection, assuming collaboration between relevant actors from a total profit perspective. Does it generate more recycled plastic than traditional curbside recycling programs? Using New Jersey as a case study, we hypothesize that circular supply chains can be profitable alternatives to traditional curbside.

Relevant Literature

Mouw, S. (2020). 2020 State of Curbside Recycling. The Recycling Partnership 2020.

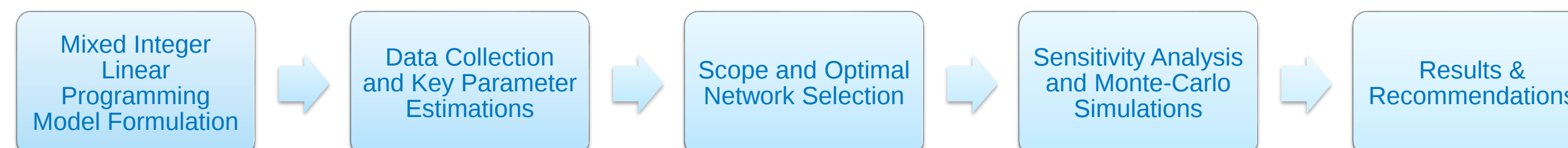
Cimpan, C., Maul, A., Wenzel, H., & Pretz, T. (2016). Techno-economic assessment of central sorting at material recovery facilities – the case of lightweight packaging waste. *Journal of Cleaner Production*, 112, 4387–4397. <https://doi.org/10.1016/j.jclepro.2015.09.011>

Huysman, S., De Schaepmeester, J., Ragaert, K., Dewulf, J., & De Meester, S. (2017). Performance indicators for a circular economy: A case study on post-industrial plastic waste. *Resources, Conservation and Recycling*, 120, 46–54. <https://doi.org/10.1016/j.resconrec.2017.01.013>



Methodology

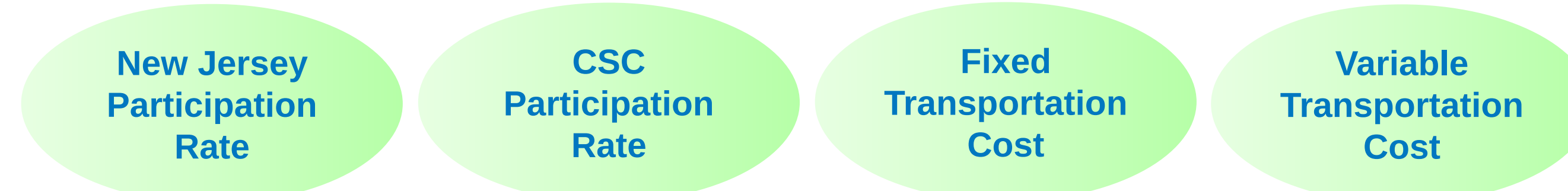
- **General approach: Profit Maximization MILP Model**



- **Network Design Evaluation**

- Proposed Networks: 1. No SMRFs 2. All SMRFs 3. Optimal SMRFs
- Net Profit = Plastic Revenue - Labor - Transportation - Dumpster - Facility Fixed Costs - Sorting Costs

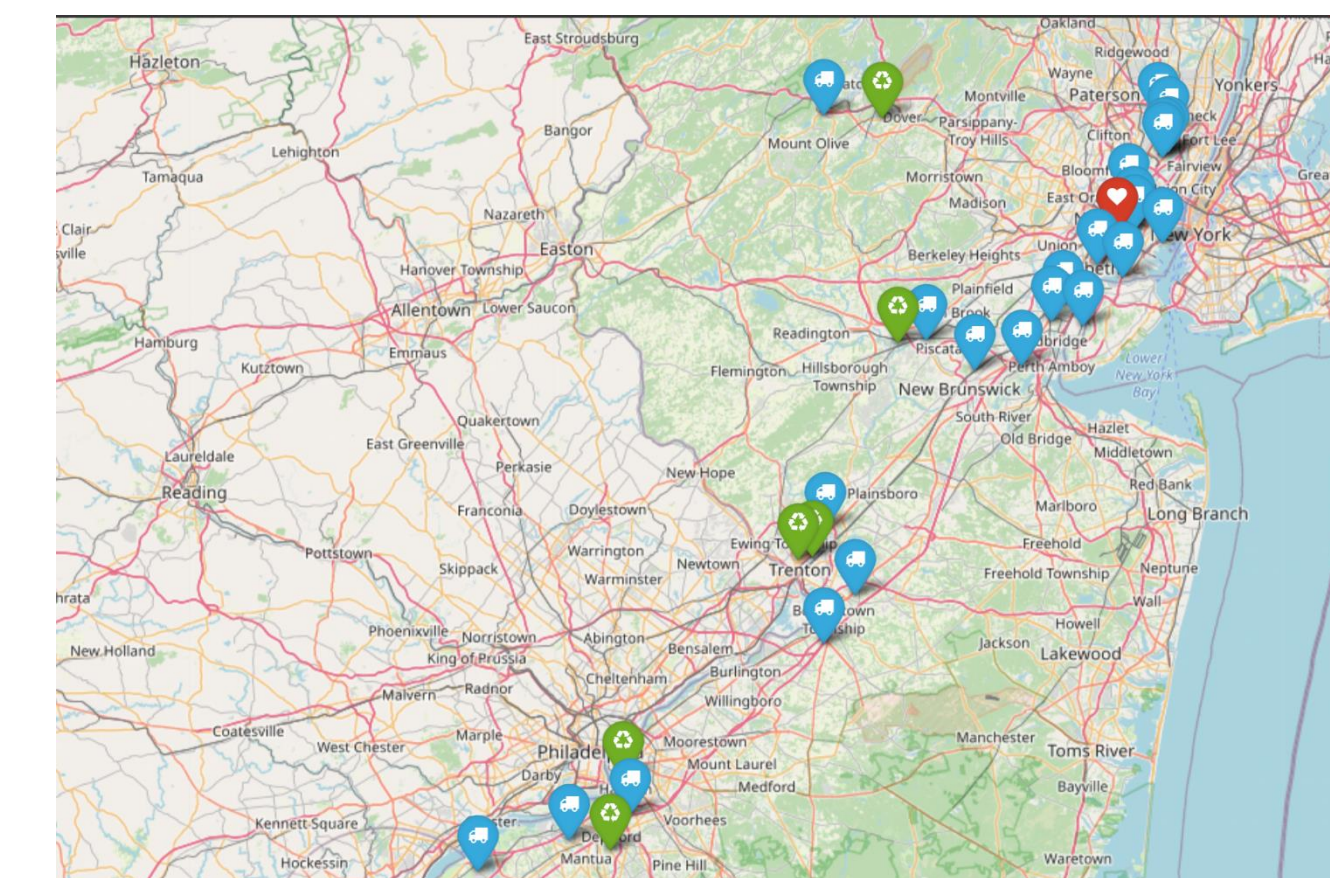
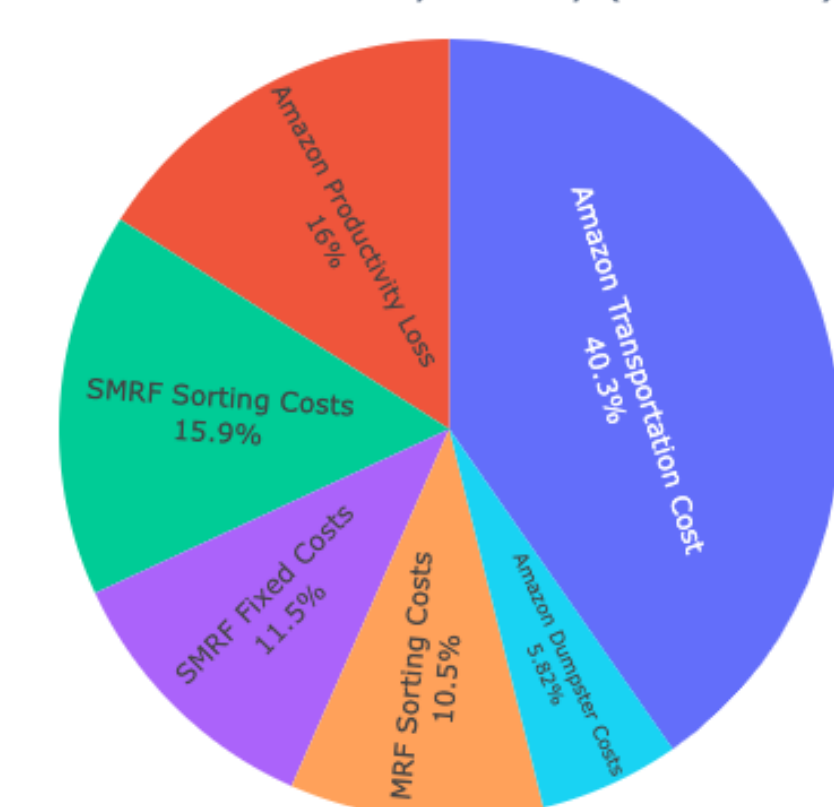
- **Sensitivity Analysis and Simulation Parameters**



Results

Network	SMRFs Opened	MRFs Opened	Total Annual PCR Plastic Revenues	Total Annual System Cost	Total Annual Profit
Network 1 (No SMRFs)	0	17	\$1,171,694	\$1,245,376	\$(73, 682)
Network 2 (All SMRFs)	26	0	\$1,556,909	\$4,724,281	\$(3,167,372)
Network 3 (Optimal SMRFs)	1	6	\$1,424,431	\$1,395,224	\$29,207

Cost Breakdown by Activity (Network 3)



- Over 75% of all simulation runs included at least one SMRF
- Networks with 6 MRFs and 1 SMRF were most common
- Amazon bears 61% of total system costs
- Variable Transportation Costs and CSC Rate are most impactful parameters on number and type of sorting facilities utilized, respectively

Contribution

- Developed a network design evaluation model that can evaluate the profitability of 3PL plastic collection and SMRF deployment.
- Identified that consumer buy-in to the 3PL network and variable cost per mile are the most relevant factors in determining number of facilities and breadth of network, respectively.
- Laid the groundwork for future research focused on contractual relationships between actors, possible cost reallocation strategies, and the necessary considerations for a pilot study.

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