**Styrofoam Degradation: One Mealworm at a Time**

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### The Issue: Plastic Waste

**The Global Perspective**

The accumulation of plastic has become a global issue, and contributes to global warming and ecosystem collapses. Some important numbers at a glance:

- 300 million tons of global plastic waste per year
- Plastic either sent to landfills, incinerated or recycled
- 30% of plastic waste is due to single-use plastic

Polystyrene is one of the most popular packaging materials as it is cheap, readily available and easy to manipulate. However, its high melting temperature and inertness make it difficult to degrade without incineration, which results in large emissions of greenhouse gases (CO₂).

**The Rutgers Perspective**

Because of its large size, Rutgers is a significant contributor to plastic waste.

- ~50,000 students enrolled
- ~21,500 students living on campus
- 16 million lbs of plastic waste/semester
- 1.5 million lbs of polystyrene waste/semester

Total cost to incinerate Rutgers plastic waste = $45,760/semester

Cost to the environment = 193,765 kg CO₂/semester

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### Our Plan

We are proposing that Rutgers establishes a polystyrene waste processing plant on the Cook-Douglass campus which would use mealworms to degrade polystyrene into CO₂ and nutrient-filled biomass. The proposed facility would include a layered mealworm farm to maximize the efficiency of the mealworm breeding and polystyrene degradation process.

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### Cost Analysis

The cost analysis assumes that 50% of polystyrene waste is converted to CO₂ by the mealworms. This equates to 1.54 kg of CO₂ for every kg of polystyrene consumed. Mealworms have four stages of life:

1. Egg (4-20 days)
2. Larva (10 weeks)
3. Pupa (6-18 days)
4. Beetle (8-12 weeks)

The mealworms can only degrade polystyrene from the larva to beetle stage, which gives ~154 days of active life. The calculated costs in the table below assume that the cost of mealworms if $0.10/1000 mealworms and that 3,000,000 mealworms are needed to process a kg of polystyrene/day. This model also assumes that the mealworm population will double every 154 days as the mealworms mate and grow their population.

<table>
<thead>
<tr>
<th></th>
<th>Recycling</th>
<th>Waste Incineration</th>
<th>Mealworms</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂ emissions l/kg polystyrene</td>
<td>0.271</td>
<td>2.6</td>
<td>1.54</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>-</td>
<td>27%</td>
<td>-</td>
</tr>
<tr>
<td>Process costs (kg)²</td>
<td>0.288</td>
<td>0.199</td>
<td>0.00</td>
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<tr>
<td>Energy requirement (kwh/kg)</td>
<td>1.347</td>
<td>7.05</td>
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</tbody>
</table>

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### The Future

The facility proposed is the first step to mitigating Rutgers’ CO₂ emissions due to polystyrene waste. As time progresses, it is hoped that this facility will grow and expand to become a research facility in addition to the polystyrene waste facility. Some additions that we envision for the future of this facility include:

- Research labs to study the bacteria in the mealworms responsible for degrading polystyrene
- Testing facilities to test the ability of mealworms, and other insect types, to degrade other plastics
- Partner with the Rutgers EcoComplex to improve the plants process to increase the efficiency of polystyrene degradation
- Collaborations with lab groups within Rutgers University to develop efficient ways to capture and use the CO₂ created in the mealworm farm as well as the biomass excreted by the worms.

By continuous research and innovation of this process, our hope is that this facility could become a birthplace for plastic waste degradation by worms and other insect life.

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### Why Mealworms?

Mealworms, the larvae of *Tenebrio molitor*, have the ability to degrade polystyrene into 47.7% CO₂ and 49.2% nutrient filled feces. Benefits of mealworms include:

- Abundant
- Cheap
- Easily accessible

Mealworms have the ability to live off a diet of polystyrene and other types of plastic, offering the potential to create a mealworm farm which can process Rutgers plastic waste and degrade it to less CO₂ (which can be captured and stored) and biomass that can be recycled for other purposes (i.e. fertilizers).

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### Acknowledgements

We would like to thank Professor Alex Bertuccio for helping guide us in putting this proposal together; we would not have stumbled upon this idea had he not been researching it in his lab. We would also like to thank the Rutgers Energy Institute for providing us with the opportunity to pursue this unorthodox idea, and for giving us a chance to present a proposal which might, one day, help mitigate the consequences of climate change.