CAPSTONE/SENIOR DESIGN EXPERIENCE 2018

Compostation Prototype

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Statement of Problem:

Design a solar-powered composting system capable of degrading food waste, paper waste, and pet waste into a nutrient-dense humus for local land application.

Objectives:

- Decrease organic material transported to landfills.
- Source system energy from renewable sources.
- Increase public awareness of the benefits of composting.
- Produce Class A biosolids for agricultural uses.

Motivation:

- Population increases have lead to strains on landfills and waste treatment facilities.
- Growing public concern of greenhouse gas emissions and environmental impacts.
- Availability of waste streams which can be converted to high-value products.

Market Share

- Niche markets already predisposed to energy conservation technologies.
- Populations where grants are available to provide funding for the development of environmentally friendly processes.
- Targeted customers include: apartment complexes, college campuses, and public parks.

Societal and Global Impacts

Positive Impacts

- Mitigation of greenhouse gas emissions due to reduction in waste transport.
- Inputs otherwise treated as waste are utilized to generate a value-added product.
- Educational benefits provided to the community at large.
- Reduced capacity requirements for local landfills.

Potential Design Drawbacks

- Net increase in emissions if the system installation is not accompanied by a reduction in garbage collection.

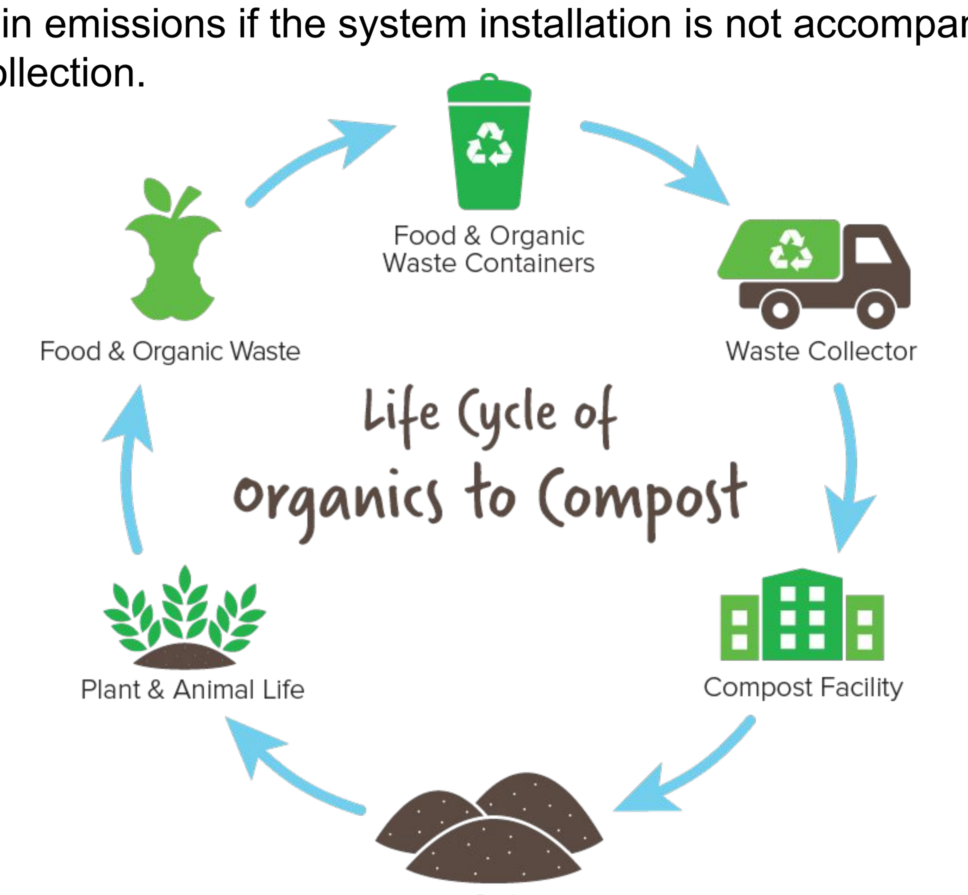
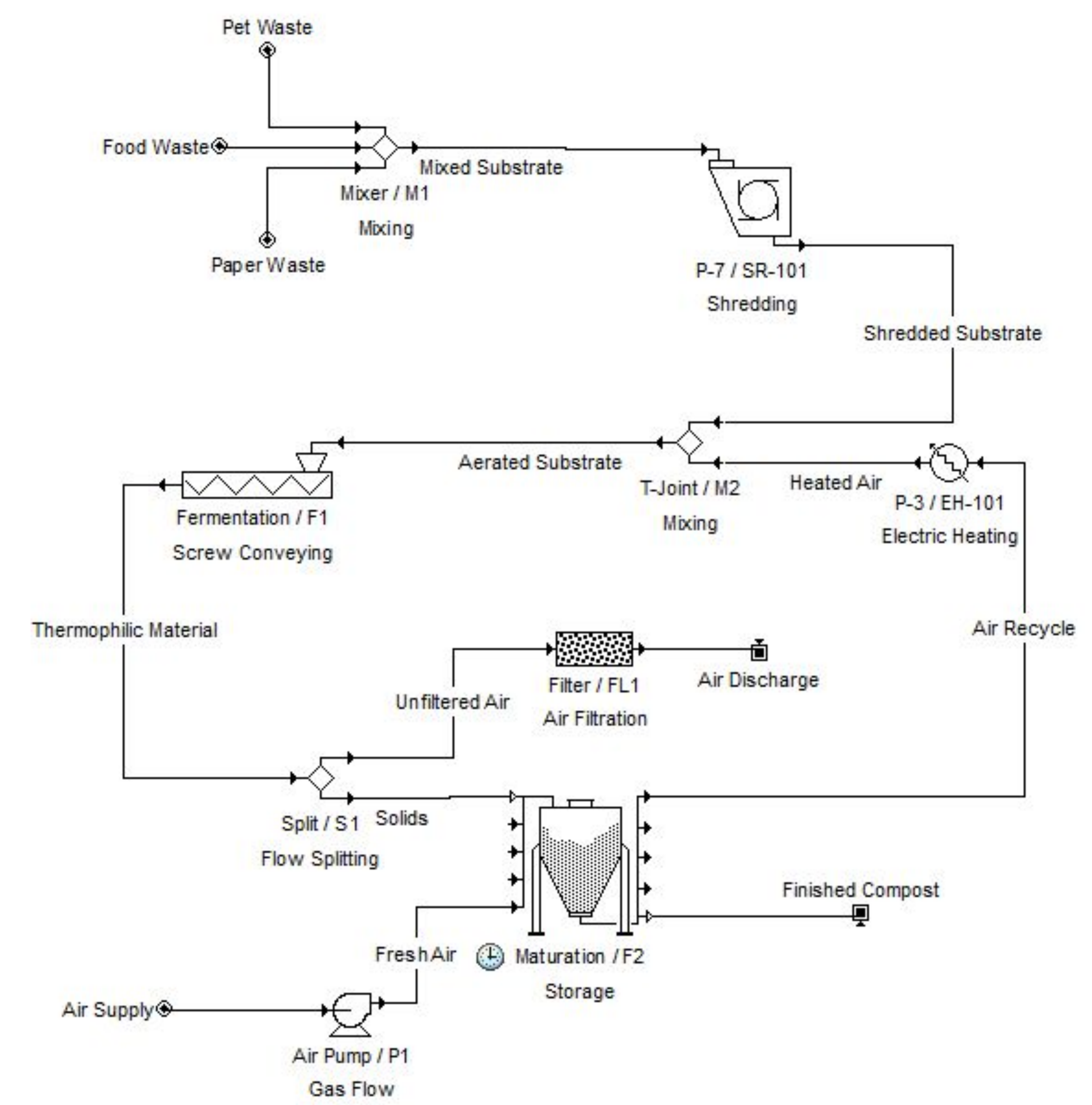


Image sourced from Live Green Landscapes[1].

Process Flow Diagram

Basis: Annual waste of 50 people.
Feed Rate: 6250 kilograms mixed substrate consumed per year.
Production Rate: 2676 kilograms compost produced per year.



Process Goals:

- Production of Class A biosolid
- High substrate conversion
- Cost effective

Alternatives Considered:

- *Shredding*
  -Cascaded shredders
  -Industrial biaxis shredder
  -Multipurpose blender
- *Thermophilic Decomposition*
  -Screw conveyor
  -Belt conveyor
  -Aerated fermenter
  -Plug flow reactor
  -Screw conveyor
- *Air Filter*
  -Carbon Filter
  -Biofiber filter
  -Combined water and air filter
- *Mesophilic Decomposition*
  -Dual fermentation tanks
  -Batch fermentation tank

Design Constraints and Challenges

- EPA Class A biosolids design standards require that compost be maintained at an operating temperature. of 40 degrees Celsius for a minimum of five days, and exceed 55 degrees Celsius for at least four hours.
- Availability of solar energy due to weather fluctuations.
- Addition of non-biodegradable substrates to the feed stream.

Moving Forward

- Obtain experimental data for the proposed prototype to measure the final quality of the finished compost.
- Analyze finished compost to confirm there are no measurable quantities of pathogenic bacteria to comply with EPA Class A biosolids guidelines.
- Design a visual model highlighting the aesthetic features of the system for marketing purposes.
- Develop a functioning prototype.

Economic Analysis:

The gross earnings of the installed pilot system has been evaluated.
Annual Sales and Savings Income: $2,685.61

Direct Costs:		
	Purchased Equipment:	$3250
	Installation:	$812.50
	Instrumentation and Controls:	$325.00
	Total:	$4,387.50
Indirect Costs:	Consultation and Design Costs:	$1,316.25
Fixed-Capital Investment (P):		$5,703.75
Fixed-Capital Investment (A):		**$1,597.48**
Direct Production Costs:		
	Maintenance and Repairs:	$1,140.75
Fixed Charges:		
	Depreciation:	$570.375
Manufacturing Costs:		$1,140.75
Total Product Cost (A):		$1,140.75
Annual Cash Flow:		**$71.99**

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[1] https://livegreenlansing.org/scraps-to-soil/