Iowa State University
Industrial and Manufacturing Systems Engineering

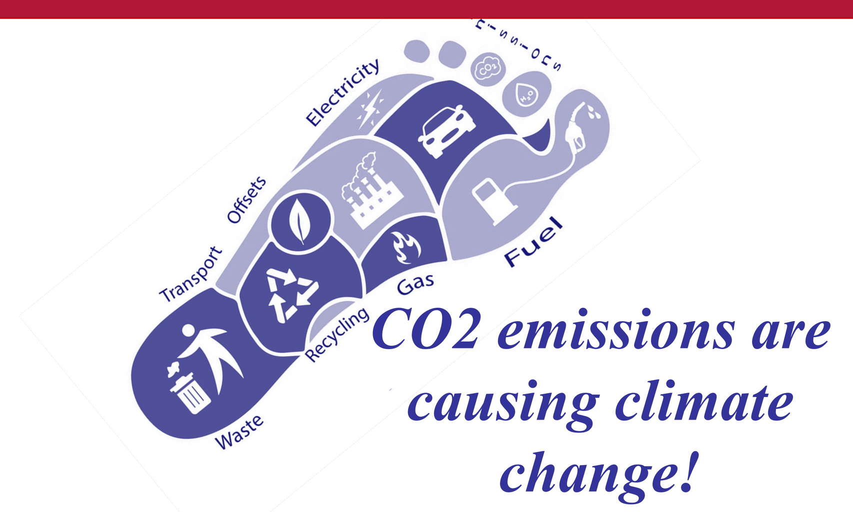
Research Symposium
January 2023

Student Name: Motahareh Kashanian

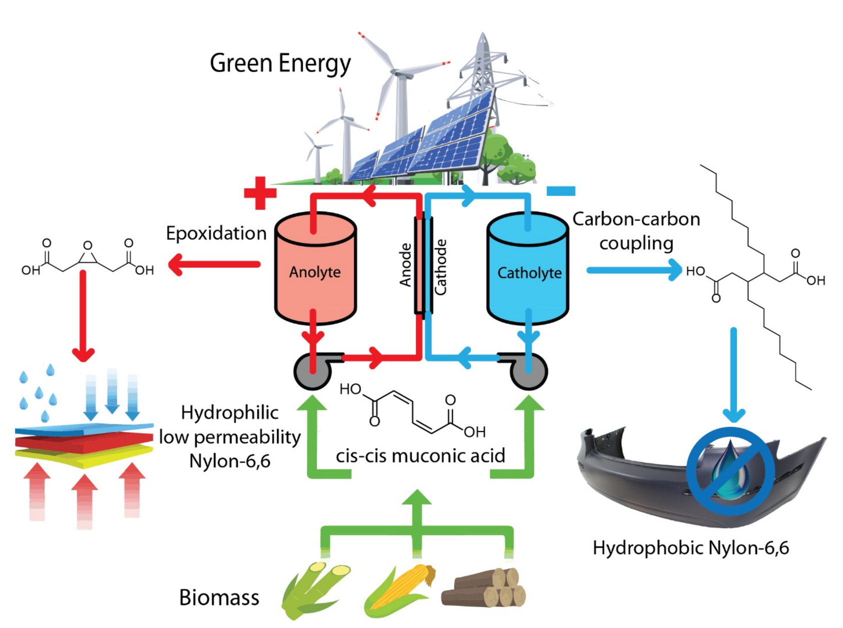
Faculty Mentor: Sarah Ryan

Supply Chain Design for Chemicals from Biomass Using Green Electrochemistry

BACKGROUND & MOTIVATION



- The chemical industry will need to switch to renewable energy.
- Replacing petroleum as a feedstock with biomass - greener materials and greener energy.
- Electrochemistry has shown promise for producing chemicals from biomass.



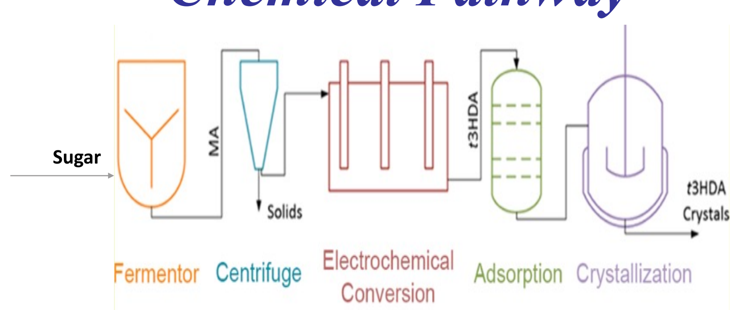
Distributed Electrochemical Manufacturing of Novel Monomers from Biomass for Production of Performance-advantaged Polyamides.

OBJECTIVE

- Optimize the design of the supply chain under uncertainty in
  - feedstock availability and quality,
  - transportation costs, and
  - market demands, to
- Identify optimal plant sizes and locations that take full advantage of the distributed feedstocks and energy resources.

APPROACH

Chemical Pathway



Process Flow Diagram for integrated chemical facility

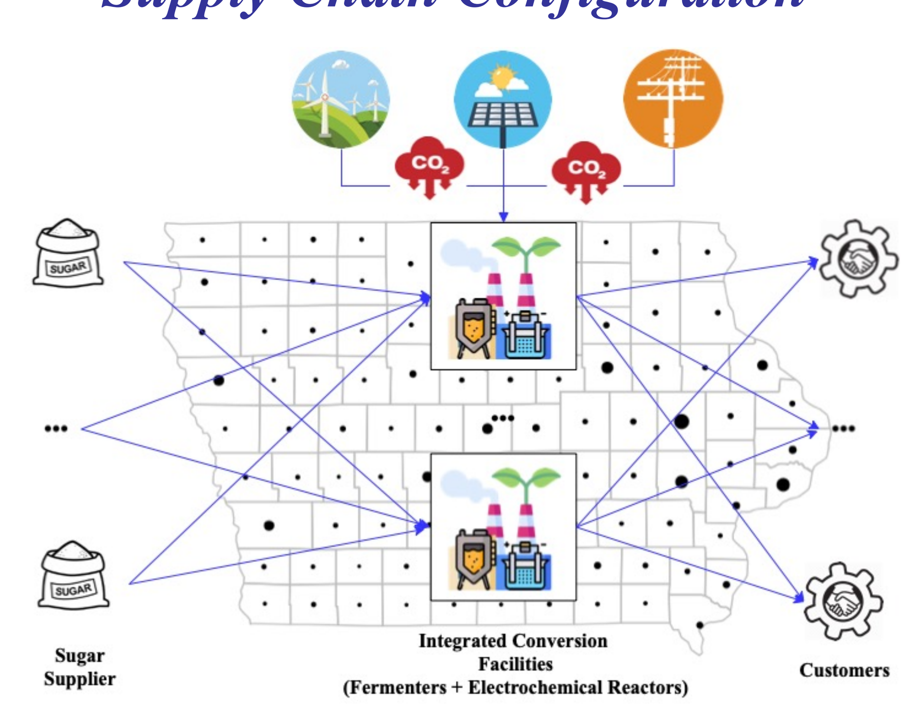
The present work investigates the electrohydrogenation of cis,cis-muconic acid (ccMA) to t3HDA in an electrochemical flow reactor and identifies parameters that are key to design a supply chain for the end-product.

Technoeconomic Analysis

Cost Breakdown for one facility ($M/Year)		
Fixed & other expenses	10.65	8%
Labor	8.30	6%
Raw	65.53	49%
Electricity	13.51	10%
Utility exp. Electricity	8.14	6%
Waste Water	26.99	20%
Total	133.12	

Early Stage TEA should be extended to include the cost analysis for different capacities.

Supply Chain Configuration



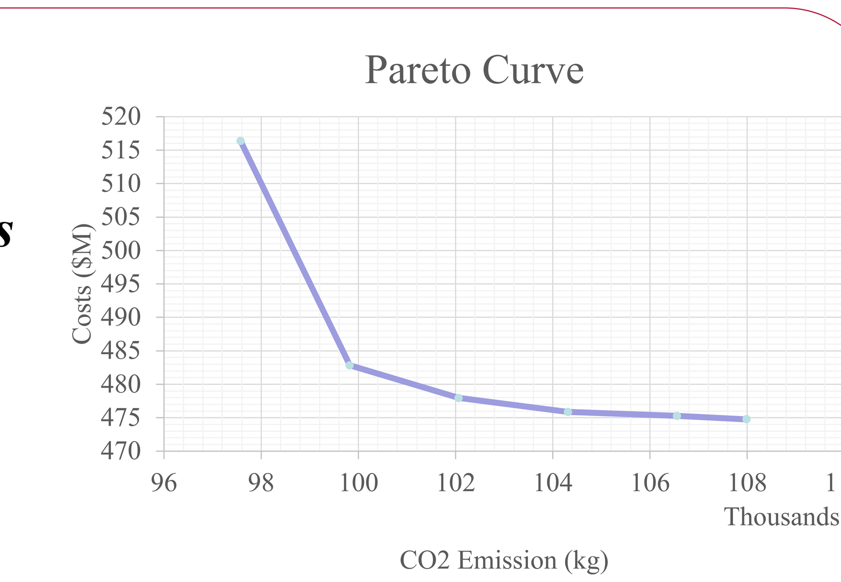
MATHEMATICAL MODEL

Decision Variables

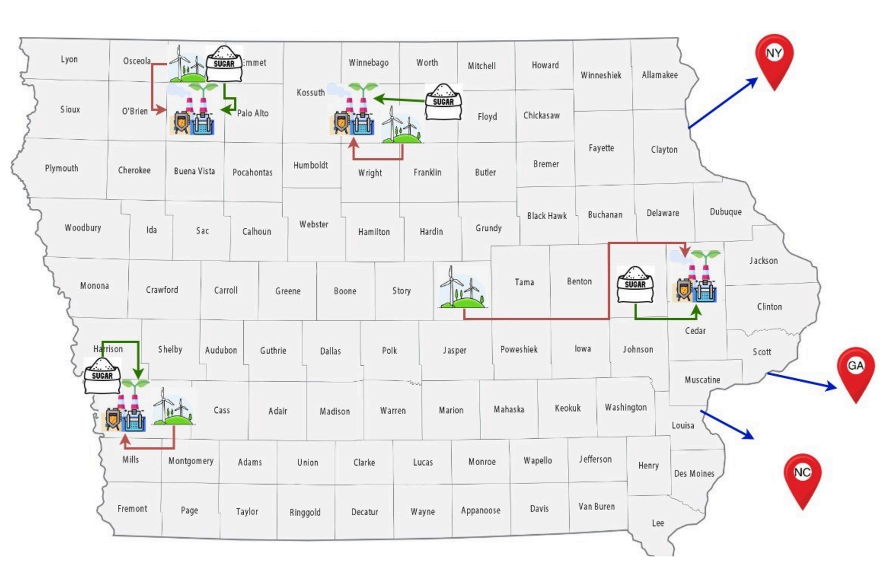
- Amt. of sugars consumed by candidate facility location j (kg\yr)
- Amt. of chemicals i transported from facility location j to demand location k (kg\yr)
- Whether a facility of capacity level l is selected at candidate facility location j (binary variable)
- Amount of wind energy from wind farm m (kWh)
- Amount of solar energy form solar plant n (kWh)
- Amount of energy from grid (kWh)

First Objective
Minimizing Total Annual Costs

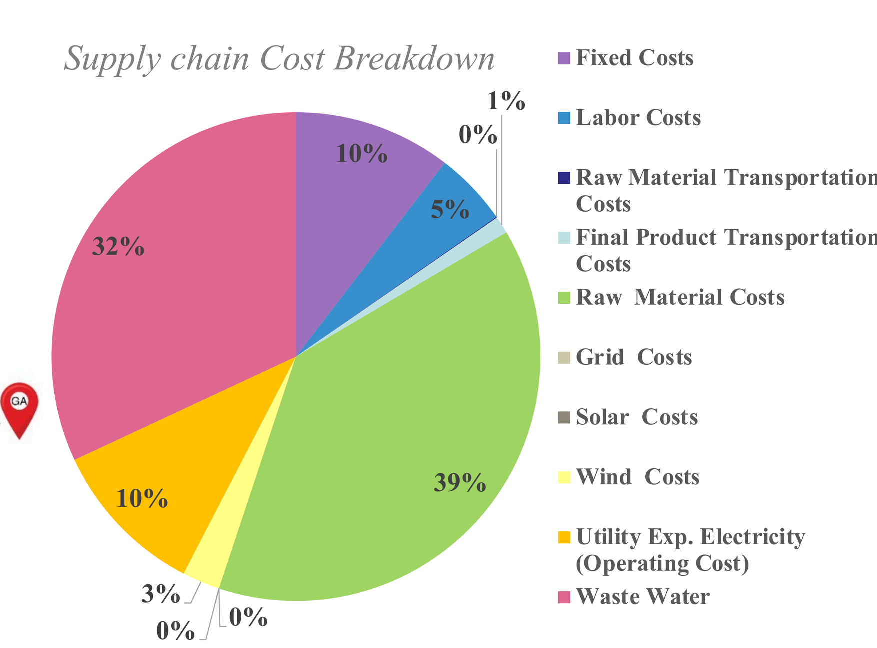
Second Objective
Minimizing CO^2 Emission



PRELIMINARY RESULTS



Optimal Supply chain Design



NEXT STEPS…?

In order to account for the major source of uncertainty, ***demand***, a two-stage stochastic MILP will be developed.

This material is based upon work supported by the National Science Foundation under Grants No. DGE-1828942 and EFMA-2132200