Chemical Engineering Senior Design Project Faculty Template:

Working Project Title: Compost Heat and CO_2 Capture and Use

Faculty Advisor: Kristina Wagstrom

External Sponsor? Yes _X__ No ___ (partner)

External Sponsor: Artza Mendi Farm, Baltic, CT as part of USDA's Small Farms Innovation Project

Sponsor Contact/Liaison: Murray Gates

Keywords: Sustainability, food, agriculture, environment

Technical Readiness Status: (Select One):

_____ Low: *A fairly new idea or highly experimental concept, with little prior art.*

__X__ Moderate: *Lab or pilot scale proof-of-concept; Full-scale design and optimization needed.*

_____ High: *Established product/process; looking for alternatives, improvements, or optimizations.*

Project Background:
Provide approximately one-two paragraphs here about the general nature of the project and how it integrates with chemical engineering.

Artza Mendi Farm was started by Murray Gates in 2023 on a former dairy farm located on 83 acres in the Town of Sprague. A veteran of the US Navy and having spent a career as a corporate project manager, Murray was drawn to agriculture through an interest in the environmental and social benefits of compost production. Of particular interest to him is the use of compost from food waste as an alternative feed for chickens. Murray has kicked off his farm with pasture raised laying hens and plans to add additional livestock as well as market garden in the coming year.

Composting uses micro-organisms to break-down organic materials rendering a valuable soil amendment. Two outputs from composting are heat and CO_2, resources which are normally lost in the composting process and emitted into the atmosphere. While there are large-scale commercial systems for heat, there are currently not approaches for capturing the CO_2.
This project aims to design an affordable system to capture both the heat and the CO_2 for use in a greenhouse to grow vegetables indoors and some of the heat for a chicken housing.

Statement of Need: Provide the scope of the project here that you anticipate the students will look at and the general expectations for deliverables that you as a project mentor will expect.

Students working on this project should expect to work collaboratively with the farm and a small team of civil engineering students in the development and design for the heat transfer and CO_2 recovery systems. The civil engineering students will primarily focus on the building design and site planning. Students will need to research existing methods and either adapt those methods to smaller scale use or develop a novel approaches. No matter which design approach is selected, the design will require adapting it to the specific site and farm in question.

This project will benefit not only Artza Mendi Farm, but also provide a roadmap for other farms to adopt similar approaches to reduce their heating needs and decrease the amount of CO_2 released to the air.

Design Requirements: Provide 3-6 relevant, specific, and measurable design requirements to constrain the "solution space" and to measure performance of the final product. (Note: Design Requirements should be crafted so that it is possible to quantify performance of the students' solution against extant alternatives. Design Requirements may come in advance directly from the sponsor, or may be generated collaboratively by the group, advisor, & sponsor during technical development.)

The following is a tentative list of the design requirements. The students will develop a finalized list as a team and in partnership with Artza Mendi Farm. The final design will:

1. Transfer heat produced by compost to a greenhouse, chicken housing, and potentially other indoor facilities.
2. Still maintain enough heat in the compost to effectively run the composting process.
3. Transfer CO2 released from the compost to a greenhouse to aid in plant growth.
4. Include final cost estimates for implementing the system at Artza Mendi Farm.

Dilapidated barn, has a foundation and cement walls. Can use this as floor and walls for operation of composting, housing of chickens in winter, growing vegetable. Indoor operation, chicken coop, greenhouse, composting
100 x 40 foundation

Skillsets/Interests that will be valuable for this project: Provide some information here on what skills you think would be particularly valuable for students considering this project to have. (Check all that apply):

CHEG Fundamentals:

_X_ Thermodynamics
__ Kinetics
_X_ Fluids

_X_ Heat Transfer
__ Mass Transfer
__ Process Control

CHEG Fields:

__ Bioengineering
__ Drug Delivery
__ Electrochemistry
__ Heterogeneous catalysis
__ Polymer processing
_X_ Other: __Sustainability, Agriculture, Environment____

CHEG Cross-Cutting:

__ Design of experiments
__ Process simulation
__ Risk assessment & uncertainty analysis
__ Constrained optimization
_X_ Other: _Site Design, Community Partnerships__

Primary Performance Measures to be Used (check all that apply):

__ Collection of Primary Data (Experiments)
_X_ Hand Calculations based on First Principles (Theory)
_X_ Computer Modeling
  __ Aspen (steady-state process simulation)
  _X_ COMSOL (finite element multi physics modeling)
  __ MATLAB
  __ Other: _SOLIDWORKS and 3D Printing__