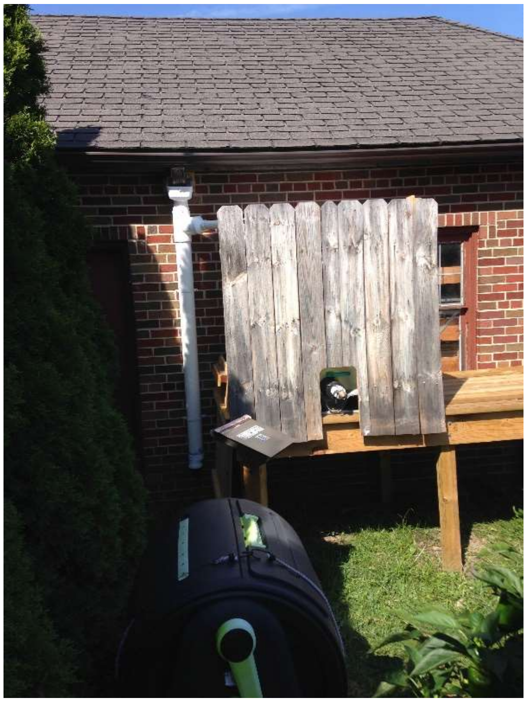
Open Hands Food Pantry Garden Irrigation System

The Open Hands Food Pantry (housed in St. John's Episcopal Church at the corner of Woodward Avenue and 11 Mile Road in Royal Oak, MI) is the largest in Oakland County and fed 14,000 people last year. The Open Hands Garden provides 300-400 lbs. of fresh produce to Open Hands Food Pantry clients each year. This project is to design, build and install an irrigation system in the Open Hands Garden.

Currently the garden’s rain water harvesting system collects up to 275 gallons from the roof into a food grade water tote elevated 3 feet above the ground. The collected water is filtered via screening and a first flush diverter. Space is available to add a second tote as an overflow reservoir. The goal is to add pumping capability to deliver water efficiently up to 100 feet away from the storage tank to irrigate the existing raised beds. The pumping system should have the capacity for a timed drip irrigation system that would extend into a possible future hoop house, and be able to provide either drip tape, buried soaker hose or sprinkler type irrigation.

The design should offer the option of using a solar powered or standard electrical powered pump and should allow for the use of the harvested rain water or municipal water if needed. The design of the timed (or sensed) irrigation system would need the flexibility to respond to varying planting patterns adjusted yearly to allow for crop rotation. Finally, the design should include features to allow for easy winterization.



Photovoltaic Integrated Greenhouse

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Phase 1: Design and construction

The purpose of the design project is to build an experimental greenhouse unit with integrated photovoltaic (PV) panel. The unit will serve as a test bed for evaluating the potential for combined power and food production on a given square meter of space, and for future development of net zero energy greenhouses.

Design requirements are as follows:

1. The greenhouse should extend the growing season as much as possible while operated under passive conditions. This means that in the absence of auxiliary heating or cooling (whether electric or other), the unit's indoor climate should be maintained within daily solar radiation and temperature range. The design must therefore make careful selection of materials for glazing, insulation, and thermal storage, as well as selection of greenhouse geometry. The design should carefully consider the following questions:
    a. What materials are most transparent to maximize solar radiation for photosynthesis?
    b. What materials are most insulating to minimize heat loss at night and during winter season?

    c. What materials are effective at storing excess heat, available for example on a hot day and which can then be radiated on a cool night?
    d. What mechanisms can be used to encourage natural ventilation on hot days?
2. The PV panel should be mounted on a stable and versatile platform. This structure should be capable of supporting PV panels with different dimensions, and capable of mounting the panels at different tilt angles from horizontal to vertical position. This mounting structure does not necessarily have to be integrated with the greenhouse structure. It can stand on its own as an independent structure. Dimensions and geometry should allow for PV panels to be installed both above the greenhouse, as well as inside the greenhouse.
3. An automated irrigation system should be integrated with the unit.
4. An automated ventilation system should be integrated with the unit.
5. All necessary sensors and instrumentation should be included to log voltage and current from PV panels, temperature and humidity inside and outside the greenhouse, temperature of greenhouse surfaces, and available solar radiation at the PV surface, at the plant surface, and at the outside ground surface.

Phase 2: Experimental investigation

The purpose of the experimental investigation is to identify the PV technology and mounting strategy that provides the highest combined yield of food and power. Experimental results will also be used to validate mathematical models for further investigation.

The methodology is as follows:

1. Baby-leaf salad mix will be planted and grown in the greenhouse units. Watering and ventilation will be automated but will nonetheless require regular attendance and monitoring. Plants will be harvested at 28 day intervals and both wet and dry weight will be measured. Several trials will be run in staggered sequence.
2. Electric energy from PV panels will be measured via voltage and current sensors, and compared to energy predicted from solar energy model.
3. Solar radiation available at the PV panel and available to the plants in the greenhouse will be measured via pyranometer and photosynthetic active radiation (PAR) meter. Data will be compared to predicted results from the solar geometry model.
4. Temperature of the greenhouse air and surfaces will be measured via thermocouples, and compared to results from thermal model.

Continued development of a water-wave electric generator system – Phase III

In the Fall 2016 and Winter 2017 semesters, three teams of students developed and refined a motor-driven test bed for the Oscillo Drive from Wave Water Works. The Oscillo Drive is a propriety mechanical transmission invented for capturing the oscillating mechanical energy from water waves and transforming it into a uni-directional rotation suitable to drive an electric generator. The test bed uses an electric motor and mechanical linkage to produce an oscillatory input to the Oscillo Drive, and the output generates electricity by spinning an automotive alternator. The ultimate goal of the project is to test the input, output and efficiency when capturing the mechanical energy of water waves and converting and storing that energy as electricity.

There are several characteristics of the Oscillo Drive that have presented significant challenges in the development of this test bed. The Oscillo Drive possesses considerable mechanical inertia that must be overcome twice per oscillation cycle. This inertia must be quantified so that it can be accounted for in the rest of the power generation system. In addition, the Oscillo Drive is inherently a low-speed, low-power device and should be paired with an efficient, cost-effective, low-speed, low-power electric generator for its most practical applications. The test bed currently uses an alternator to generate electrical power, which requires high speeds and considerable torque to drive.

The tasks required in the Summer 2017 semester are:

- Develop a plan to directly measure the mechanical inertia and friction of the 3 sizes of Oscillo Drives available in the SDL, perform and document these measurements
- Search for (obtain and install) a small (< ½ hp) low-speed, cost-effective electric generator that can be driven directly from the Oscillo Drive at speeds of 12-60 rpm.
- Search for (obtain and install) a low-speed, cost-effective test-bed drive system to directly deliver an oscillatory motion to the Oscillo Drive at of 12-30 rpm with the necessary torque to power the low-speed generator above, considering the mechanical inertia and friction of the Oscillo Drive
- Develop, construct and demonstrate a buoyant float system to capture motion of water waves (2-6 ft amplitude, 12-24 cycles per minute, 24-144 linear feet of upward wave motion per minute) and that can directly replace the test-bed drive system above
- Develop a realistic, detailed model of an Oscillo Drive power generation system
- Demonstrate the operation and function of the Oscillo Drive system through 200 hours of continuous test-bed operation and 200 continuous hours of float operation. The electric power generated and stored during these tests must be logged and analyzed.

Note: a force of 100 lb (445 N, buoyant force) moving upwards through 6 ft (1.83 m, wave height from trough to crest) at a rate of 24 times per minute (wave frequency) generates 0.44 hp or 326 W. Also note that this calculation assumes that power is delivered only on the upstroke of the buoyant float.

Students will have access to the materials from the two previous semesters of work on this project. Non-disclosure and non-compete agreements are required before students can commence work on this project.

Development and demonstration of a hybrid 3-wheeled scooter – Phase II

Berylline is a small company in the OU-INC business incubator, developing a 3-wheeled hybrid scooter to be used as secondary, short-range transportation. The Berylline hybrid system features a boost electric motor to improve both starting and hill-climbing performance while enhancing fuel economy.

In the Winter 2017 semester, two groups of students took on this challenge. One group tested a stock Ice Bear 150cc 3-wheeled scooter for acceleration performance and fuel economy on the Formula SAE dynamometer, converted it to EFI, then ran it through the identical dyno test to establish baseline performance metrics. In the process, they identified several issues with the Ice Bear scooter and its engine controller. The other group developed a comprehensive design for the hybrid drive and control system, including motor and battery packaging.

This Summer 2017 project consists of the following scope of work:

1. Review and refine (if necessary) the hybrid system developed in the Winter 2017 semester
2. Obtain, manufacture, assemble and adjust the components of the hybrid drive
3. Incorporate the hybrid drive onto the Ice Bear scooter
4. Using the fixture developed for the Formula SAE dynamometer, perform dyno test 3:
    a. Vehicle/driver weight
    b. Acceleration: 0-30MPH
    c. Acceleration: 20-40MPH
    d. Fuel Economy: Decide a specific driving loop, measure fuel consumption

Non-disclosure and non-compete agreements are required before students can commence work on this project.

Rotary Valve Cylinder Head – Phase II

A local inventor holds the patent on a valve system for internal combustion engines that has the potential to greatly enhance the performance of an engine while drastically reducing the parts count, improving reliability and decreasing noise and vibration. He would like us to apply this concept to ta specific engine, and provide independent testing of the system and suggestions for improvement.

The Winter 2017 project consisted of the following scope of work:

1. Map 2 new 13 HP Honda/clone Predator engines - valve timing events, intake and exhaust lift, duration, lobe separation angle, centerlines, relative to crankshaft angle. Sponsor has developed a fixture to assist with this mapping
2. Remove cylinder head from second engine and flow test both intake and exhaust ports at various valve positions using the Formula SAE flow bench
3. Design various rotary valve port runner shapes to match poppet valve flow at various positions up to the maximum lift recorded from base engine.
4. Spec ceramic material and mating surface material, finish, and/or surface coating that performs best without lubrication. (i.e. Saint Gobain Hexaloy)
5. Design and fabricate mock-up rotary valve and housing to spin test assembly and validate ceramic rotor shell to housing wear

Phase II (Summer 2017) of this project will consist of

1. Design and machine complete rotary valve cylinder head and assemble onto second test engine with appropriate timing belt/chain drive
2. Dyno test base (stock) engine and record results, measure and record torque, HP, BSFC, BMEP, ignition timing, emission output
3. Dyno test rotary valve engine, measure and record torque, HP, BSFC, BMEP, ignition timing requirements (may have to machine offset keyways and/or an adjustable timing bracket to allow for more timing advance), emission output

Non-disclosure and non-compete agreements are required before students can commence work on this project.