Department of Mechanical and Materials Engineering

SENIOR DESIGN ORGANIZATION SYNOPSIS – SPRING 2014

R.I.S.E: Renewable and Integrated Systems of Energy

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This project presents a technical model for the creation of a sustainable community, particularly for developing nations. The aim of this project is an initiative to join engineering technology with communities to impulse and assure the basic human rights of energy, water and sanitation to developing nations as part of the United Nations Millennium Development Goals for 2015.

The sustainable community model involves discrete but integrated subsystems including solar and hydro energy, water and sanitation treatment and a recycling system. A model of a ten home community was used in the determination of an economic analysis for the application of the different components presented in this thesis.

Solar data was collected using two 210 W PV panels to assess the efficiencies in the conversion and distribution of this renewable energy source under varying daily weather patterns in South Florida. A hydro energy system was developed to supplement solar energy in order to meet a community's electricity needs. The hydro system can simulate different elevations by the direct relationship of pressure and head. Another aspect analyzed was the possibility of producing a Pelton-type water wheel primarily made from recycled plastic.

Bio-sand filters were assessed as a viable water filtration system. The mechanical, physical and biological properties of bio-sand filters were studied as a function of the hydraulic loading rate and type of media selected for filtration. Wastewater from a household was evaluated in two ways: grey water and black water. The methodology of construction and sizing of constructed

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wetlands, or bio-filters, was researched as an alternative to treat and reclaim grey-water. An experimental set up for an aerobic digester was made to investigate the co-digestion capabilities of multiple organic substrates within a digester. The anaerobic digester produces methane-rich biogas that can be used for cooking, heating and electricity, as well as a nutrient rich fertilizer for crop lands or other applications.

The increasing plastic pollution problem across the world was addressed by designing and constructing an innovative plastic recycling mechanism. The recycler intakes various thermoplastics and transforms them into recycled plastic filament that can be used in a 3D printer, or into plastic pellets to be used in the manufacturing of recycled plastic goods.

The results of our study indicate that a model ten home community located in a tropical region can generate up to 88% of its electricity needs from ten 420 Watt PV arrays. The average daily energy output obtained from the PV array was 1.2 kW-hr. The remaining electricity needs can be fulfilled from harnessing energy from flowing water or from an integrated rain catching system. A ten m^3 anaerobic digester was designed to account for the cooking needs of the ten households. Based on our design criteria 8 m^3 of biogas can be obtained from manure and the remaining 2 m^3 from the addition of house hold kitchen wastes and agricultural wastes. The calculated C/N ratio was 29 which closely resembles the optimum figure of 30 given by many literature sources. The recycler was constructed and successfully extruded recycled PLA plastic. Further development will lead to the production of a consistent diameter filament that will be used to create a test sample to analyze the mechanical properties of this recycled plastic.